2011 ANNUAL REPORT

GROUNDWATER/SURFACE WATER REMEDY

Simplot Operable Unit

Eastern Michaud Flats Superfund Site

Pocatello, Idaho

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Acronyms and Abbreviations

AFLB	American Falls Lake Bed
ARAR	Applicable of Relevant and Appropriate Requirements
AWQC	Ambient water quality criteria
BRS	Batiste Road Spring
BTS	Batiste Spring
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfs	cubic feet per second
COC	Contaminant of Concern
CSM	Conceptual Site Model for groundwater
DO	Dissolved Oxygen
EMF Site	Eastern Michaud Flats Superfund Site
EPA	Environmental Protection Agency
ft	feet
ft/day	feet per day
gpm	gallons per minute
GWPS	Groundwater Protection Standard
IDEQ	Idaho Department of Environmental Quality
IDWR	Idaho Department of Water Resources
IRODA	Interim Record of Decision Amendment
HDPE	high density polyethylene
i	hydraulic gradient
k	Hydraulic conductivity
kg/day	kilograms per day
lb/day	pounds per day
MCL	Maximum Contaminant Level
mg/L	milligrams per liter
n_e	effective porosity
NTU	Nephelometric Turbidity Units
OU	Operable Unit
PAP	Phosphoric Acid Plant
pH	hydrogen ion activity
POC	Point of Compliance
POTW	Pocatello Waste Water Treatment Plant
RBC	Risk-Based Concentration
RCRA	Resource Conservation and Recovery Act
ROD	Record of Decision
RODA	Record of Decision Amendment
RDR	Remedial Design Report
SOW	Remedial Design/Remedial Action Consent Decree Statement of Work
t	t-Test Value

Acronyms and Abbreviations (cont.)

t_{cp}	t-Test Value Critical point
TDS	total dissolved solids
TMDL	Total Maximum Daily Load
TSS	Total suspended solids
UCL	Upper Confidence Limit
VCO/CA	Voluntary Consent Order/Compliance Agreement
VFD	variable frequency drive

EXECUTIVE SUMMARY

This report presents the 2011 annual summary of operational information, monitoring results and evaluations of performance of the groundwater/surface water remedy for the Simplot Operable Unit (OU) of the Eastern Michaud Flats (EMF) Superfund Site (the Site) located near Pocatello, Idaho.

The groundwater/surface water remedy has been designed to meet the requirements of a Record of Decision issued by the Environmental Protection Agency (EPA) in 1998 and an Interim Record of Decision Amendment (IRODA) for the Simplot Operable Unit issued by EPA in February 2010. The remedy and monitoring also meets the requirements of a Voluntary Consent Order/Compliance Agreement (VCO/CA) between the Idaho Department of Environmental Quality (IDEQ) and the J.R. Simplot Company intended to fulfill Simplot's obligations for the Portneuf River Total Maximum Daily Load (TMDL). The two projects are intertwined because groundwater affected by Simplot sources discharges to the Portneuf River, resulting in phosphorus concentrations above TMDL targets.

The groundwater and surface water remedy consists of three elements: 1) lining of the existing gypsum stack to allow for continued placement of gypsum on top of the liner, 2) source controls in the Phosphoric Acid Plant Area (PAP Area), and 3) groundwater extraction and reuse within the facility process. This report has been prepared in accordance with the Groundwater and Surface Water Monitoring Plan (Formation 2010d), and is intended to fulfill the reporting requirements for both the Superfund and VCO/CA projects.

A summary of the progress of remedy implementation in 2011 and the remedy performance is provided in the following paragraphs.

Remedial Implementation/Status

<u>Gypsum Stack Source Control</u>

Source control for the gypsum stack will be achieved by lining the entire stack with a high density polyethylene liner in multiple phases of work. Phase I consisted of Decant Pond construction and lining of the lower stack. The Decant Pond is necessary for water management during the operation of a lined stack. The Decant Pond construction was completed in October 2009, and the lined-lower stack was brought into operation in July 2011. The second and third phases of work include lining the upper west stack and the upper east stack, respectively. The the upper west stack will be split into two sub-compartments to allow each to be completed within one construction season. The design of the upper west stack has been submitted to the Agencies and construction is planned to begin in 2012.

PAP Area Source Control

Source control in the PAP Area in 2011 consisted of the upgrades to the Dilution Tank, upgrades to the SF Unloading Area, and on-going tank, pad and sump inspections. Numerous smaller projects and operational changes were also implemented to reduce the potential for releases from the PAP Area.

Groundwater Extraction System

The groundwater extraction system consists of a network of Upper and Lower Zone wells near the northern and northwestern edge of the gypsum stack and downgradient of the PAP Area. The wells have been located to intercept groundwater affected by gypsum stack seepage and sources in the PAP Area. The extraction system is designed to extract affected groundwater downgradient of these areas in the Simplot OU prior to mixing with impacted groundwater from the adjacent FMC facility area and then with regional groundwater inflow prior to discharging to the Portneuf River. Fifteen extraction wells were operating at the beginning of the fourth quarter. Two new extraction wells installed as part of the Phase 3 implementation, wells 421 and 422, were brought on line in September, 2011. Extraction well 410 was taken off line in August, 2011 (well 422 is a replacement for well 410). The extraction system was shut down for routine annual maintenance (plant turnaround) beginning on June 1st through June 11th. All extraction wells except wells 410, 421 and 422 were in operation at or above 90 percent of the time, and approximately 425 million gallons of groundwater were extracted during 2011.

Groundwater Data Evaluation

The groundwater data evaluation addresses the hypothesis tests and decision rules for the five monitoring program areas discussed in the following sections.

Tracking Groundwater Quality in the Don Plant Area

The extent of indicator analytes arsenic, phosphorus, and sulfate, in the Don Plant Area at the end of 2011 was similar to that at the end of 2010. Phosphorus concentrations in some wells in the East Plant Area have been increasing since the initiation of monitoring in 2004. Analyses suggest that the source of the increasing phosphorus concentrations is related to the long-term operation of the gypsum stack, and is not related to the construction or operation of the Decant Pond or the lining of the Lower Stack. A decrease in groundwater concentrations is expected once the lining of the entire gypsum stack is complete.

Demonstrating Source Control in the PAP Area

The elevated concentration of phosphorus in groundwater in this area has been monitored since the completion of the PAP Area Subsurface Investigation in 2009 (Simplot 2009b). Source control actions in the PAP Area have also been ongoing since 2009 and have achieved significant reductions in measured phosphorus concentrations in groundwater. Additional source control projects are proposed annually, the projects that were planned for 2011 were outlined in the Phosphorus Source Control Program (Simplot 2011a). The zone of elevated phosphorus concentrations in groundwater in the PAP Area is controlled by groundwater extraction at wells 414, 416, and 419. Groundwater extraction is both reducing the phosphorus concentrations in groundwater and limiting the potential for downgradient migration of affected groundwater.

Demonstrating Hydraulic Control in the Target Capture Zones

Demonstrating hydraulic control in the target capture zones is performed according to EPA's *Systematic Approach for Evaluation of Capture Zones at Pump and Treat Systems* (EPA 2008). When the extraction system is operating as intended, affected groundwater should be captured by the extraction wells to the extent necessary to meet remedial objectives.

The estimated total rate of mass removal by the groundwater extraction system in 2011 was:

- 2.1 lbs arsenic/day
- 2,200 lbs total phosphorus/day
- 18,400 lbs sulfate/day

Based on the mass flux rate at the Target Capture Zones, the estimated average concentrations in groundwater discharging to the Portneuf River at the springs based on the model developed to support the remedial design are:

- 0.011 mg/L arsenic
- 6.1 mg/L phosphorus
- 109 mg/L sulfate

While the extraction system does not capture all affected groundwater, the capture zone analysis for 2011 indicates that additional groundwater extraction is not necessary to meet the goal of reducing arsenic below MCLs in groundwater discharging to the Portneuf River. Source

control actions (gypsum stack lining) will reduce the required extraction rate once they become effective.

Evaluating Reduction in Extent and Concentration of COCs in the Assessment Area

The extent of arsenic, phosphorus, and sulfate in the Assessment Area at the end of 2011 was similar to that at the end of 2010, including data from the wells installed in fall of 2010. Decreasing trends of indicator analytes were observed in most wells in the Assessment Area in 2011. A few exceptions to this general trend are noted: arsenic and sulfate concentrations increased in wells 532B and 535A (although phosphorus in well 532B decreased significantly). Phosphorus in well 527 (located along Highway 30) also increased. These trends may be the result of small shifts in the groundwater plume due to current conditions. Monitoring will continue to assess these effects.

Groundwater monitoring was performed in four quarterly events in 2011. Samples were analyzed for field parameters, general chemistry parameters, and selected metals and nutrients. Analyses were performed in accordance with referenced EPA methods. Data validation was performed and a checklist of the validation process was prepared to document the review process and results.

Evaluate Source Control System Prevention in the Migration into the Off-Plant OU at Concentrations above the MCL or RBC

Exceedances of the MCL for arsenic were observed in the Compliance Area at wells 537A, 538A, 539B and at Batiste Spring. Total phosphorus concentrations above background were also observed in the Compliance Area monitoring locations; however, a risk-based concentration has not yet been established for groundwater. Due to the groundwater travel time to these locations, the observed concentrations do not reflect the full influence of groundwater extraction.

Surface Water Data Evaluation

Surface water samples were collected on a monthly basis during 2011 and analyzed for a range of constituents, including phosphorus. Assessment of surface water monitoring data for 2011 identified the following key conclusions:

- The river is not affected by EMF groundwater at Batiste Road and this location can be used as a background monitoring location.
- Phosphorus concentrations at Siphon Road have decreased significantly starting in 2007. The 12-month median phosphorus concentration at the end of 2011 was to 0.41 mg/L. This is below the December 31st, 2013 VCO/CA target.

- The reduced phosphorus concentration at Siphon Road is primarily due to reduced input to the Portneuf River from EMF groundwater. The estimated average phosphorus load from EMF groundwater at Siphon Road was 736 lb/day in 2011. This represents a 75% reduction from the 2007 average of 2,930 lb/day.

- Although flow at Siphon Road in 2011 was higher than in most years since 2003, a continued significant decline in phosphorus load from EMF groundwater is primarily responsible for reduced concentrations in phosphorus at Siphon Road.

- Average daily minimum summer dissolved oxygen levels were 6.64 mg/L and 7.16 mg/L at Siphon Road and Batiste Road, respectively. The number of days that the dissolved oxygen dipped below 6.0 mg/L at Siphon Road fell from 82 days in 2010 to 7 days in 2011.

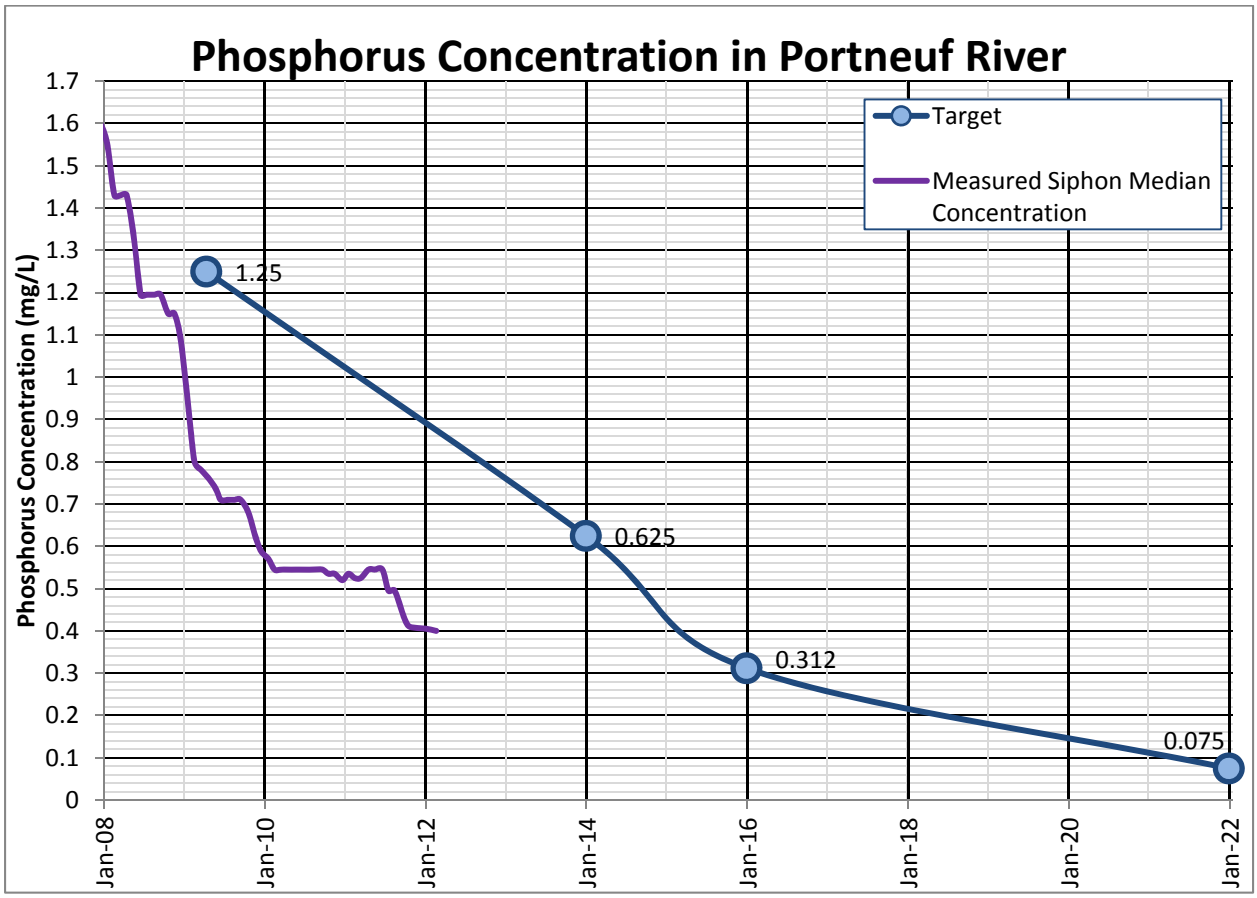
Remedy Performance

The performance of the remedy was evaluated for 2011. This analysis indicated the following:

- The phosphorus load to groundwater attributable to the PAP Area was steady at 115 lb/day in 2011. This is down from an average of 175 lb/day in 2010. Groundwater affected by the PAP is captured by the extraction system.

- Overall, the extraction system removed approximately 54% of the estimated phosphorus load (total, including from the gypsum stack and PAP Area), 58% of the estimated sulfate load and 60% of the estimated arsenic load in 2011. The total mass removed for 2011 was approximately 800,000 pounds of phosphorus, up from 780,000 pounds in 2010 and 700,000 pounds in 2009.

The phosphorus concentrations measured in the Portneuf River at Siphon Road have decreased considerably since 2007. This is primarily due to reduction of the phosphorus load from EMF groundwater; from 2,920 pounds per day on average estimated in 2007 to 736 pounds per day in 2011. The VCO/CA sets phosphorus concentration targets in the Portneuf River at Siphon Road. These are shown on the figure below. The purple line shows the rolling 12 month median phosphorus concentrations at Siphon Road. Concentrations have decreased quickly, indicating that remedial actions are being more effective and/or resulting in a more rapid effect than predicted by modeling.



Remedy Components Planned for 2012

Consistent with the Superfund and VCO/CA requirements, Simplot will continue remedy implementation in 2012. Planned activities include:

- No significant modifications to the groundwater extraction system or groundwater monitoring system are planned. The plans to take Well 409 offline due to insufficient flow are described in the fourth quarter 2011 monitoring report (Formation 2012b).
- Complete lining of the northern sub-compartment in the Upper West Stack.
- Begin preparation of the northern sub-compartment of the Upper East Stack for lining.

- Major improvement projects are planned in the PAP Area at the #4 Sump and Pad (replacement), SPA Aging Tank Floor (upgrade) and the SPA Aging Tank Pad (upgrade).

- Additional source control in the PAP Area will be achieved through inspection and maintenance which is explained in the 2012 letter to EPA and IDEQ, 2012 Proposed Project Scope and Schedule (Simplot 2012a), sent January 30, 2012.

The effect of the remedy will continue to be assessed through quarterly monitoring of groundwater and monthly monitoring in the Portneuf River.

1.0 INTRODUCTION

This report provides a description of the groundwater/surface water remedy implementation and performance in 2011 at the Simplot Operable Unit (OU) of the Eastern Michaud Flats (EMF) Superfund Site near Pocatello Idaho.

The Simplot OU includes the operating Simplot Don Plant facility, which produces a variety of solid and liquid phosphorus- and nitrogen-based fertilizers. The principal raw material for the process is phosphate ore, which is conveyed to the facility via a slurry pipeline from the Smoky Canyon Mine, near Afton, Wyoming. The primary byproduct from the Don Plant process is gypsum (calcium sulfate), which is stacked on site (the gypsum stack).

The EMF Site has been divided into three areas in the Record of Decision (ROD; EPA 1998):

- The **FMC OU** includes the FMC Elemental Phosphorus Facility (which ceased operations in December 2001) and contiguous land owned by FMC;
- The **Simplot OU** includes the J.R. Simplot Don Plant, and contiguous land owned by Simplot; and
- The **Off-Plant OU** surrounds the FMC and Simplot OUs.

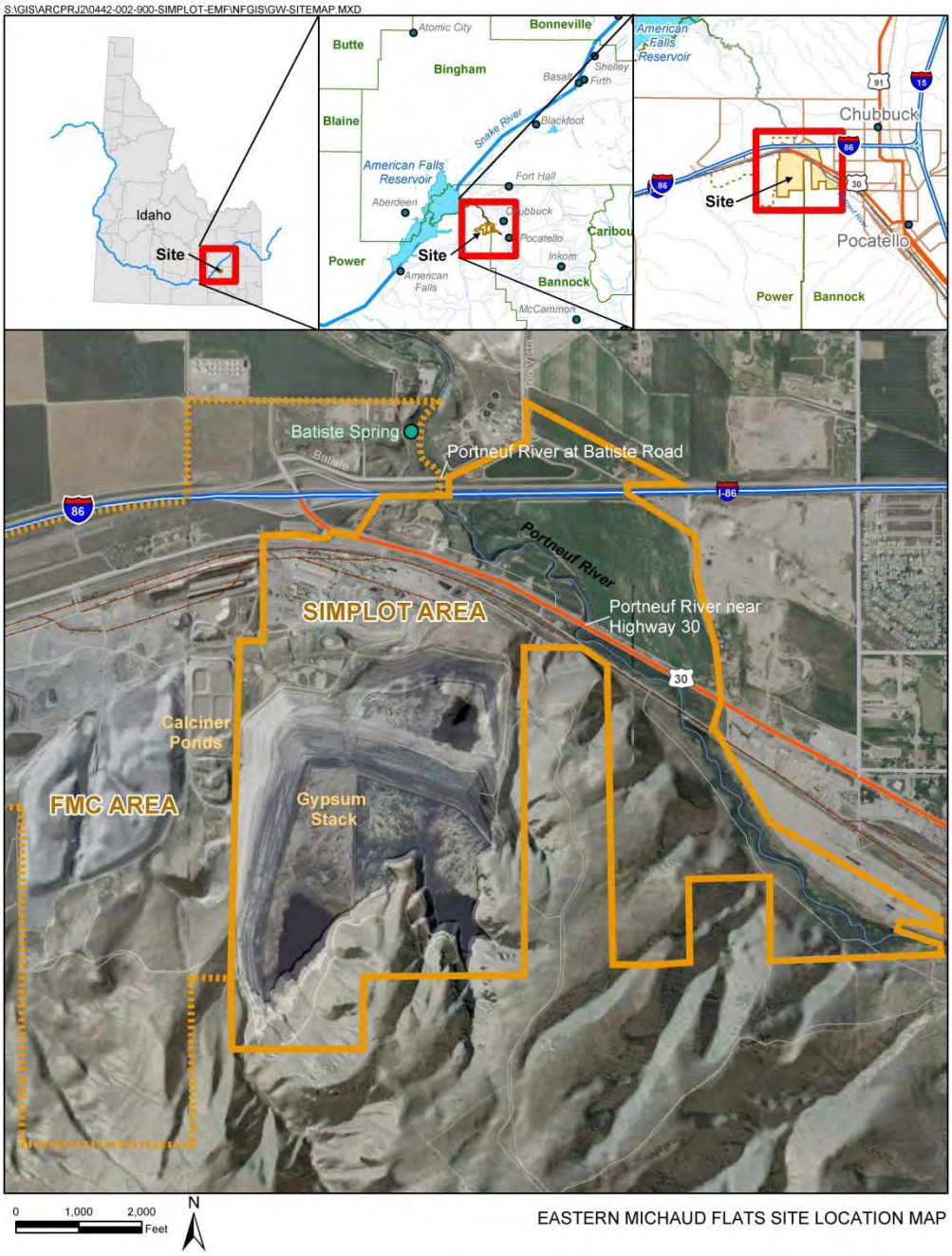


Figure 1-1: Site Location Map.

A groundwater/surface water remedial action is being implemented. The remedy described in the Consent Decree (CD; EPA 2002), the Record of Decision (ROD; EPA, 1998), the Interim Record of Decision Amendment (IRODA; EPA 2010a), and the First Amended Consent Decree (EPA, 2010b). In addition, groundwater remedial actions and requirements for groundwater and surface water monitoring are specified in the Voluntary Consent Order/Compliance Agreement (VCO/CA) between the Idaho Department of Environmental Quality (IDEQ) and the J.R. Simplot Company intended to fulfill Simplot's obligations for the Portneuf River Total Maximum Daily

Load (TMDL). As set forth in the IRODA and First Amended CD, the remedial action for the Simplot OU addresses phosphorus as a Contaminant of Concern (COC) and provides appropriate modifications to the overall remedy. The VCO/CA provides target phosphorus concentrations for the Portneuf River based on the TMDL process. The remedy consists of the following the same basic elements:

- Installation of a high density polyethylene (HDPE) liner on top of the existing gypsum stack with continued placement of gypsum on the liner;
- Control of sources of phosphorus in the PAP Area;
- Extraction of groundwater downgradient of the gypsum stack and PAP Area; and
- Groundwater and surface water monitoring to assess the performance of the remedial actions.

This report provides a description of remedy implementation in 2011 and groundwater and surface water data to assess the remedy performance. It also provides a brief description of remedy activities planned for 2012. The report is structured as follows:

- Section 2 Background – Provides an overview of the remedy and monitoring plan, and their respective objectives.
- Section 3 Remedy Implementation Status – Provides a description of the gypsum stack lining, source controls in the PAP area, and details of the extraction system well operation, maintenance, and performance.
- Section 4 Groundwater Monitoring – Provides a review of groundwater monitoring activities and presents a summary of groundwater monitoring results.
- Section 5 Groundwater Data Evaluation – Presents analyses of groundwater data as prescribed in the Groundwater and Surface Water Monitoring Plan (Formation 2010a).
- Section 6 Surface Water Monitoring – Provides the results and analyses of surface water monitoring activities.
- Section 7 Remedy Performance – Provides a summary of the performance of the remedy actions completed.
- Section 8 Remedy Components Planned for 2012 – This section reviews the planned remedy actions for the upcoming year.
- Section 9 Summary and Conclusions.

2.0 BACKGROUND

The groundwater extraction and monitoring system elements of the groundwater remedy are described in the Consent Decree (CD; EPA 2002), the Record of Decision (ROD; EPA, 1998), the Interim Record of Decision Amendment (IRODA; EPA 2010a), and the First Amended Consent Decree (EPA, 2010b). In addition, groundwater remedial actions and requirements for groundwater and surface water monitoring are specified in the Voluntary Consent Order/Compliance Agreement (VCO/CA) between the Idaho Department of Environmental Quality (IDEQ) and the J.R. Simplot Company intended to fulfill Simplot's obligations for the Portneuf River Total Maximum Daily Load (TMDL). As set forth in the IRODA and First Amended CD, the remedial action for the Simplot OU addresses phosphorus as a COC and provides appropriate modifications to the overall remedy. The VCO/CA provides target phosphorus concentrations for the Portneuf River based on the TMDL process. The following sections summarize remedial design criteria pertinent to the groundwater extraction and groundwater monitoring systems.

2.1 Groundwater/Surface Water Remedy Objectives and Description

The major components of the Simplot OU groundwater remedy are:

- The groundwater extraction system consists of a network of shallow and deep groundwater wells on the northern edge of the gypsum stack and/or the Phosphoric Acid Plant.
- The extracted groundwater is recycled into the Don Plant process water system.
- Development and implementation of a plan to control primary and secondary sources of phosphorus within PAP Area.
- Installation of a synthetic liner on the receiving surface of the gypsum stack to reduce water from infiltrating through the stack into groundwater.
- The groundwater extraction system will continue to be developed, operated, maintained and augmented to the extent necessary, if any, to keep arsenic and phosphorus levels at or below MCLs or RBCs shown in Table 2-1.
- Groundwater monitoring and evaluation shall be conducted as part of the cleanup remedy to determine the effectiveness of the extraction system and other source control measures in reducing the COCs within the Simplot OU to levels that achieve MCLs and RBCs.

- Development of a protective numerical cleanup level for phosphorus in groundwater consistent with achieving the TMDL for surface water in the Portneuf River (currently 0.07 mg/L (low flow) and 0.125 mg/L (high flow)).
- Identification of monitoring points in, and in the vicinity of, the Portneuf River.
- Implementation of legally enforceable land use controls that will run with the land (e.g., deed restrictions, limited access, well restrictions and/or well head protection) to prevent ingestion of groundwater with COCs above MCLs or RBCs.

2.1.1 Groundwater Extraction

The ROD specifies that the groundwater extraction system will consist of a network of shallow and deep groundwater wells on the northern edge of the gypsum stack and/or the PAP. The extracted groundwater is recycled into the Don Plant process water system.

EPA recognizes that operation of the extraction system may not necessarily result in achievement of the MCLs or RBCs throughout the plant area and has not identified this as a performance criterion until closure of the gypsum stack. After closure of the gypsum stack, operation and maintenance of this system will continue until COCs in groundwater throughout the Simplot OU are reduced to below MCLs or RBCs, or until EPA determines that continued groundwater extraction would not be expected to result in additional practicable reduction in COC concentrations within the Simplot OU. Institutional controls will remain in place to control groundwater use until MCLs or RBCs are achieved in the Simplot OU.

2.1.2 Groundwater and Surface Water Monitoring

Groundwater and surface water monitoring includes sampling and analysis of groundwater from selected wells, surface water from springs and the Portneuf River and the evaluation and reporting of the monitoring data.

2.2 Remedial Action Objectives and Performance Standards

The overall objective of the groundwater remedial actions for the Simplot OU is to provide an effective mechanism for protecting human health and the environment. To address the potential risks, the following groundwater cleanup objectives were developed and presented in the ROD and IRODA:

- Reduce the release and migration of COCs to groundwater from facility sources that may result in concentrations in groundwater exceeding RBCs or chemical specific Applicable or Relevant and Appropriate Requirements (ARARs), specifically MCLs.

- Reduce the release and migration of COCs to surface water from facility sources that result in concentrations in groundwater exceeding RBCs or chemical specific ARARs, including ambient water quality criteria pursuant to the Clean Water Act.

- Achieve source control for the existing gypsum stack and PAP Area within the shortest practicable timeframe.

- Prevent potential ingestion of groundwater containing COCs having concentrations exceeding RBCs or MCLs (chemical specific ARARs) (see Table 36 of the ROD). The RBCs shown in the ROD, Table 36, correspond to a cancer risk of 10^{-6} or a Hazard Index of 1.0.

- Restore groundwater that has been impacted by EMF Site sources to meet all RBCs or MCLs for the COCs

- Define groundwater and surface water human health and ecological RBC targets for phosphorus consistent with the TMDL for surface water in the Portneuf River.

The MCLs and RBCs are shown in Table 2-1.

The VCO/CA specifies the remedy goal of meeting the following concentration-based requirements in the Portneuf River as measured at Siphon Road:

- Achieve a 50 percent reduction (0.625 mg/L) in the concentration of total phosphorus in the Portneuf River as measured by the annual median of monthly samples collected at Siphon Road by December 31, 2013.

- Achieve a 75 percent reduction (0.938 mg/L) in the concentration of total phosphorus in the Portneuf River as measured by the annual median of monthly samples collected at Siphon Road by December 31, 2015.

- Achieve a 94 percent reduction (1.175 mg/L) in the concentration of total phosphorus in the Portneuf River as measured by the annual median of monthly samples collected at Siphon Road by December 31, 2021. This level equates to the water quality target of 0.075 mg/L established for total phosphorus for this segment of river as set forth in the approved TMDL.

The baseline condition determined by IDEQ is 1.250 mg/L as the annual median of monthly samples, based on data collected from 2004 to 2007.

Table 2-1: Risk-based and Maximum Contaminant Level for Groundwater COCs.

Contaminant of Concern [1]	Units	Maximum Contaminant Level (MCL)	Risk-Based Concentration (RBC) [1]
Antimony	mg/L	0.006	0.006
Arsenic [2]	mg/L	0.010	0.000048
Beryllium	mg/L	0.004	0.000019
Boron	mg/L	NA	1.36
Cadmium	mg/L	0.005	0.008
Chromium	mg/L	0.1	0.077
Fluoride	mg/L	4.0	0.93
Manganese	mg/L	NA	0.077
Mercury	mg/L	0.002	0.0046
Nickel	mg/L	NA [3]	0.299
Nitrate	mg/L	10	25.03
Phosphorus	mg/L	NA	NA [4]
Selenium	mg/L	0.05	0.39
Thallium	mg/L	0.002	0.07
Vanadium	mg/L	NA	0.001
Zinc	mg/L	NA	0.108
Tetrachloroethene	mg/L	0.005	3.92
Trichloroethene	mg/L	0.005	0.001
Radium 226 [5]	pCi/L	5	0.002
Gross Alpha	pCi/L	15	NA
Gross Beta	millirems/yr	4	NA

[1] From ROD Table 36
[2] The MCL for Arsenic was revised to be 0.010 mg/L in 2006.[3] The MCL and MCLG for nickel were remanded on February 9, 1995
[4] The RBC for phosphorus will be determined as described in Section III.7.d of the SOW.
[5] Combined for Radium 226 and Radium 228

2.2.1 Objective of Groundwater Remedy

The objective of the groundwater remedy is to prevent the migration of arsenic, phosphorus, and other COCs at concentrations above MCLs or groundwater RBCs into the Off-Plant OU, and to achieve source control for the existing gypsum stack and PAP Area. Where there is an MCL, the MCL shall control. The extraction system, in combination with the institutional controls program, source controls and the groundwater and surface water monitoring program, will address this remedial action objective and the overarching objective of protecting human health and the environment.

Performance standards for the groundwater extraction system are as follows:

- Demonstrate hydraulic control for groundwater influenced by gypsum stack seepage. Preliminary work indicates the cumulative annual average pumping rate necessary to achieve hydraulic control during operation of the gypsum stack is 750 gpm. The annual

average pumping rate will be established through system design, including the schedule for implementation and achievement of the required pumping rate. At a minimum, the implementation schedule will allow for a system startup period of one year.

- Once the annual average pumping rate has been achieved, the performance standard will be the MCLs or groundwater RBCs for arsenic, phosphorus and other COCs, as measured at appropriate Off-Plant Area locations as determined by EPA. Where there is an MCL, the MCL shall control.

While not specifically stated in the IRODA or CD, the performance of the groundwater extraction system in the PAP Area is implied in these documents. These performance standards for the groundwater extraction system down gradient of the PAP Area are as follows:

- Demonstrate hydraulic control for groundwater influenced by seepage of impacted groundwater from the PAP Area.
- Demonstrate source control by showing equivalent concentrations in groundwater down gradient of PAP Area as up gradient.
- The performance standard will be the MCLs or groundwater RBCs for arsenic, phosphorus and other COCs, as measured at appropriate Off-Plant locations. Where there is an MCL, the MCL shall control.

2.2.2 Groundwater Monitoring

The objective of groundwater monitoring is to collect sufficient data of adequate quality to evaluate the performance of the extraction system and other source control measures in reducing the extent and concentration of arsenic, phosphorus, and other COCs in groundwater in the Simplot OU and in preventing migration of arsenic, phosphorus and other COCs into the Off-Plant OU at concentrations above MCLs or groundwater RBCs (where there is an MCL, the MCL shall control). Specifically, components of the monitoring program will provide data to document the effectiveness of the extraction system in capturing seepage from the gypsum stack, to track water quality in areas potentially affected by sources other than gypsum stack seepage, and to confirm the attainment of performance standards and the long-term effectiveness of the remedy.

Performance standards for groundwater monitoring are as follows:

- Groundwater samples will be collected from wells on a quarterly basis for a period of five years and the samples analyzed for arsenic, phosphorus and other site related constituents. The specific wells to be monitored, the analytes, and the data evaluation procedures are provided in Section 3 of the Groundwater and Surface Water Monitoring Plan (Formation 2010a).

- After the five-year period, the monitoring locations and frequency will be evaluated and monitoring will continue on at least a semiannual basis.

- Monitoring of Batiste Spring and other Off-Plant locations will be initiated on a quarterly basis at the time of system startup. After successful demonstration of compliance with the performance standard, samples will be collected semi-annually. The data evaluation procedures are provided in Section 4 of the Groundwater and Surface Water Monitoring Plan (Formation 2010a).

- The performance monitoring strategy shall provide a mechanism to identify when additional contingency actions are required, and shall measure progress toward achieving final groundwater RBCs as measured at the locations approved by EPA.

2.2.3 Surface Water Monitoring

The objective of surface water monitoring is to collect sufficient data of adequate quality to evaluate the performance of the groundwater extraction system and source control measures. The performance monitoring strategy provides a mechanism to identify when additional contingency actions are required, and means to measure progress toward achieving final surface water RBCs as measured at the locations approved by EPA.

2.3 Groundwater Monitoring System Design

The groundwater monitoring system for the Simplot remedy has been divided into 5 sub-areas based on monitoring objectives and performance criteria. The sub-areas are shown in Figure 2-1 and described in detail in the 2009 Annual Report (Formation 2010c) and the Groundwater and Surface Water Monitoring Report (Formation 2010a). The sub-areas are as follows:

- Don Plant Area

- PAP Area (in Don Plant Area)

- Target Capture Zones (in Don Plant Area)

- Assessment Area

- Compliance Area

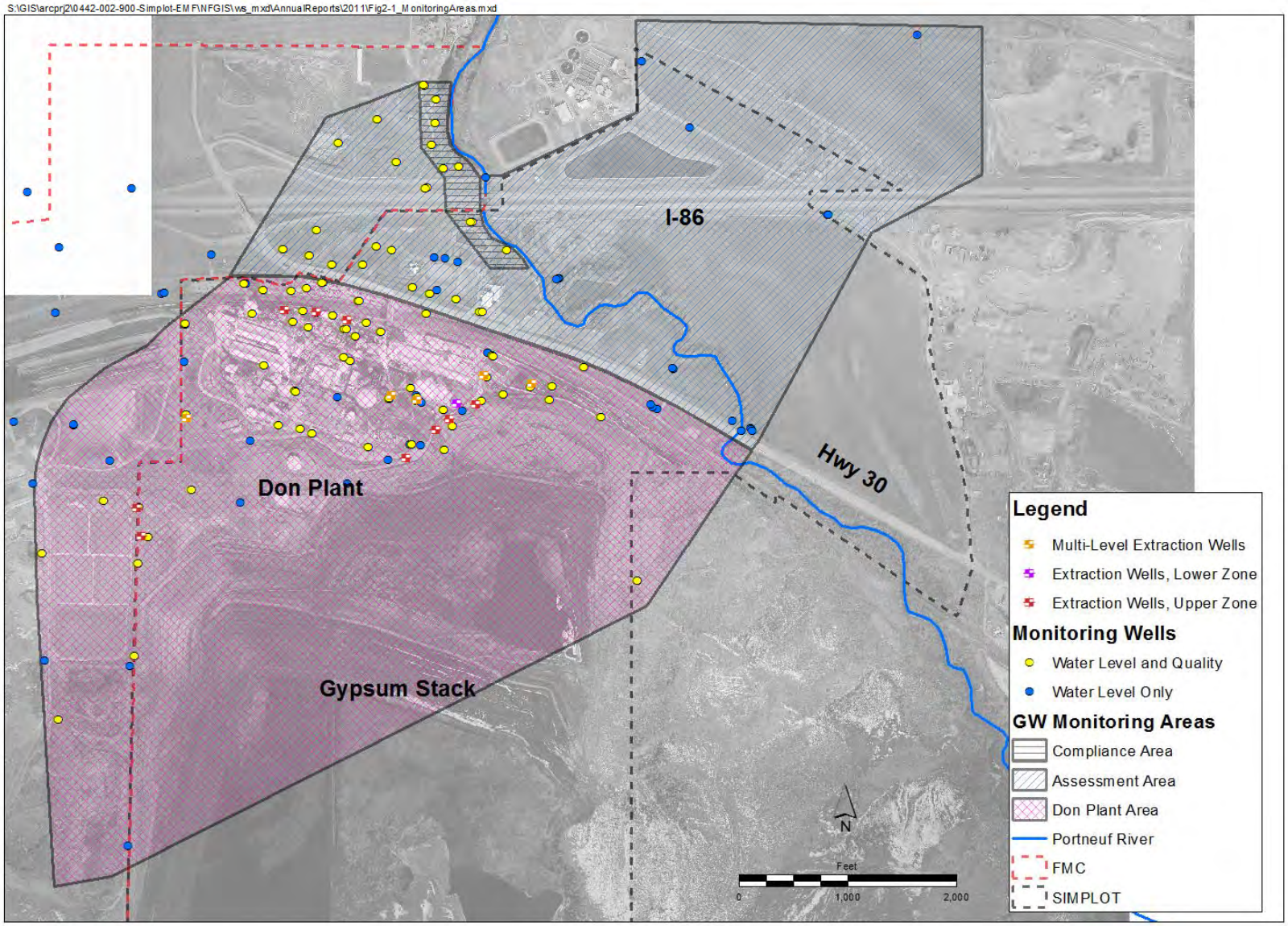


Figure 2-1: Monitoring Areas.

Items described in either the Groundwater and Surface Water Monitoring Plan (Formation 2010d) or the VCO/CA (IDEQ 2008) for annual reporting include the following:

- Narrative summary of sampling and analysis activities;
- Narrative summary of analytical data quality;
- Tabulated analytical and measurement results, by location;
- Maps illustrating the potentiometric surfaces of the Upper and Lower Zones;
- Maps illustrating distributions of indicator constituents;
- Summary of extraction system performance including an estimate of the gallons of groundwater extracted and the pounds of phosphorus in extracted groundwater;
- Demonstration of extraction well capture by the 6-step capture analysis methodology;
- Results and discussion of statistical tests and calculations performed if needed to evaluate achievement of performance standards;
- Data evaluations and time-series plots of indicator parameters for groundwater and surface water, as appropriate,
- Results of trend tests performed on time-series data, (including evaluation of other sources) as appropriate;
- An estimate of the pounds of phosphorus not released due to remedial actions; and
- Narrative discussion of results and conclusions including an assessment of the effectiveness of the extraction system to remove phosphorus from groundwater with a predicted trend toward compliance with the TMDL at Siphon Road.

3.0 REMEDY IMPLEMENTATION/STATUS

The interim ROD amendment (EPA 2010a) includes source control for the gypsum stack and the PAP as a remedy objective. Source control for the gypsum stack will be achieved by lining the entire stack with an impermeable membrane. Source control for the PAP Area will be achieved through infrastructure improvements. These controls are described in the following sections.

3.1 Gypsum Stack Source Controls

Lining of the existing gypsum stack is being performed as a source control action to reduce seepage and loading of phosphorus and arsenic to groundwater beneath the stack. The stack lining is expected to eventually reduce concentrations of phosphorus and arsenic in the plant area below levels of concern. This will allow the groundwater extraction system to be phased out of operation when reduced concentrations are verified by the groundwater monitoring system. A detailed description of the effects of gypsum stack seepage on groundwater quality and loading to the Portneuf River is provided as part of the groundwater conceptual site model (CSM) in the Groundwater RDR (Formation 2010e). The technical challenges of lining the gypsum stack are significant. The gypsum stack is currently operated in three compartments, a lower stack and an upper stack that is divided into two compartments (Figure 3-1). A multi-year approach is being used to execute the lining with the lower stack being lined first followed by the west compartment of the upper stack then the east compartment of the upper stack. A detailed engineering assessment along with preliminary design drawings and specifications for the first phase of the project are included in Appendix A of the Remedial Action Plan (Simplot 2009a). A detailed description of the lining process is included in the Phosphorus Source Control Program (Simplot 2011a). An overview of the project and status for 2011 is provided in the following paragraphs.

The gypsum stack is being lined in multiple phases of work. Phase I consisted of Decant Pond construction and lining of the lower stack. The Decant Pond was completed in October 2009. The lined-lower stack was brought into operation in July 2011.

The second and third phases of work include lining the upper west stack and the upper east stack, respectively. The design has been revised and the upper west stack will be split into two sub-compartments to allow each sub-compartment to be completed within one construction season. The design of the upper west stack has been submitted to the Agencies and construction is planned to begin in 2012.

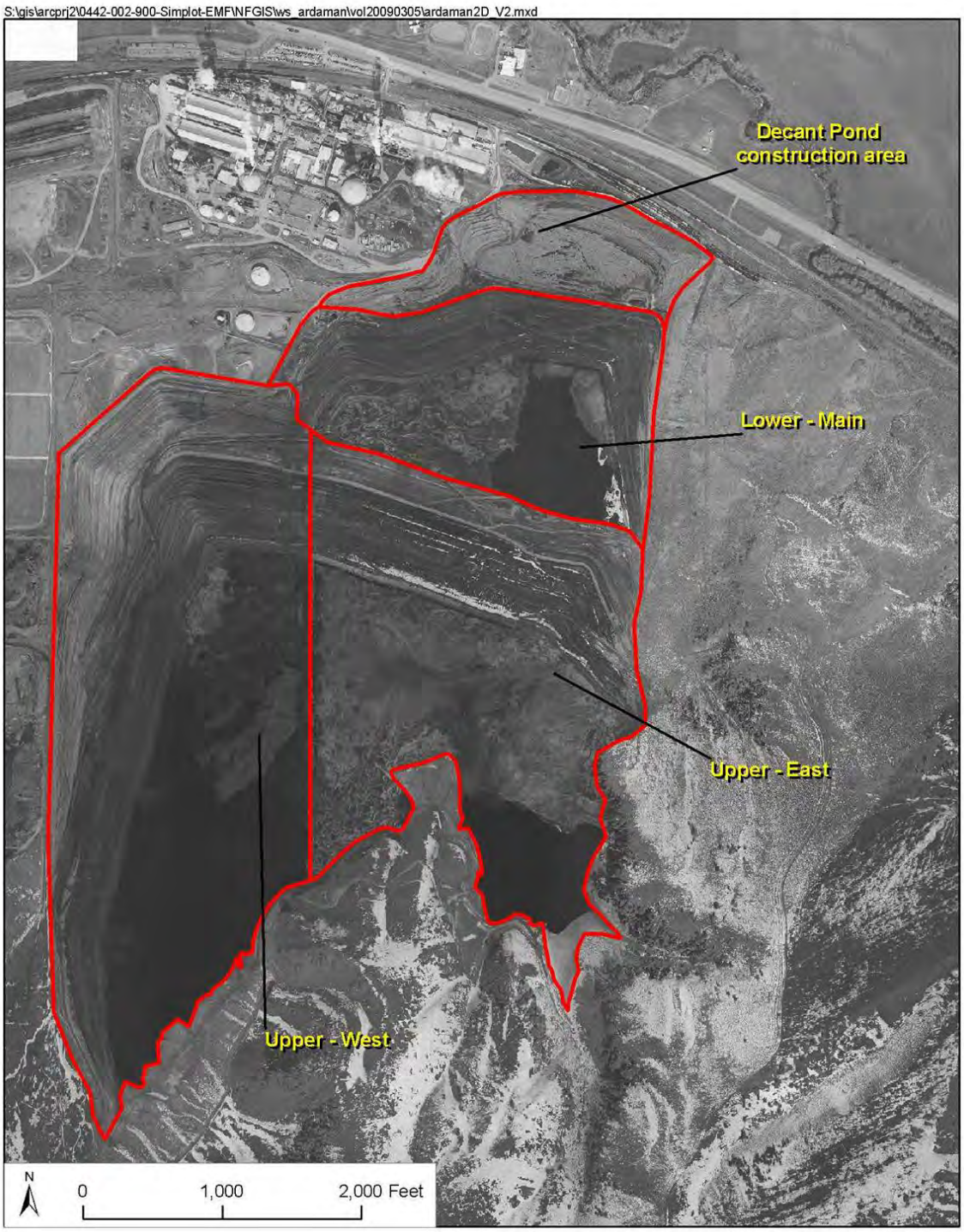


Figure 3-1: Sections of the gypsum stack.

A preliminary schedule that allows for all the elements of work to be completed is as follows:

Decant Pond:

- Construction complete October 2009
- Operations began in June 2010

Lower Stack:

- Construction complete.
- Operations began in July 2011

Upper West Stack – North Sub-Compartment:

- Build final upper road. Completed in 2011.
- Move the power line. Completed in 2011.
- Extend Gypsum Banks for New Dikes in late 2011 into early 2012
- Curtain Drain Installation in early 2012
- Dewater and Dry Stack in early 2012
- Site Preparation during construction season 2012
- South Slope prep work during construction season 2012
- Install underdrain and decant piping during construction season 2012
- Line the north portion of west compartment during construction season 2012
- Final preparations during late construction season 2012
- Begin operation December 2012

Upper East Stack North Sub-Compartment:

- Line the north portion of the upper east compartment using a similar schedule to that of the north portion of the upper west compartment during the construction season of 2013.

Upper West Stack South Sub-Compartment:

- Line the south portion of the upper west compartment using a similar schedule to that of the north portion of the upper west compartment during the construction season of 2014.

Upper East Stack South Sub-Compartment:

- Line the south portion of the upper east compartment using a similar schedule to that of the south portion of the upper west compartment during the construction season of 2015.

3.2 PAP Area Source Controls

Improvements in the PAP Area have been and will be performed as both short-term and long-term actions to eliminate the potential for seepage and resulting loading of phosphorus to soils and groundwater beneath the plant area. The Don Plant uses a three-pronged approach to minimize the potential for groundwater impacts from the PAP Area: 1) an inspection program; 2) routine maintenance and repairs; and 3) capital projects. Details can be found in the Phosphorus Source Control Program (Simplot 2011a).

A detailed description of the sources in the PAP Area and the influence of sources on groundwater quality and loading to the Portneuf River is provided in Technical Report No. 1 (Simplot 2009b). This section briefly summarizes recent and planned improvements to the Don

Plant Production Areas. These improvements include maintenance and repair activities designed to minimize the potential for releases. Projects planned for 2012 are described in detail in the 2012 letter to EPA and IDEQ, 2012 Proposed Project Scope and Schedule (Simplot 2012a), sent January 30, 2012.

3.2.1 Sump and Pad Management

The Don Plant operates and maintains process sumps with associated pads and separate leak detection systems throughout the complex. The purpose of these process sumps and pads is to recover product and to minimize potential for environmental impacts.

Process sumps and pads are managed in a manner to ensure that process liquids stay within the sump, pad, and associated containment areas at all times. Process sumps and pads are not used for primary containment of process materials. Process sumps and pads are for emergencies or upset conditions only. Any process materials that contact them are removed immediately.

There are two separate inspections conducted and documented for all process sumps and pads. One inspection is conducted by an area operator or his designee, and the second inspection is completed by the yard supervisor after a guzzler operator has removed all liquids from and otherwise cleaned the process sump.

Results from the two separate monthly inspections are recorded on the appropriate inspection form. The operator/supervisor also submits any liquid samples to the Analytical Lab for analysis. After the inspection is complete, the forms must be submitted to the Area Supervisor for approval. The Area Supervisor must follow up on any work order and record any lab analysis results on the applicable sump inspection form. If a concern noted during the inspection relates to the integrity or functionality of a process sump system, immediate notification must be made to the appropriate Area Supervisor.

All Don Plant Employees receive web-based awareness training on the Process Sump and Pad Management Program. Specialized training on the Process Sump and Pad Management Program is given to all personnel who will be involved in the monthly and quarterly inspection program.

In addition to the inspection and monitoring program described above, the Don Plant has a number of projects planned to further improve the infrastructure associated with tanks, sumps, pads and sewers, especially in the production area (liquid and phosphoric acid plants area). This list and schedule may change based on recommendations from the Don Plant Sump and Pad Team. These recommendations will be based on the current sump/pad/tank design, equipment inspections, analytical data and other pertinent information.

In addition to the inspection, maintenance and repair of process equipment, Don Plant procedures and operating practices are designed to protect the environment. For example, if

process material is released to a pad area, it is cleaned up as quickly as possible. It is not our practice to "store" material on the pads. Simplot is very aggressive in keeping all process material contained. Pumps and line leaks are repaired as soon as possible. Simplot is continually looking for ways conduct activities in ways that minimize the potential for impacts to the environment.

3.2.2 Don Plant Projects Completed

The Don Plant engineering staff completed two major improvement projects in the PAP Area in 2011 (Table 3-1). In addition to these projects, the Don Plant has conducted other maintenance and repair activities. These are described in the PAP Area Source Control and Groundwater Monitoring Monthly Report. Detailed scopes and schedules for these projects were presented as Appendix D of the Phosphorus Source Control Program (Simplot 2011a).

Table 3-1: PAP Area Projects Completed in 2011.

Project
Dilution Tank Upgrade
SF Unloading Area Upgrade

3.3 Groundwater Extraction System

Under CERCLA, the design of the existing groundwater extraction system has been conducted using a "phased and integrated approach" (EPA 1997). In this approach, extraction wells have been installed and tested to provide location-specific performance data. Monitoring wells and exploratory borings have also been installed in phases to address specific data gaps in the site conceptual model for groundwater. Uncertainties in the CSM for groundwater have been greatly reduced with the completion of each phase of the extraction system and sufficient information is now available to design the remaining elements of the system, demonstrate that the complete system will meet remedy objectives, and plan the steps necessary to implement the design.

The groundwater extraction system currently consists of 15 active extraction wells that were installed in three phases of work; phase 1 in 2003-2004, phase 2 in 2007-2008, and phase 3 in 2010-2011. Two of the east plant area Upper Zone wells have been taken offline prior to 2011 due to insufficient saturated thickness to maintain extraction (Simplot 2011b). In addition, well 403 has never operated due to lack of water. As part of phase 3, well 410 was taken out of service in early August 2011, and two new multi-level extraction wells were brought on line in mid-August 2011 in the East Plant, 421 and 422. The locations of the extraction wells are shown in Figure 3-2. The design of the groundwater extraction and monitoring systems is presented in detail in the Groundwater Extraction and Monitoring System Remedial Design Report (Formation 2010e).

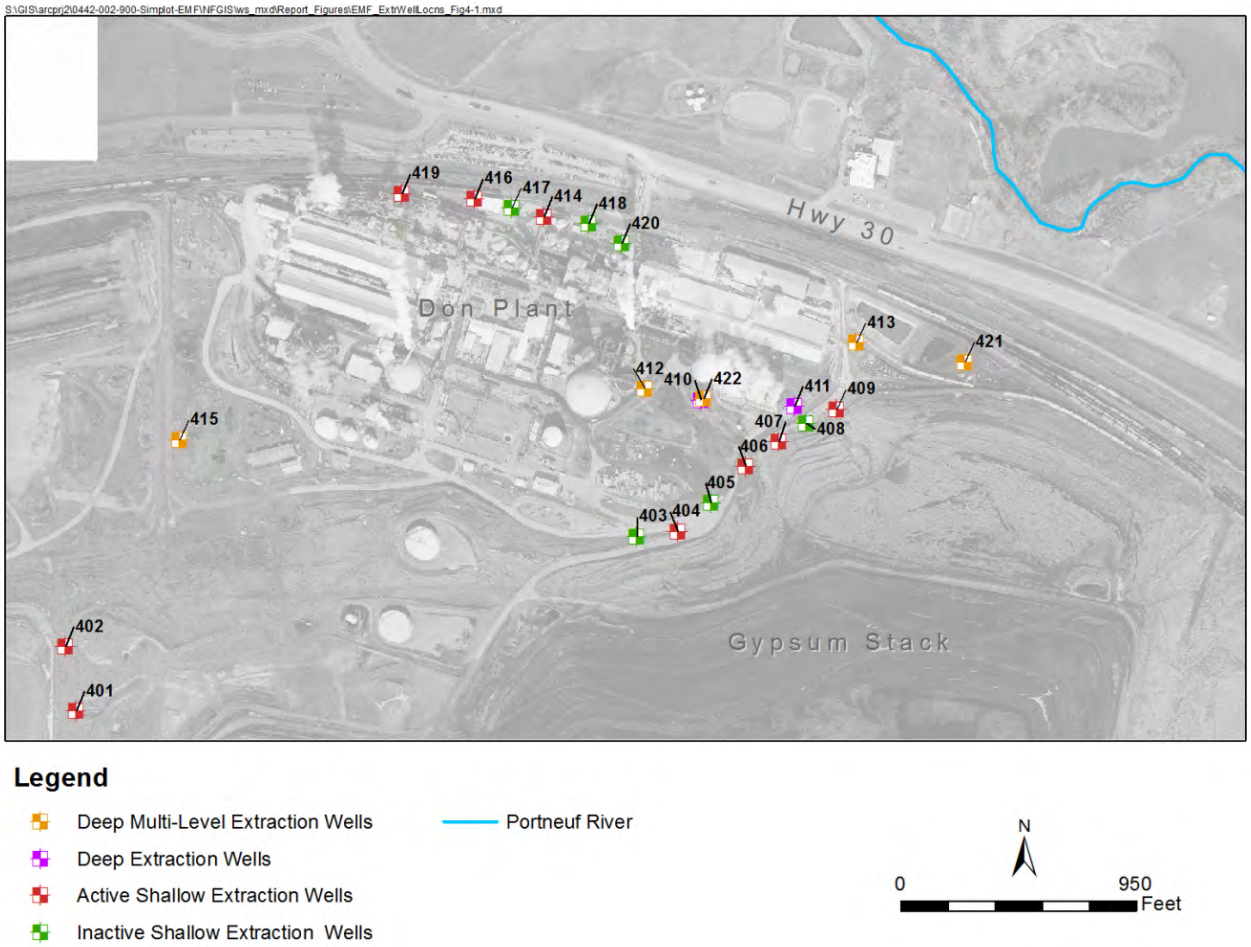


Figure 3-2: Location of existing extraction wells and new multi-level wells, 421 and 422.

Groundwater extraction system operational summaries along with groundwater monitoring data have been provided in four quarterly reports (Formation 2011a, 2011b, 2012a, 2012b). This section provides an analysis of annual data, including extraction well performance, and an assessment of the effects of extraction on downgradient groundwater chemistry and other data trends. Information on the groundwater extraction system operation in 2011 is provided in Section 3.3.1. Section 3.3.2 provides a well maintenance summary, while Section 3.3.3 provides a well performance summary. The new multi-level extraction wells are discussed in Section 3.3.4 and an evaluation of water flows within the Don Plant process is described in Section 3.3.5.

3.3.1 Well Operation Summary

The extraction system operated throughout the year, except when the system was shut down during the annual Don Plant maintenance turnaround, beginning on June 1st. Following turnaround, wells 401, 402, 404, 406, 407, 409, 410, 411, 412, 413, 414 and 415 were brought back online on June 11th and wells 416 and 419 were brought back on line on June 20th.

A summary of the operation of the extraction wells, including percent time online, and extraction rates during 2011 for each well is presented in Table 3-2 Using the time each well was online and the average extraction rate, the total groundwater extracted in 2011 was calculated.

Table 3-2: Extraction Well 2011 Operation Summary

Extraction Well	Time Well Offline[1] (%)	Extraction Rate Goal (gpm)	Annual Extraction Rates			
			Maximum (gpm)	Calendar-day Average[2] (gpm)	Stream-day Average[3] (gpm)	Total[4] Extraction (million gallons)
West Plant Area						
401	5.7%	25	36.4	19.8	21.1	10.43
402	4.5%	45	94.8	52.4	54.8	27.54
415	3.2%	35	45.1	40.5	41.6	21.29
Central Plant Area - Upper Zone						
414	5.2%	10	12.1	9.3	9.9	4.91
416	8.0%	35	35.9	31.1	33.9	16.36
419	10.2%	15	35.0	12.9	14.3	6.77
East Plant Area - Upper Zone						
403	-	-	-	-		-
404	7.0%	5	2.5	1.6	1.7	0.85
405	-	-	-	-		-
406	10.6%	15	21.5	8.8	9.8	4.62
407	4.2%	5	8.0	5.8	6.1	3.05
408	-	-	-	-		-
409	9.0%	5	3.2	1.7	1.9	0.92
East Plant Area - Lower Zone						
410[5]	43.9%	150	77.2	37.9	67.7	19.94
411	4.7%	100	90.5	54.0	56.6	28.40
412	3.8%	400	474.0	376.7	392.1	197.99
413	5.9%	125	133.5	102.9	110.5	54.07
421[6]	63.8%	125	197.5	36.1	99.7	18.95
422[6]	63.8%	150	219.0	54.3	150.0	28.52
Total:		1095		808.0	1004.1	424.7

Notes:

1. *All downtime including scheduled Don Plant turnaround.*
2. *Average rate calculated over 365 days, including all down time periods for the wells.*
3. *Average rate for all time the pump was on line.*
4. *Based on calendar-day average for 365 days total.*
5. *Well 410 was taken out of service on August 2, 2011 and replaced with a larger-diameter well, 422.*
6. *Multi-level wells 421 and 422 were brought on line in mid-September. These wells draw primarily from the lower zone.*

A summary of the removal of indicator analytes by the extraction system in 2011 is provided in Table 3-3.

Table 3-3: Mass Removal 2011 Summary, Extraction System

Extraction Well	Calendar-day Average Extraction Rate (gpm)	Average[1] Daily Mass Removal		
		Arsenic (lb/day)	Phosphorus (lb/day)	Sulfate (lb/day)
West Plant Area				
401	19.8	0.084	44	622
402	52.4	0.217	103	1,671
415	40.5	0.114	24	852
Central Plant Area - Upper Zone				
414	9.3	0.037	14	247
416	31.1	0.086	46	693
419	12.9	0.021	100	257
East Plant Area - Upper Zone				
403		-	-	-
404	1.6	0.009	3	51
405		-	-	-
406	8.8	0.029	91	325
407	5.8	0.020	49	214
408		-	-	-
409	1.7	0.006	11	62
East Plant Area - Lower Zone				
410[2]	37.9	0.138	214	1,408
411	54.0	0.184	338	1,925
412	376.7	0.734	861	6,338
413	102.9	0.278	269	2,577
421[3]	36.1	0.024	10	313
422[3]	54.3	0.093	64	846
Total:	808.0	2.073	2,241	18,403

Notes:

1. *Average rate calculated over 365 days, including all down time periods for the wells.*
2. *Well 410 was taken out of service on August 2, 2011 and replaced with a larger-diameter well, 422.*
3. *Well 421 and 422 were brought on line in mid-September.*

Stack-affected groundwater was also removed by facility production well SWP-4. Based on the average quarterly flow rate and the measured concentrations each quarter, it is estimated that SWP-4 removed 0.11 lbs/day of arsenic, 7.0 lbs/day phosphorus, and 1070 lbs/day sulfate.

3.3.2 Well Maintenance Summary

3.3.2.1 West Plant Extraction Wells

Maintenance activities on West Plant extraction wells 401, 402 and 415 included line cleaning in January, telemetry work in March, additional line cleaning in April, leak repairs in November, and routine pressure gauge and ball valve replacement in December. West Plant extraction wells were also down one day in July to accommodate tie-in work associated with new multi-level wells 421 and 422.

3.3.2.2 Central Plant Extraction Wells

Maintenance activities on Central Plant extraction wells 414, 416 and 419 included valve replacement in late June and routine pressure gauge and ball valve replacement in December. Additional maintenance activities at well 419 included pump repair or replacement in February, April, September, October and November and pH probe replacement in March and August. Pump and pH probe maintenance at well 419 is more frequent than at other extraction well locations because of mineral encrustation and scaling related to pH changes.

3.3.2.3 East Plant Upper Zone Extraction Wells

Maintenance activities on East Plant upper zone extraction wells 404, 406, 407 and 409 included telemetry work in March, line cleaning in late April and early May, tie-in work in July and August, routine pressure gauge and ball valve replacement in December and piping work associated with removing inactive extraction wells 403, 405 and 408 and adding them to the monitoring system in December.

3.3.2.4 East Plant Deep and Multi-Level Extraction Wells

Maintenance activities on East Plant lower zone extraction wells 410, 411, 412 and 413 included telemetry work in March, line cleaning in May, tie-in work in July and August, leak repair in November, routine pressure gauge and ball valve replacement in December and piping work associated with removing inactive extraction wells 403, 405 and 408 and adding them to the monitoring system in December.

New multi-level extraction wells 421 and 422 were brought on line in August, following tie-in work and aquifer testing. Maintenance activities on these new wells included piping work associated with removing inactive extraction wells 403, 405 and 408 and adding them to the monitoring system in December.

3.3.3 Well Performance Summary

Flow and water level data are collected continuously for each extraction well. Flow rates are measured with electromagnetic flow meters (manufactured by Krohne). In all the East Plant Upper Zone extraction wells, the water levels are measured with admittance-to-current transducers, otherwise known as capacitance probes (manufactured by Drexelbrook). The Drexelbrook level indicators are configured to provide only a relative reading of water level in the well and are primarily used to control pumping rate. In Wells 401, 402, 410, and 411 the Drexelbrook water level indicators were switched to pressure transducers (manufactured by InSitu) in August 2006. The InSitu level indicators provide more reliable pump control and may provide more accurate water level indication. All of the well pumps are fitted with a variable frequency drive (VFD) which allows the speed of the pump motor to be varied to regulate flow rate. The flow and water level data have been examined and an assessment of the performance of each well has been made, as described in the following subsections.

3.3.3.1 West Plant Extraction Wells

Well 401

Excluding downtime for the Don Plant maintenance turnaround, extraction well 401 was on stream 97% of the time in 2011 (Figure 3-3). Unplanned electrical power outages accounted for most of the non-maintenance downtime on well 401.

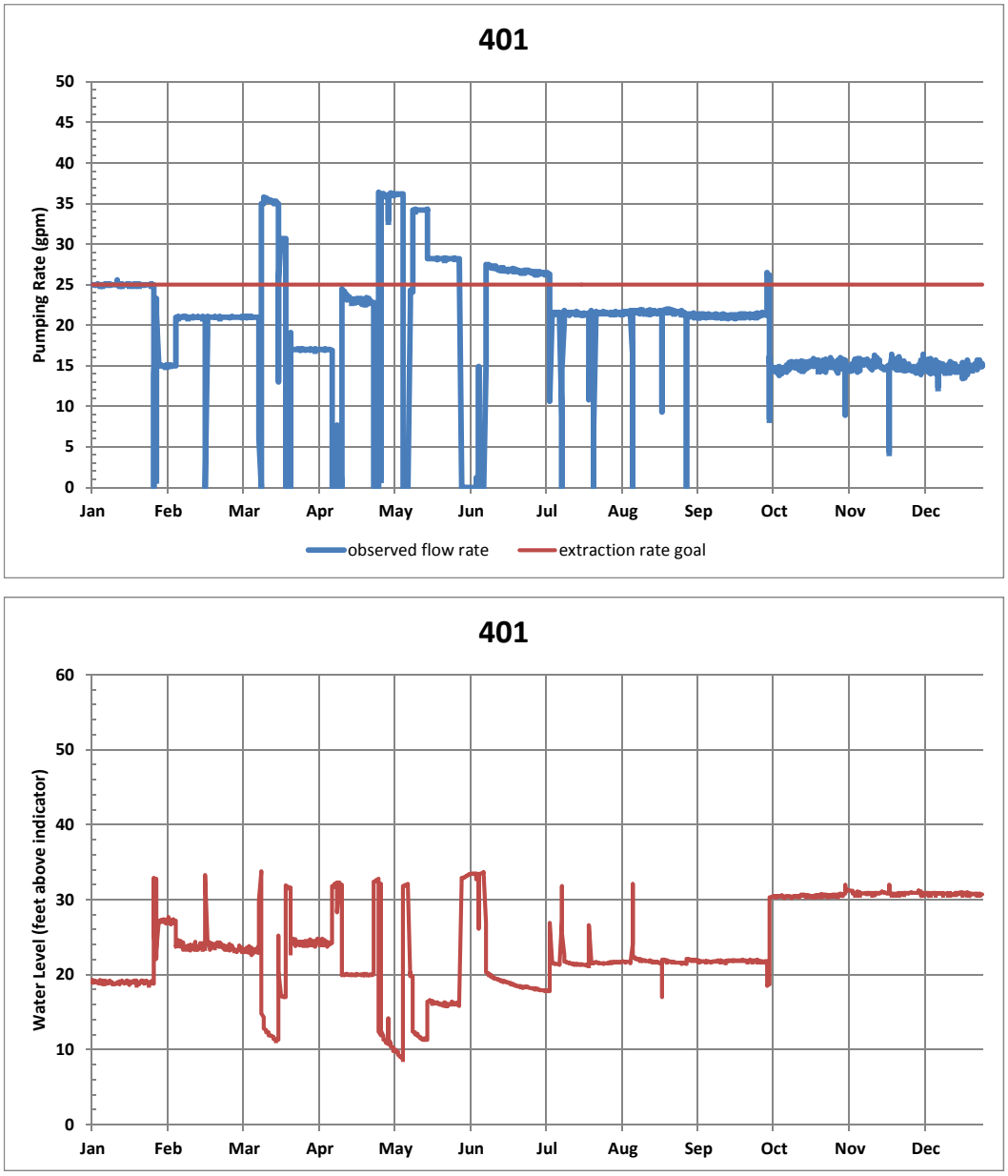


Figure 3-3: Well 401 Extraction Rate and Water Level

Well 402

Excluding downtime for the Don Plant maintenance turnaround, extraction well 402 was on stream 98% of the time in 2011 (Figure 3-4). Unplanned electrical power outages accounted for most of the non-maintenance downtime on well 402.

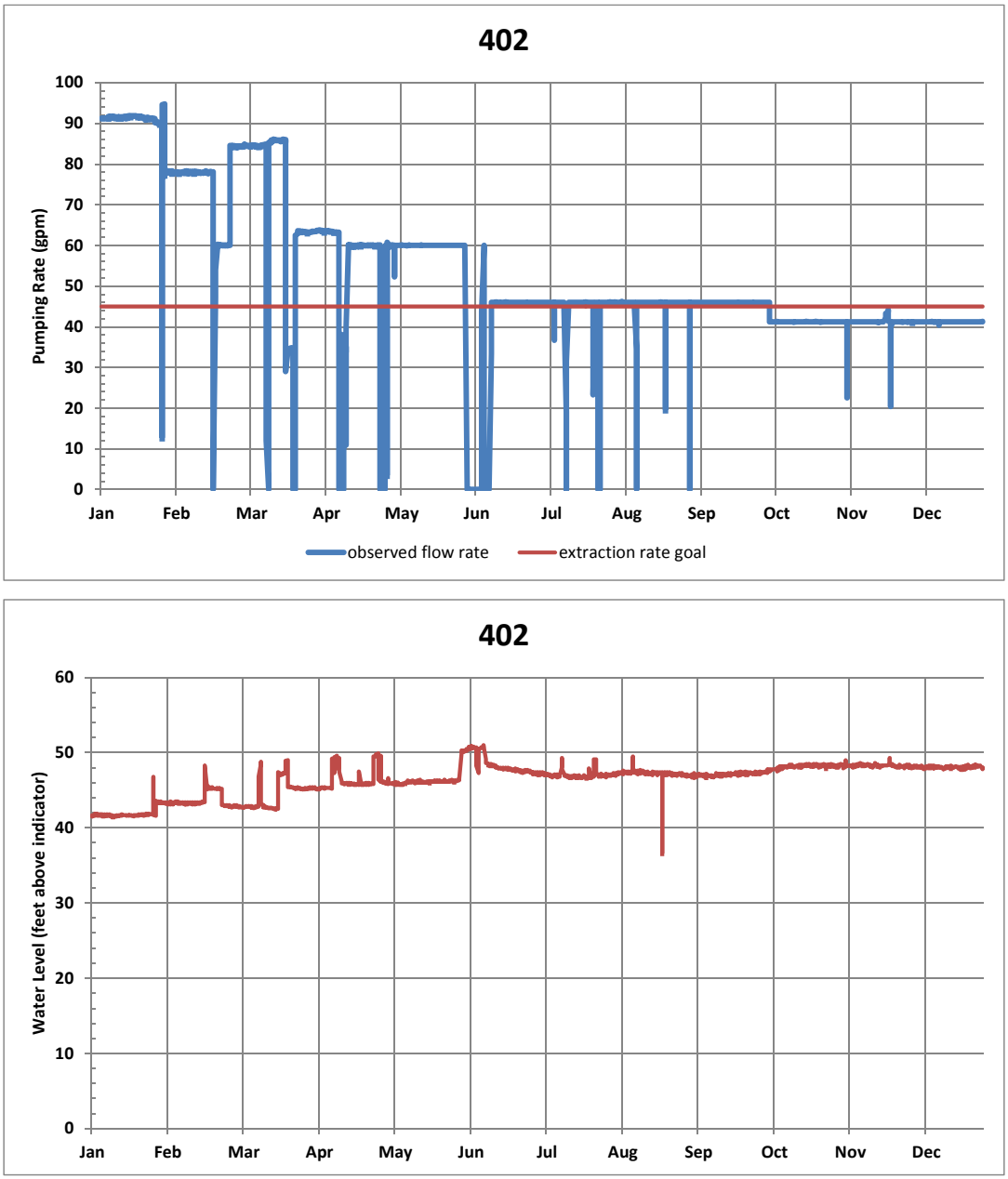


Figure 3-4: Well 402 Extraction Rate and Water Level

Well 415

Excluding downtime for the Don Plant maintenance turnaround, extraction well 415 was on stream over 99% of the time in 2011 (Figure 3-5). Water level observations from early March through mid-May are not available.

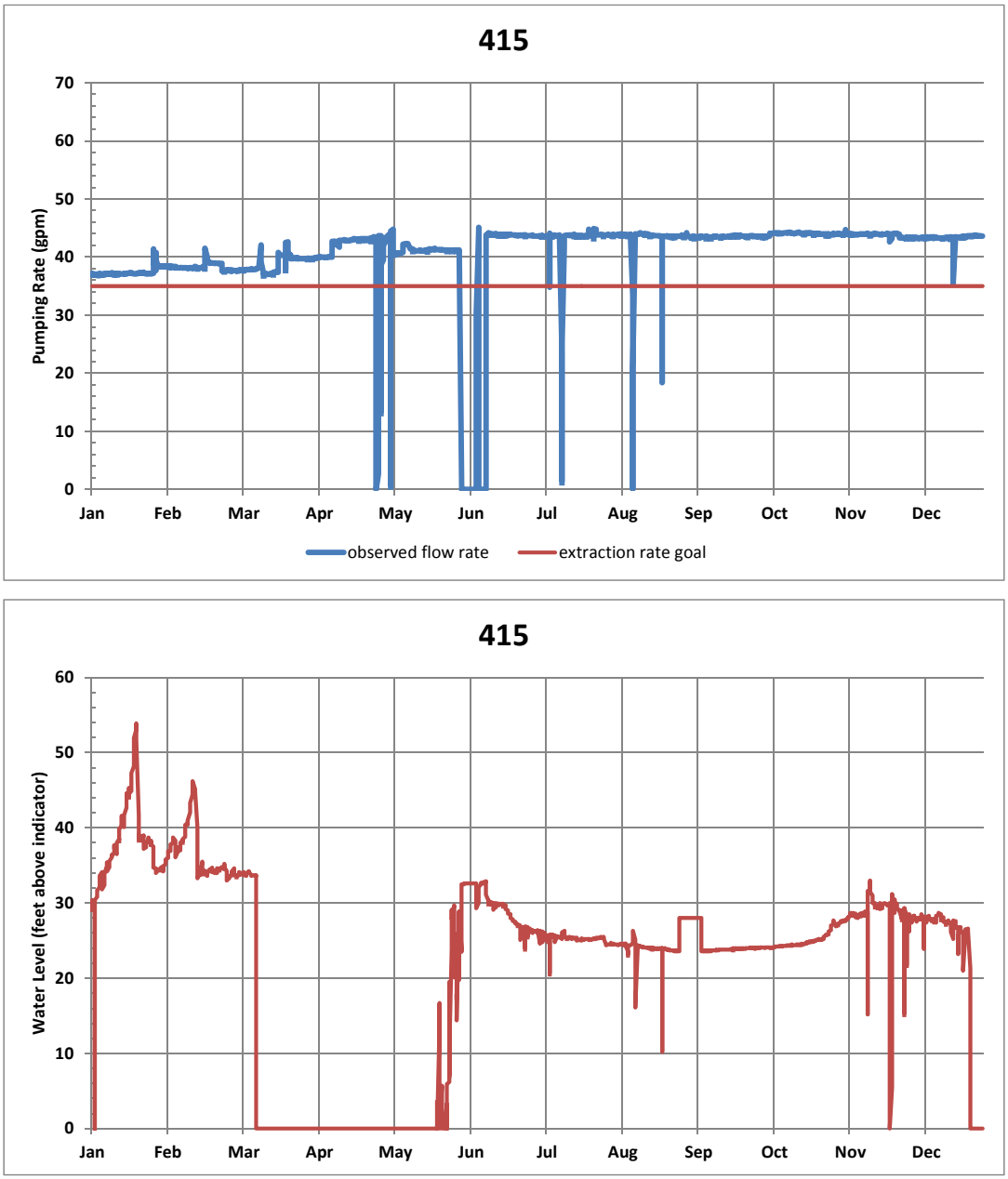


Figure 3-5: Well 415 Extraction Rate and Water Level

3.3.3.2 Central Plant Extraction Wells

Well 414

Excluding downtime for the Don Plant maintenance turnaround, extraction well 414 was on stream 97% of the time in 2011 (Figure 3-6). Water level observations from early June through early May are not available.

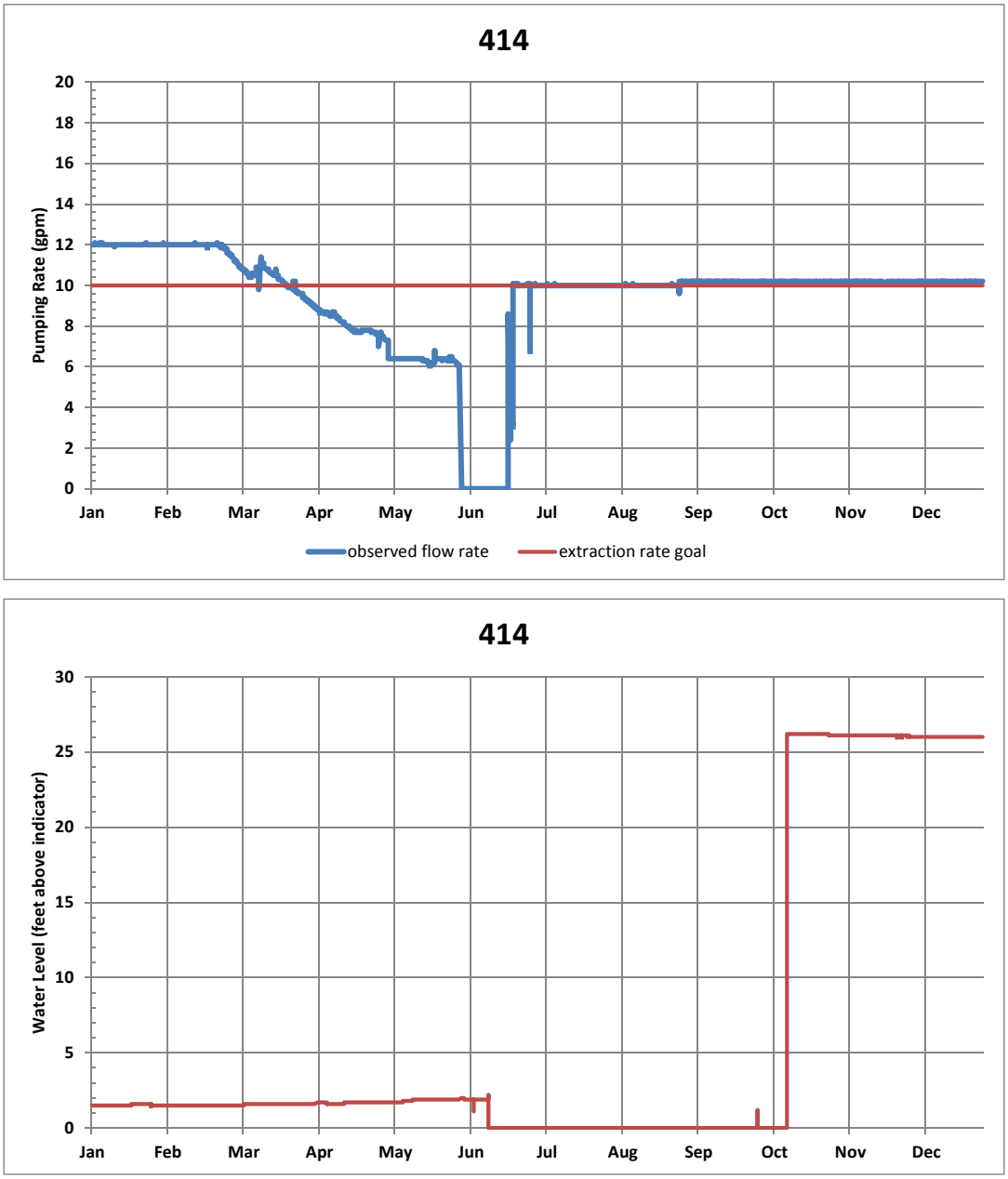


Figure 3-6: Well 414 Extraction Rate and Water Level

Well 416

Excluding downtime for the Don Plant maintenance turnaround, extraction well 416 was on stream 97% of the time in 2011 (Figure 3-7). Unplanned electrical power outages accounted for most of the non-maintenance downtime on well 416.

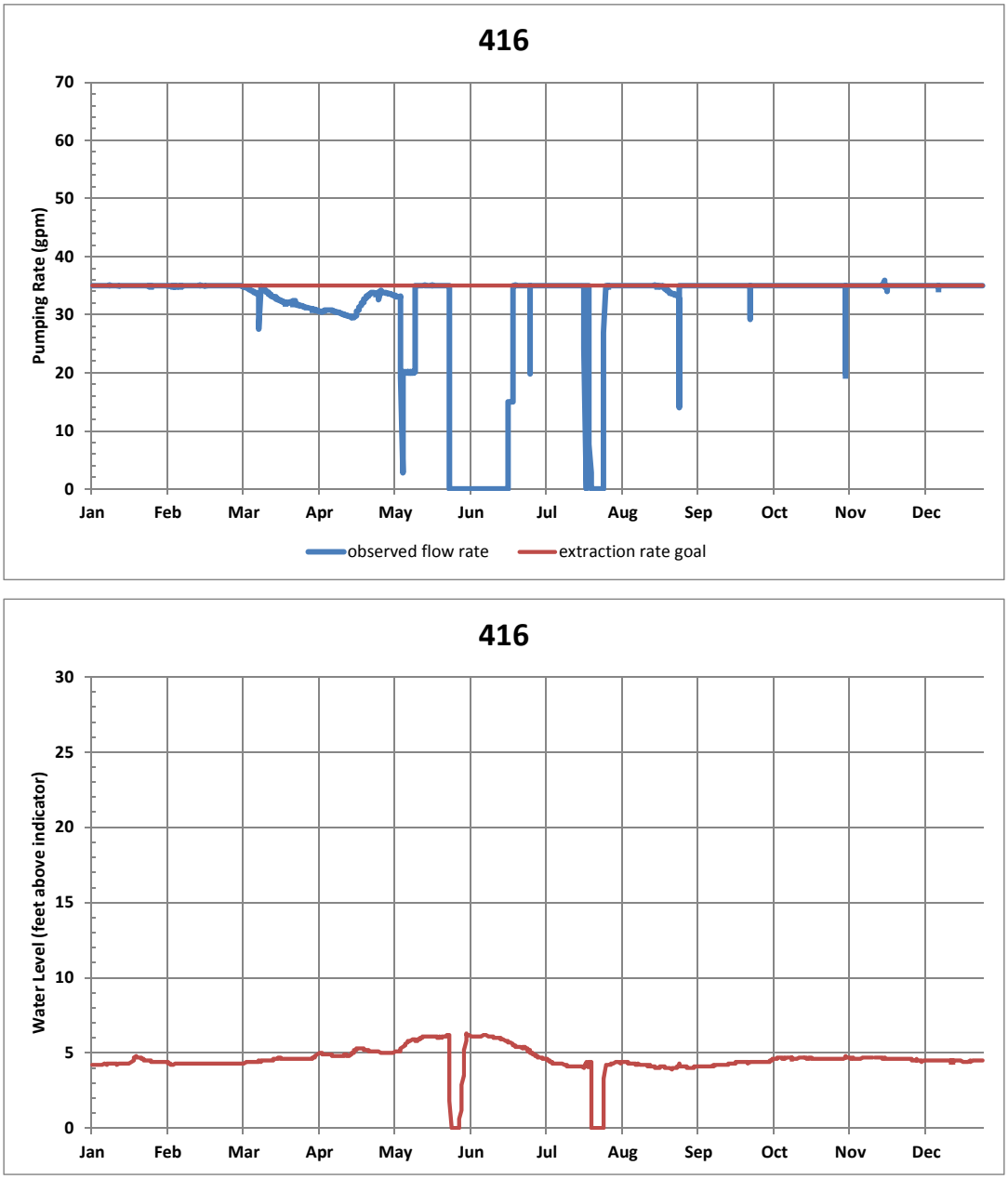


Figure 3-7: Well 416 Extraction Rate and Water Level

Well 419

Excluding downtime for the Don Plant maintenance turnaround, extraction well 419 was on stream 95% of the time in 2011 (Figure 3-8). Pump maintenance and replacement at well 419 is more frequent than other extraction well pumps and accounts for much of the downtime in 2011.

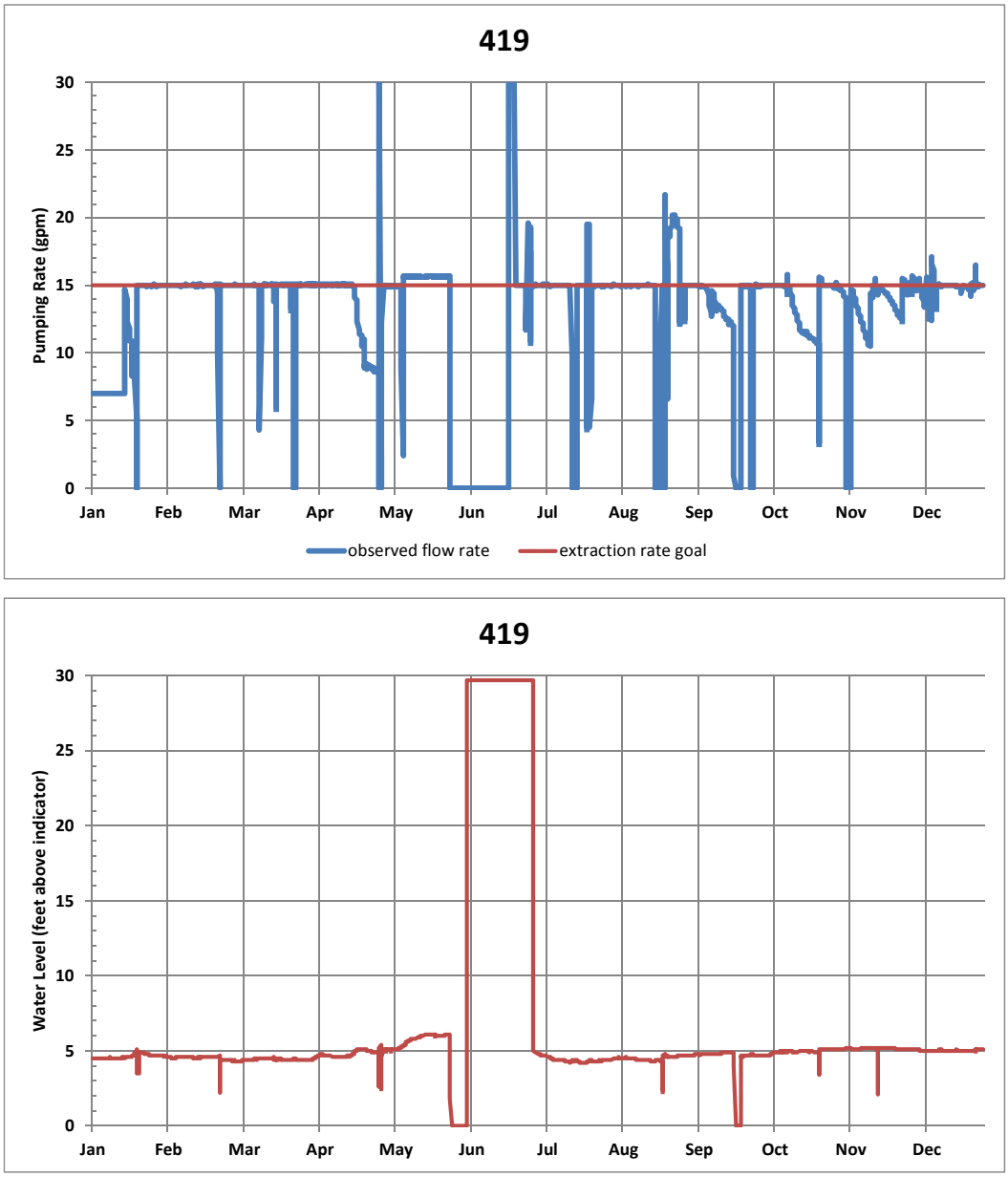


Figure 3-8: Well 419 Extraction Rate and Water Level

3.3.3.3 East Plant Upper Zone Extraction Wells

Well 404

Excluding downtime for the Don Plant maintenance turnaround, extraction well 404 was on stream 96% of the time in 2011 (Figure 3-9). Aquifer testing in September accounted for most of the non-maintenance downtime at well 404 in 2011.

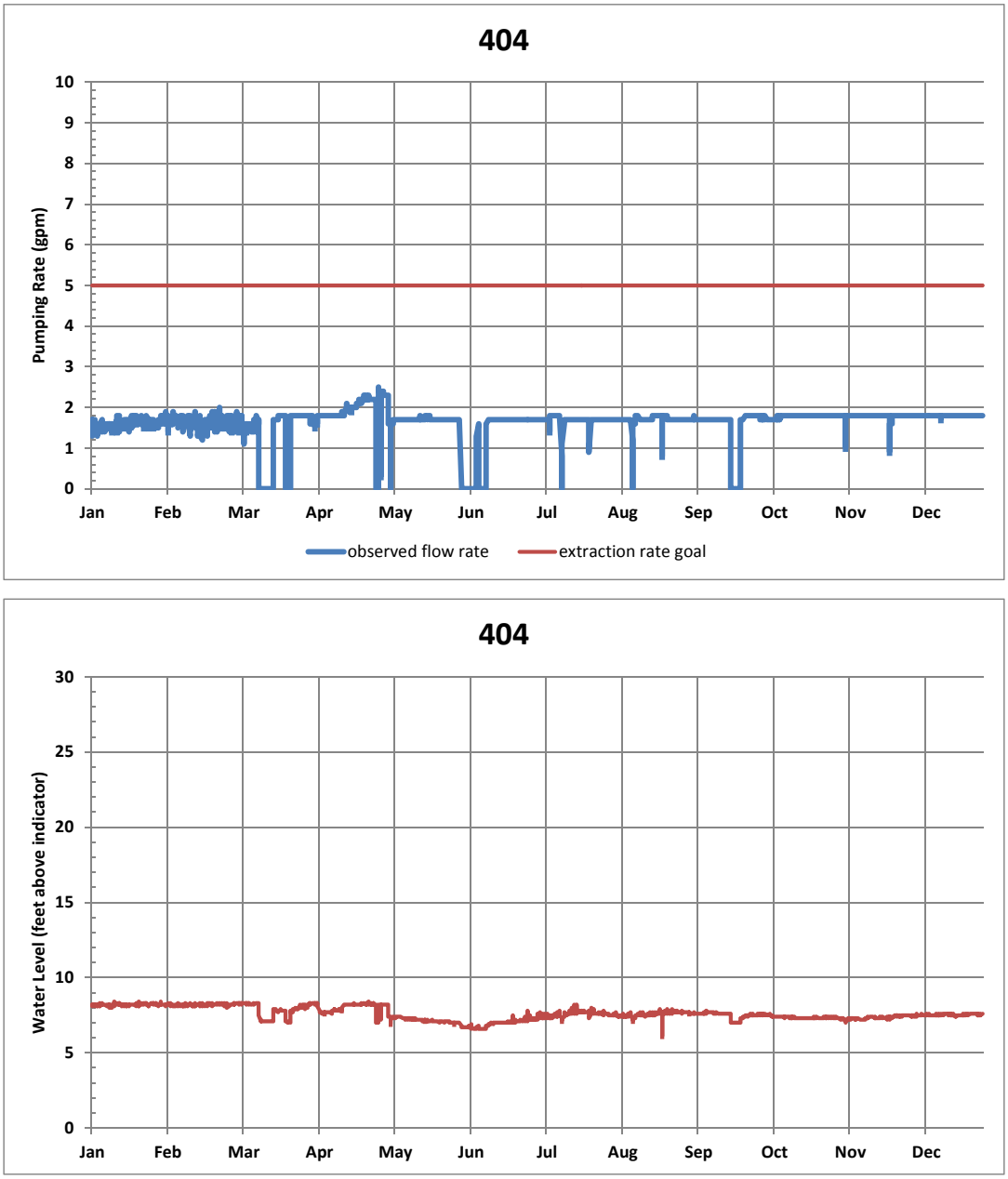


Figure 3-9: Well 404 Extraction Rate and Water Level

Well 406

Excluding downtime for the Don Plant maintenance turnaround, extraction well 406 was on stream 92% of the time in 2011. The extraction rate was reduced in August following a steady decline in water level in the well (Figure 3-10). Aquifer testing in September and October accounted for most of the non-maintenance downtime at well 406 in 2011.

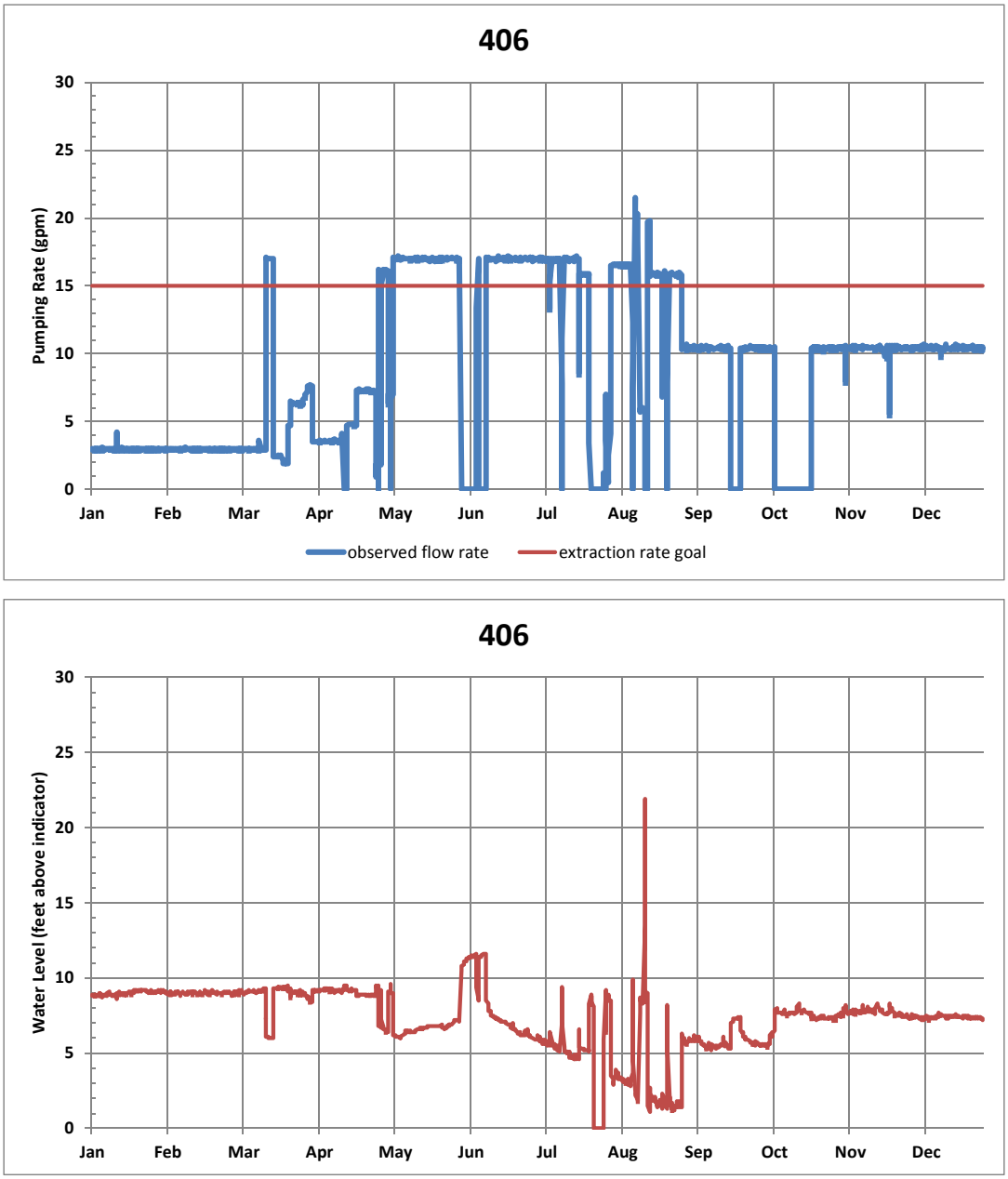


Figure 3-10: Well 406 Extraction Rate and Water Level

Well 407

Excluding downtime for the Don Plant maintenance turnaround, extraction well 407 was on stream 98% of the time in 2011 (Figure 3-11). Aquifer testing in September accounted for most of the non-maintenance downtime at well 407 in 2011.

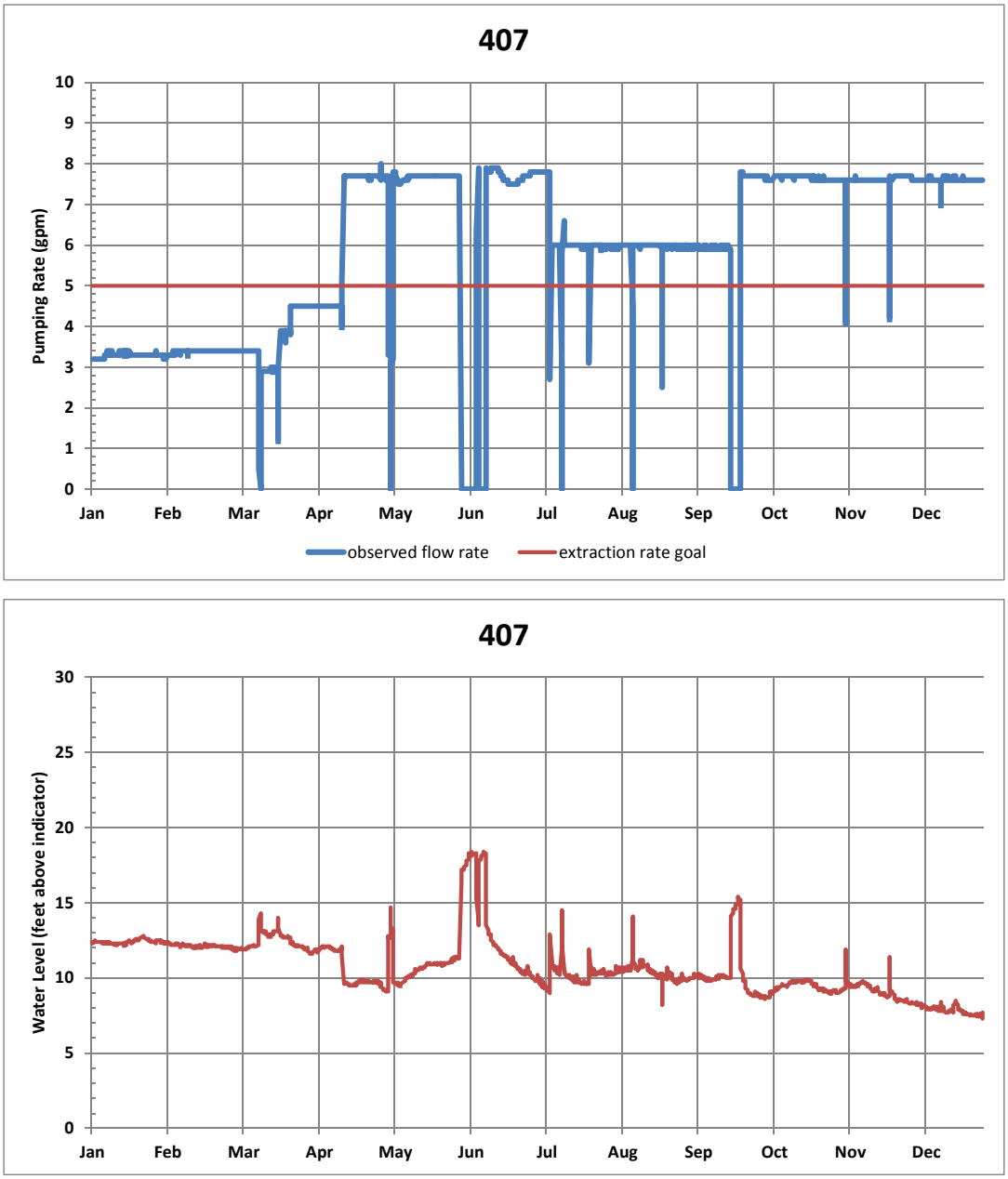


Figure 3-11: Well 407 Extraction Rate and Water Level

Well 409

Excluding downtime for the Don Plant maintenance turnaround, extraction well 409 was on stream 90% (flow rate in excess of 0.5 gpm minimum) of the time in 2011 (Figure 3-12). Limited water availability in the extraction zone negatively impacted extraction rates from well 419 in late 2011.

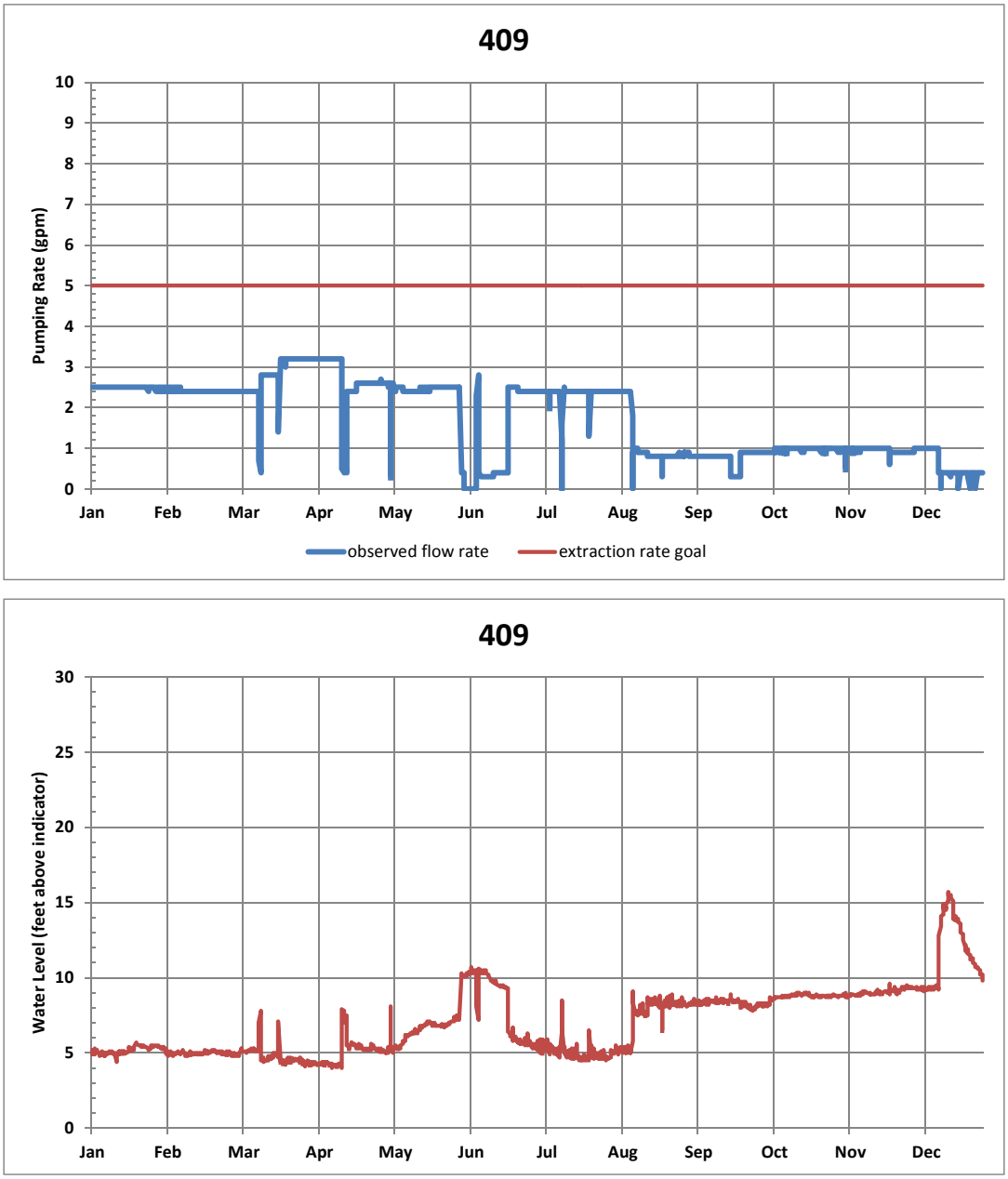


Figure 3-12: Well 409 Extraction Rate and Water Level

3.3.3.4 East Plant Lower Zone and Multi-Level Extraction Wells

Well 410

Extraction well 410 operated at a stream-day average rate of 67 gpm until it was taken out of service in early August and replaced by well 422 (Figure 3-13).

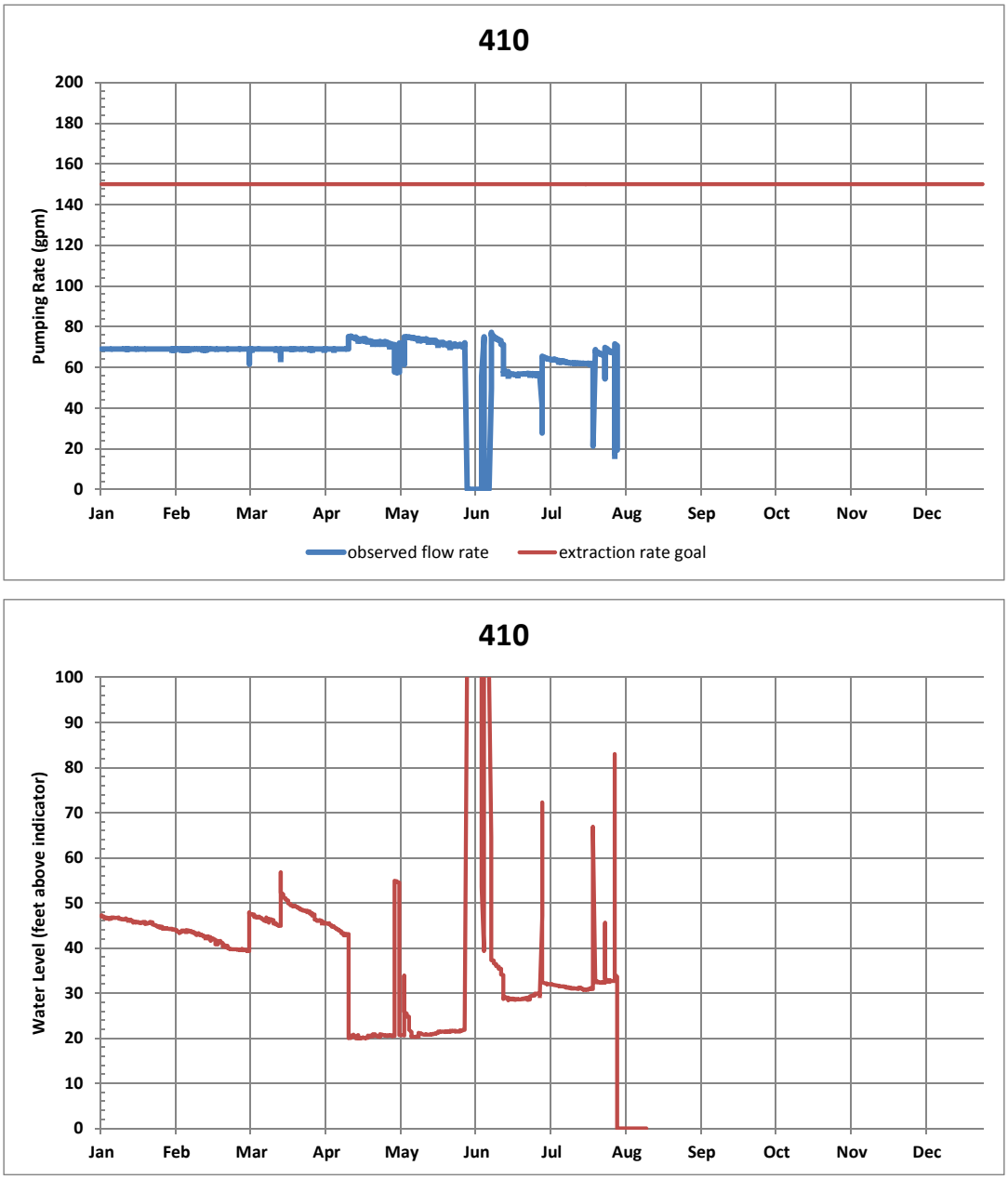


Figure 3-13: Well 410 Extraction Rate and Water Level

Well 411

Excluding downtime for the Don Plant maintenance turnaround, extraction well 411 was on stream 98% of the time in 2011 (Figure 3-14).

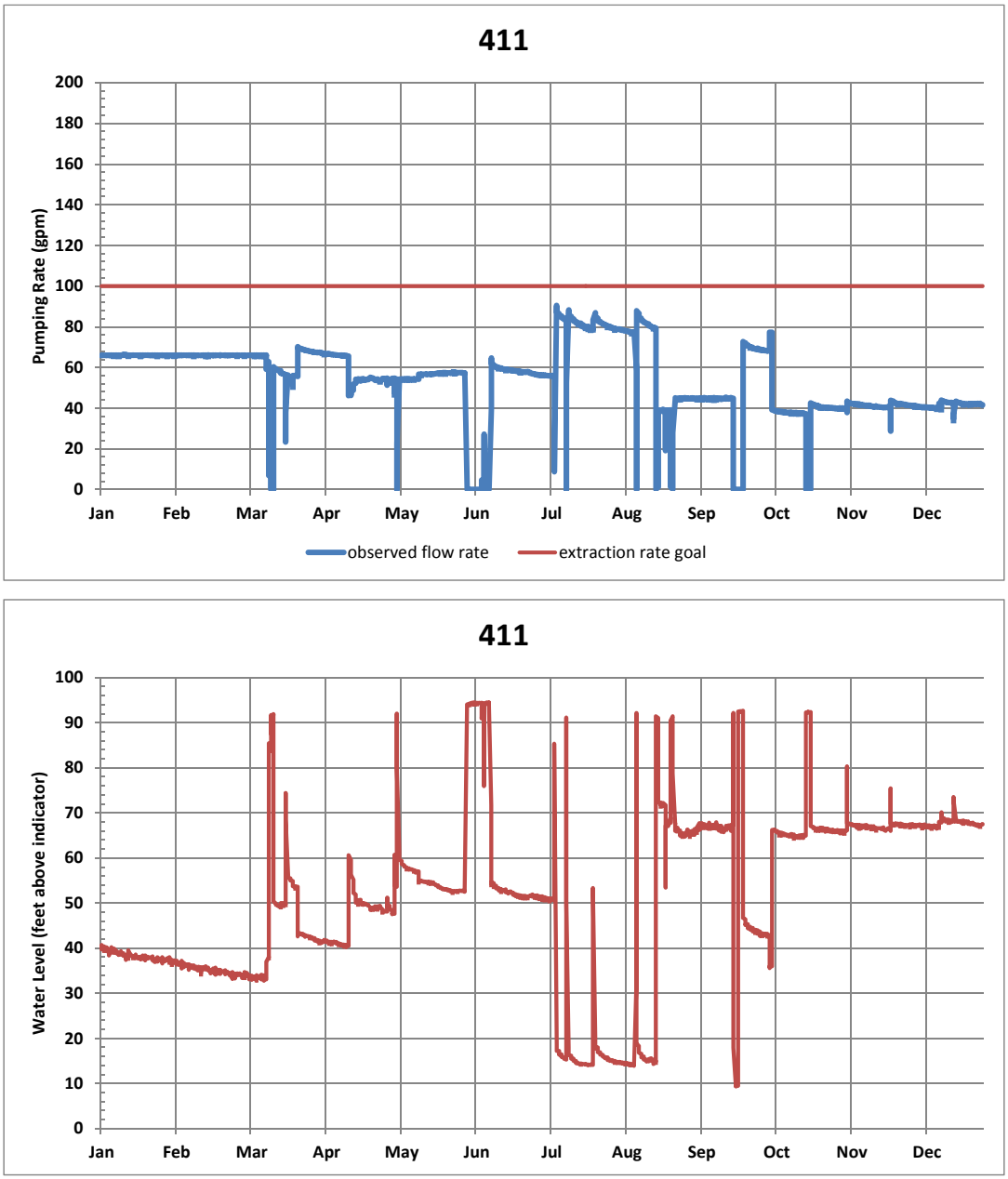


Figure 3-14: Well 411 Extraction Rate and Water Level

Well 412

Excluding downtime for the Don Plant maintenance turnaround, extraction well 412 was on stream 98% of the time in 2011 (Figure 3-15).

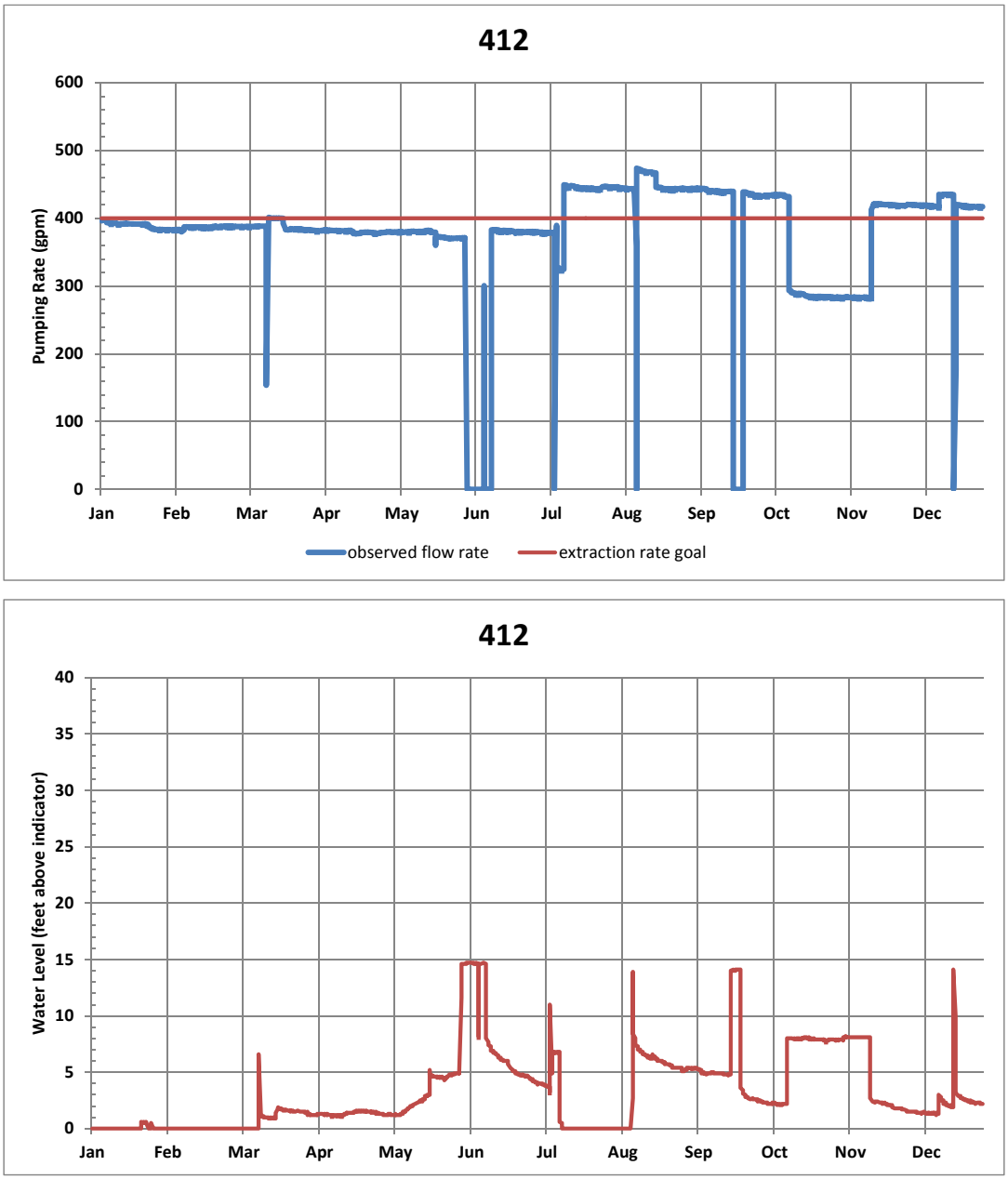


Figure 3-15: Well 412 Extraction Rate and Water Level

Well 413

Excluding downtime for the Don Plant maintenance turnaround, extraction well 413 was on stream 97% of the time in 2011 (Figure 3-16).

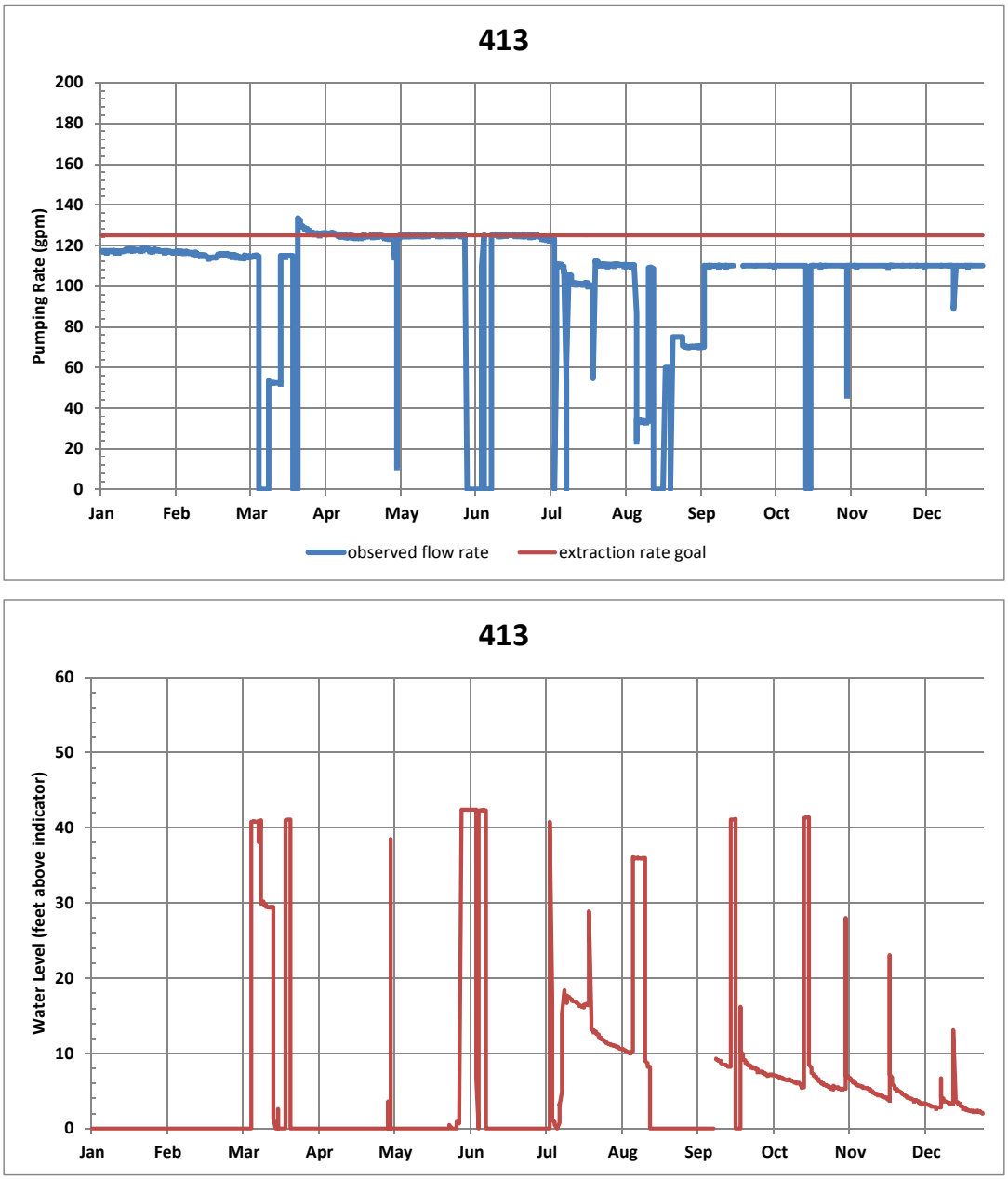
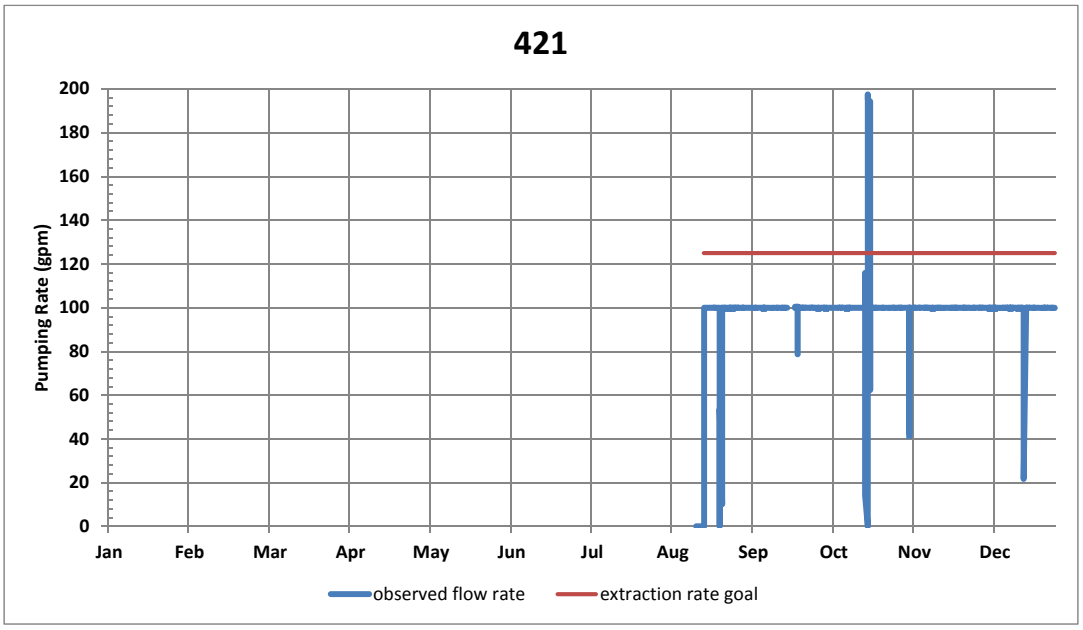


Figure 3-16: Well 413 Extraction Rate and Water Level

3.3.4 New East Plant Multi-Level Extraction Wells

Well 421

Extraction well 421 was brought on stream in mid-September. It draws water primarily from the lower zone. Since startup, the extraction rate has averaged 100 gpm with very little downtime thus far. The current extraction rate goal for well 421 is 125 gpm, however this rate may be revised in 2012 as more data about extraction performance become available (Figure 3-17).



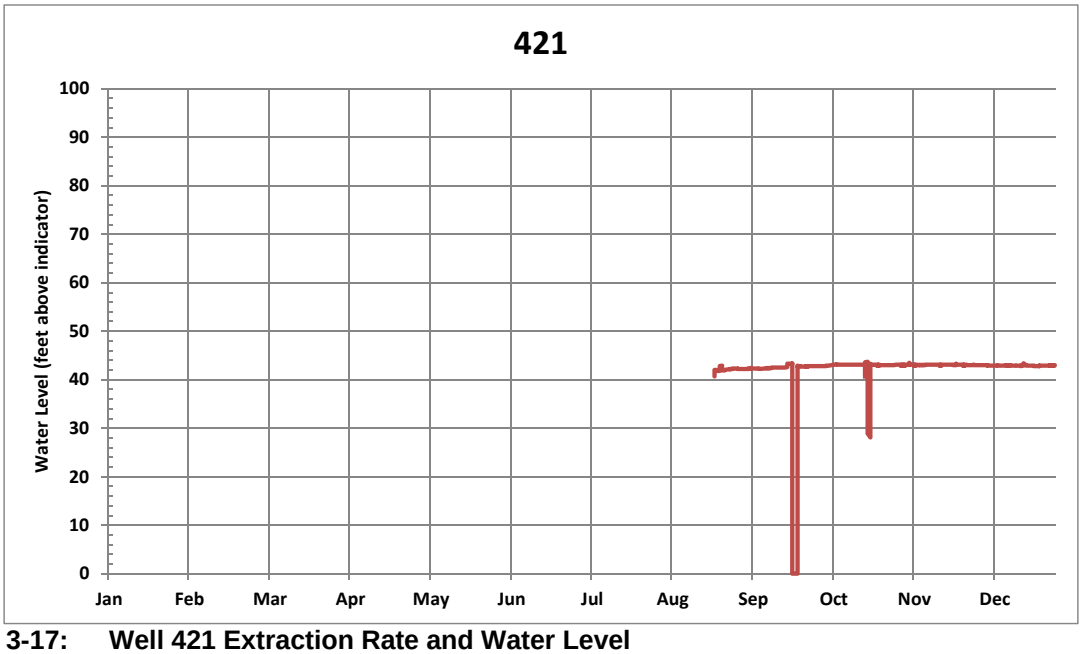


Figure 3-17: Well 421 Extraction Rate and Water Level

Well 422

Extraction well 422 was brought on stream full-time in mid-September to replace well 410 in the extraction system network. It draws water primarily from the lower zone. Since September, the extraction rate has averaged 150 gpm with very little downtime thus far. The current extraction rate for well 422 is 150 gpm, however goal may be revised in 2012 as more data about extraction performance become available (Figure 3-18).

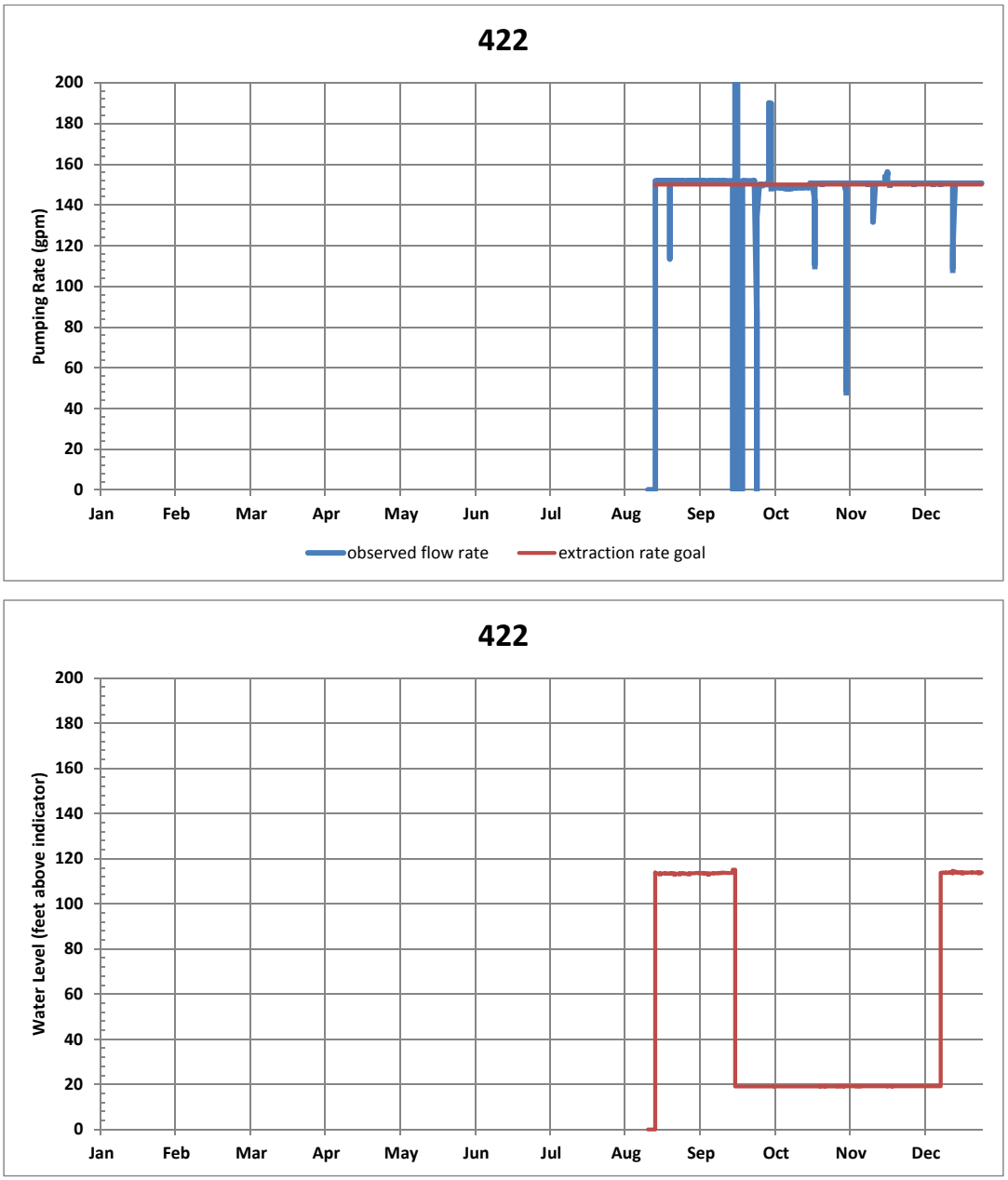


Figure 3-18: Well 422 Extraction Rate and Water Level

3.3.5 Don Plant Facility Water Flows

The Don Plant water balance is complex and it is integral to successful facility operation. Numerous unit operations require different water flows and have different minimum water quality requirements. Flows are continuously measured at key points within the process as part of routine operation and have been reported to EPA on a monthly basis.

- Production Wells Fresh water is pumped from three production wells (SWP-4, SWP-5, and SWP-7). Flows are measured continuously at SWP-5 and SWP-7 and at various downgradient locations. Flows from SWP-4 are calculated from the total downgradient flows and the other production well flows.

- Phosphoric Acid Plant A portion of the production well water is sent to the phosphoric acid plant. Water requirements are driven by process conditions including production rate and associated cooling needs. Flows are measured at four different locations in the phosphoric acid plant and the total flow is reported.

- Extraction Wells Extraction well flows are used in the phosphoric acid plant via the extraction well water collection tank, replacing production well water that was previously used in the phosphoric acid plant. Flows are measured continuously for each extraction well.

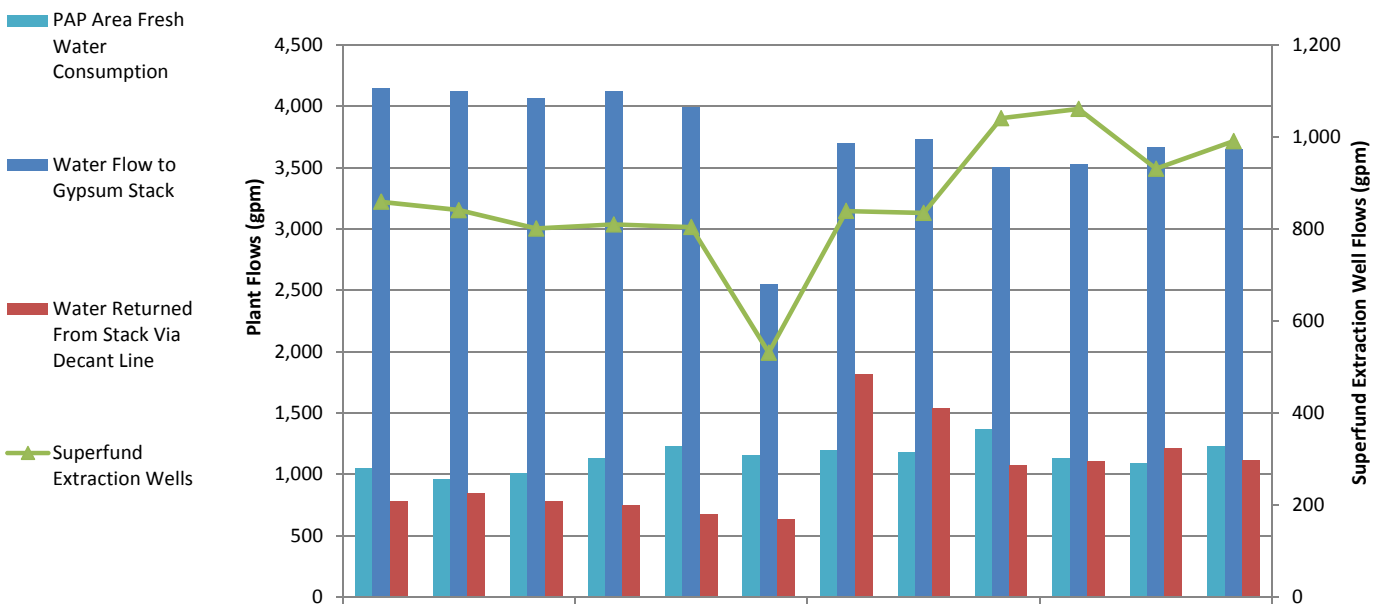
- Water Flows to Gypsum Stack The principal byproduct of the phosphoric acid plant process is gypsum which is slurried to the gypsum stack. The process is operated to maintain the solids content of the slurry within a given range (typically 28 to 32%). Effluent water from the phosphoric acid plant unit operations (such as scrubber water blowdown and reclaimed cooling system blowdown) is used as needed to maintain the required solids content. The slurry density, solids content, and total flow are measured continuously at the gypsum thickeners. The water flow is calculated based on the data collected and the density of gypsum.

- Gypsum Stack Decant Return Water from the gypsum slurry forms ponds on the top of the stack as the gypsum settles out. The extent of the ponded water is managed to allow dike building operations to occur. Water is pumped from the ponded area back to the gypsum thickener sluice water tanks. The flow rate is set by the operators on an as-needed basis.

Monthly water flows related to the phosphoric acid plant for 2011 are shown in Figure 3-19. On average, extraction well water used in the phosphoric acid plant accounted for 43% of the total water used in the phosphoric acid plant in 2011. All rates were negatively impacted in June by the production shutdown and maintenance turnaround.

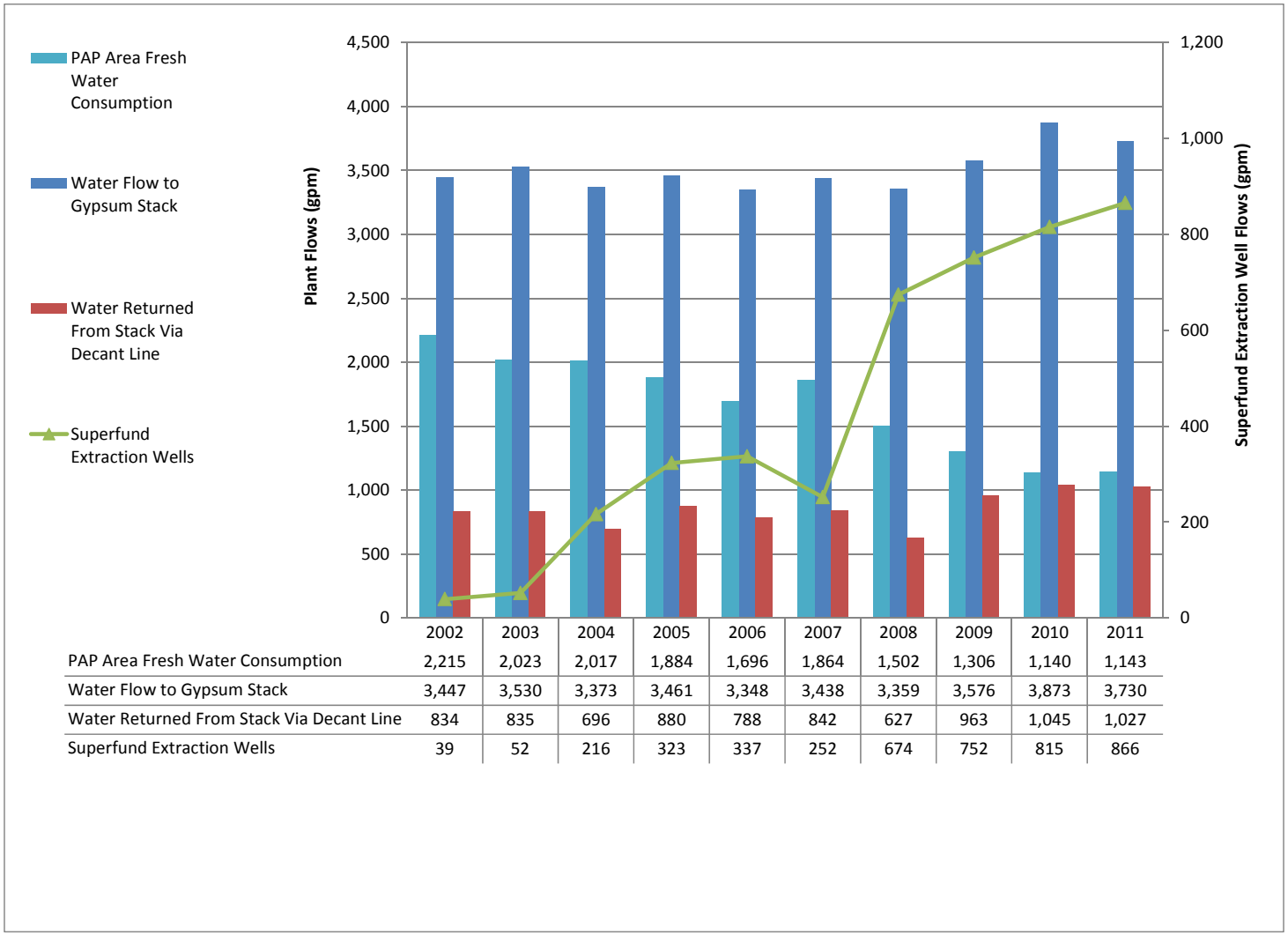
Annual average flows associated with the PAP are shown in Figure 3-20. Since 2002, the average flow from the extraction wells to the PAP Area has increased from less than 50 to over

850 gallons per minute in 2011. Fresh water flows from production wells have been declining as a result of reuse of extraction well water in the PAP Area. Water returned from the gypsum stack as a percentage of flow to the stack has increased slightly. For the period 2002 – 2008, the return water amounted to 23% of the flow to the stack, and for the period 2009 – 2011 it amounted to 27%. As the stack lining project progresses, the portion of water returned from the stack will continue to increase.



	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11
PAP Area Fresh Water Consumption	1,052	959	1,007	1,127	1,228	1,157	1,199	1,178	1,363	1,129	1,087	1,227
Water Flow to Gypsum Stack	4,148	4,119	4,062	4,119	3,993	2,551	3,699	3,729	3,501	3,523	3,664	3,645
Water Returned From Stack Via Decant Line	776	846	782	748	676	630	1,816	1,540	1,073	1,109	1,212	1,117
Superfund Extraction Wells	859	841	801	810	804	531	839	835	1,041	1,061	931	991

Figure 3-19: Monthly Plant Flows



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
PAP Area Fresh Water Consumption	2,215	2,023	2,017	1,884	1,696	1,864	1,502	1,306	1,140	1,143
Water Flow to Gypsum Stack	3,447	3,530	3,373	3,461	3,348	3,438	3,359	3,576	3,873	3,730
Water Returned From Stack Via Decant Line	834	835	696	880	788	842	627	963	1,045	1,027
Superfund Extraction Wells	39	52	216	323	337	252	674	752	815	866

Figure 3-20: Yearly Plant Flows

While the use of production well water in the PAP Area has been declining, overall production well rates remain flat since 2009 at about 2,650 gallons per minute. Rates from individual production wells are plotted for the period 2002 through 2011 in Figure 3-21.

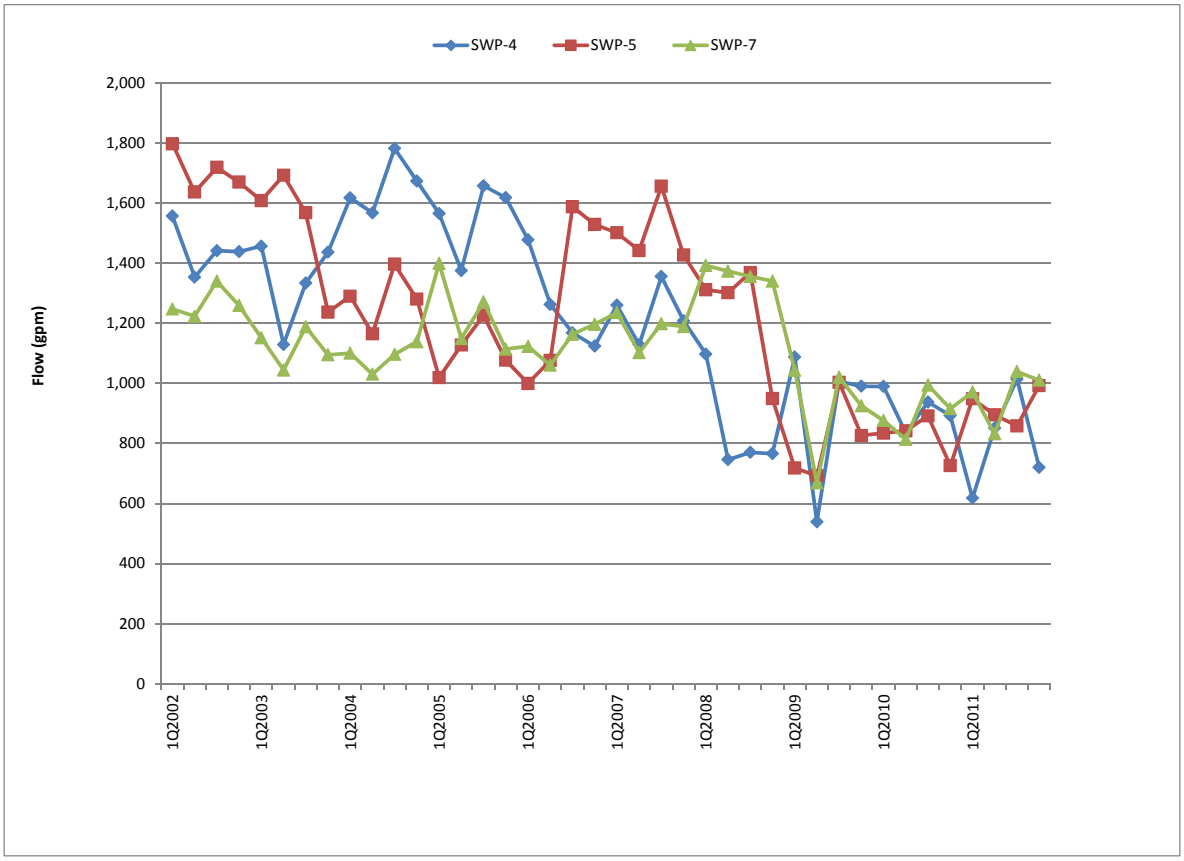


Figure 3-21: Quarterly Production Well Flows

4.0 GROUNDWATER MONITORING

The groundwater monitoring program was designed to provide adequate and appropriate data to address groundwater monitoring objectives and support future decision making in each monitoring area.

The groundwater monitoring system in the Simplot OU has been divided into five sub-areas based on monitoring objectives and performance criteria. The sub-areas are shown in Figure 2-1. The sub-areas are as follows:

- Don Plant Area
- PAP Area (in Don Plant Area)
- Target capture zones (in Don Plant Area)
- Assessment Area
- Compliance Area

Details of each sub-area are provided in Section 2.3 and a summary of the groundwater monitoring objectives and the monitoring locations for each of the monitoring areas is included in the Groundwater and Surface Water Monitoring Plan.

The approach used to design the monitoring program follows EPA's *Guidance for Monitoring at Hazardous Waste Sites: Framework for Monitoring Plan Development and Implementation* (EPA 2004). Consistent with that guidance, the hypotheses that will be tested through monitoring and the decisions to be made based on monitoring data are described in the Groundwater and Surface Water Monitoring Plan. The results presented in this document serve to test the hypotheses stated in the plan and to guide decisions where applicable.

Depending on the results of the data, several different quantitative and statistical methods may be used to support decision making. The statistical methods that may be used are described in the Groundwater and Surface Water Monitoring Plan and are consistent with the methods presented in EPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* (EPA 2009) and widely-accepted statistical practices for groundwater monitoring programs (e.g., EPA 1992; ASTM 2004).

Groundwater sampling methods are discussed in Section 4.1, data review and data quality assurance procedures are discussed in Section 4.2 and site-wide results for groundwater levels and concentrations of arsenic, phosphorus and sulfate are presented in Section 4.3.

4.1 Sampling Activities

Sampling was performed on a quarterly basis in 2011. Table 4-1 lists the analyses performed. Table 4-2 lists the locations where quarterly water quality (WQ) and water levels (GWL) were measured and the stations where only water levels were measured. Figure 4-1, Figure 4-2, and Figure 4-3 illustrate the groundwater quality monitoring locations in the Bedrock, Upper, and Lower Zones. Portneuf River water elevation was also measured at two locations: the Highway 30 Bridge (Station PTRA30 and PTRA30WG), and Batiste Road bridge (Station PBATR).

Table 4-1: Quarterly groundwater monitoring analyte list

Analyte	Method	Reporting Limit (RL) or Field Meter Sensitivity	Units
Field Parameters			
Oxidation Reduction Potential	Field Meter	1 mV	mV
Oxygen, Dissolved	Field Meter	0.1	mg/L
pH	Field Meter	±0.1	SU
Specific Conductivity	Field Meter	5	µmho/cm
Temperature	Field Meter	0.1	^{o}C
Turbidity	Field Meter	±0.1	NTU
General Chemistry			
Alkalinity	SM 2320B	1	mg/L
Chloride	EPA 300.0	0.2	mg/L
Hardness	SM 2340B	0.347	mg/L
Sulfate	EPA 300.0	0.3	mg/L
TDS	SM 2540C	10	mg/L
Metals			
Arsenic	EPA 200.8	0.003	mg/L
Calcium	EPA 200.7	0.04	mg/L
Magnesium	EPA 200.7	0.06	mg/L
Potassium	EPA 200.7	0.5	mg/L
Sodium	EPA 200.7	0.5	mg/L
Nutrients			
Nitrite+Nitrate (as N)	EPA 353.2	0.02	mg/L
Phosphorus, Total	EPA 365.2	0.01	mg/L
	SM-4500-P-E	0.01	mg/L

Table 4-2: Summary of Monitoring Locations by Objective

Monitoring Location	Hydro Unit	Monitoring Data	Well Type	Analyte List	Well Used to Meet Objectives					
					Don Plant Area	PAP Area	Target Capture Zones	Assessment Area	Assess-ment Area (Interim Targets)	Compliance Area
189	Shallow	GWL, WQ	Monitoring Well	Indicator	X		X			
190	Bedrock	GWL, WQ	Monitoring Well	Indicator	X					
191	Shallow	GWL, WQ	Monitoring Well	Indicator	X					
305	Bedrock	GWL, WQ	Monitoring Well	Indicator	X					
307	Shallow	GWL, WQ	Monitoring Well	Indicator	X		X			
308	Shallow	GWL, WQ	Monitoring Well	Indicator	X		X			
309	Deep	GWL, WQ	Monitoring Well	Indicator	X		X			
310	Shallow	GWL, WQ	Monitoring Well	Indicator	X		X			
312	Shallow	GWL, WQ	Monitoring Well	Indicator	X					
313	Bedrock	GWL, WQ	Monitoring Well	Indicator	X					
315	Deep	GWL, WQ	Monitoring Well	Indicator	X					
316	Shallow	GWL	Monitoring Well	None	X					
317	Deep	GWL, WQ	Monitoring Well	Indicator	X		X			
318	Shallow	GWL, WQ	Monitoring Well	Indicator	X		X			
319	Deep	GWL, WQ	Monitoring Well	Indicator	X					
320	Shallow	GWL, WQ	Monitoring Well	Indicator	X					
321	Deep	GWL	Monitoring Well	None	X					
322	Deep	GWL	Monitoring Well	None	X					
323	Bedrock	GWL	Monitoring Well	None	X					
324	Shallow	GWL	Monitoring Well	None	X					

Table 4-2: Summary of Monitoring Locations by Objective

Monitoring Location	Hydro Unit	Monitoring Data	Well Type	Analyte List	Well Used to Meet Objectives					
					Don Plant Area	PAP Area	Target Capture Zones	Assessment Area	Assess-ment Area (Interim Targets)	Compliance Area
325	Shallow	GWL, WQ	Monitoring Well	Indicator	X					
326	Deep	GWL, WQ	Monitoring Well	Indicator	X		X			
327	Shallow	GWL, WQ	Monitoring Well	Indicator	X					
328	Shallow	GWL, WQ	Monitoring Well	Indicator	X					
329	Deep	GWL	Monitoring Well	None	X					
330	Deep	GWL	Monitoring Well	None	X					
331	Shallow	GWL, WQ	Monitoring Well	Indicator	X					
332	Shallow	GWL, WQ	Monitoring Well	Indicator	X					
333	Shallow	GWL, WQ	Monitoring Well	Indicator	X					
334	Shallow	GWL, WQ	Monitoring Well	Indicator	X					
335D	Deep	GWL, WQ	Monitoring Well	Indicator	X					
335S	Shallow	GWL, WQ	Monitoring Well	Indicator	X					
336	Shallow	GWL, WQ	Monitoring Well	Indicator	X		X			
337	Deep	GWL	Monitoring Well	None	X		X			
338	Shallow	GWL, WQ	Monitoring Well	Indicator	X					
339	Shallow	GWL	Monitoring Well	None	X		X			
340	Shallow	GWL, WQ	Monitoring Well	Indicator	X	X	X			
341	Shallow	GWL, WQ	Monitoring Well	Indicator	X					
342	Shallow	GWL, WQ	Monitoring Well	Indicator	X					
344	Deep	GWL	Monitoring Well	None	X		X			

Table 4-2: Summary of Monitoring Locations by Objective

Monitoring Location	Hydro Unit	Monitoring Data	Well Type	Analyte List	Well Used to Meet Objectives					
					Don Plant Area	PAP Area	Target Capture Zones	Assessment Area	Assess-ment Area (Interim Targets)	Compliance Area
346	Deep	GWL, WQ	Monitoring Well	Indicator	X					
347	Deep	GWL, WQ	Monitoring Well	Indicator	X					
348	Shallow	GWL, WQ	Monitoring Well	Indicator	X					
350	Shallow	GWL, WQ	Monitoring Well	Indicator	X					
351	Bedrock	GWL, WQ	Monitoring Well	Indicator	X					
352		GWL	Monitoring Well	None	X					
353	Shallow	GWL	Monitoring Well	None	X					
354	Shallow	GWL, WQ	Monitoring Well	Indicator	X					
355	Bedrock Shallow	GWL	Monitoring Well	None	X					
356	Shallow	GWL, WQ	Monitoring Well	Indicator	X					
357	Shallow	GWL, WQ	Monitoring Well	Indicator	X					
358	Shallow	GWL, WQ	Monitoring Well	Indicator	X					
361AR	Deep	GWL, WQ	ZIST Well	Indicator	X		X			
361BR	Deep	GWL	ZIST Well	None	X		X			
361CR	Deep	GWL	ZIST Well	None	X		X			
361DR	Bedrock	GWL	ZIST Well	None	X		X			
362	Shallow	GWL, WQ	Monitoring Well	Indicator	X		X			
363AR	Deep	GWL, WQ	ZIST t Well	Indicator	X		X			
363BR	Deep	GWL	ZIST Well	None	X		X			
363CR	Bedrock	GWL	ZIST Well	None	X		X			

Table 4-2: Summary of Monitoring Locations by Objective

Monitoring Location	Hydro Unit	Monitoring Data	Well Type	Analyte List	Well Used to Meet Objectives					
					Don Plant Area	PAP Area	Target Capture Zones	Assessment Area	Assess-ment Area (Interim Targets)	Compliance Area
364AR	Deep	GWL, WQ	ZIST Well	Indicator	X		X			
364BR	Deep	GWL	ZIST Well	None	X		X			
364CR	Bedrock	GWL	ZIST Well	None	X		X			
365	Shallow	GWL, WQ	Monitoring Well	Indicator	X		X			
366AR	Deep	GWL, WQ	ZIST Well	Indicator	X		X			
366BR	Deep	GWL	ZIST Well	None	X		X			
366CR	Bedrock	GWL	ZIST Well	None	X		X			
367	Shallow	GWL, WQ	Monitoring Well	Indicator	X	X	X			
368AR	Deep	GWL	ZIST Well	None	X		X			
368BR	Bedrock	GWL	ZIST Well	None	X		X			
369	Shallow	GWL, WQ	Monitoring Well	Indicator	X	X	X			
370	Shallow	GWL, WQ	Monitoring Well	Indicator	X	X	X			
371	Shallow	GWL, WQ	Monitoring Well	Indicator	X	X	X			
372	Shallow	GWL, WQ	Monitoring Well	Indicator	X	X	X			
373	Shallow	GWL, WQ	Monitoring Well	Indicator	X	X	X			
374	Shallow	GWL, WQ	Monitoring Well	Indicator	X	X	X			
375	Shallow	GWL, WQ	Monitoring Well	Indicator	X		X			
376A	Deep	GWL, WQ	Monitoring Well	Indicator	X		X			
376B	Deep	GWL, WQ	Monitoring Well	Indicator	X		X			
376C	Deep	GWL, WQ	Monitoring Well	Indicator	X		X			

Table 4-2: Summary of Monitoring Locations by Objective

Monitoring Location	Hydro Unit	Monitoring Data	Well Type	Analyte List	Well Used to Meet Objectives					
					Don Plant Area	PAP Area	Target Capture Zones	Assessment Area	Assess-ment Area (Interim Targets)	Compliance Area
401	Shallow	GWL, WQ	Extraction Well	Indicator	X		X			
402	Shallow	GWL, WQ	Extraction Well	Indicator	X		X			
403	Shallow	GWL, WQ	Monitoring Well	None	X		X			
404	Shallow	GWL, WQ	Extraction Well	Indicator	X		X			
405	Shallow	GWL, WQ	Monitoring Well	None	X		X			
406	Shallow	GWL, WQ	Extraction Well	Indicator	X		X			
407	Shallow	GWL, WQ	Extraction Well	None	X		X			
408	Shallow	GWL, WQ	Monitoring Well	Indicator	X		X			
409	Shallow	GWL, WQ	Extraction Well	Indicator	X		X			
410	Deep	GWL, WQ	Monitoring Well	None	X		X			
411	Deep	GWL, WQ	Extraction Well	Indicator	X		X			
412	Multilev	GWL, WQ	Extraction Well	Indicator	X		X			
413	Multilev	GWL, WQ	Extraction Well	Indicator	X		X			
414	Shallow	GWL, WQ	Extraction Well	Indicator	X	X	X			
415	Multilev	GWL, WQ	Extraction Well	Indicator	X		X			
416	Shallow	GWL, WQ	Extraction Well	Indicator	X	X	X			
417	Shallow	GWL, WQ	Monitoring Well	Indicator	X	X	X			
418	Shallow	GWL, WQ	Monitoring Well	Indicator	X	X	X			
419	Shallow	GWL, WQ	Extraction Well	Indicator	X	X	X			
420	Shallow	GWL, WQ	Monitoring Well	Indicator	X	X	X			

Table 4-2: Summary of Monitoring Locations by Objective

Monitoring Location	Hydro Unit	Monitoring Data	Well Type	Analyte List	Well Used to Meet Objectives					
					Don Plant Area	PAP Area	Target Capture Zones	Assessment Area	Assess-ment Area (Interim Targets)	Compliance Area
421	Multilev	GWL, WQ	Extraction Well	Expanded			X			
422	Multilev	GWL, WQ	Extraction Well	Expanded			X			
503	Shallow	GWL, WQ	Monitoring Well	Indicator				X		
504	Deep	GWL, WQ	Monitoring Well	Expanded				X		X
505	Shallow	GWL, WQ	Monitoring Well	Expanded				X		X
506	Shallow	GWL	Monitoring Well	None				X		
507	Shallow	GWL	Monitoring Well	None				X		
508	Deep	GWL	Monitoring Well	None				X		
509	Shallow	GWL	Monitoring Well	None				X		
509A	Shallow	GWL	Monitoring Well	None				X		
510	Deep	GWL	Monitoring Well	None				X		
511	Shallow	GWL	Monitoring Well	None				X		
511A	Shallow	GWL	Monitoring Well	None				X		
512	Deep	GWL	Monitoring Well	None				X		
513	Shallow	GWL	Monitoring Well	None				X		
518	Shallow	GWL, WQ	Monitoring Well	Indicator				X		
519	Deep	GWL, WQ	Monitoring Well	Indicator				X		
520	Shallow	GWL	Monitoring Well	None				X		
524	Deep	GWL, WQ	Monitoring Well	Expanded				X		X
525	Shallow	GWL, WQ	Monitoring Well	Expanded				X		X

Table 4-2: Summary of Monitoring Locations by Objective

Monitoring Location	Hydro Unit	Monitoring Data	Well Type	Analyte List	Well Used to Meet Objectives					
					Don Plant Area	PAP Area	Target Capture Zones	Assessment Area	Assess-ment Area (Interim Targets)	Compliance Area
526	Deep	GWL, WQ	Monitoring Well	Indicator				X	X	
527	Shallow	GWL, WQ	Monitoring Well	Indicator				X	X	
528AR	Shallow	GWL, WQ	ZIST Well	Indicator				X	X	
528BR	Deep	GWL, WQ	ZIST Well	Indicator				X	X	
528CR	Deep	GWL, WQ	ZIST Well	Indicator				X	X	
528DR	Deep	GWL, WQ	ZIST Well	Indicator				X	X	
529AR	Shallow	GWL, WQ	ZIST Well	Indicator				X	X	
529BR	Shallow	GWL, WQ	ZIST Well	Indicator				X	X	
529CR	Deep	GWL, WQ	ZIST Well	Indicator				X	X	
529DR	Deep	GWL, WQ	ZIST Well	Indicator				X	X	
530A	Shallow	GWL, WQ	Monitoring Well	Indicator				X	X	
530B	Shallow	GWL, WQ	Monitoring Well	Indicator				X	X	
530C	Deep	GWL, WQ	Monitoring Well	Indicator				X	X	
531A	Shallow	GWL, WQ	Monitoring Well	Indicator				X	X	
531B	Shallow	GWL, WQ	Monitoring Well	Indicator				X	X	
531C	Deep	GWL, WQ	Monitoring Well	Indicator				X	X	
532A	Shallow	GWL, WQ	Monitoring Well	Indicator				X	X	
532B	Shallow	GWL, WQ	Monitoring Well	Indicator				X	X	
532C	Deep	GWL, WQ	Monitoring Well	Indicator				X	X	
533A	Shallow	GWL, WQ	Monitoring Well	Indicator				X		

Table 4-2: Summary of Monitoring Locations by Objective

Monitoring Location	Hydro Unit	Monitoring Data	Well Type	Analyte List	Well Used to Meet Objectives					
					Don Plant Area	PAP Area	Target Capture Zones	Assessment Area	Assess-ment Area (Interim Targets)	Compliance Area
533B	Shallow	GWL, WQ	Monitoring Well	Indicator				X		
533C	Deep	GWL, WQ	Monitoring Well	Indicator				X		
534A	Shallow	GWL, WQ	Monitoring Well	Expanded				X		X
534B	Shallow	GWL, WQ	Monitoring Well	Expanded				X		X
535A	Shallow	GWL, WQ	Monitoring Well	Indicator				X	X	
535B	Shallow	GWL, WQ	Monitoring Well	Indicator				X	X	
535C	Deep	GWL, WQ	Monitoring Well	Indicator				X	X	
536A	Shallow	GWL, WQ	Monitoring Well	Indicator				X	X	
536B	Shallow	GWL, WQ	Monitoring Well	Indicator				X	X	
536C	Deep	GWL, WQ	Monitoring Well	Indicator				X	X	
537A	Shallow	GWL, WQ	Monitoring Well	Expanded				X		X
537B	Shallow	GWL, WQ	Monitoring Well	Expanded				X		X
538A	Shallow	GWL, WQ	Monitoring Well	Expanded				X		X
538B	Shallow	GWL, WQ	Monitoring Well	Expanded				X		X
539A	Shallow	GWL, WQ	Monitoring Well	Expanded				X		X
539B	Shallow	GWL, WQ	Monitoring Well	Expanded				X		X
539C	Shallow	GWL, WQ	Monitoring Well	Expanded				X		X
540A	Shallow	GWL, WQ	Monitoring Well	Indicator				X		
540B	Shallow	GWL, WQ	Monitoring Well	Indicator				X		
540C	Deep	GWL, WQ	Monitoring Well	Indicator				X		

Table 4-2: Summary of Monitoring Locations by Objective

Monitoring Location	Hydro Unit	Monitoring Data	Well Type	Analyte List	Well Used to Meet Objectives					
					Don Plant Area	PAP Area	Target Capture Zones	Assessment Area	Assess-ment Area (Interim Targets)	Compliance Area
541A	Shallow	GWL, WQ	Monitoring Well	Indicator				X		
541B	Shallow	GWL, WQ	Monitoring Well	Indicator				X		
630	Shallow	GWL	Monitoring Well	None				X		
640	Shallow	GWL	Monitoring Well	None				X		
650	Shallow	GWL	Monitoring Well	None				X		
Batiste Spring (BTS)	Shallow	GWL, WQ	Spring	Expanded				X		X
Spring at Batiste Road (BRS)	Shallow	GWL, WQ	Spring	Expanded				X		X
Portneuf River at Batiste Road (PBATR)	River	GWL	River	None				X		
Portneuf River at Hwy 30 (PTRA30)	River	GWL	River	None				X		
SWP-4	Deep	WQ	Production Well	Indicator	X		X			
SWP-5	Deep	WQ	Production Well	Indicator	X		X			
SWP-7	Deep	WQ	Production Well	Indicator	X		X			
TW-11S	Shallow	GWL, WQ	Monitoring Well	Indicator				X		
TW-12S	Shallow	GWL, WQ	Monitoring Well	Indicator				X		

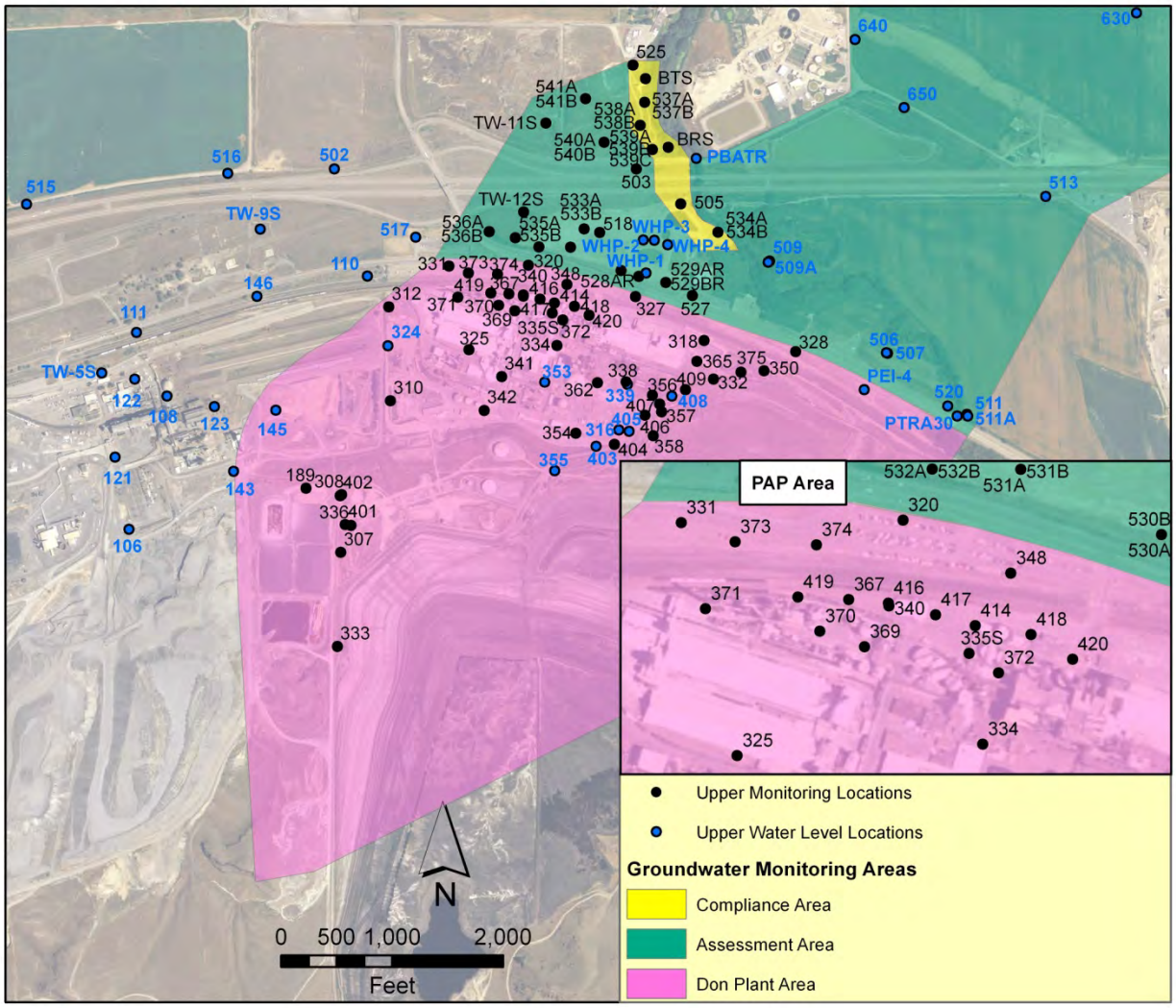


Figure 4-1: Groundwater quality monitoring locations in the Upper Zone, 2011

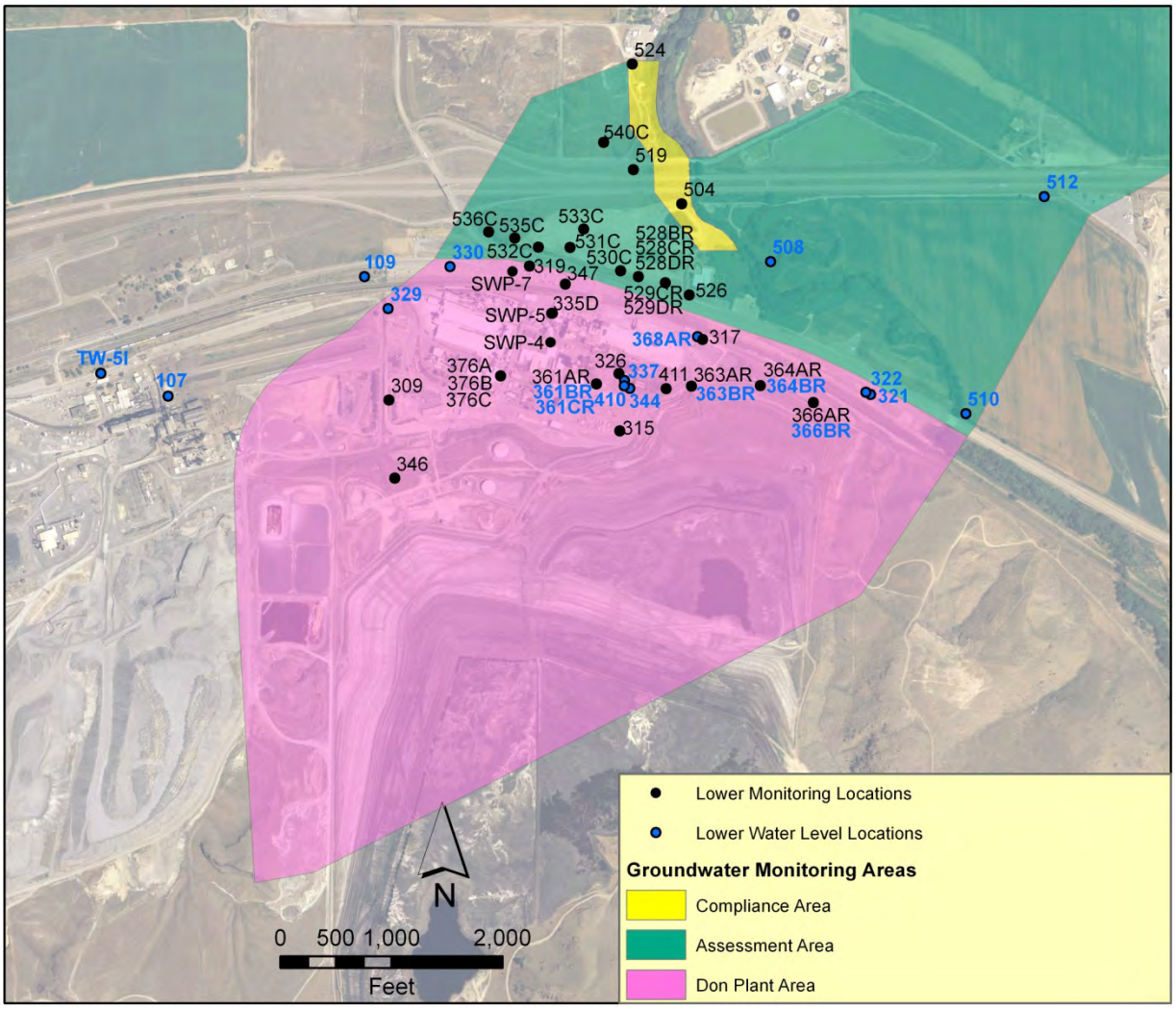


Figure 4-2: Groundwater quality monitoring locations in the Lower Zone, 2011

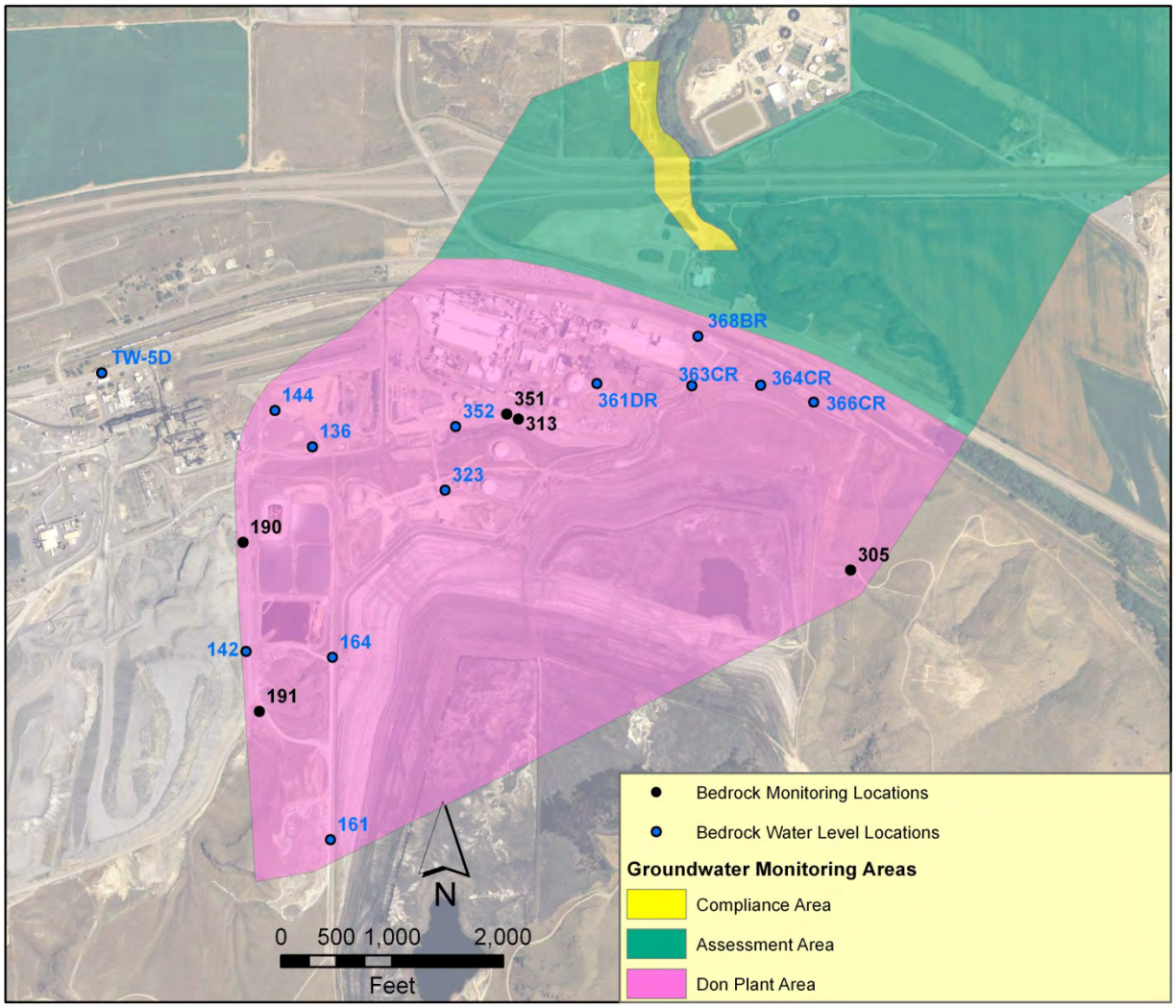


Figure 4-3: Groundwater quality monitoring locations in the Bedrock Zone, 2011

4.2 Groundwater Data Review and Quality

This section describes the QC policies and procedures which ensured that the data collected in the field and analyzed by the laboratory were of appropriate quality to meet the sampling objectives.

Equipment rinsate samples and field duplicate samples were collected to evaluate the accuracy and reproducibility of the field sampling methods. The equipment rinsates and field duplicates were analyzed for the same suite of analytical parameters as the original sample.

The commercial laboratory (SVL) performed the requested analyses in accordance with referenced EPA methods and operated under an internal QA Management Plan.

The data were reviewed and evaluated along with the sample results (including field duplicate and bottle/preservation blank and/or equipment blank results) to confirm that the data met the DQOs. Any data not meeting the quality requirements were flagged and appropriately qualified.

Complete raw data packages from the laboratory were evaluated to assess compliance with DQIs. Data review included reviewing Chain of Custody forms, calibration requirements, evaluating accuracy of chemical data, and reviewing data for transcription errors, detection limit discrepancies, data omissions, and suspect or anomalous values.

Data validation was performed and a checklist of the validation process was prepared to document the review process and results.

All 2011 groundwater data are provided in Appendix A. Validated laboratory data for metals and general chemistry are provided in Tables A-1 and A-2, respectively. Field measurement data are provided in Table A-3.

4.3 Site-Wide Groundwater Trends

4.3.1 Groundwater Levels

This section presents the potentiometric surface elevations throughout 2011. The potentiometric surfaces were generally consistent among all quarters and support the basic conceptual site model. Water level data from 2011 are provided in Appendix A, table A-4.

4.3.1.1 Upper Zone

Groundwater surface elevations and the interpreted potentiometric surfaces for each quarter in the Upper Zone are presented in Figure 4-4, Figure 4-5, Figure 4-6, and Figure 4-7.

Water levels were highest across the Site in the Upper Zone during the April sampling event and at the lowest levels in February. Groundwater elevations varied by 0.36 to 10.33 feet during the year in individual wells.

The potentiometric surface in the Upper Zone illustrates a significant decrease in hydraulic gradient at the northern boundary of the Don Plant facility area. This pattern is consistent with an increase in hydraulic conductivity observed in aquifer materials. An increase in hydraulic gradient at the toe of the gypsum stack and in the West Plant Area (beneath and south of the closed FMC calciner ponds) is consistent with lower hydraulic conductivities observed in these areas.

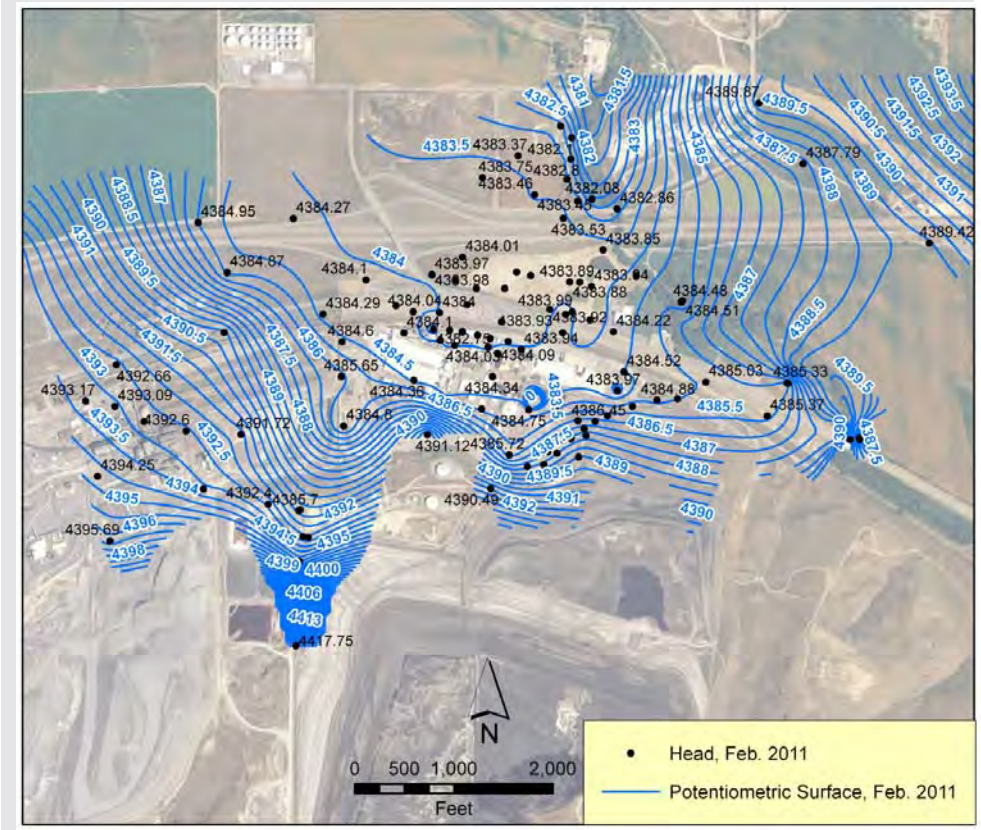


Figure 4-4: Interpreted potentiometric surfaces for Upper Zone, first quarter 2011

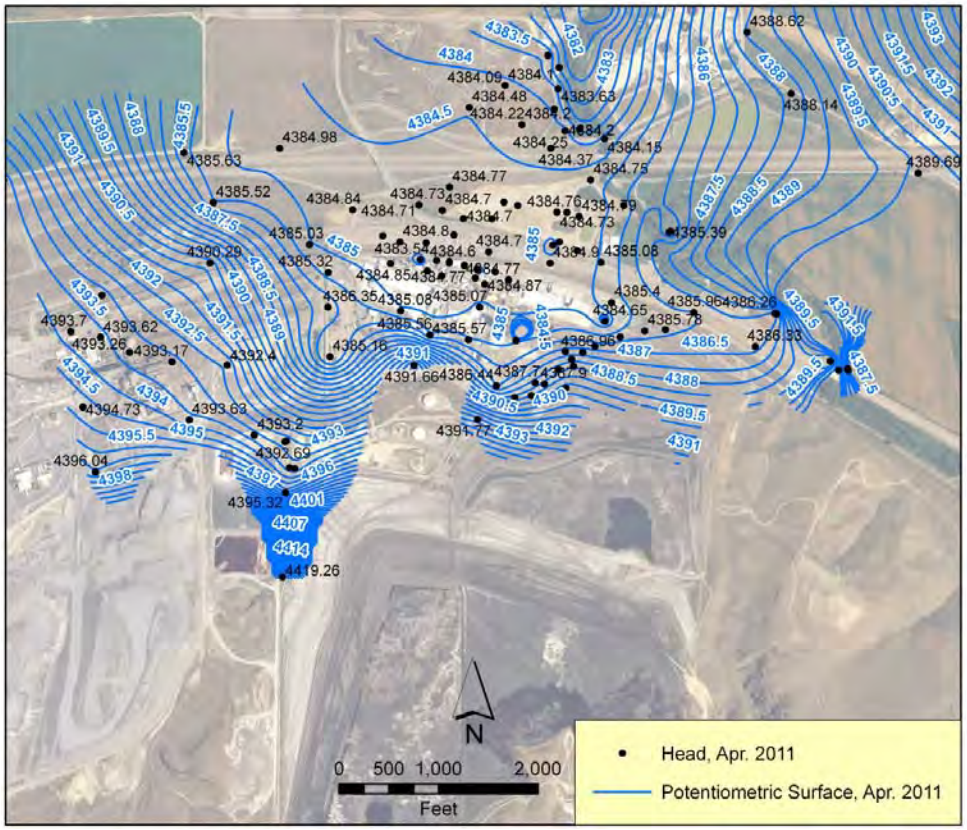


Figure 4-5: Interpreted potentiometric surfaces for Upper Zone, second quarter 2011

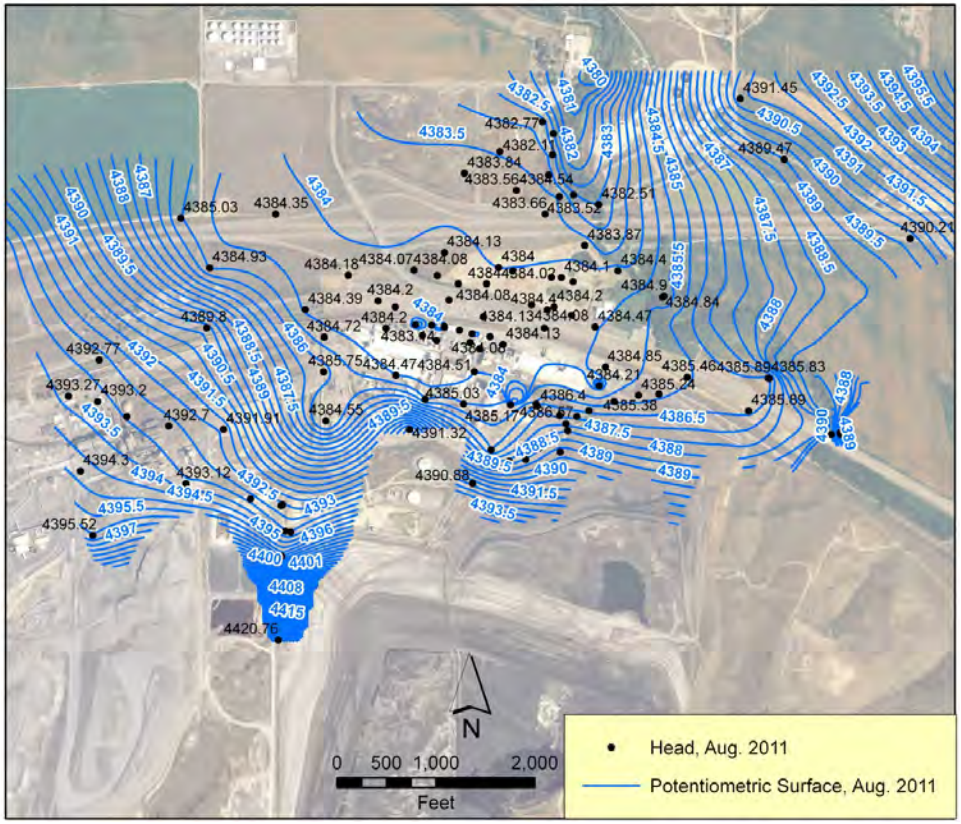


Figure 4-6: Interpreted potentiometric surfaces for Upper Zone, third quarter 2011

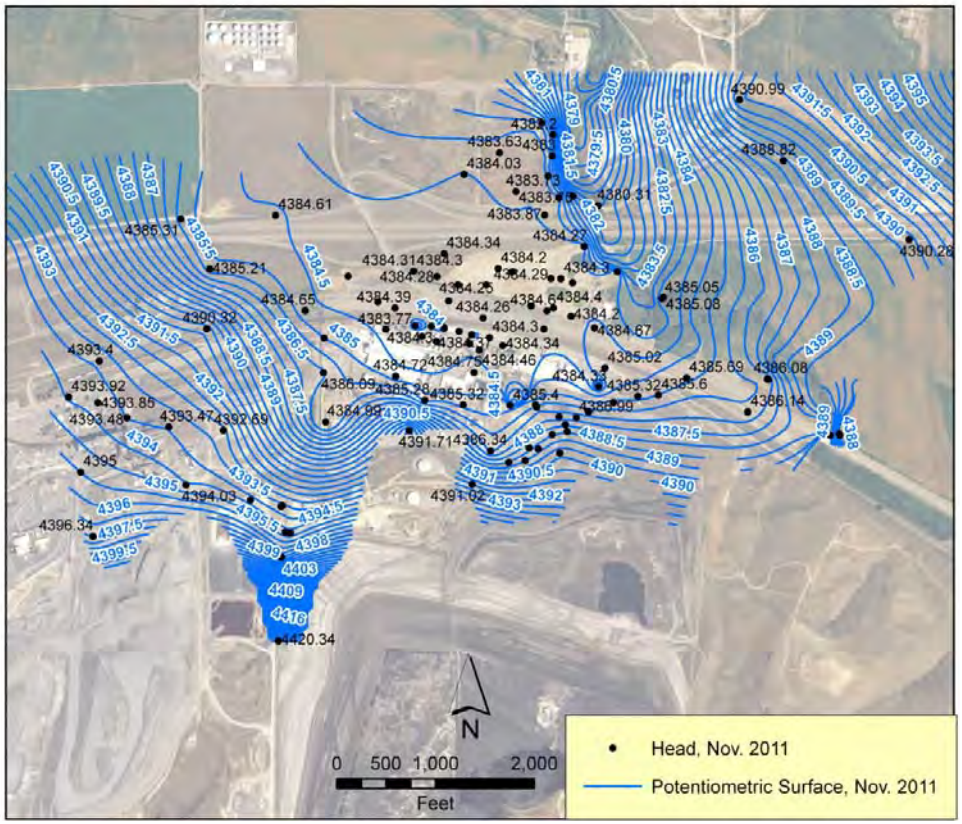


Figure 4-7: Interpreted potentiometric surfaces for Upper Zone, fourth quarter 2011

4.3.1.2 Lower Zone

Groundwater surface elevations and the interpreted potentiometric surfaces for each quarter in the Lower Zone are presented in Figure 4-8, Figure 4-9, Figure 4-10, and Figure 4-11.

Water levels were highest across the site in the Lower Zone during the April sampling event and at the lowest levels in February. Groundwater elevations varied by 0.58 to 18.17 feet during the year in individual wells.

An increase in hydraulic gradient at the toe of the gypsum stack is consistent with lower hydraulic conductivities observed in this area.

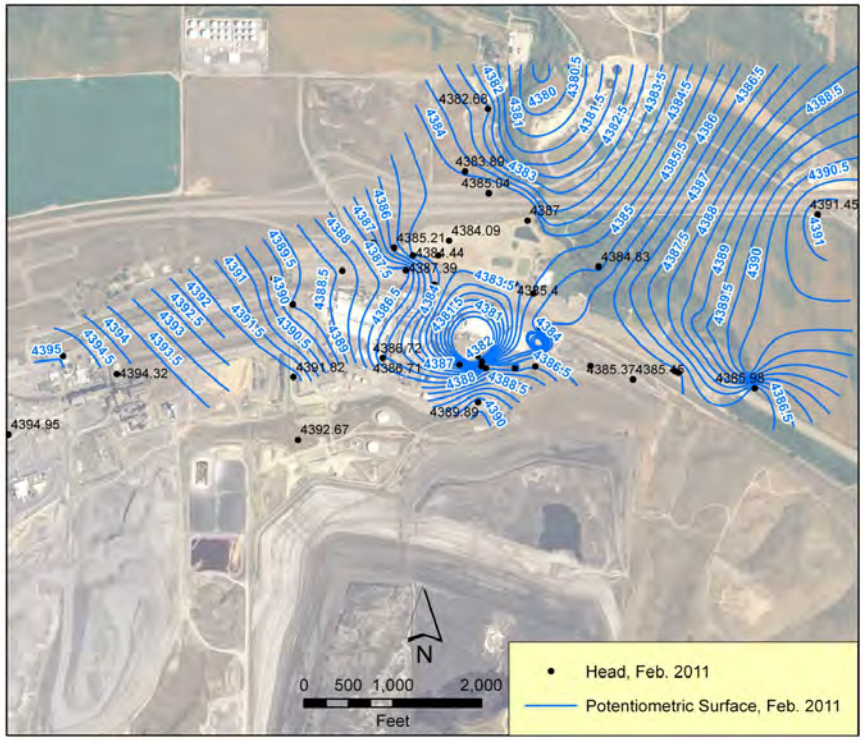


Figure 4-8: Interpreted potentiometric surfaces for Lower Zone, first quarter 2011

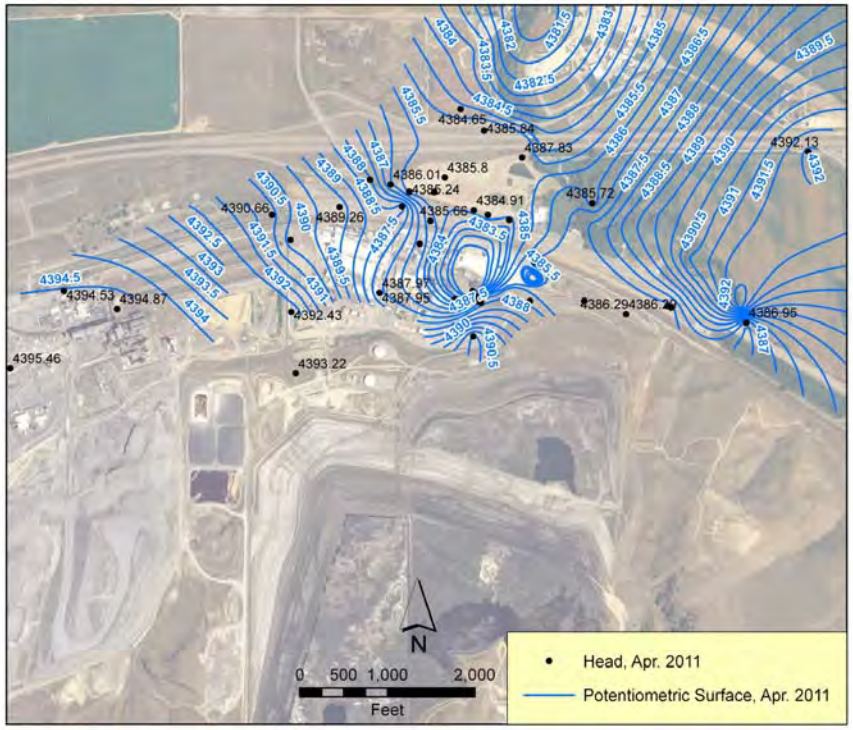


Figure 4-9: Interpreted potentiometric surfaces for Lower Zone, second quarter 2011

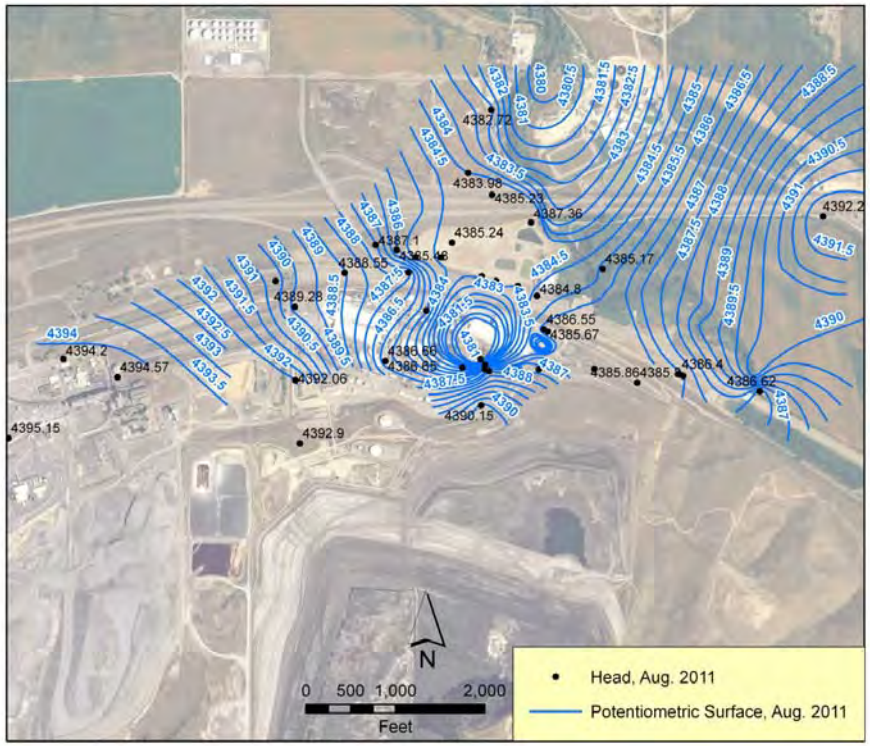


Figure 4-10: Interpreted potentiometric surfaces for Lower Zone, third quarter 2011

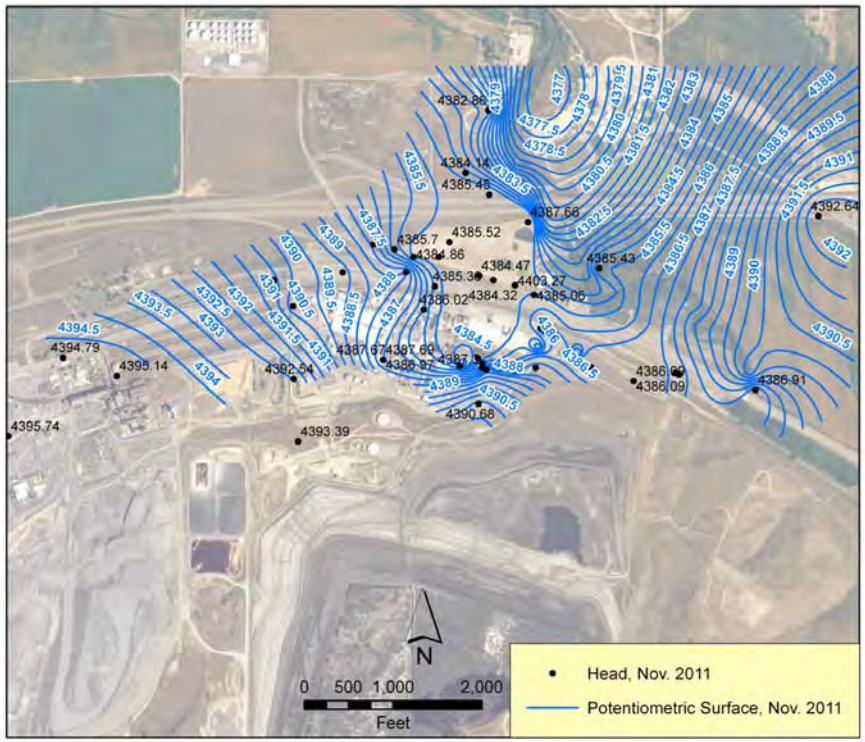


Figure 4-11: Interpreted potentiometric surfaces for Lower Zone, fourth quarter 2011

4.3.1.3 Bedrock

Groundwater surface elevations and the interpreted potentiometric surfaces for each quarter in the Bedrock are presented in Figure 4-12, Figure 4-13, Figure 4-14, and Figure 4-15.

Water levels were highest in April and lowest during the February sampling event. Groundwater elevations varied by 0.12 to 1.98 feet during the year in individual wells.

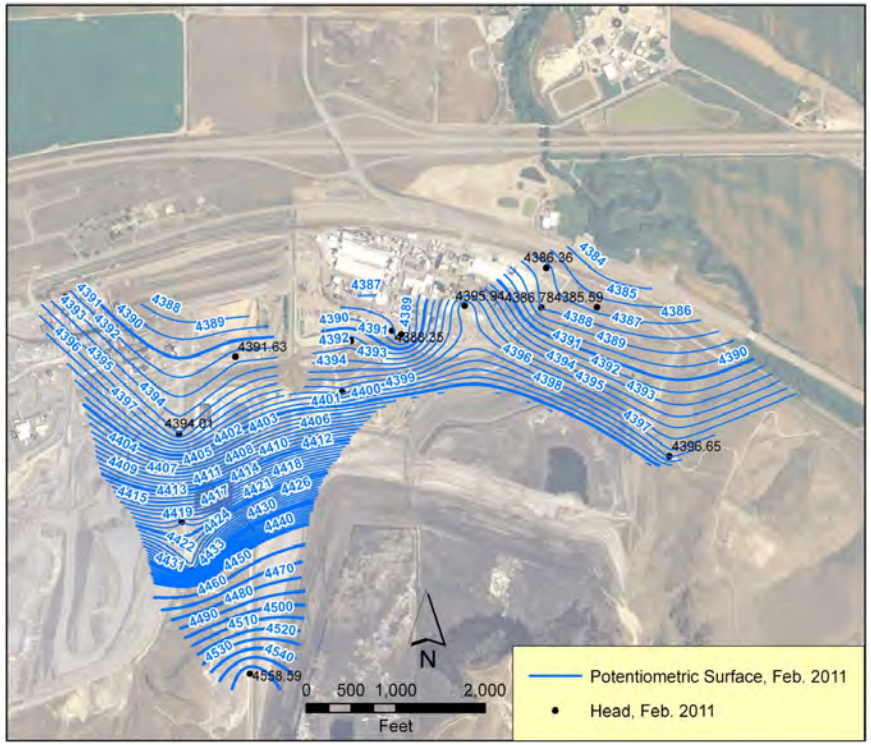


Figure 4-12: Interpreted potentiometric surfaces for Bedrock, first quarter 2011

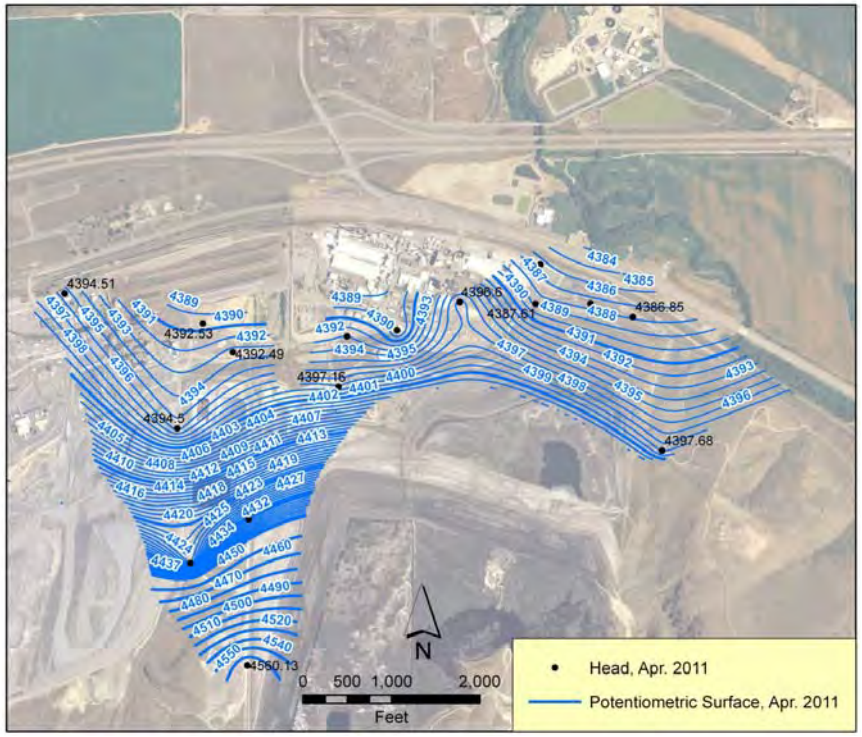


Figure 4-13: Interpreted potentiometric surfaces for Bedrock, second quarter 2011

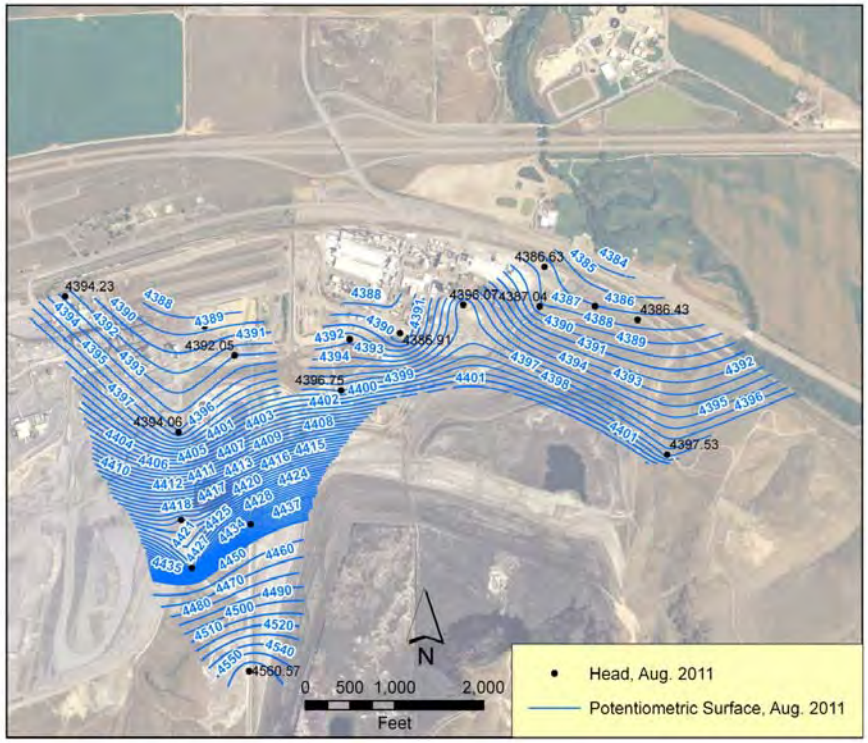


Figure 4-14: Interpreted potentiometric surfaces for Bedrock, third quarter 2011

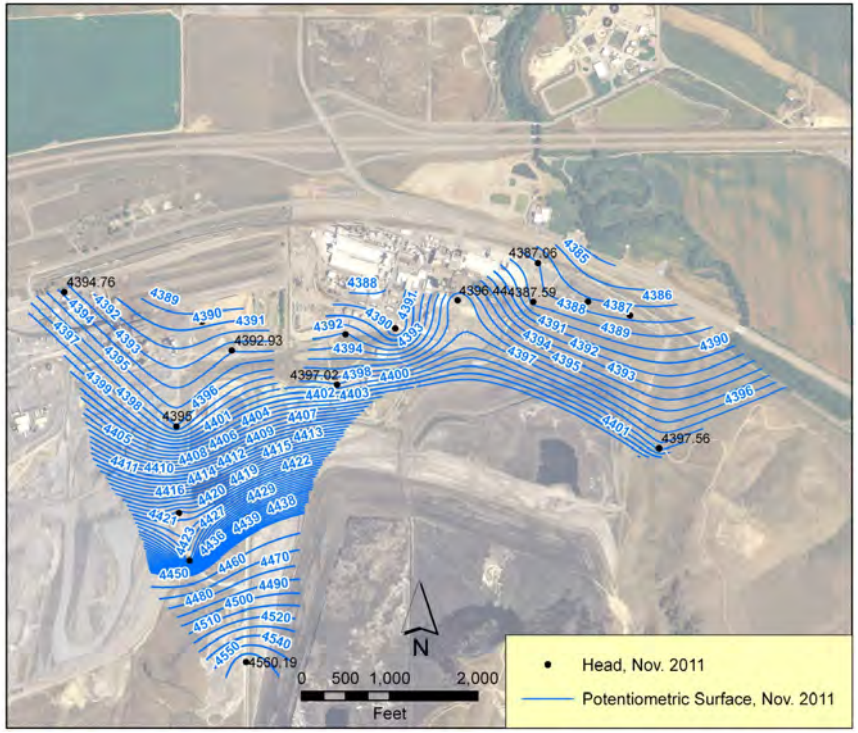


Figure 4-15: Interpreted potentiometric surfaces for Bedrock, fourth quarter 2011

4.3.2 Groundwater Chemistry

4.3.2.1 Arsenic

Figure 4-16, Figure 4-17, Figure 4-18, and Figure 4-19 illustrate the spatial distribution of arsenic in the Upper and Lower Zones and Bedrock during 2011. The general spatial distribution is consistent throughout the year and supports the basic conceptual site model.

The highest arsenic concentrations were measured in the target extraction areas (East and West Plant Areas) and in the Upper Zone beneath and downgradient of the PAP.

Concentrations decrease downgradient as groundwater migrates to the Portneuf River area.

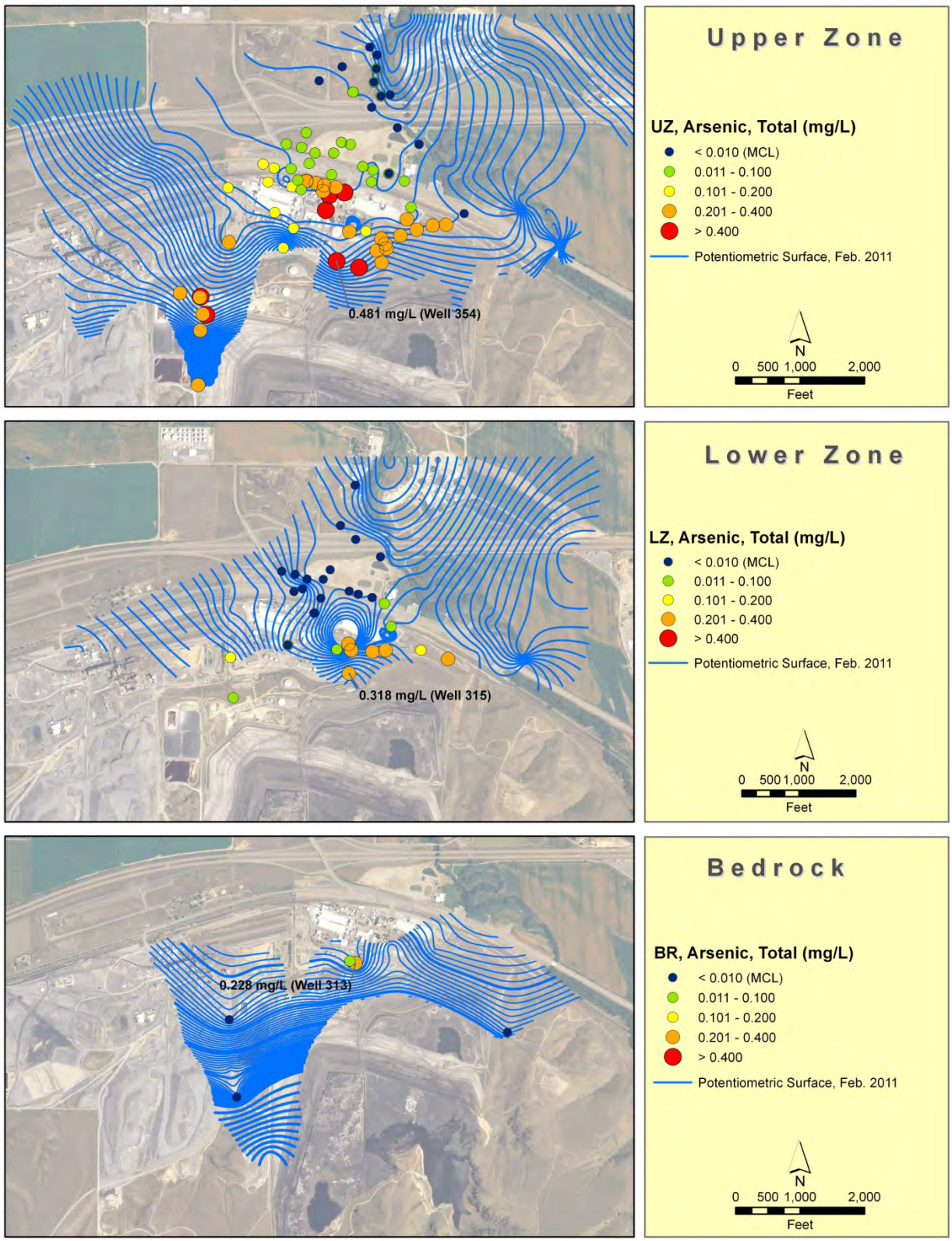


Figure 4-16: Post plots of arsenic (total) in Upper, Lower Zones, and Bedrock, first quarter 2011. Maximum observed concentrations are posted.

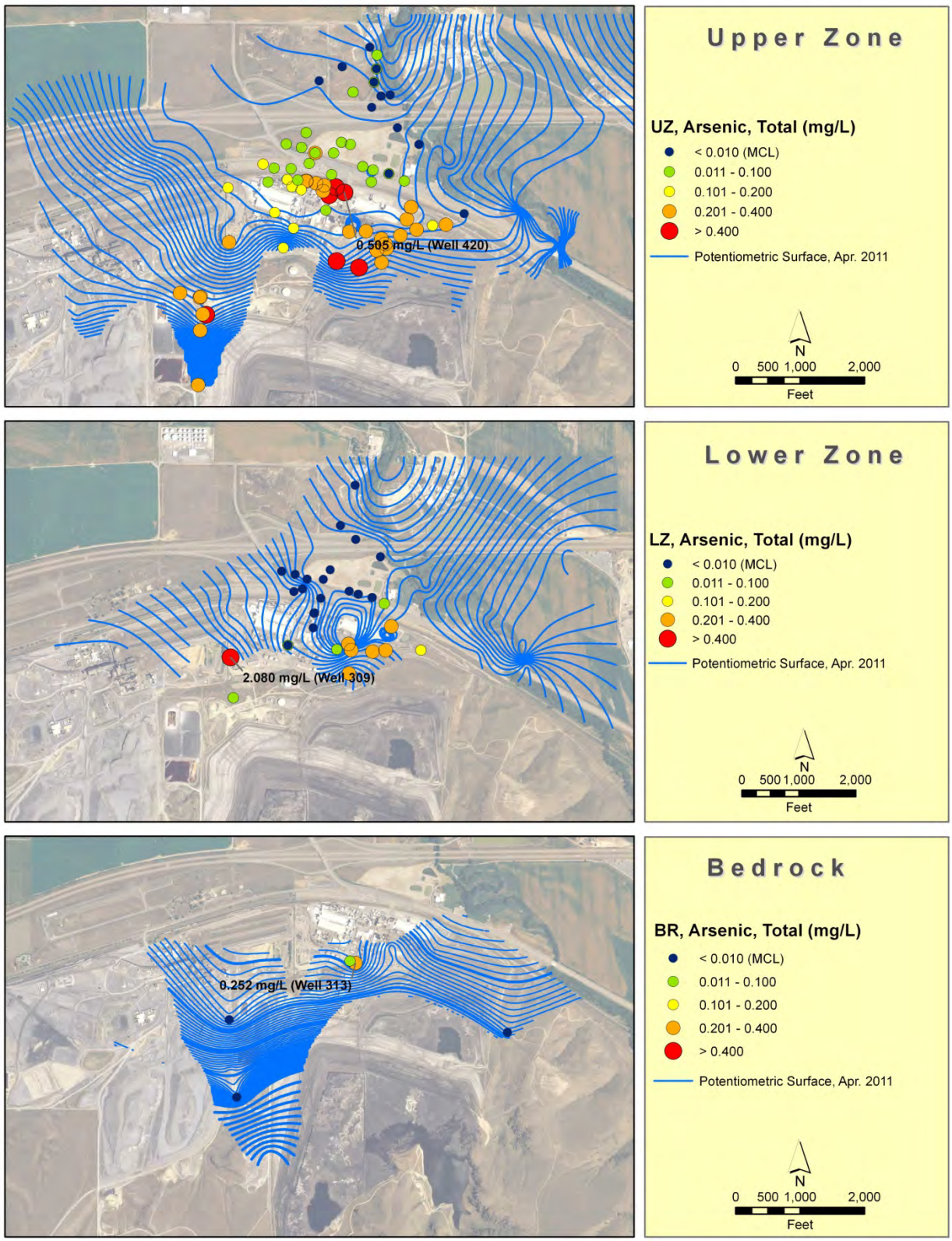


Figure 4-17: Post plots of arsenic (total) in Upper, and Lower Zones, and Bedrock second quarter 2011. Maximum observed concentrations are posted.

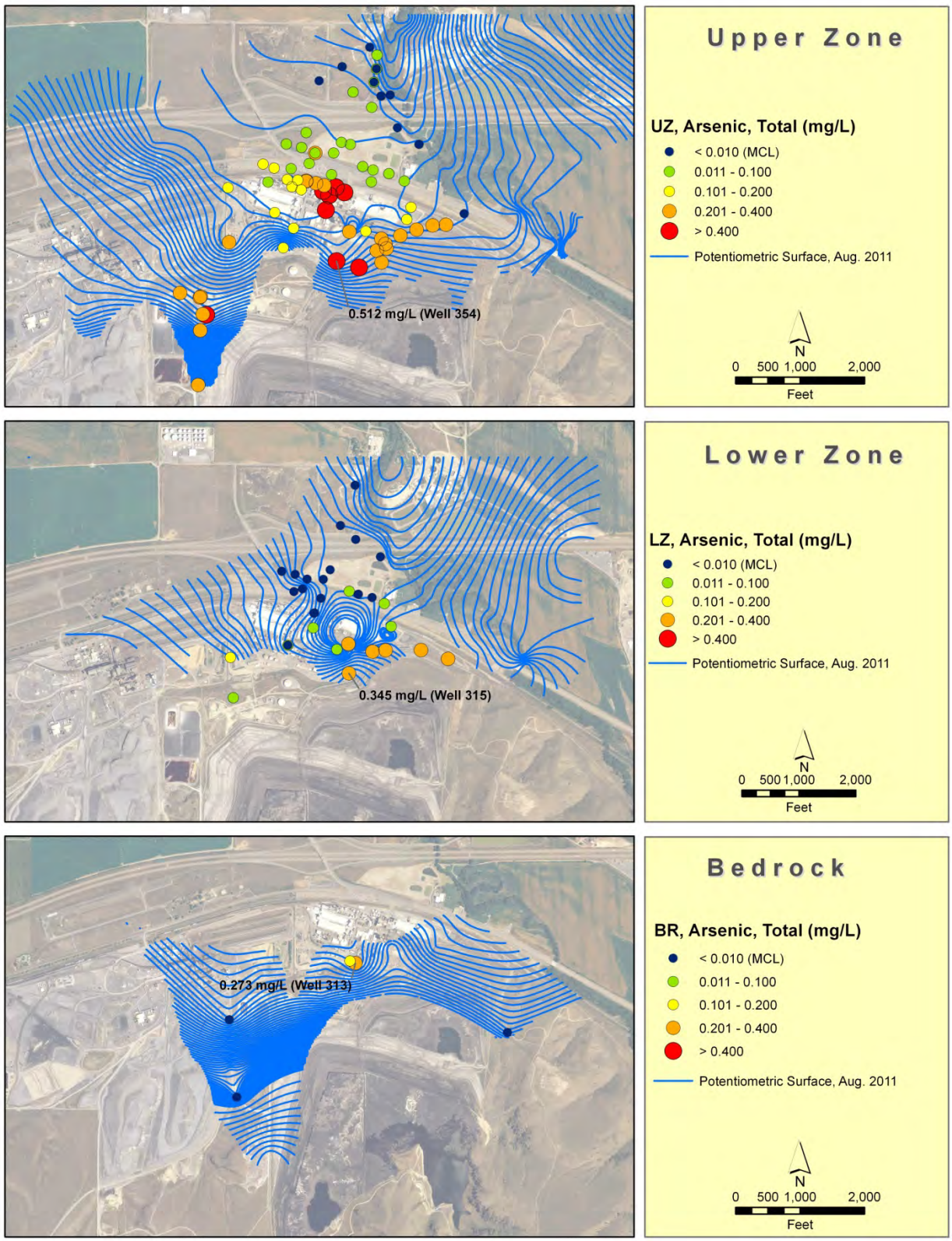


Figure 4-18: Post plots of arsenic (total) in Upper and Lower Zones, and Bedrock, third quarter 2011. Maximum observed concentrations are posted.

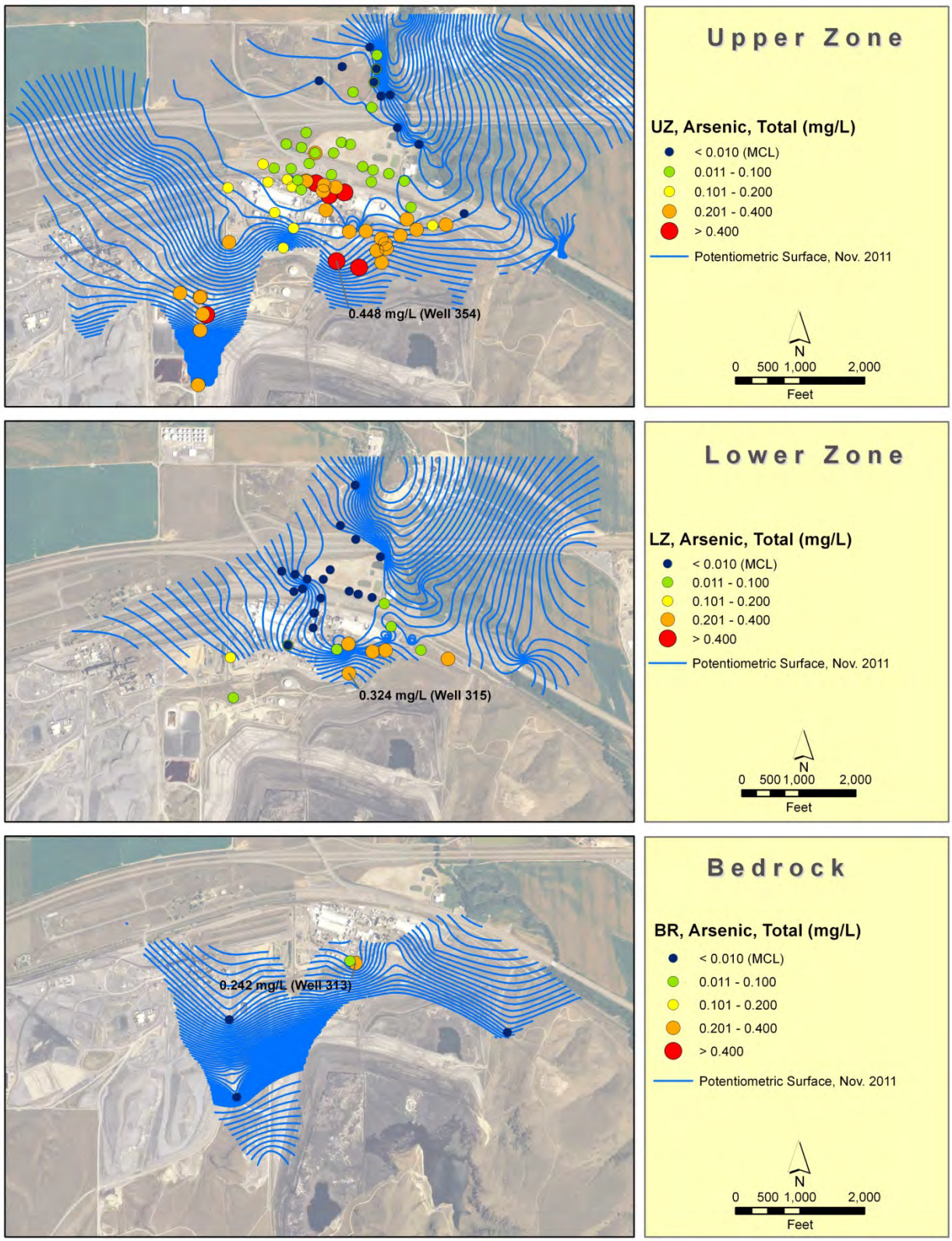


Figure 4-19: Post plots of arsenic (total) in Upper and Lower Zones, and Bedrock, fourth quarter 2011. Maximum observed concentrations are posted.

4.3.2.2 Phosphorus

Figure 4-20, Figure 4-21, Figure 4-22, and Figure 4-23 illustrate the spatial distribution of phosphorus in the Upper and Lower Zones and Bedrock during 2011. The general spatial distribution is consistent throughout the year.

The highest concentrations were measured near the current East Plant Area extraction system (Upper and Lower Zones) and at wells downgradient of the phosphoric acid plant. The isolated elevated concentrations downgradient of the phosphoric acid plant (at well 340, for example) indicate influence of a facility source or sources. The Lower Zone is not impacted in this area.

West Plant Area wells have relatively lower concentrations of phosphorus. The bedrock knob area has lower concentrations compared to areas of the current extraction system.

Concentrations decrease downgradient as groundwater migrates to the Portneuf River area.

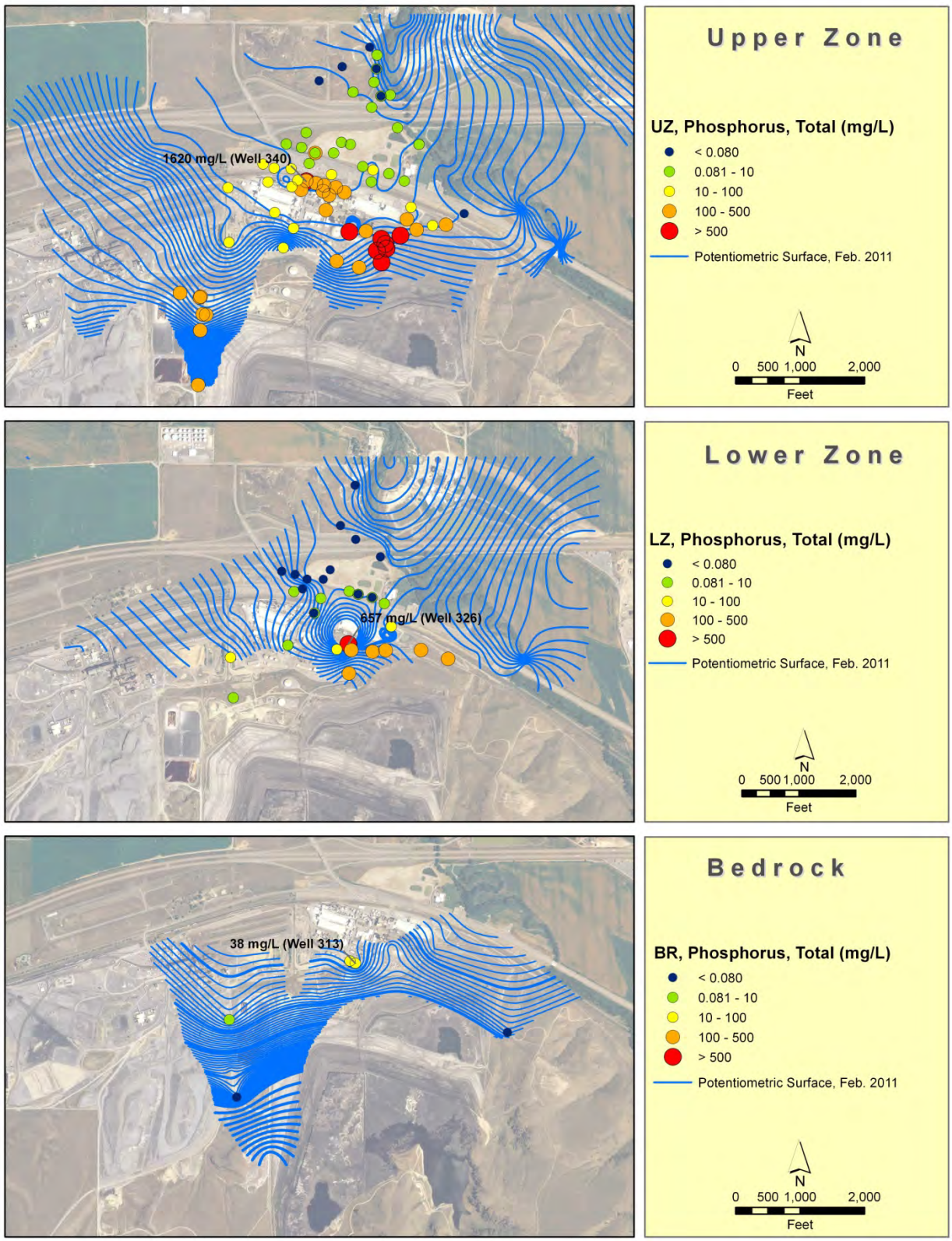


Figure 4-20: Post plots of phosphorus (total) in Upper and Lower Zones, and Bedrock first quarter 2011. Maximum observed concentrations are posted.

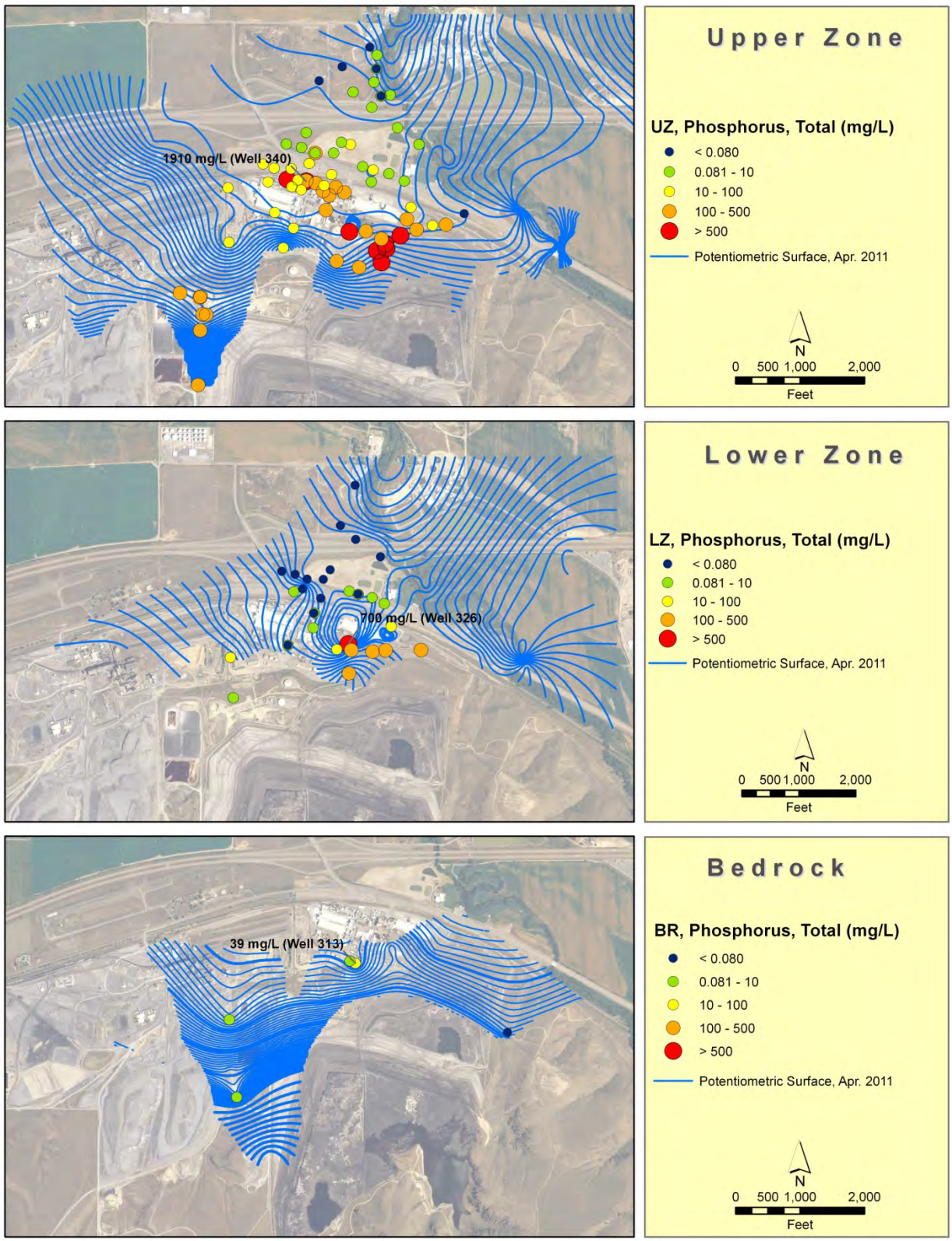


Figure 4-21: Post plots of phosphorus (total) in Upper and Lower Zones, and Bedrock second quarter 2011. Maximum observed concentrations are posted.

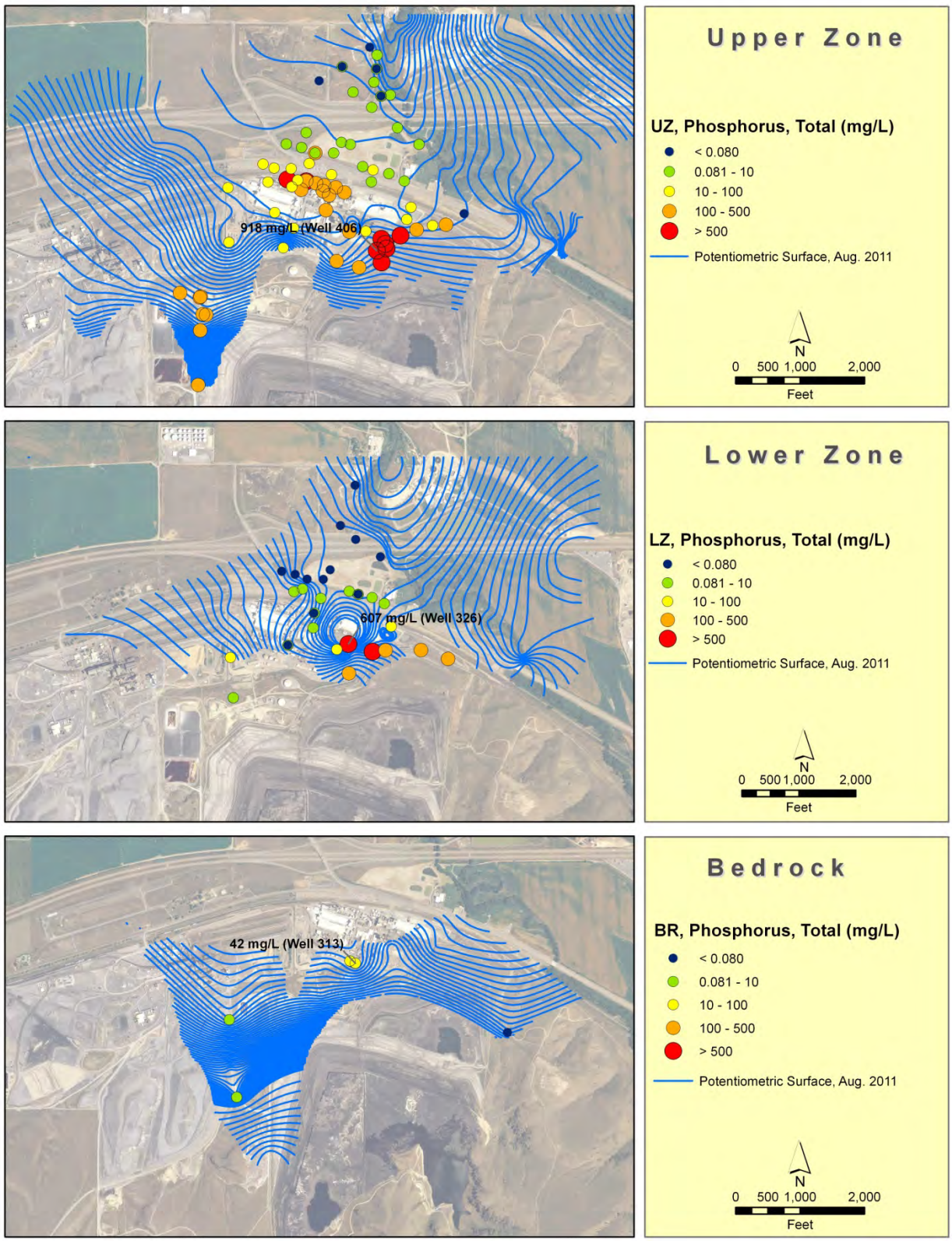


Figure 4-22: Post plots of phosphorus (total) in Upper and Lower Zones, and Bedrock, third quarter 2011. Maximum observed concentrations are posted.

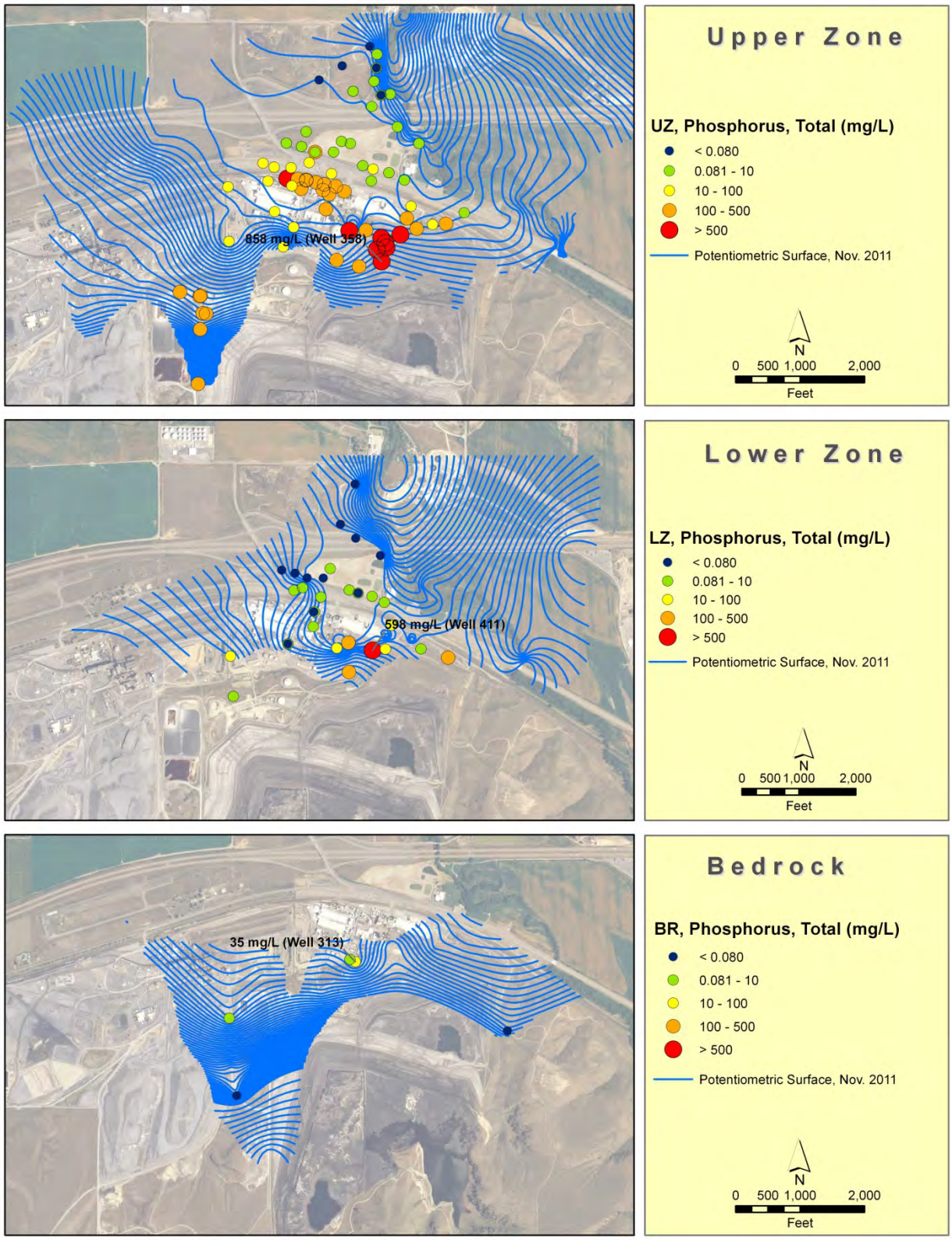


Figure 4-23: Post plots of phosphorus (total) in Upper and Lower Zones, and Bedrock, fourth quarter 2011. Maximum observed concentrations are posted.

4.3.2.3 Sulfate

Figure 4-24, Figure 4-25, Figure 4-26, and Figure 4-27, illustrates the spatial distribution of sulfate in the Upper and Lower Zones and Bedrock during 2011. The general spatial distribution is the same throughout the year and is consistent with the distribution of arsenic associated with the gypsum stack source.

The highest sulfate concentrations were measured in the target extraction areas (East and West Plant Areas).

Concentrations decrease downgradient as groundwater migrates to the Portneuf River area.

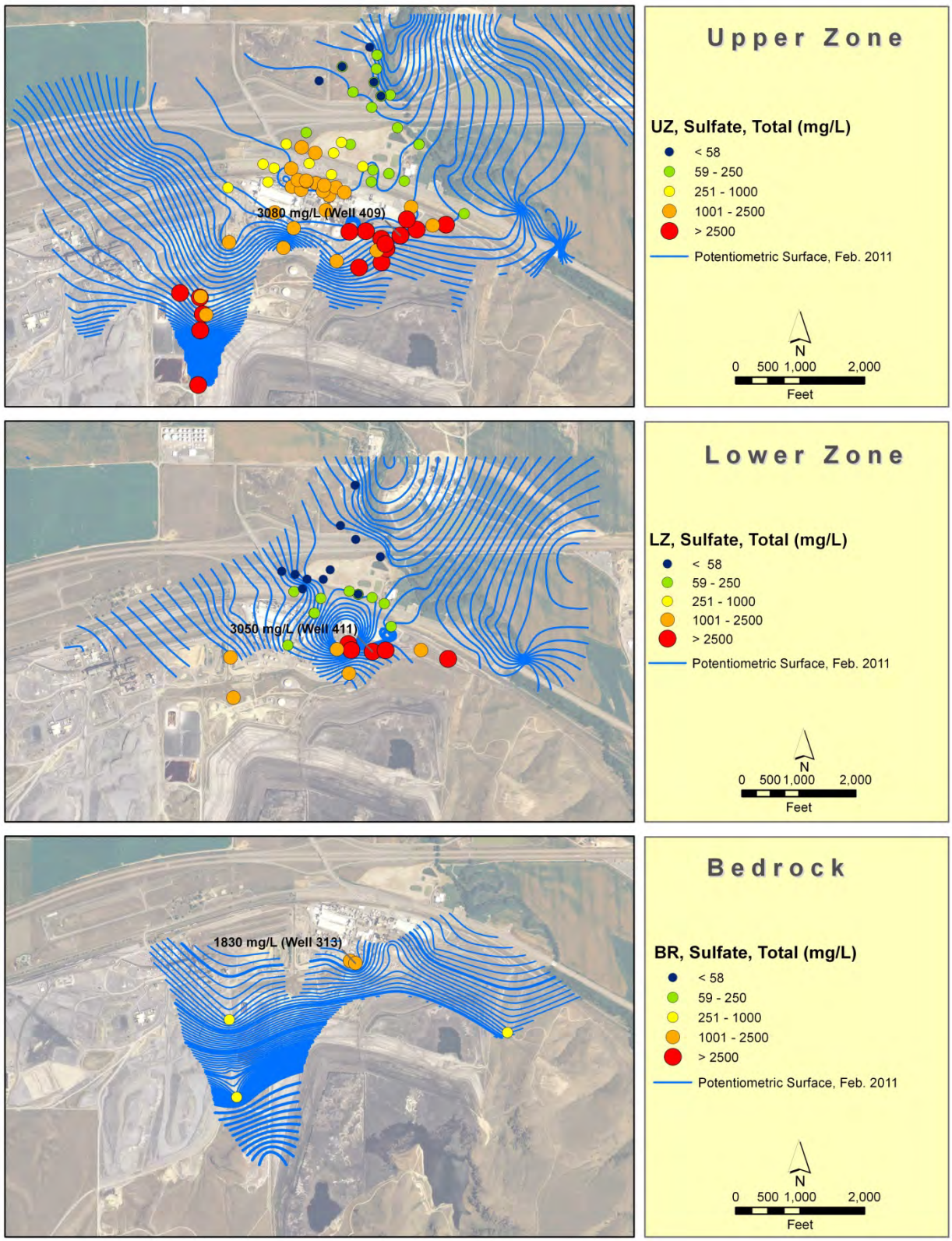


Figure 4-24: Post plots of sulfate in Upper and Lower Zones, and Bedrock, first quarter 2011. Maximum observed concentrations are posted.

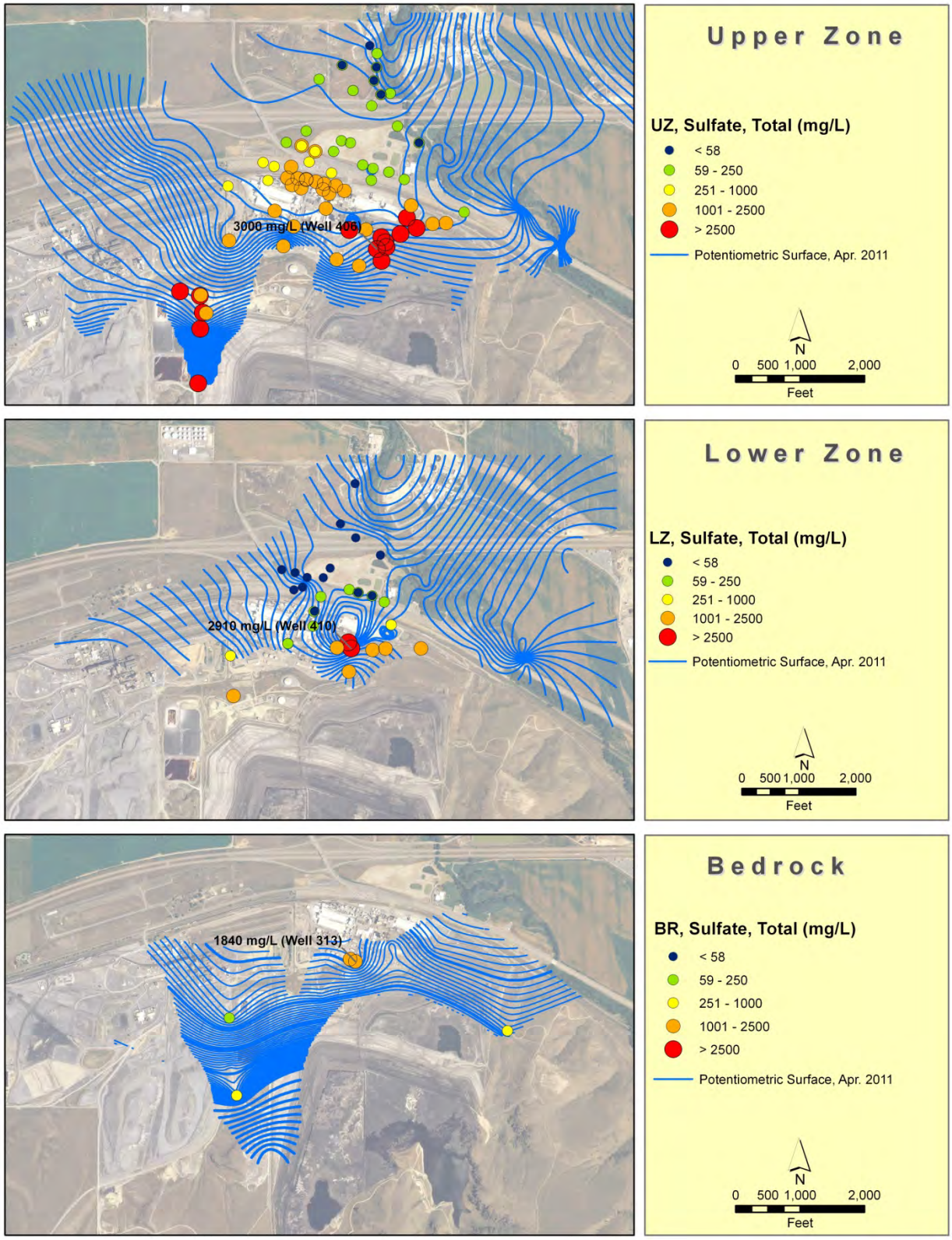


Figure 4-25: Post plots of sulfate in Upper and Lower Zones, and Bedrock, second quarter 2011. Maximum observed concentrations are posted.

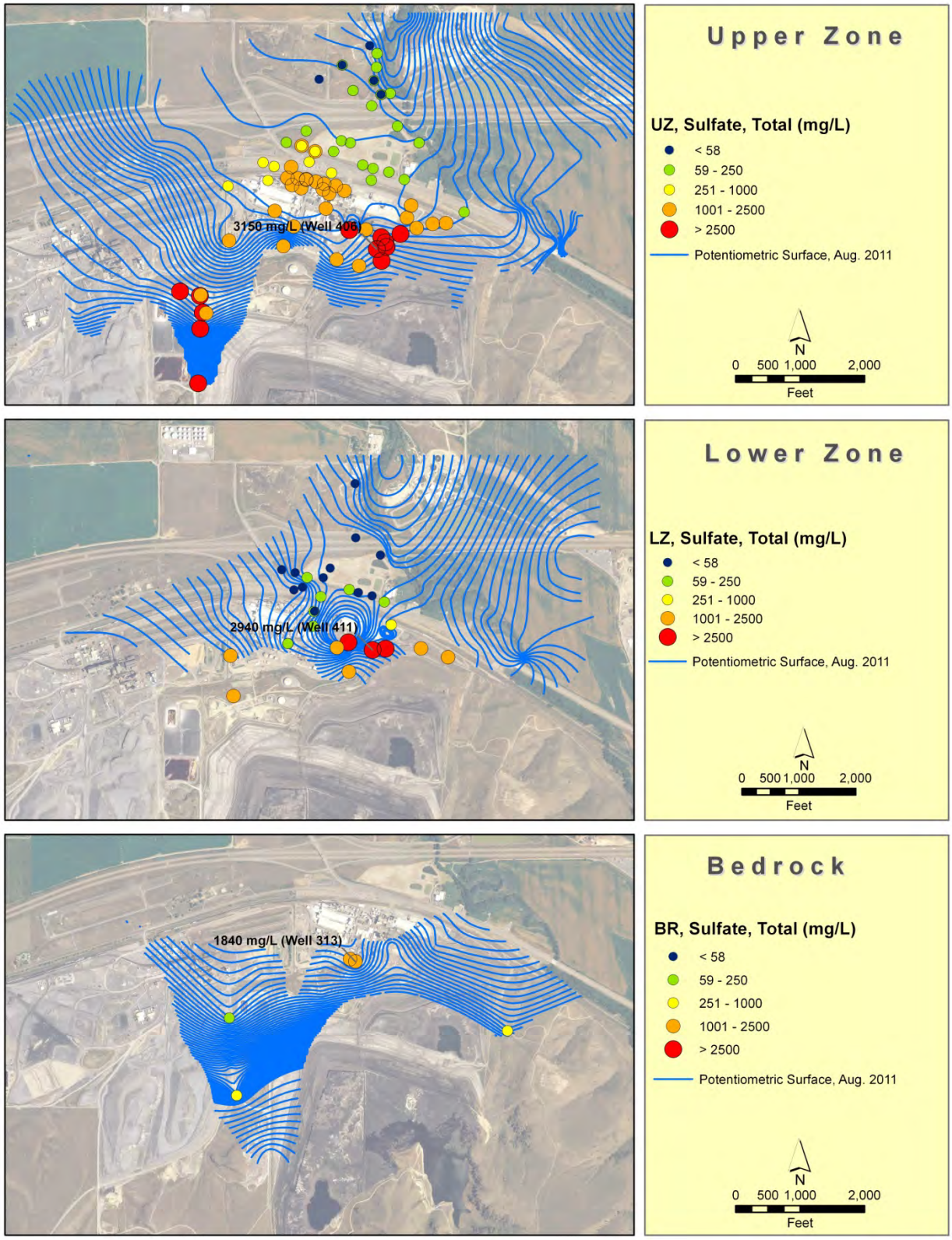


Figure 4-26: Post plots of sulfate in Upper and Lower Zones, and Bedrock, third quarter 2011. Maximum observed concentrations are posted.

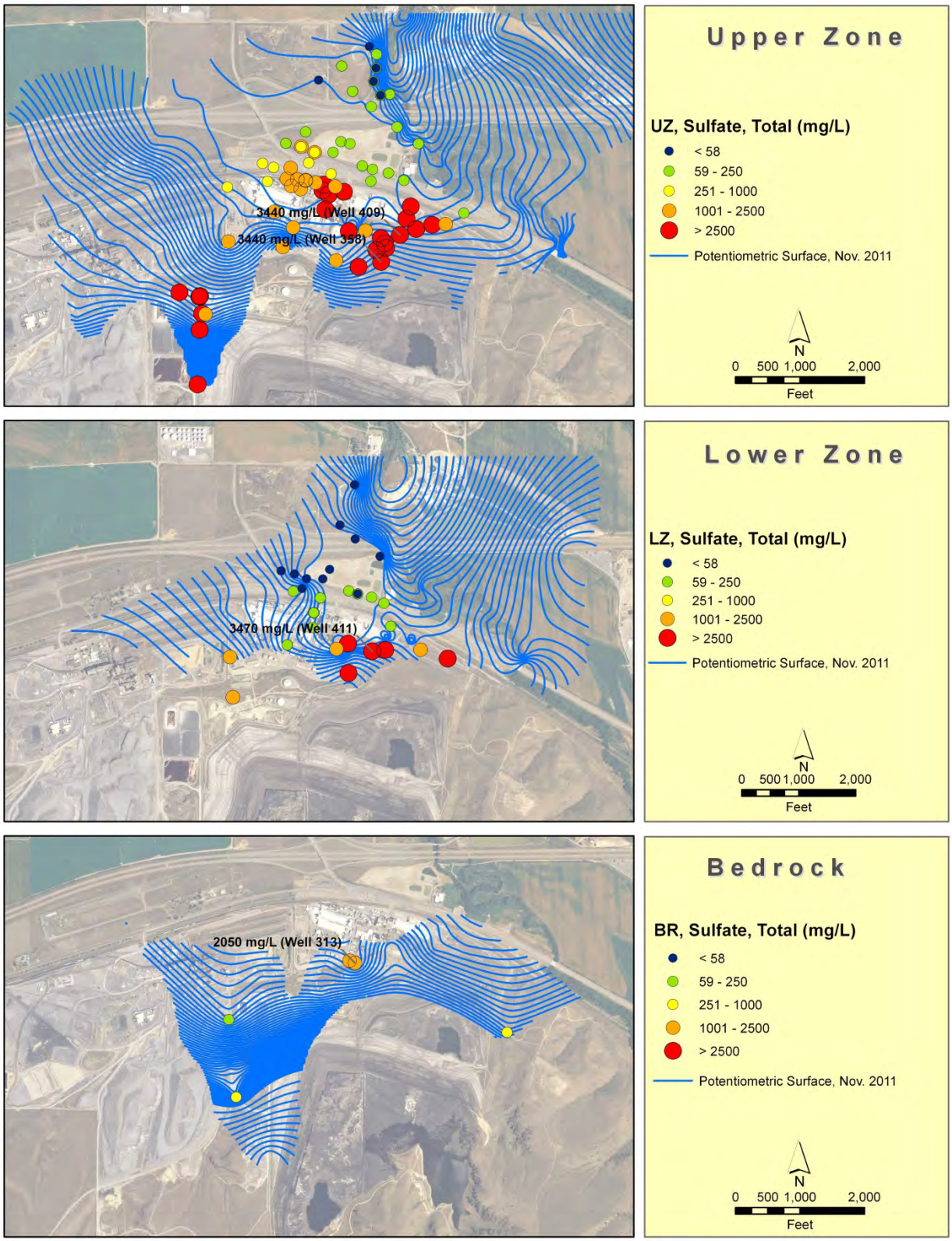


Figure 4-27: Post plots of sulfate in Upper and Lower Zones, and Bedrock, fourth quarter 2011. Maximum observed concentrations are posted.

5.0 GROUNDWATER DATA EVALUATION

The discussion in the following paragraphs provides data analysis and discussion that addresses the hypothesis tests and decision rules for the five monitoring program areas as follows:

- Tracking groundwater quality in the Don Plant Area and demonstrating source control;
- Demonstrating source control in the PAP Area;
- Demonstrating hydraulic control of the extraction system in the target capture zones;
- Evaluating extraction system reduction towards the extent and concentration of COCs in the Assessment Area;
- Establishing interim target concentrations in selected Assessment Area wells; and
- Evaluating extraction system performance in terms of preventing COC migration into the Off-Plant OU at concentrations above the MCL or RBC in the Compliance Area.

5.1 Tracking Groundwater Quality in the Don Plant Area

The decision rule for assessing reduction of extent and concentration of COCs in the Don Plant Area is as follows:

> If concentrations of indicator analytes in groundwater down gradient of the gypsum stack and PAP Areas decrease after demonstration that the source controls are operating, then source control is demonstrated.

An assessment of the 2011 data with respect to this decision rule is provided in the following paragraphs.

5.1.1 Extent of Indicator Analytes

The extent of indicator analytes arsenic, phosphorus, and sulfate, in the Don Plant Area at the end of 2011 was similar to that at the end of 2010 (see Section 4.3.2). Time-series charts for indicator analytes for wells in the Don Plant Area are included in Appendix B.

Concentrations of arsenic are elevated in groundwater samples from wells completed in the Upper Zone in the PAP Area, near the foot of the gypstack, and in the West Plant Area (located near the fenceline with FMC property). In the west, groundwater samples from the FMC wells 108 and 517 have arsenic concentrations, between 0.019 and 0.024 mg/L. To the east,

groundwater samples from well 328 consistently had non-detected arsenic concentrations. Lower Zone arsenic concentrations were elevated in wells 363AR, 411, 326, and 315. Concentrations ranged between 0.219 and 0.345 mg/L. At well 366AR, the furthest east monitoring point concentrations were between 0.219 to 0.248 mg/L. In bedrock, concentrations were highest near the foot of the gypsum stack, and decreased to the west. Groundwater samples from well 305 were non-detect for arsenic. This spatial extent was constant throughout 2011.

Concentrations of total phosphorus are elevated in groundwater samples from wells completed in the Upper Zone near the foot of the gypstack, and in the Central Plant area (downgradient of the PAP Area). Concentrations decrease to the east and west. To the west, groundwater samples from wells 312 and 331, located near the border with FMC property had phosphorus concentrations less than 20 mg/L throughout 2011. To the east, groundwater samples from well 328 consistently had phosphorus concentrations at background levels. In the Lower Zone, phosphorus concentrations were highest in the East Plant Area, and decreased to the west and north. To the west, groundwater samples from wells 309 and 346 had stable concentrations of less than 30 mg/L and 10 mg/L phosphorus, respectively. In bedrock, phosphorus concentrations were highest in groundwater samples from wells completed near the foot of the gypsum stack. Groundwater samples from well 305 were non-detect for phosphorus. Slightly elevated phosphorus concentrations were found in groundwater samples from well 190 to the west. This spatial extent was constant throughout 2011.

The extent of groundwater with elevated sulfate concentrations is similar to that of arsenic. In the Upper Zone, groundwater samples from well 328 to the east had sulfate concentrations less than 66 mg/L which is near the background level. To the west, wells 110, 143, 312, 331, and 517 all had sulfate concentrations less than 900 mg/L. In the Lower Zone, groundwater has elevated sulfate concentrations in samples from wells in the East Plant Area. Concentrations decrease toward the west. In bedrock, elevated concentrations occur in groundwater samples collected from wells completed near the foot of the gypsum stack. This spatial extent was constant throughout 2011.

5.1.2 Groundwater Concentration Trends

Phosphorus concentrations in wells 356, 357, 406 and 407, west of the Decant Pond, have been increasing since 2004 (Figure 5-1), while phosphorus concentration trends in wells 328, 332, 350 and 375, north of the Decant Pond, have remained flat since 2004 (Figure 5-2). Measured groundwater potential and simulated particle tracking (Figure 5-3) in the areas west and north of the Decant Pond suggest that the source of the increasing phosphorus concentrations in wells west of the Decant Pond is likely related to the long-term operation of the gypsum stack, and is not related to the construction or operation of the Decant Pond or the lining of the Lower Stack.

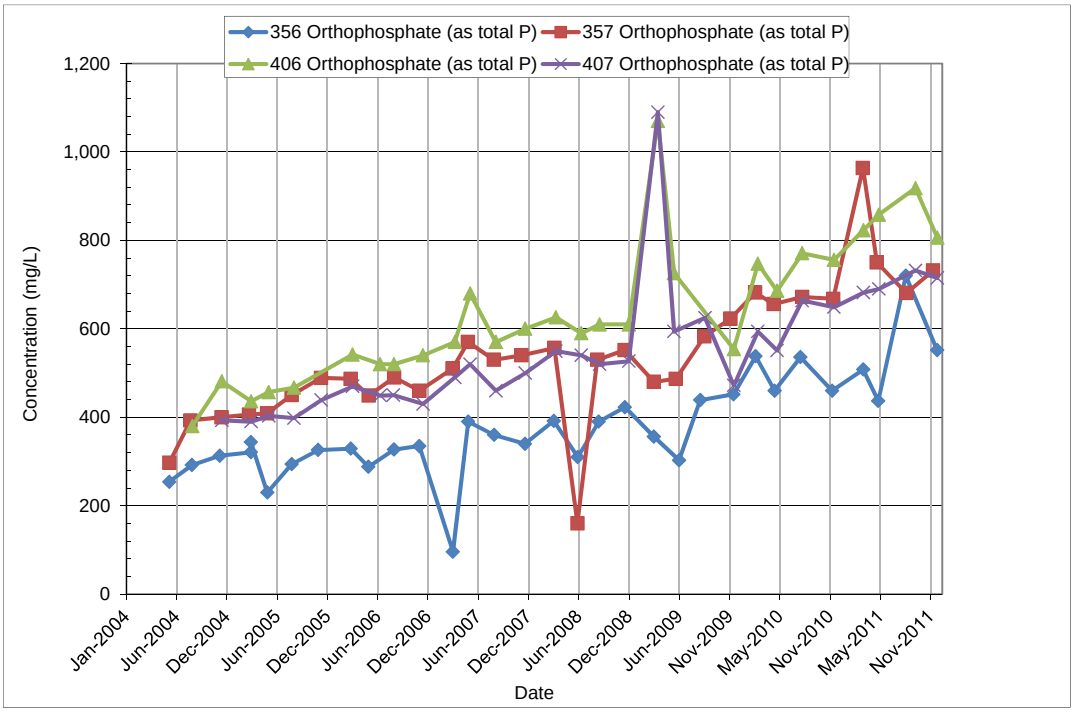


Figure 5-1: Phosphorus concentration trends in wells west of the Decant Pond

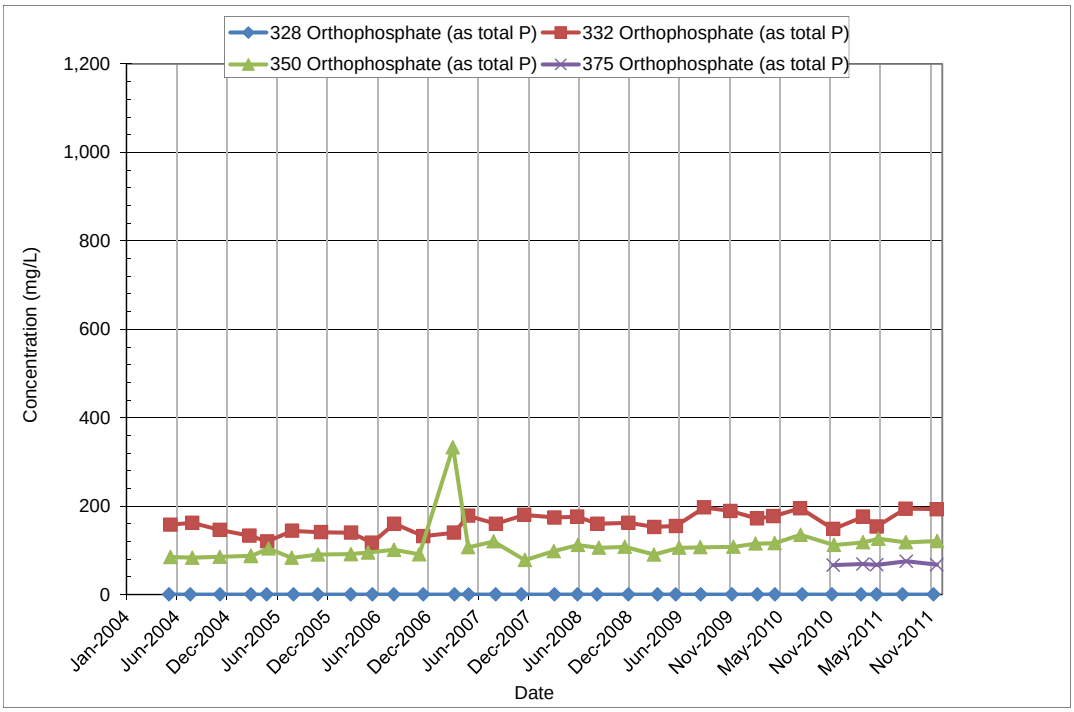


Figure 5-2: Phosphorus concentration trends in wells north of the Decant Pond

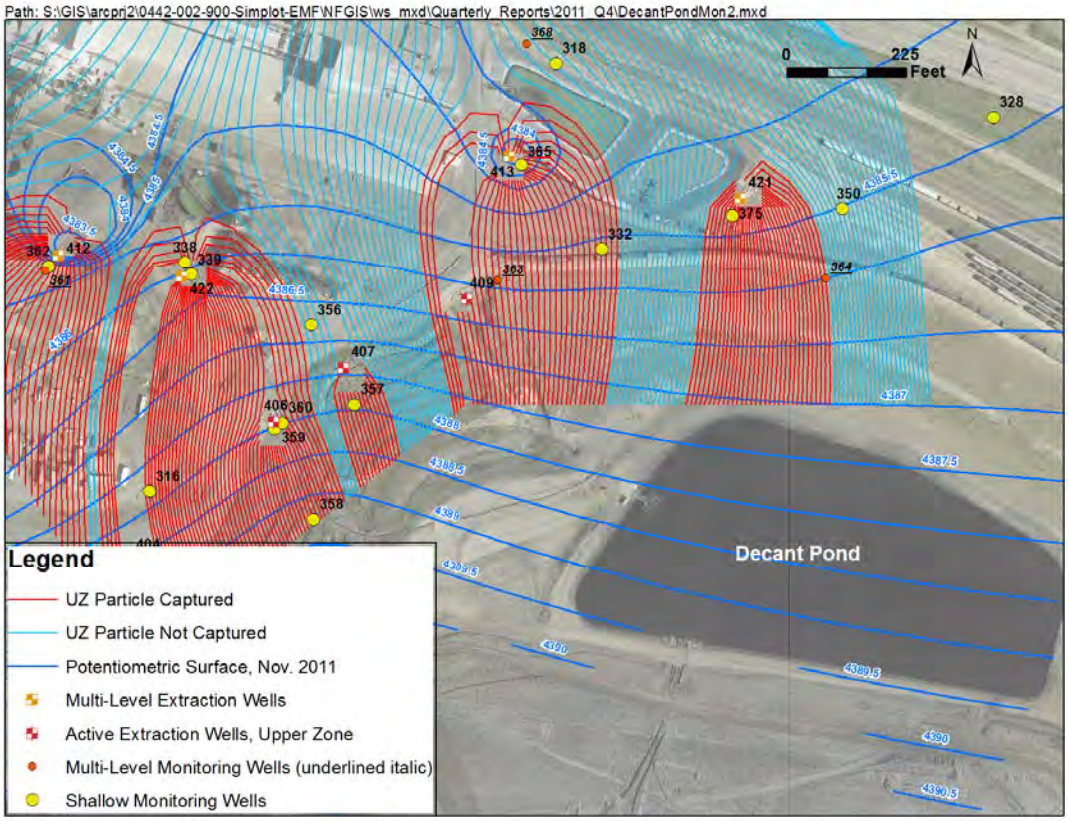


Figure 5-3: Groundwater hydraulics and monitoring wells near the Decant Pond

5.1.3 Constituent Transport Time

Table 5-1 summarizes the estimated groundwater travel times for two of the three areas (travel time from infiltration beneath the stack to the foot of the stack was not included). Groundwater travel times through the Don Plant Area were not calculated due to the complexity of the area. Detailed calculations can be found in Appendix C.

Table 5-1: Summary of groundwater travel times and parameters used in calculation.

		Effective porosity	Hydraulic conductivity (ft/day)	Gradient (ft/ft)	Average linear groundwater velocity (ft/day)	Flow Length (ft)		Travel time (years)	
						min	max	min	max
Upper Zone	Don Plant Area (Foot of stack to Extraction line)	0.2	200	0.0078	7.8	750	2,300	0.26	0.81
	Assessment Area (Highway 30 to River)	0.2	2,700	0.0013	17.55	1,400	1,800	0.22	0.28
Lower Zone	Don Plant Area (Foot of stack to Extraction line)	0.2	100	0.0067	3.35	750	2,300	0.61	1.88
	Assessment Area (Highway 30 to River)	0.2	2,700	0.0034	45.9	1,400	1,800	0.08	0.11

5.2 Demonstrating Source Control in the PAP Area

Groundwater quality data from PAP Area wells are used to assess changes in water quality over time and to help evaluate source control effectiveness in the PAP Area. Data are collected more frequently from the PAP Area wells (Table 4-2, Figure 5-4) as described in the Groundwater and Surface Water Monitoring Plan (Formation 2010a). Results of water level measurements and groundwater quality analyses from a selected subset of wells in the PAP Area are reported monthly in the PAP Area Source Control and Groundwater Monitoring Report.

The results of groundwater sample analyses are used to compare groundwater analyte concentrations upgradient to concentrations within and downgradient the PAP Area and evaluate whether the remedy objective of source control is being achieved. Upgradient concentrations are defined in the Monitoring Plan as the concentrations observed in groundwater samples at wells 325, 334, or 341. Upgradient groundwater concentrations vary, and selection of the appropriate well for a point to point comparison is based on a flow path analysis. When the gypsum stack and PAP Area source controls are operating as intended, the concentration of COCs will be reduced in the PAP Area and downgradient. The null and alternate hypotheses for monitoring to demonstrate source control in the PAP Area are:

H_0: The concentrations of indicator analytes in groundwater downgradient of the PAP Area are greater than those upgradient of the PAP Area.

H_A: The concentrations of indicator analytes in groundwater downgradient of the PAP Area are less than or equal to than those upgradient of the PAP Area.

When conditions result in a decision to reject the null hypothesis, source control in the PAP Area will be demonstrated. The decision rule for assessing source control in the PAP Area is as follows:

> If the concentration of phosphorus in groundwater within or downgradient of the PAP Area is less than or equal to the upgradient concentration, then source control is demonstrated.

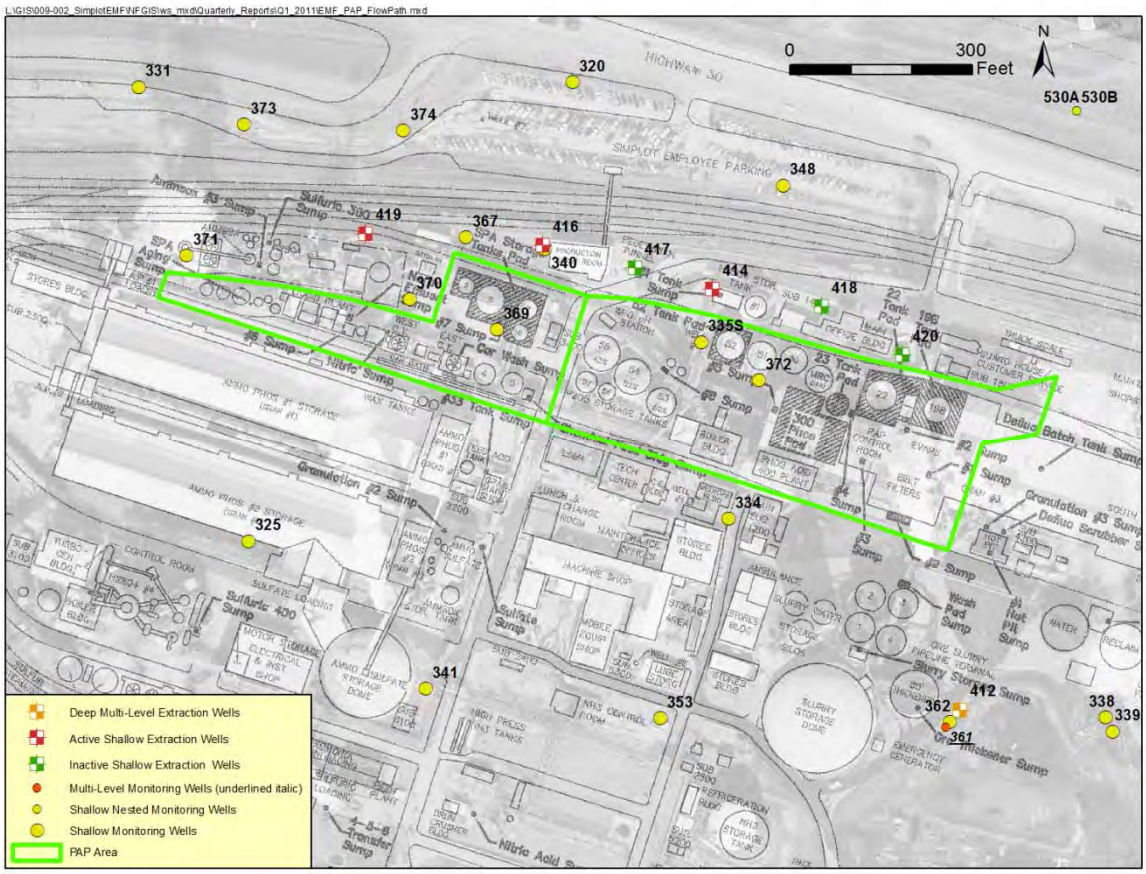


Figure 5-4: Location of wells in the PAP Area.

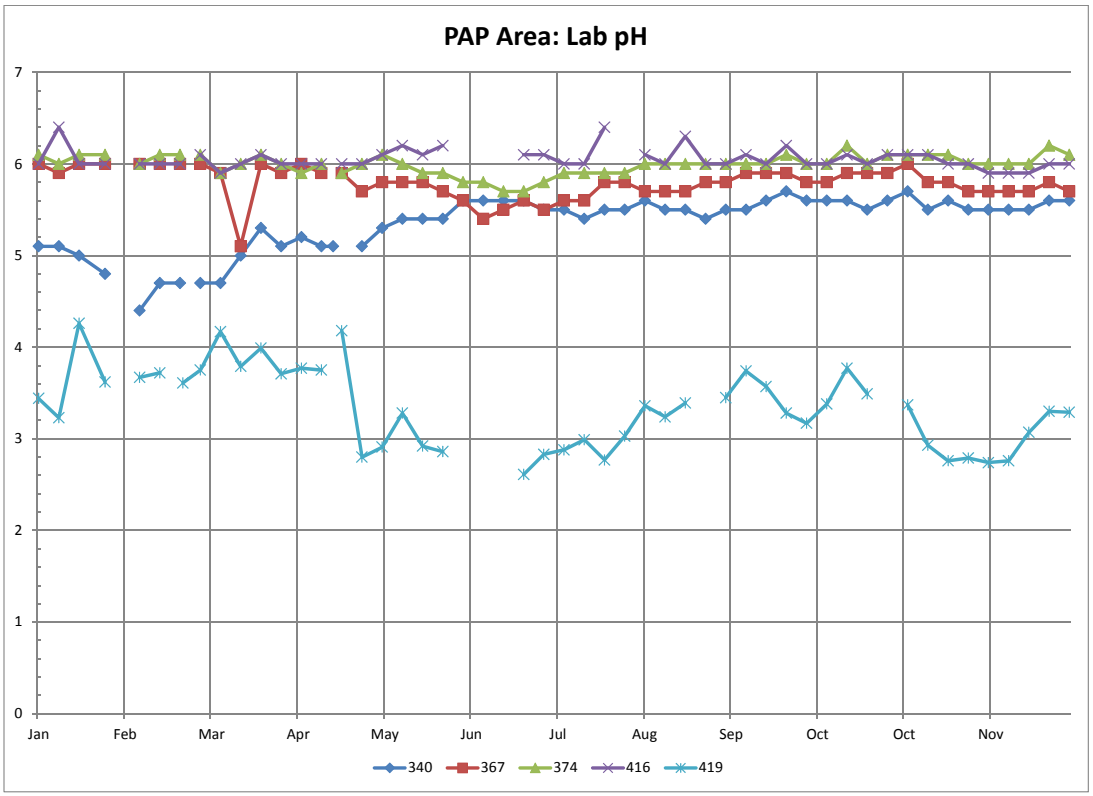
5.2.1 PAP Area-Specific Data

The data collection program for 2011 in the PAP Area included weekly pH measurements in wells 340, 367, 374, 416 and 419, monthly pH measurements in wells 335S, 369, 370, 371, 372, 373, 417, 418, and 420, quarterly groundwater level and sample collection. More frequent sampling is conducted if the pH in any well drops below 5 su. The details of this data collection program are described in the Groundwater and Surface Water Monitoring Plan (Formation 2010d). The status of the groundwater monitoring effort and results of analyses in the PAP Area are reported each month in the PAP Area Source Control and Groundwater Monitoring Monthly Report.

The Groundwater and Surface Water Monitoring Plan (Formation 2010d) includes a plan for sampling of metals when the pH in any phosphoric acid plant well decreases below 4 su. The provisions of the revised plan were implemented during 2010. In 2011, only samples from well

419 had pH values below 4 su[1]. Results of pH and analyses for metals concentrations were presented in the monthly PAP Area Groundwater Summary reports and are provided in Appendix D. Time-series of weekly pH measurements are shown in Figure 5-5**.**

[1] pH measured on a sample from well 335S on February 10, 2011 measured 3.71 su. The well was resampled and pH was found to be 5.58. Further testing for metals was deemed unnecessary



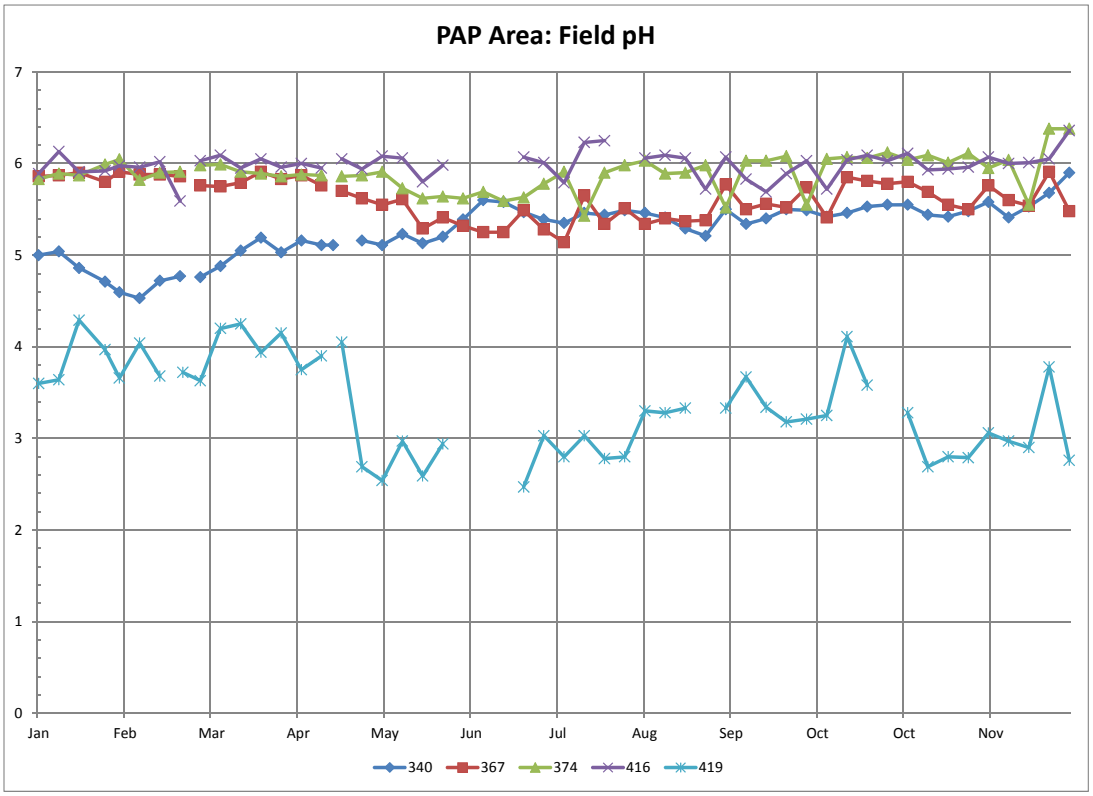


Figure 5-5: Time series of weekly pH in PAP Area wells 340, 367, 374, 416 and 419 for 2011.

5.2.2 Groundwater Flow Path Analysis

Detailed potentiometric surface map are prepared each quarter for the PAP Area. The potentiometric surface map for the third quarter is shown in Figure 5-6. This map is typical of the flow pattern that was observed in this area in all four quarters. Groundwater flow paths are depicted in the figure as red arrows that are perpendicular to the groundwater potential contours. Groundwater flow is generally to the north toward the Portneuf River and is influenced by pumping at extraction wells 414, 416, and 419, which were operated at flow rates of 10, 35, and 15 gpm respectively. Based on this map, the flow paths to wells downgradient of the PAP Area can be assessed and the wells paired with a well up gradient of the PAP Area that is on the same flow path. A summary of the upgradient/downgradient well pairing is provided in Table 5-2.

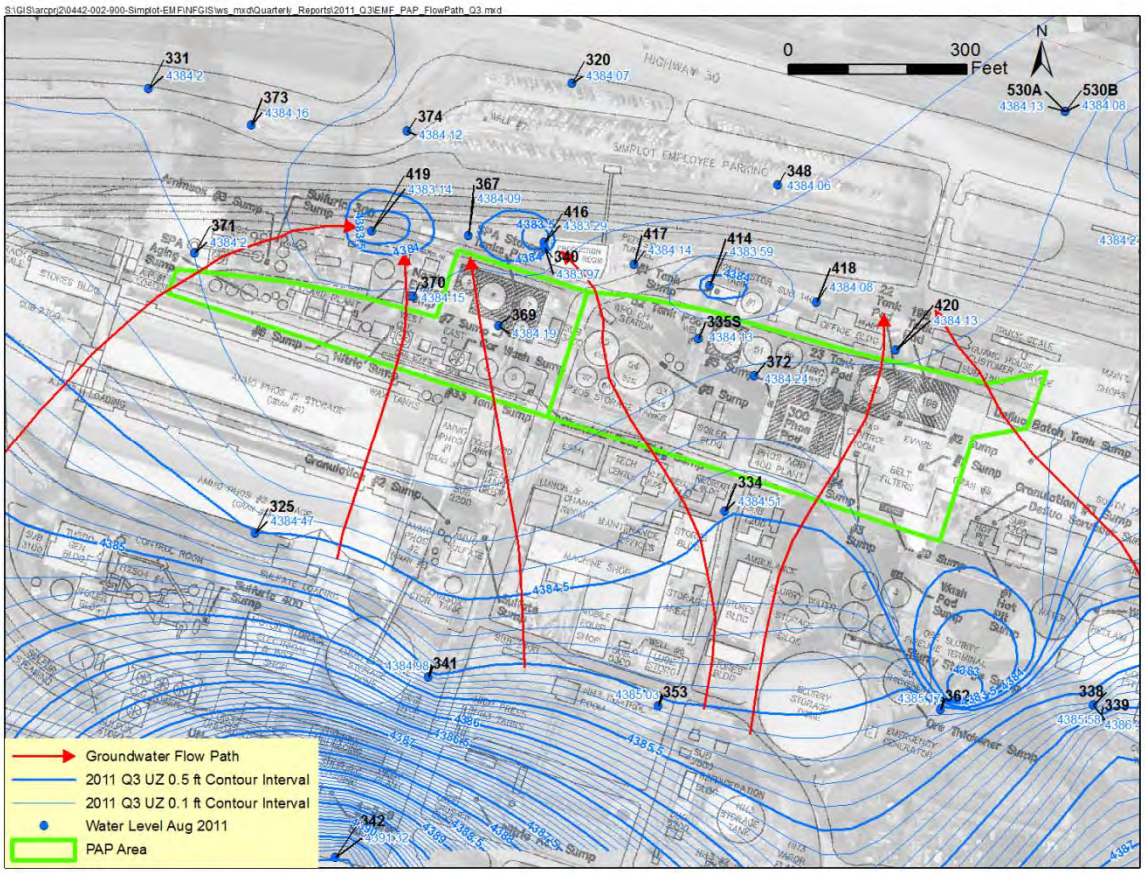


Figure 5-6: Upper Zone groundwater potential, August 2, 2011. Groundwater flow pathways shown by red arrows.

Table 5-2: Selection of well pairs in up gradient and down gradient of the PAP area.

Downgradient Well	Upgradient Well
371	325
373	
374	
419	
370	
367	341
369	
340	334
416	
417	
335S	
414	
372	
418	
420	

5.2.3 Comparison of Total Phosphorus Concentrations

The Welch's *t*-test is used to compare upgradient and downgradient phosphorus concentrations for well pairs in the PAP Area. A summary of the calculations involved with the Welch's *t*-test analysis is provided in Table 5-3. With the exception of well pair 334-340, the statistical comparison of sample means is conclusive. For well pair 334-340, the value of *t*-Test observed (2.25) is nearly equal to the value of *t*-Test from the tables (2.35), however one may reasonably conclude that the two means are not equal because the phosphorus concentration downgradient at well 340 (1094 mg/L) is much greater than the phosphorus concentration at well 334 (207 mg/L).

Table 5-3: Summary of two-sample statistical comparison of concentrations in well pairs.

Well Pair	Upgradient Phosphorus (mg/L)[1]	Downgradient Phosphorus (mg/L)[1]	t-Test value (t) observed	degrees of freedom	t-Test value (tcp) from table (95%)	Is t less than or equal to tcp?	Statistical Comparison of Population Means - Are the Means Equal?	Downgradient Conc. Greater than Upgradient Conc.?
325 : 371	12.5	14.1	-1.27	3.92	2.13	YES	EQUAL	NO
325 : 373	12.5	13.0	-0.88	4.17	2.10	YES	EQUAL	NO
325 : 374	12.5	23.2	-6.42	3.50	2.22	NO	NOT EQUAL	YES
325 : 419	12.5	662	-3.80	3.00	2.35	NO	NOT EQUAL	YES
325 : 370	12.5	66.8	-7.27	3.02	2.35	NO	NOT EQUAL	YES
341 : 367	24.6	90.5	-7.74	3.03	2.35	NO	NOT EQUAL	YES
341 : 369	24.6	143	-5.31	3.00	2.35	NO	NOT EQUAL	YES
334 : 340	207	1094	-2.25	3.00	2.35	YES	EQUAL	YES[3]
334 : 372	207	148	6.73	3.68	2.17	NO	NOT EQUAL	NO
334 : 414	207	119	6.83	5.84	1.95	NO	NOT EQUAL	NO
334 : 416	207	126	6.35	5.86	1.95	NO	NOT EQUAL	NO
334 : 417	207	153	5.80	4.40	2.06	NO	NOT EQUAL	NO
334 : 418	207	144	5.37	6.00	1.94	NO	NOT EQUAL	NO
334 : 420	207	183	2.59	4.69	2.04	NO	NOT EQUAL	NO
334 : 335S	207	150	3.54	4.93	2.02	NO	NOT EQUAL	NO

Notes: 1.) Average of four quarterly samples in 2011.
2.) Use the absolute value of t in the comparison with tcp.
3.) Based on a straight-up comparison of the concentrations, it is reasonablly concluded that the concentration in well 340 is greater than the concentration in well 334.

5.2.4 Trend Analysis

Downgradient phosphorus concentrations at wells 340, 367, 369, 370, 374 and 419 are greater than upgradient concentrations at wells 325, 334 and 341, but inspection of phosphorus concentration trends at the downgradient wells demonstrates that source control measures in the PAP Area are helping to reduce the effect on groundwater from facility sources. Since 2009, phosphorus concentration trends in downgradient wells are flat or have decreased significantly, except for a spike at well 340 in 2011 (Figure 5-7). In February 2011, the total phosphorus concentration at well 340 increased to 2,133 mg/L. There were no identified leaks or releases from the facility during this time, however, additional inspections were conducted and the schedule for associated infrastructure improvements was expedited and completed in early 2011. By the end of 2011, phosphorus concentration at well 340 was back down to 315 mg/L.

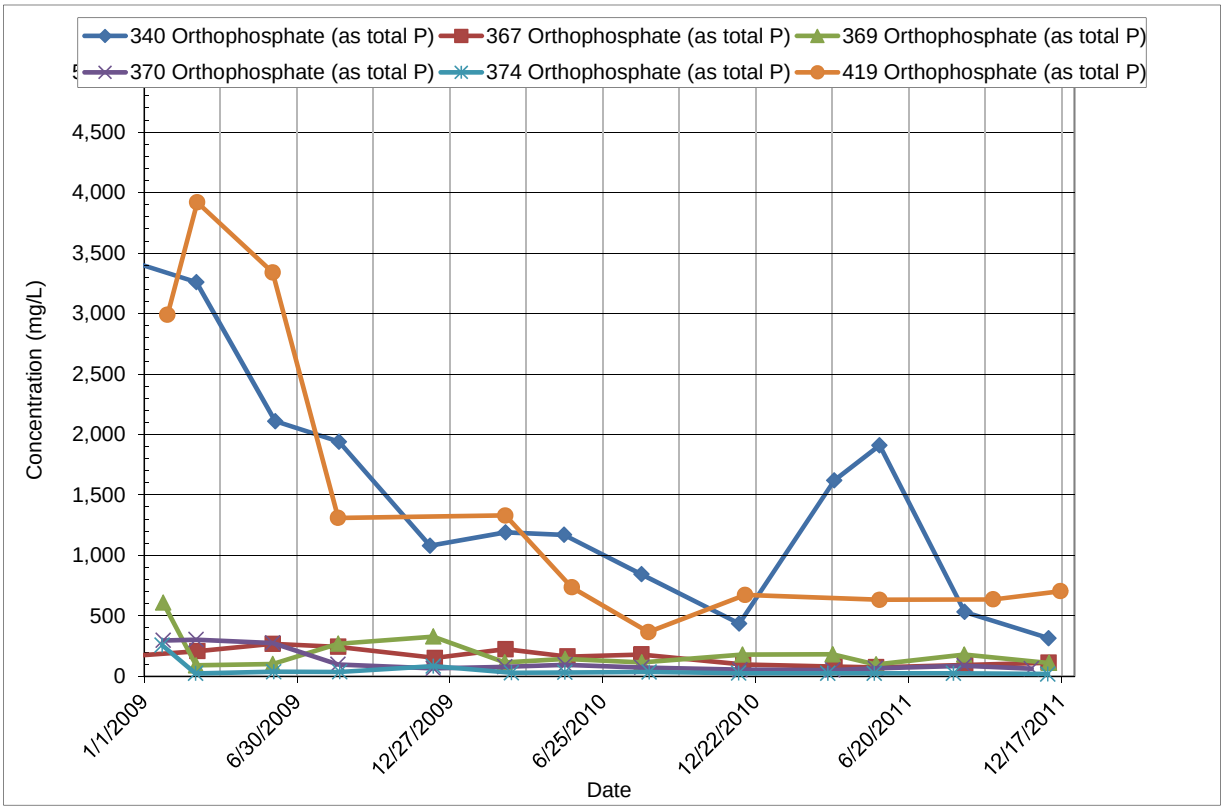


Figure 5-7: Total phosphorus concentration trends in downgradient wells

5.2.5 Assessment of Source Control

Based on the observed concentrations and trends, downgradient phosphorus concentrations are greater than the upgradient concentrations at the location of wells 340, 367, 369, 370, 374 and 419. These wells are located in the western portion of the PAP area, in the vicinity of and downgradient of the Liquid Plant. The elevated concentration of phosphorus in groundwater in this area has been monitored since the completion of the PAP Area Subsurface Investigation in 2009 (Simplot 2009b). Source control actions in the PAP Area completed since 2009 have achieved significant reductions in measured phosphorus concentrations in groundwater (Figure 5-7). Additional source control projects are proposed annually, the projects that were planned for 2011 were outlined in the Phosphorus Source Control Program (Simplot 2011a). The zone of elevated phosphorus concentrations in groundwater in the PAP Area is controlled by groundwater extraction at wells 414, 416, and 419. Groundwater extraction is both reducing the phosphorus concentrations in groundwater and limiting the potential for downgradient migration of affected groundwater.

5.3 Demonstrating Hydraulic Control in the Target Capture Zones

Demonstrating hydraulic control in the target capture zones is performed according to EPA's *Systematic Approach for Evaluation of Capture Zones at Pump and Treat Systems* (EPA 2008). When the extraction system is operating as intended, affected groundwater should be captured by the extraction wells to the extent necessary to meet remedial objectives.

The wells in the target capture zones that are monitored and the data that have been collected are listed in Table 4-2, and the monitoring well locations are shown in Samples of groundwater were collected and analyzed for the indicator analytes shown in Table 4-1.

The EPA approach involves a six-step systematic evaluation of capture zones:

- Step 1 – review site data, site CSM and remedy objectives;
- Step 2 – define the target capture zones;
- Step 3 – interpret water levels;
- Step 4 – perform calculations including flow budget, constituent mass flux, capture zone width calculation and numerical modeling to simulate particle tracking in the capture zones;
- Step 5 – evaluate concentration trends in selected Assessment Area monitoring wells and compare to trends in upgradient extraction wells; and
- Step 6 – interpret actual capture based on steps 1-5, compare the actual capture to the target capture, and assess uncertainties and data gaps.

The information contained in Sections 1 through 3 of the Remedial Design Report constitutes Step 1 in the process (Formation 2010e). Summaries of the evaluations and calculations that were performed as part of Steps 2 through 6 are provided in the following paragraphs.

5.3.1 Delineation of Target Capture Zones (Step 2)

Target capture zones are three-dimensional zones within affected groundwater flow where groundwater extraction will be focused to satisfy the requirements of the remedy. The target capture zones for the Simplot Plant Area were determined based upon multiple hydrogeologic criteria. The zones take into account all known EMF Site data, the CSM, and the remedy objectives (EPA 2008). The target capture zones were delineated during the groundwater remedial design and a detailed description of this delineation is included in the Remedial Design Report. The lateral delineation of the target capture zones is shown in Figure 5-8 and Figure 5-9.

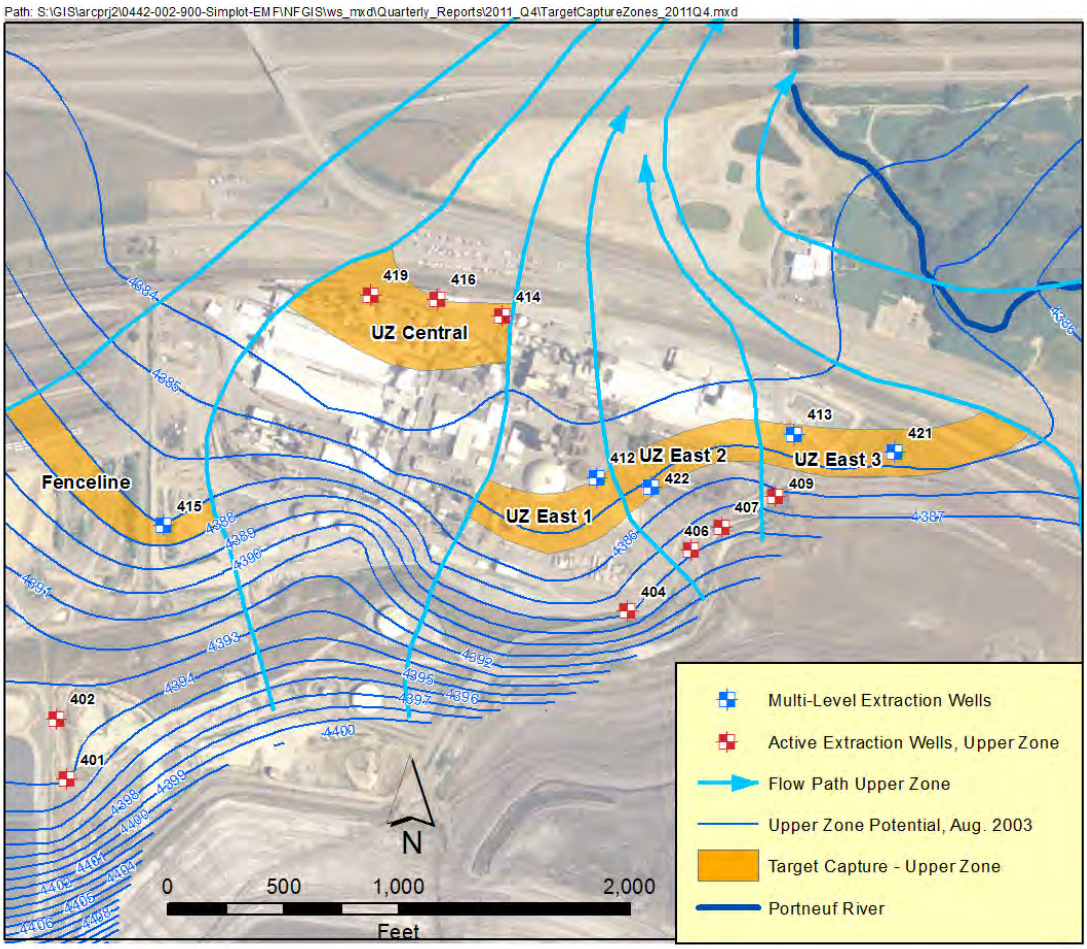


Figure 5-8: Target capture zones for the Upper Zone.

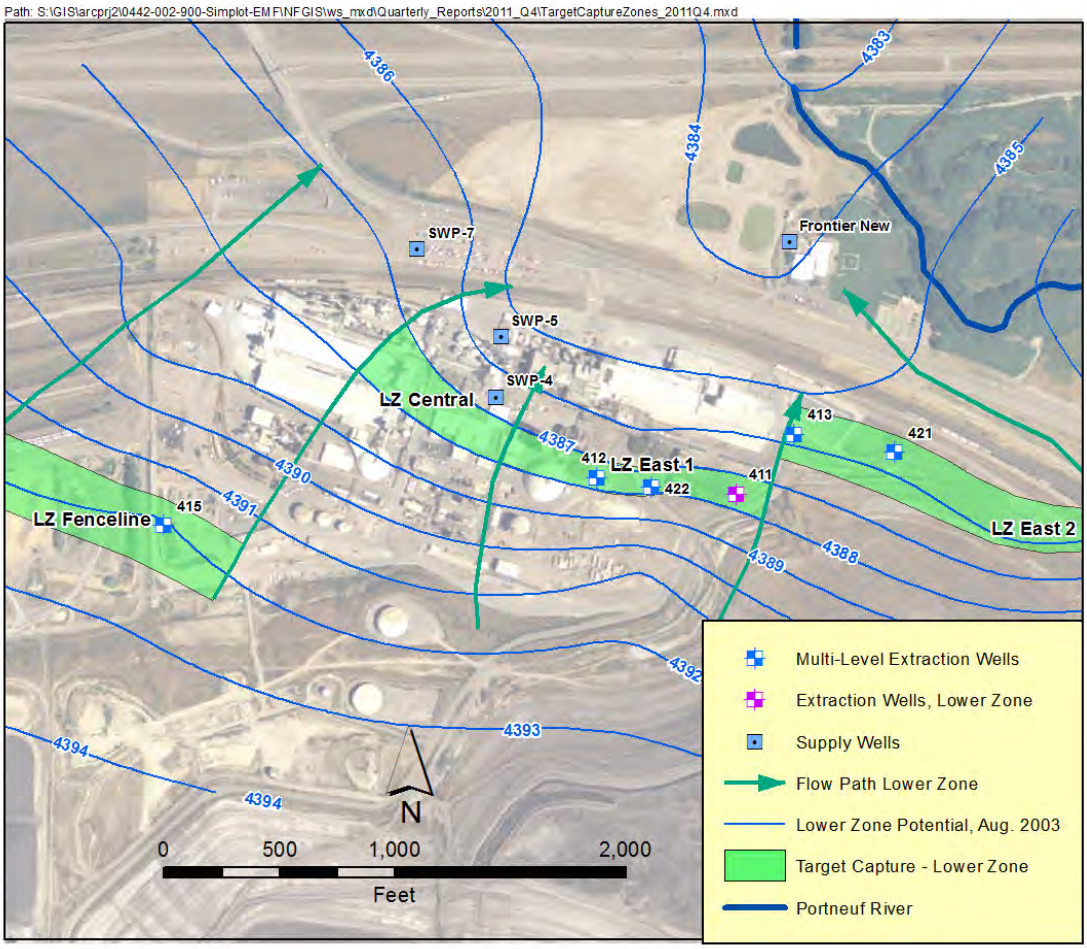


Figure 5-9: Target capture zones for the Lower Zone.

5.3.2 Interpretation of Water Levels (Step 3)

The interpretation of the groundwater level data is presented in Section 4.3 of this report. Groundwater surface elevations and the interpreted potentiometric surfaces for the Upper Zone, Lower Zone, and Bedrock are presented in Figure 4-4 through Figure 4-15. The potentiometric surfaces are consistent with previous sampling events and support the basic conceptual site model.

5.3.3 Hydraulic Control Calculations (Step 4)

5.3.3.1 Mass Removal Evaluation

Mass removal rates of key constituents during are calculated using the average extraction flow rate (including down time) and the groundwater quality results. The calculations are performed each quarter and the results are summarized in this report. The assessment provides estimates the mass of the key constituents being removed by the extraction system, the mass that

bypasses the extraction system, the average concentration of the key constituents in groundwater at the compliance area if no further groundwater extraction is provided. The 2011 assessment was made based on observed extraction well discharge rates (average quarterly flow rate), observed constituent concentrations in each target capture zone (based on the quarterly monitoring results), and the mass lost to attenuation based on values calculated for the pre-extraction system. The calculation is included in Appendix H of the Quarterly Groundwater/Surface Water Remedy Monitoring Reports.

Constituent Load in Affected Groundwater

The total constituent load in affected groundwater was evaluated each quarter, for target capture zones using the groundwater flow rates for each zone and the constituent concentrations present in each zone. Flow rates were assumed to be constant in each zone, since groundwater gradients have not changed significantly. Average groundwater concentrations for each target capture zone were evaluated on a quarterly basis using all available data for the wells in each target capture zone. A summary of the total estimated constituent load in groundwater at the target capture zones for each quarter in 2011 is provided in Table 5-4.

Table 5-4: Summary of total estimated constituent load in affected groundwater at the target capture zones.

Quarter	Constituent Loads		
	Phosphorus (lb/day)	Sulfate (lb/day)	Arsenic (lb/day)
Q1	4,081	33,078	3.54
Q2	4,347	31,712	3.52
Q3	3,940	31,080	3.63
Q4	3,553	31,292	3.11

Constituent Load Removed by the Groundwater Extraction System

The total constituent load removed by each extraction well in 2011 is provided in Table 3-3. A summary of the load removed per quarter is provided in Table 5-4.

Table 5-5: Summary of estimated constituent loads removed by groundwater extraction in the target capture zones.

Quarter	Constituent Loads		
	Phosphorus (lb/day)	Sulfate (lb/day)	Arsenic (lb/day)
Q1	2,127	18,441	2.15
Q2	2,235	17,298	1.90
Q3	2,288	19,070	2.21
Q4	2,317	18,856	2.05

The lower constituent loads removed in the second quarter are the result of turning the groundwater extraction wells off during turnaround.

Effect of Extraction Well Load Removal

The effect of constituent load removal by the groundwater extraction system can be evaluated in terms of predicted groundwater discharge concentrations at the Portneuf River by accounting for the constituent load not extracted, and estimating the effect of the attenuation of this load as the affected groundwater moves toward the Portneuf River. A summary of the effect of extraction well load removal in the springs at the Portneuf River is provided in Table 5-6.

Table 5-6: Summary of the effect of the constituent removal by groundwater extraction in the target capture zones.

Description	Units	Q1			Q2			Q3			Q4		
		Phos	Sulfate	Arsenic	Phos	Sulfate	Arsenic	Phos	Sulfate	Arsenic	Phos	Sulfate	Arsenic
Mass Flux in Groundwater Downgradient of Stack	lb/day	4,080	33,046	3.54	4,337	31,703	3.52	3,973	31,070	3.63	3,551	31,282	3.11
Mass Flux in Groundwater Added in PAP Area	lb/day	118	116	0.010	118	21	0.002	111	22	0.003	110	23	0.003
Mass Flux Extracted (including well SWP-4)	lb/day	2,108	18,640	2.15	2,214	17,275	1.88	2,288	19,251	2.22	2,170	18,410	1.94
Attenuation of Uncaptured PAP-Affected Groundwater	lb/day	106	104	0.010	106	19	0.002	100	20	0.003	99	21	0.002
Attenuation of Stack-Affected Groundwater	lb/day	774	2,884	0	833	2,886	0	647	2,364	0	543	2,575	0
Local Unaffected Groundwater Flow	cfs	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6
Local Groundwater Concentration	mg/L	0.08	57	0.004	0.08	57	0.004	0.08	57	0.004	0.08	57	0.004
Mass Flux from Local Groundwater	lb/day	13	9,405	0.64	13	9,416	0.64	13	9,422	0.64	13	9,412	0.64
Total West Side Groundwater Discharge	cfs	34	34	34	34	34	34	34	34	34	34	34	34
Estimated Constituent Concentrations in the Springs at the River	mg/L	**6.7**	**114**	**0.011**	**7.2**	**114**	**0.012**	**5.6**	**103**	**0.011**	**4.7**	**106**	**0.010**

5.3.3.2 Analytical Capture Calculations

The lateral dimensions of the capture zone of each extraction well can be calculated using an analytical calculation (Javandel and Tsang 1986). A detailed description of the capture zone width calculation is provided in Appendix I of the Quarterly Groundwater/Surface Water Remedy Monitoring Reports. These calculations are performed each quarter and are summarized below in Table 5-7 for 2011 and the interpretation of the potentiometric surfaces and capture zones are shown in Figure 5-10 through Figure 5-13.

Y_{max} represents the maximum capture zone width from the central line of the plume (half of total width); Y_{well} is the capture zone width at the location of the well from the central line of the plume (half of total width); and X_o represents the distance from the well to the downgradient end of the capture zone along the central line of flow (Javandel and Tsang 1986).

Table 5-7: Summary of extraction well capture zone dimensions.

Zone	Section	Well	Q1			Q2			Q3			Q4		
			Y_{max} (ft)	Y_{well} (ft)	X_o (ft)	Y_{max} (ft)	Y_{well} (ft)	X_o (ft)	Y_{max} (ft)	Y_{well} (ft)	X_o (ft)	Y_{max} (ft)	Y_{well} (ft)	X_o (ft)
Upper Zone	East 1	412	177	88	56	177	88	56	177	88	56	177	88	56
		404	11	5	3	11	6	4	11	6	4	13	6	4
	East 2	406	12	6	4	35	17	11	36	18	12	27	14	9
		422	-	-	-	-	-	-	-	-	-	80	40	25
		407	11	5	3	20	10	6	19	9	6	24	12	8
	East 3	409	51	26	16	42	21	13	30	15	9	16	8	5
		421	-	-	-	-	-	-	-	-	-	494	247	157
		413	494	247	157	494	247	157	494	247	157	494	247	157
	Central	414	104	52	33	54	27	17	93	46	29	94	47	30
		416	314	157	100	211	105	67	296	148	94	321	160	102
		419	121	61	39	103	51	33	122	61	39	127	63	40
	West	401	77	39	25	77	38	24	75	38	24	54	27	17
		402	273	137	87	170	85	54	159	80	51	147	74	47
		415	89	45	28	89	45	28	89	45	28	89	45	28
Lower Zone	East 1	410	70	35	22	63	31	20	63	32	20	-	-	-
		422	-	-	-	-	-	-	-	-	-	127	63	40
		411	65	32	21	52	26	17	61	30	19	42	21	13
		412	368	184	187	318	159	101	392	196	125	348	174	111
	East 2	421	-	-	-	-	-	-	-	-	-	378	189	120
		413	414	207	132	436	218	139	310	155	99	417	208	133
	West	415	97	49	31	89	45	28	132	66	42	138	69	44

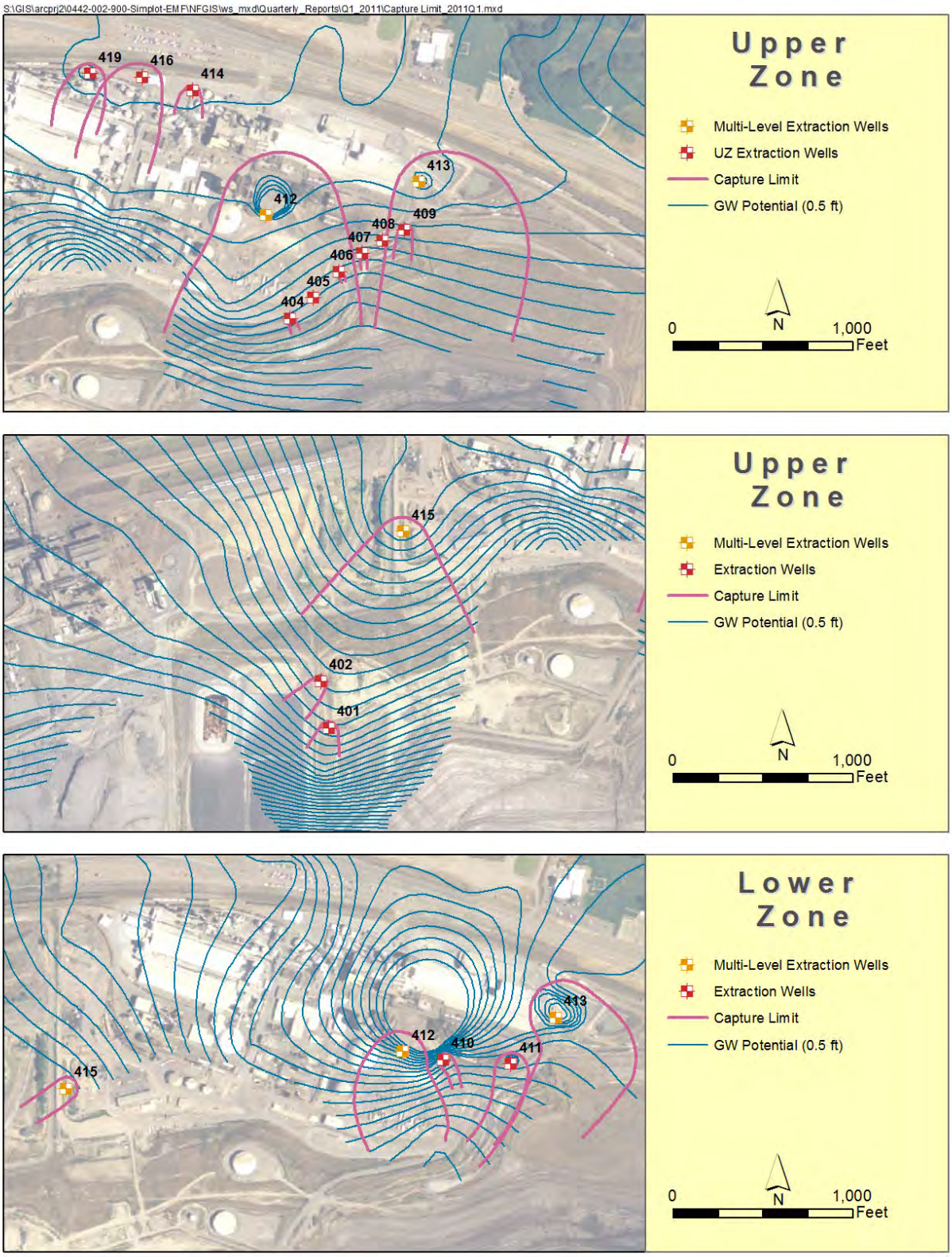


Figure 5-10: Calculated capture zones for Upper and Lower Zone extraction wells, first quarter 2011

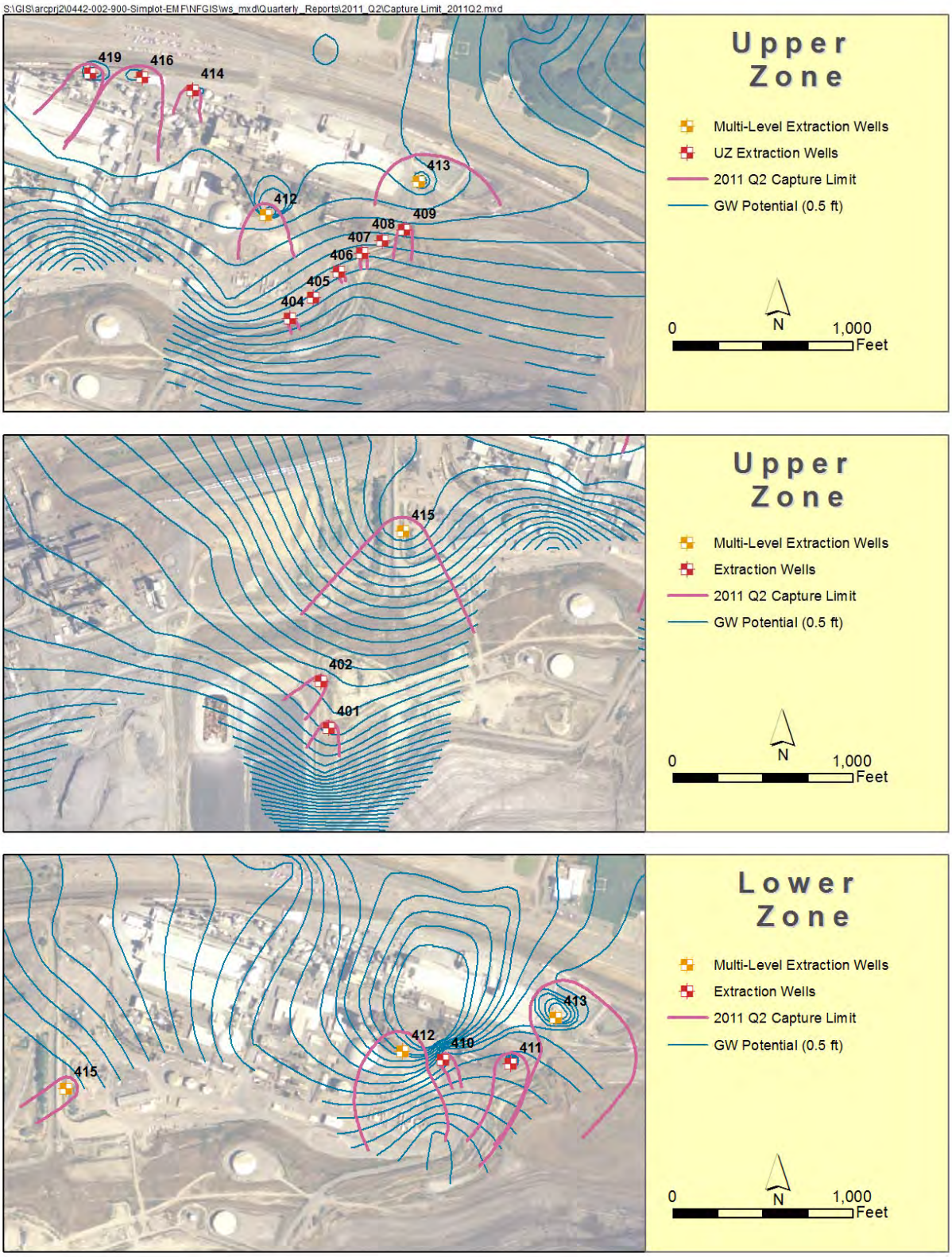


Figure 5-11: Calculated capture zones for Upper and Lower Zone extraction wells, second quarter 2011

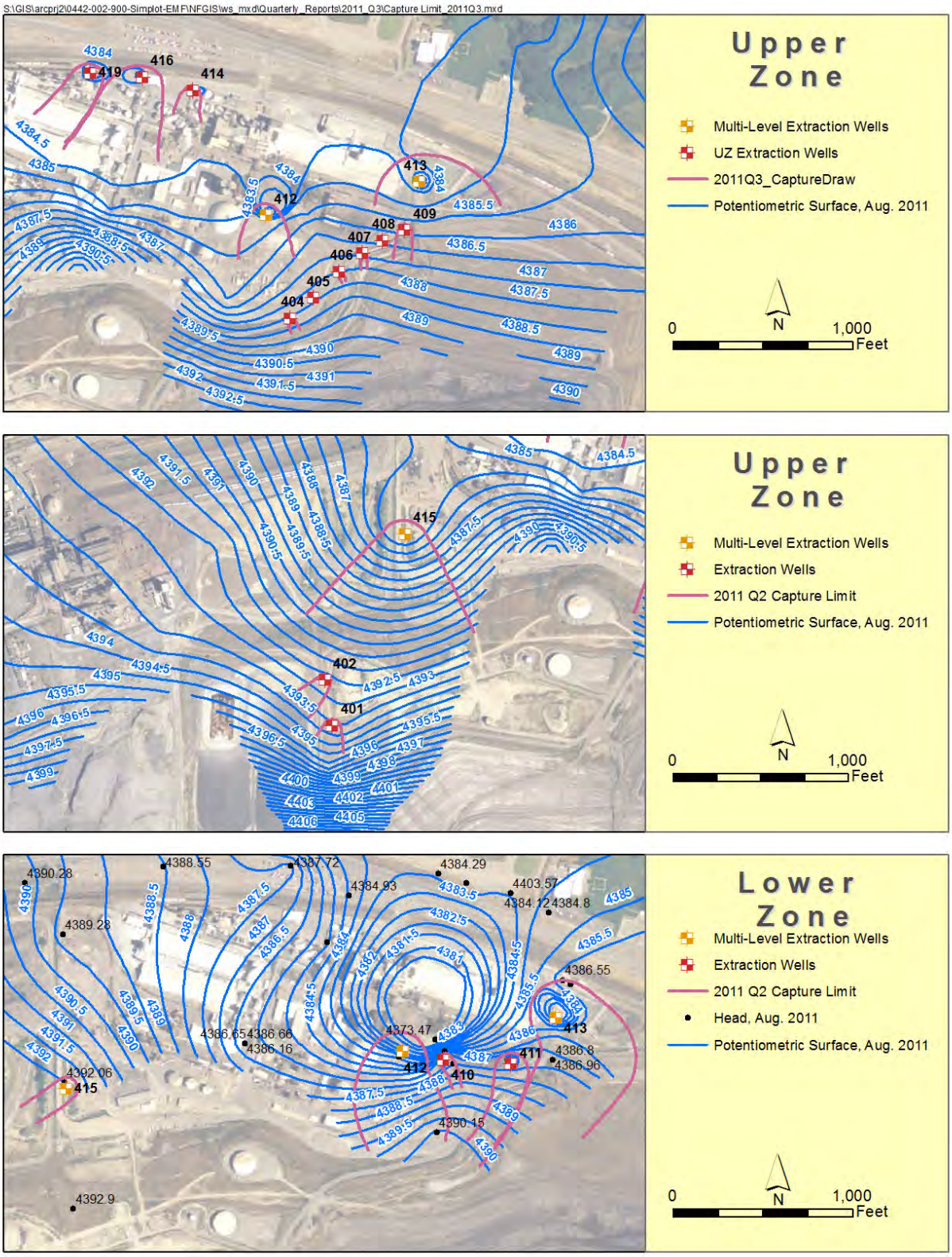


Figure 5-12: Calculated capture zones for Upper and Lower Zone extraction wells, third quarter 2011

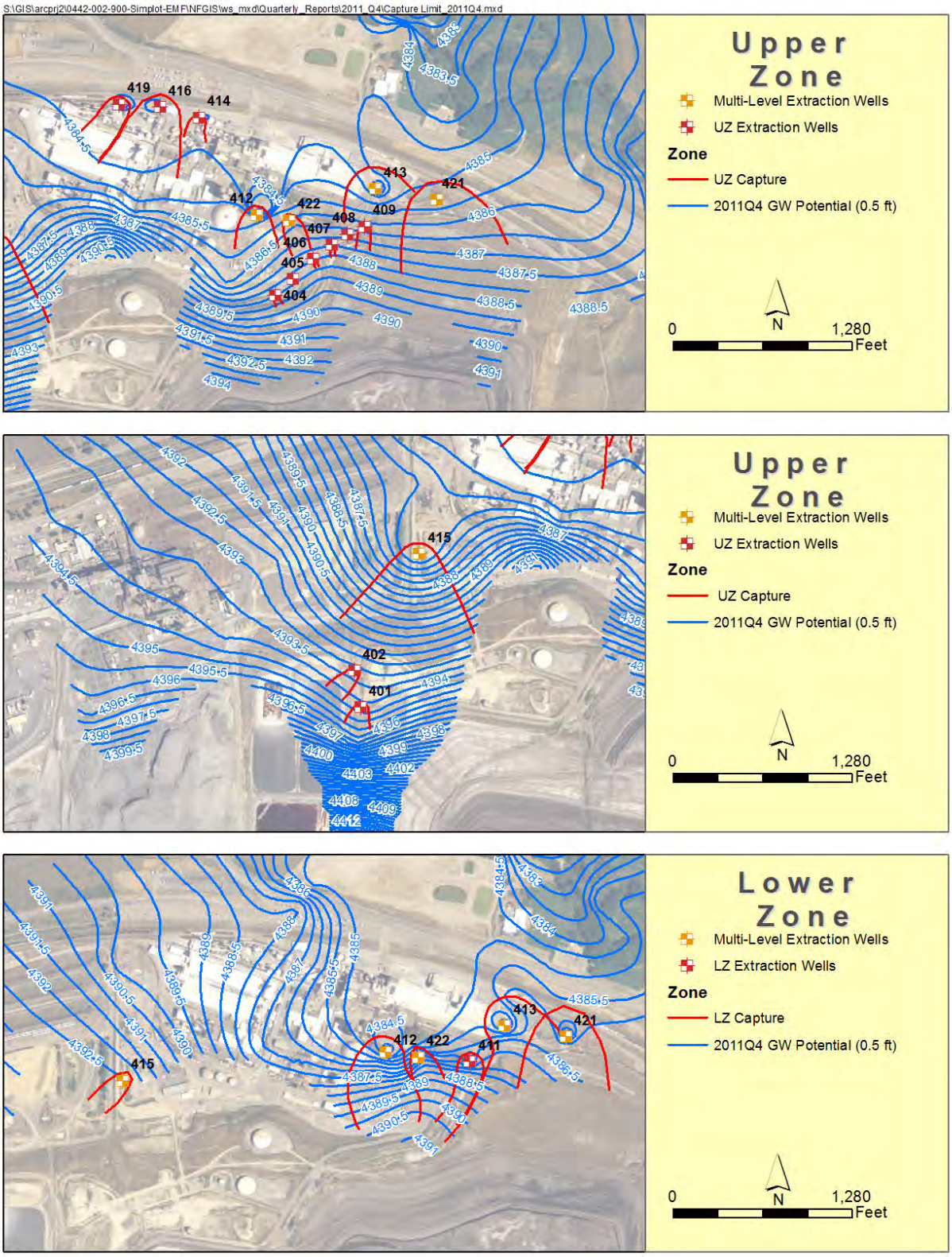


Figure 5-13: Calculated capture zones for Upper and Lower Zone extraction wells, fourth quarter 2011

5.3.3.3 Numerical Particle Tracking Models

A numerical groundwater flow model was developed during the remedial design and is now used for particle tracking. The groundwater flow model Modflow (McDonald and Harbaugh 1988) was used in conjunction with the particle tracking model Modpath (Pollock 1994) inside the pre- and post-processing software Groundwater Vistas to provide the simulations.

The model was calibrated to steady-state conditions observed in August 2003. The model is then modified to simulate pumping conditions in each quarter of 2011 by adding extraction wells with steady-state pumping rates allocated to the appropriate screened intervals. Note that the average pumping rate for the quarter used in this analysis is the rate during operation. A detailed description of the setup of the model is included in Appendix J of the Quarterly Groundwater/Surface Water Remedy Monitoring Reports. A summary of the results of the particle tracking modeling is provided in the following paragraphs.

The Site-wide model is comprised of 7 layers, the top layer simulates the Upper Zone, layer 2 simulates the AFLB, layers 3-5 simulate the Lower Zone, and layers 6 and 7 simulate the Tertiary bedrock. Layer elevations are directly input from the Site hydrostratigraphic model. The lateral grid spacing is uniform at 50 feet in both the x and y directions. Constant head boundaries are provided at both the up gradient and down gradient limits of the model in the Upper and Lower Zones (layers 1, 3, 4, and 5) and throughout the bottom of the model in layer 7 to provide the observed lateral and vertical hydraulic gradients. The Portneuf River was simulated using three river reaches. Hydraulic conductivities vary throughout the model and are based on aquifer testing results. Forward particle tracking is employed to observe the effects of pumping wells. The dense network of particles released up gradient of the pumping wells allows a visualization of well capture zones as well as areas where groundwater is not captured.

The results of particle tracking simulations for the upper capture zones are shown in Figure 5-14 through Figure 5-17 and for the lower capture zones in Figure 5-18 through Figure 5-21. Captured particle traces are shown in red.

Numerical modeling demonstrates that the extraction system does not capture all particles in the Upper Zone in the East Plant Area. This is consistent with expectations for the design of the extraction system in this area. The addition of two new East Plant multi-level extraction wells, 421 and 422 in the third quarter of 2011, has increased the extent of capture in the East Plant Upper Zone. This is evident when comparing the particle traces in Figure 5-16 with those in Figure 5-17. In the Central Plant Area Upper Zone, the primary plumes of affected groundwater pass through or very nearby the locations of wells 416 and 419. Particle traces in this area are intercepted by extraction wells 414, 416, and 419. As in the East Plant, the extraction wells in this area are not intended to capture all of the groundwater flow.

In the Lower Zone, the results of the numerical modeling indicate that large zones of particle capture are provided by wells 411, 412, 413, 421 and 422. Capture zones for the three production wells, SWP-4, SWP-5, and SWP-7, are not shown in the analysis so that capture

from the extraction wells can be better visualized. Groundwater quality samples from production wells SWP-5 and SWP-7 indicate that they do not capture any affected groundwater and water quality in well SWP-4 has improved considerably since well 412 began operation. In the western area, the model indicates that well 415 provides limited particle capture.

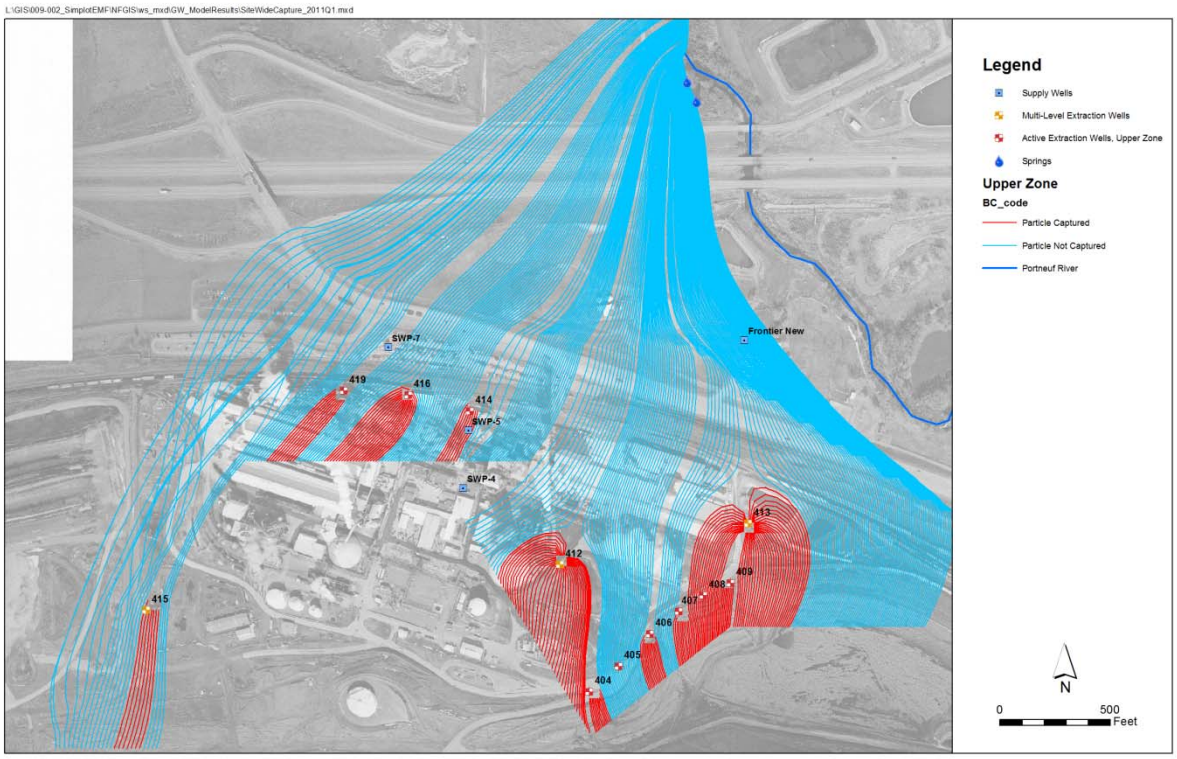


Figure 5-14: Results of particle tracking simulation in the Upper Zone, first quarter 2011

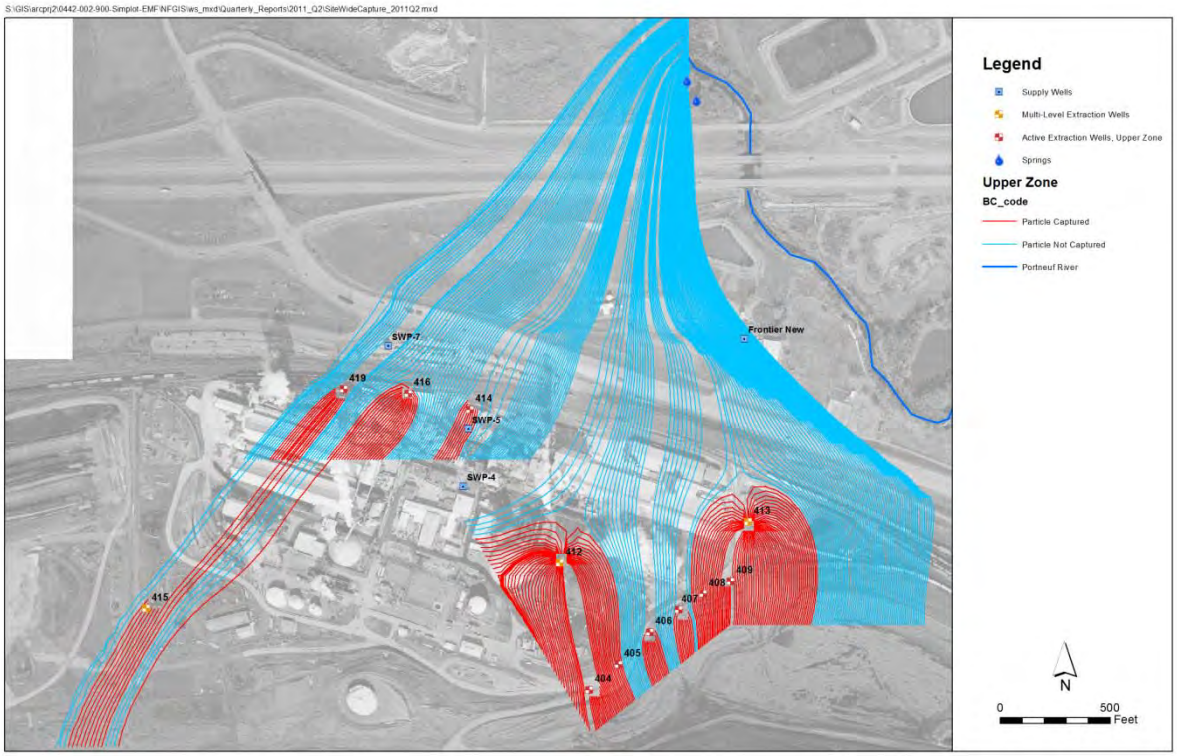


Figure 5-15: Results of particle tracking simulation in the Upper Zone, second quarter 2011

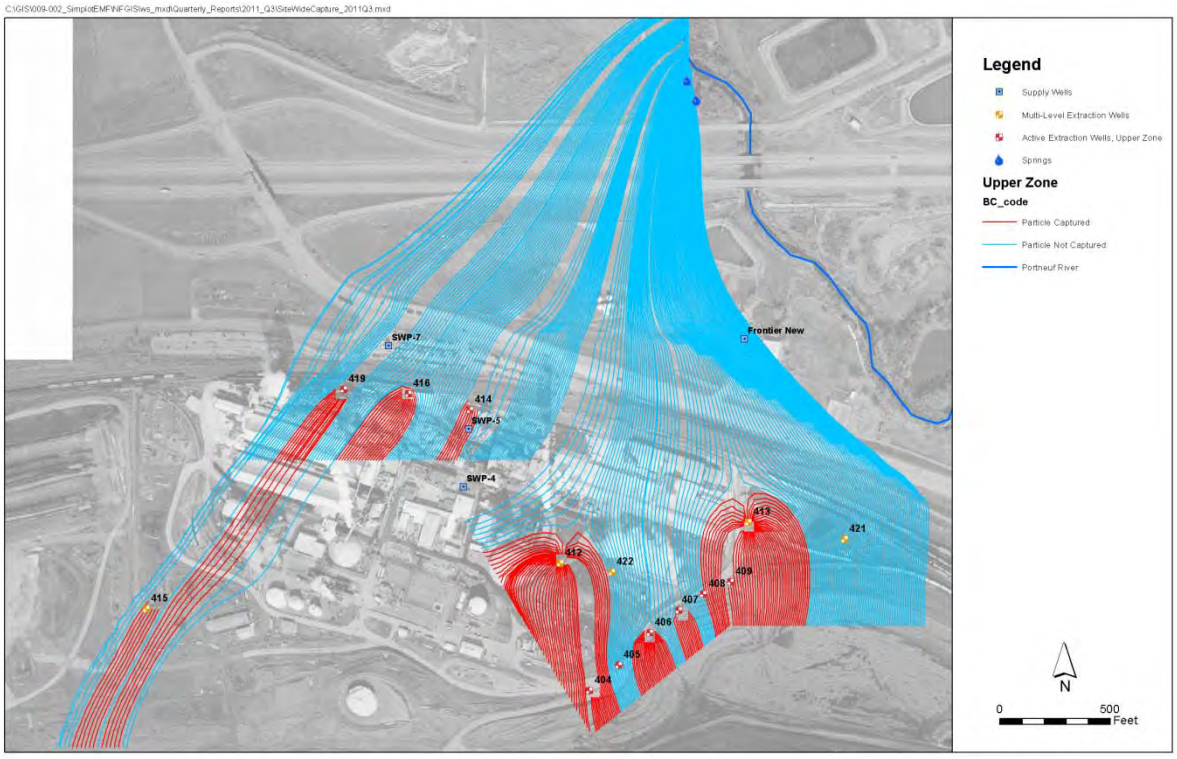


Figure 5-16: Results of particle tracking simulation in the Upper Zone, third quarter 2011

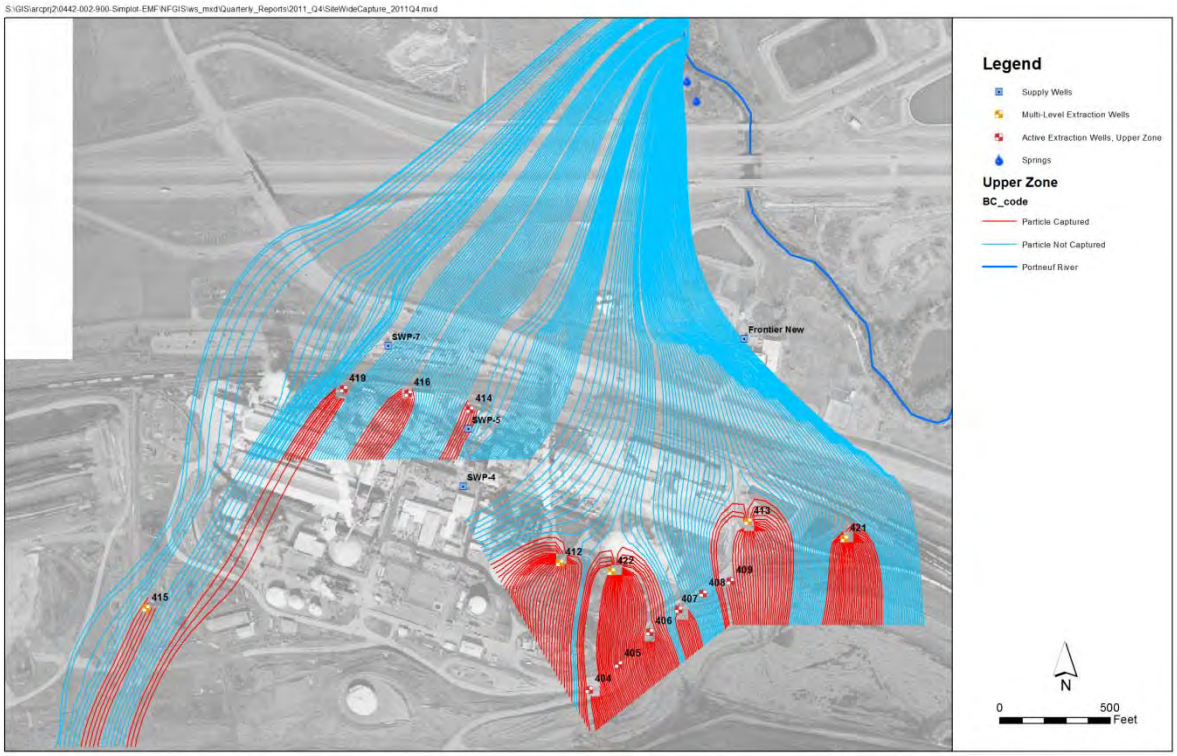


Figure 5-17: Results of particle tracking simulation in the Upper Zone, fourth quarter 2011

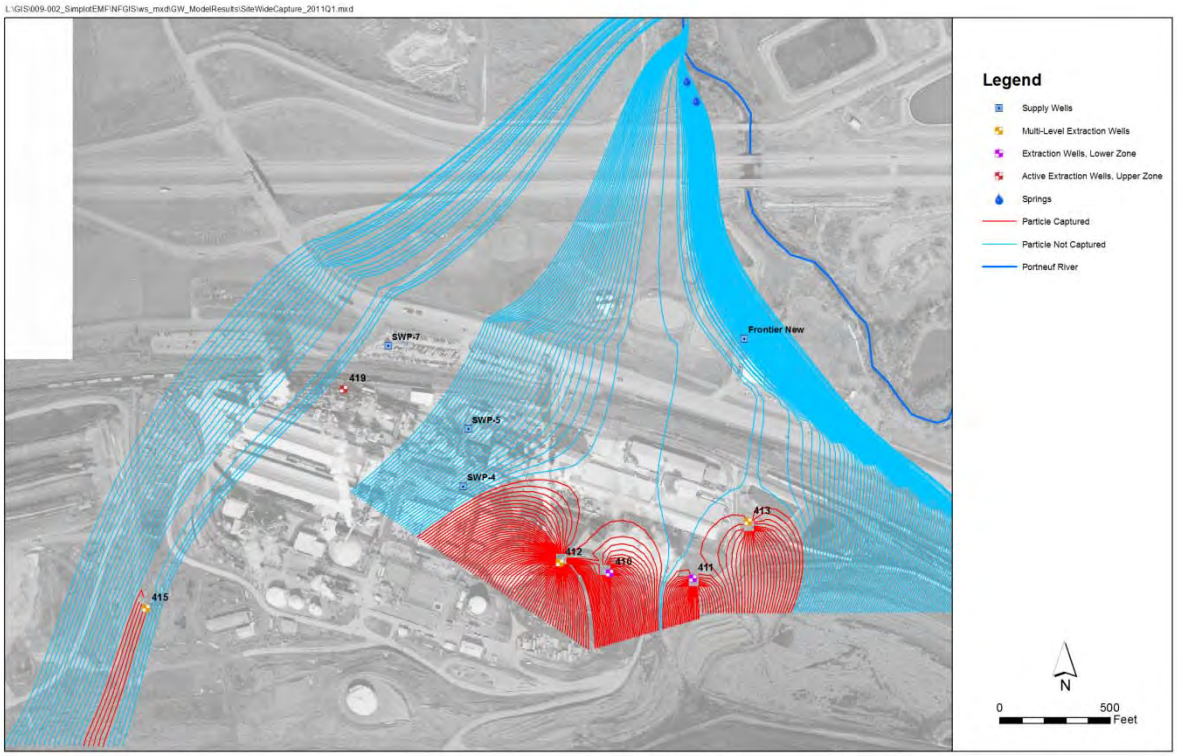


Figure 5-18: Results of particle tracking simulation in the Lower Zone, first quarter 2011

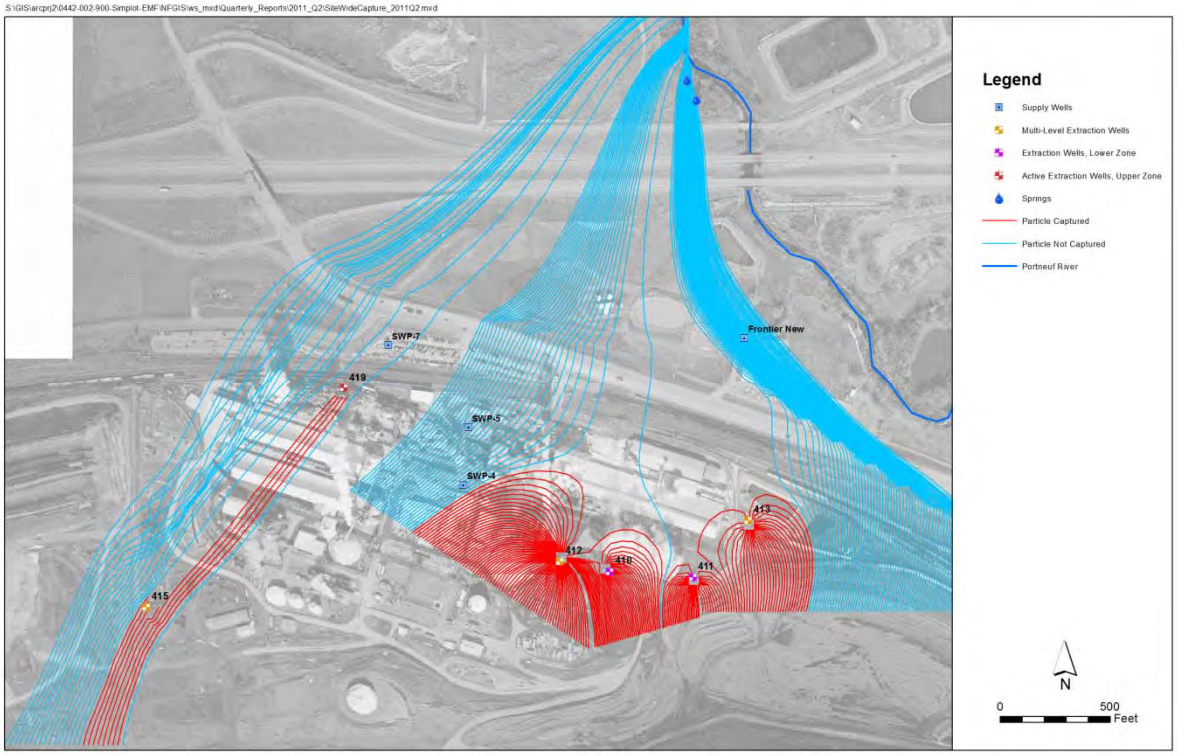


Figure 5-19: Results of particle tracking simulation in the Lower Zone, second quarter 2011

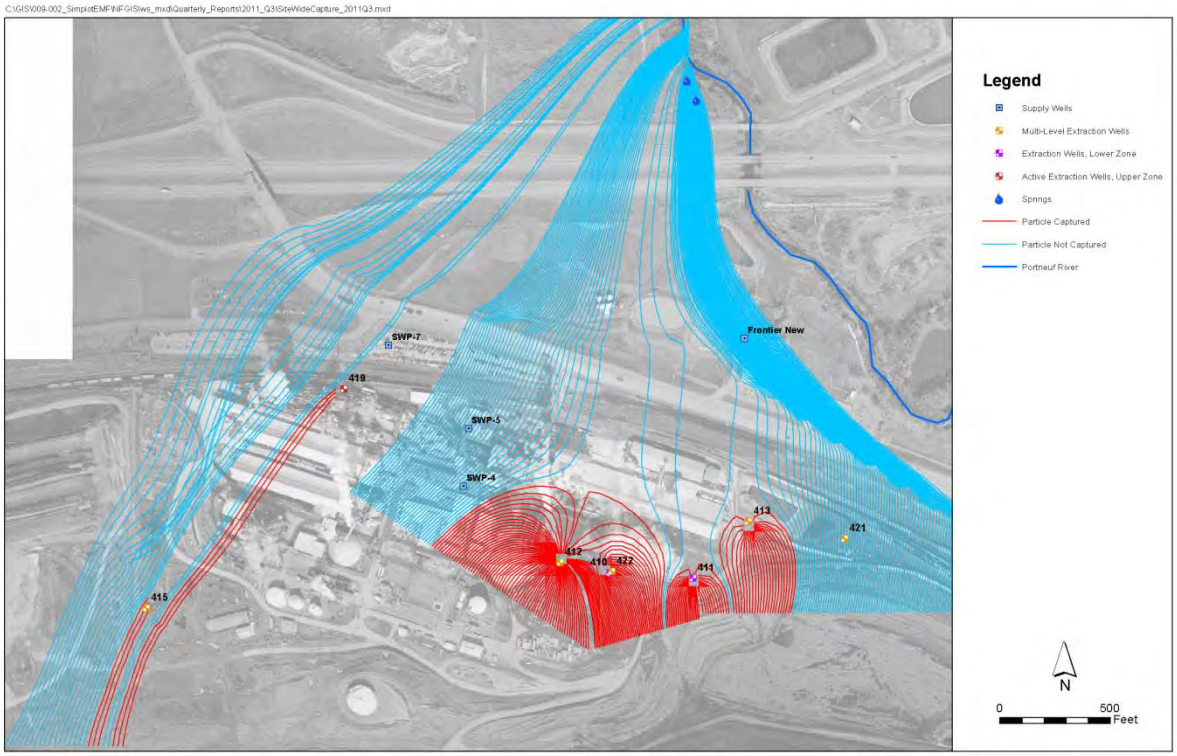


Figure 5-20: Results of particle tracking simulation in the Lower Zone, third quarter 2011

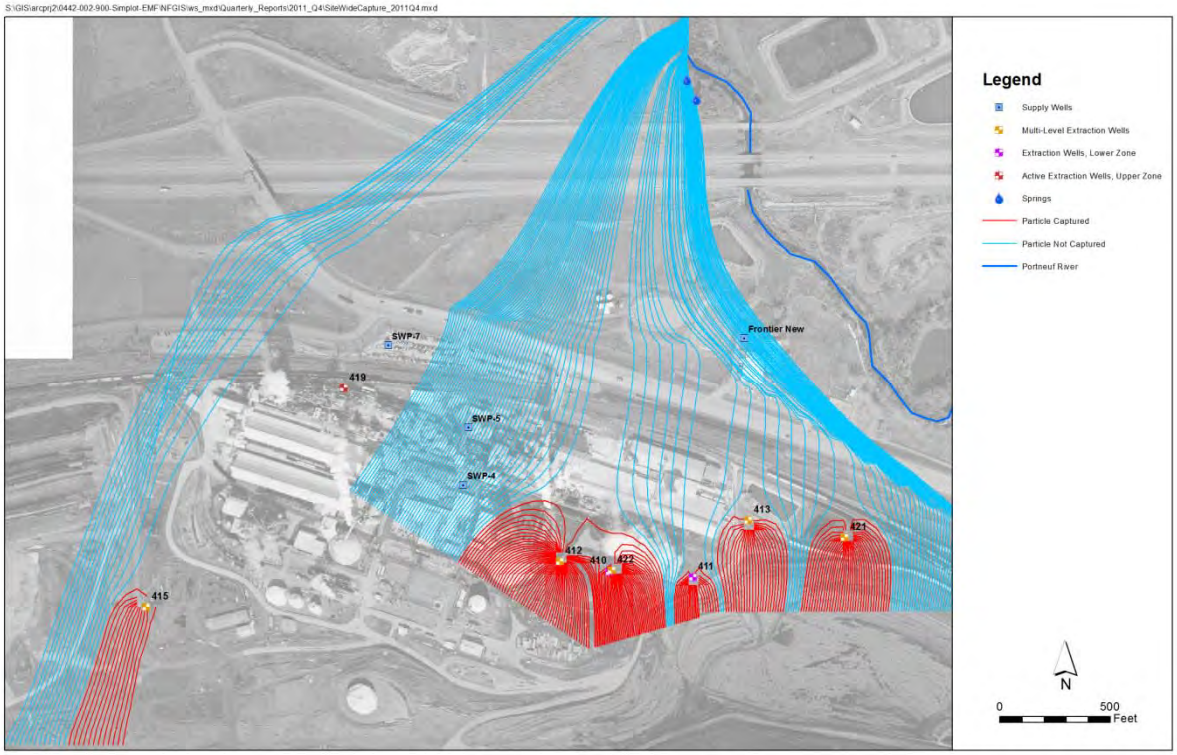


Figure 5-21: Results of particle tracking simulation in the Lower Zone, fourth quarter 2011

5.3.4 Evaluation of Concentration Trends of Indicator Analytes in Groundwater (Step 5)

The concentration trends of Site-derived constituents, in groundwater samples collected from monitoring wells in a line just north of Highway 30 in the Assessment Area, can be used to assess the influence of groundwater extraction on the concentration of key constituents in groundwater down gradient. Concentration trends in downgradient monitoring wells are compared to trends in extraction wells to assess the effectiveness of extraction system capture on an annual basis (Formation 2010e). Trend analyses of wells site-wide are included in Appendix B of this report and are reported annually (MFG 2005, NewFields 2006a, NewFields 2007, NewFields 2008a, Formation 2010c). In order to assess the effects of the extraction system on downgradient concentrations, the following factors must be considered:

- Downgradient monitoring wells must be positioned properly with respect to the extraction system to observe an effect.
- Downgradient monitoring wells must have a period of record that can be correlated temporally with periods of extraction.
- Groundwater travel time must be accounted for in the assessment.

The phase 1 extraction system went into operation in June of 2004 and the phase 2 system in January of 2008. Extraction wells installed as part of the phase 2 extraction system include multi-level wells 412, 413, 415, and Upper Zone well 414. The phase 3 system was initiated with the conversion of wells 419 and 416 to extraction wells in April of 2010. Also part of the phase 3 installation, extraction well 410 was taken out of service in August of 2011 and two new multi-level extraction wells were brought on line in September of 2011, wells 421 and 422.

A network of multi-level monitoring wells was installed in 2010 in the Assessment Area north of Highway 30, downgradient of the Target Capture Zones. Concentration data for indicator analytes from these new multi-level monitoring wells along with concentration data from wells 528 and 529 (sampled since 2007) are now available to evaluate the effectiveness of the extraction system in reducing the extent and concentration of indicator analytes in the Assessment Area. These monitoring wells are positioned properly with respect to the extraction system to observe an effect and now have a period of record that can be correlated temporally with periods of extraction.

The locations of multi-level monitoring wells downgradient of Target Capture Zones are shown in Figure 5-22. Time-series concentration data for arsenic, phosphorus and sulfate in extraction wells and monitoring wells located in specific Capture Zones are plotted in Figure 5-23 through Figure 5-30.

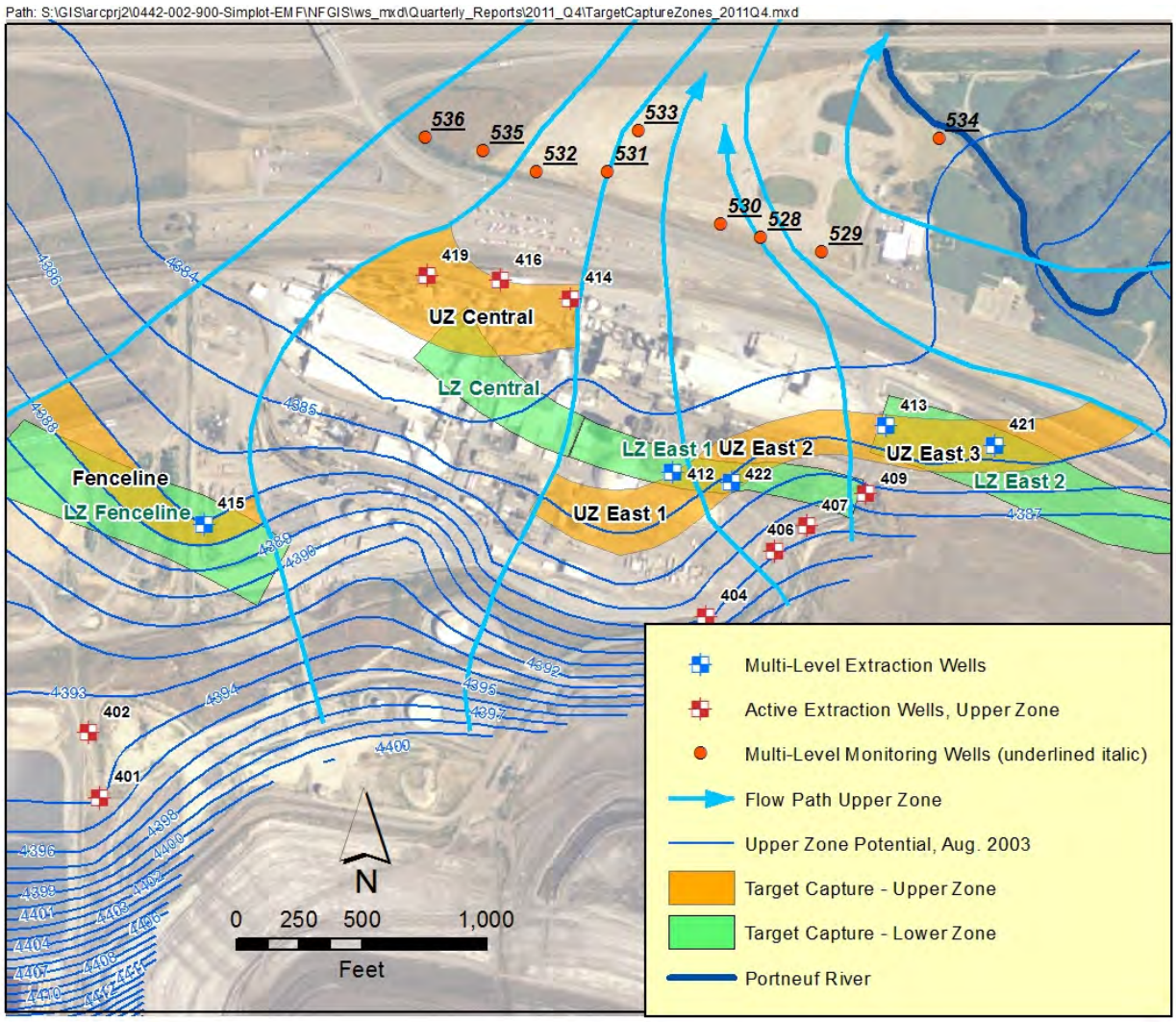


Figure 5-22: Monitoring well locations for assessment of capture zones

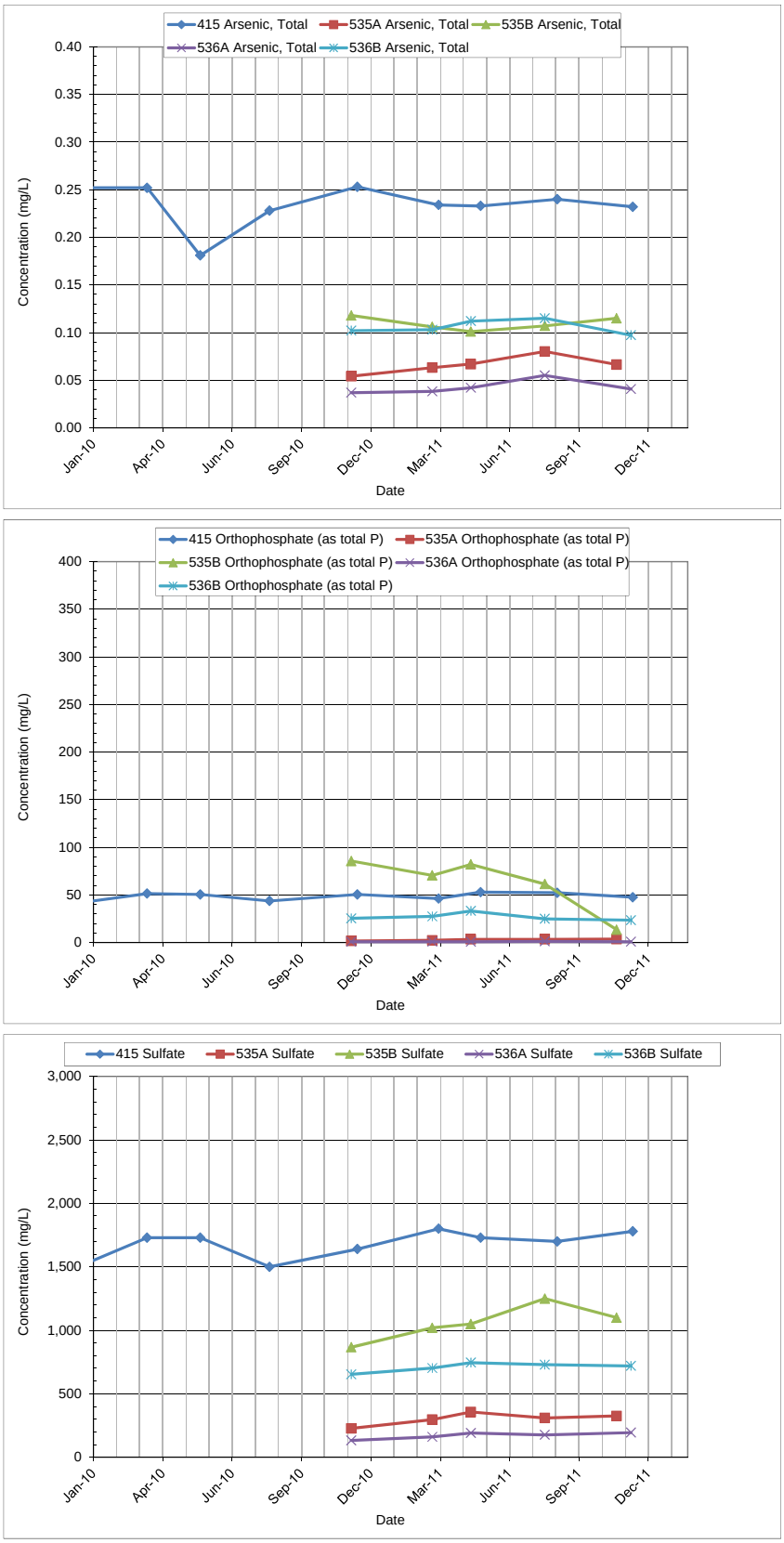


Figure 5-23: Indicator Analytes for wells in Upper and Lower Fencline Capture Zones

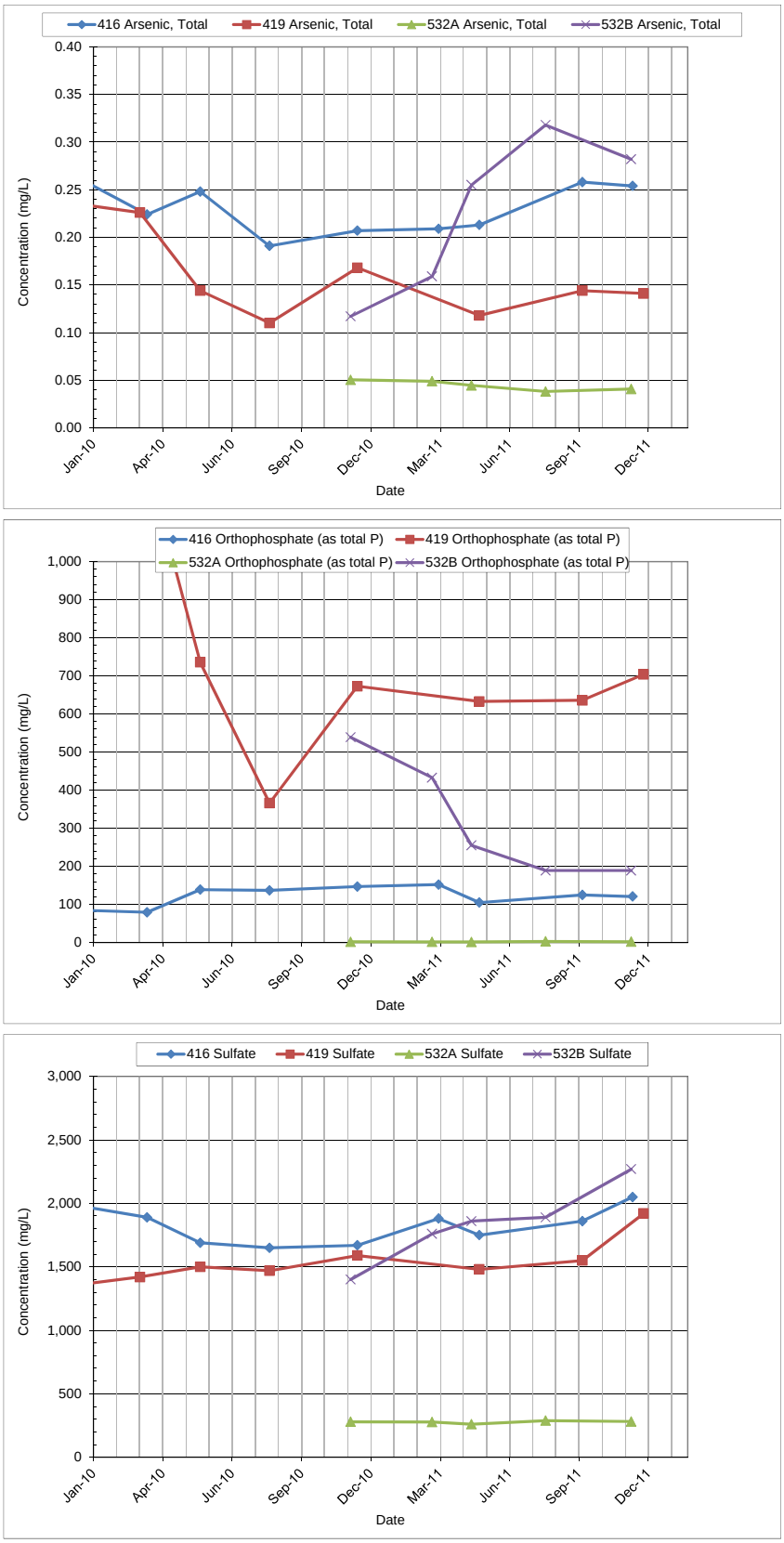


Figure 5-24: Indicator Analytes for wells in Upper Central Capture Zones

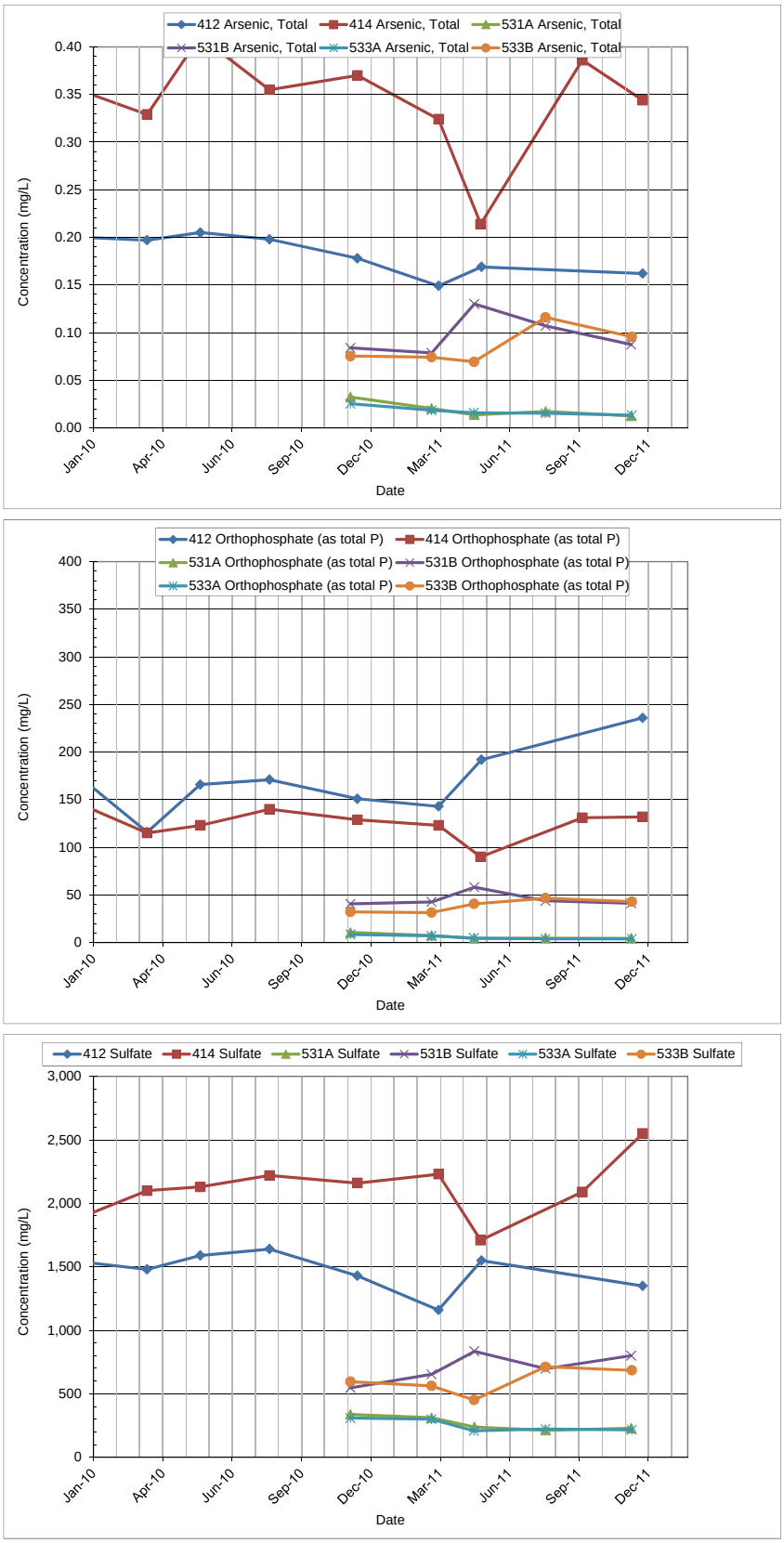


Figure 5-25: Indicator Analytes for wells in Upper and Lower East 1 Capture Zones

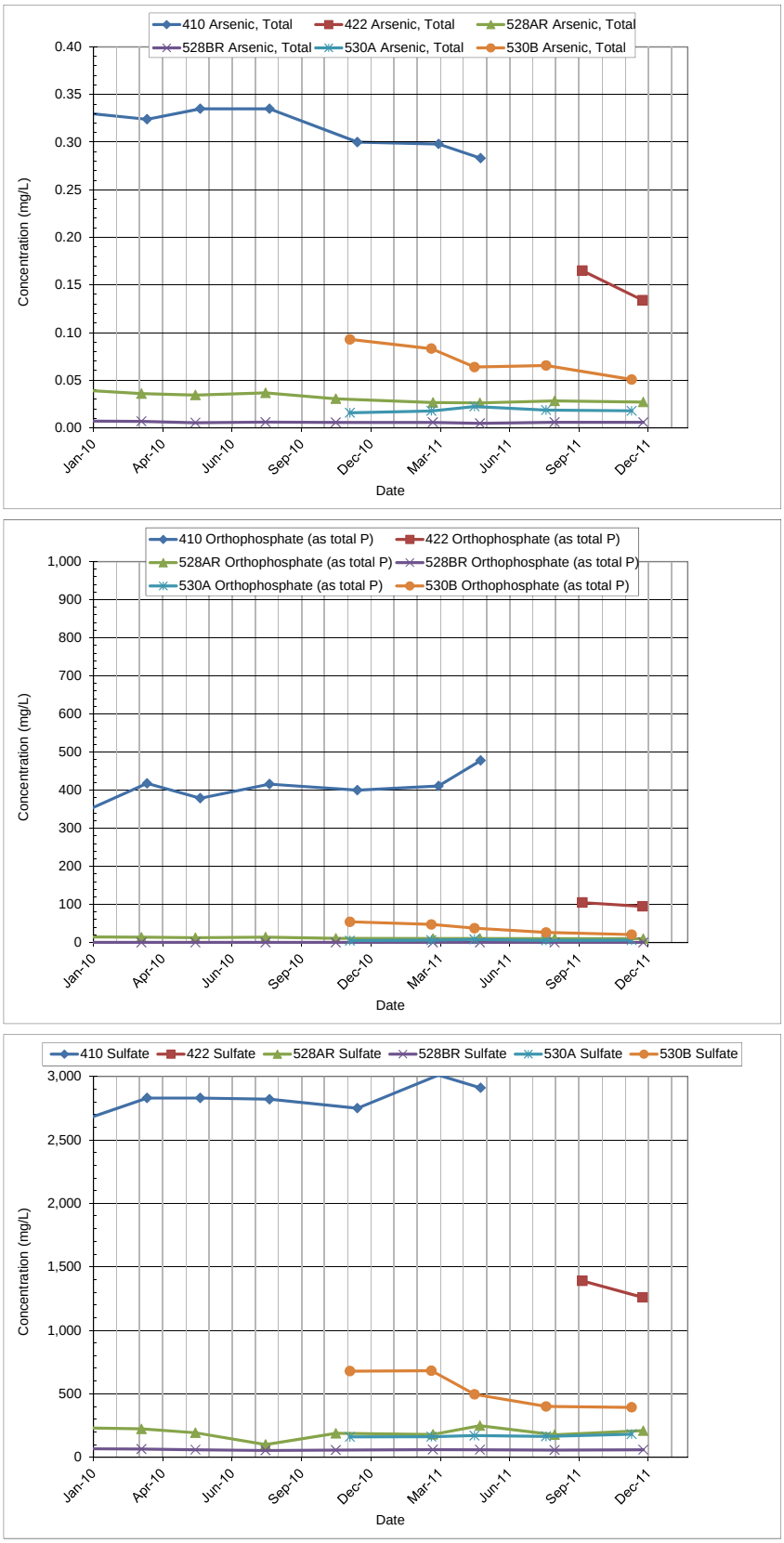


Figure 5-26: Indicator Analytes for wells in Upper East 2 and Lower East 1 Capture Zones

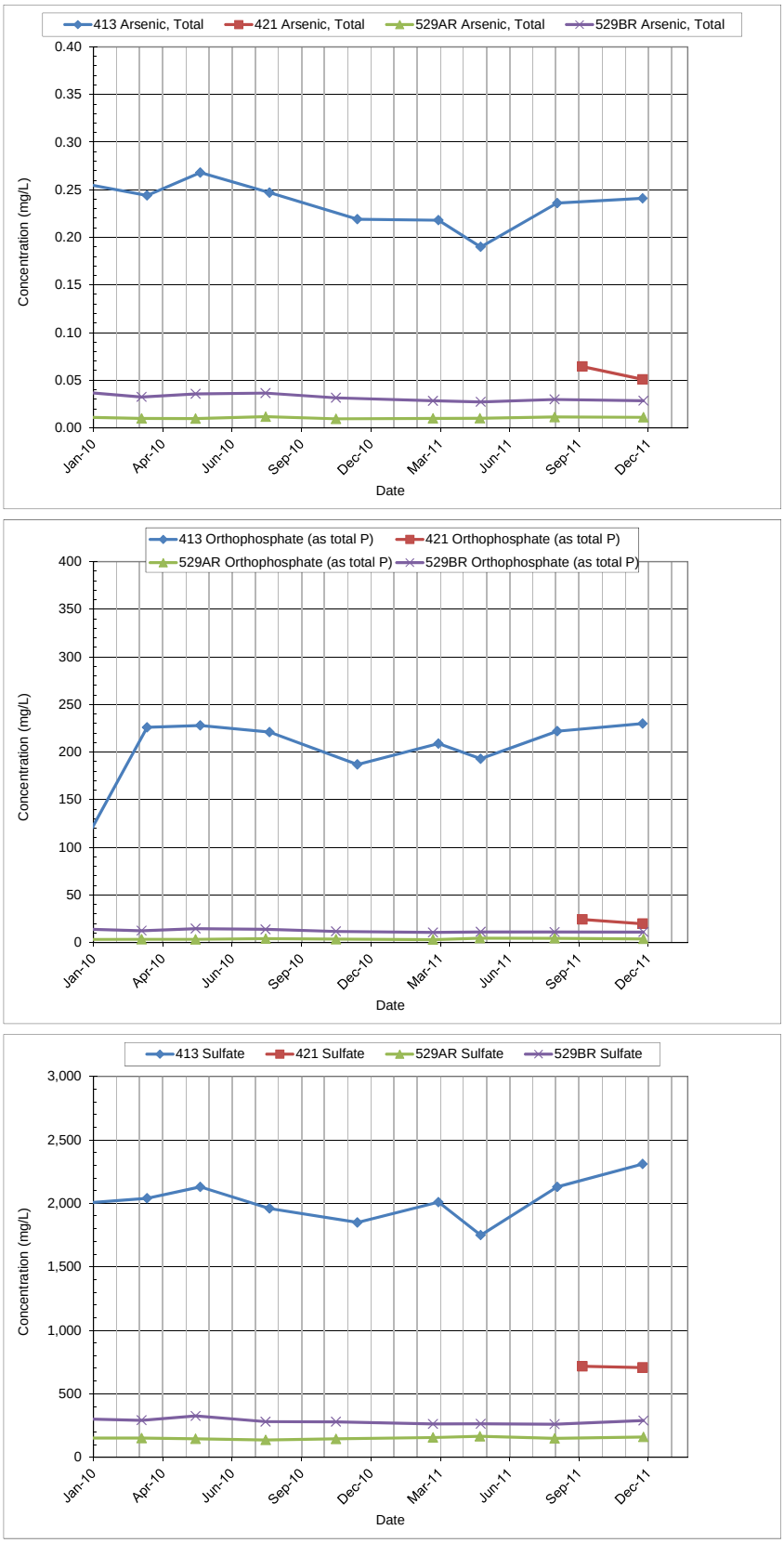


Figure 5-27: Indicator Analytes for wells in Upper East 3 and Lower East 2 Capture Zones

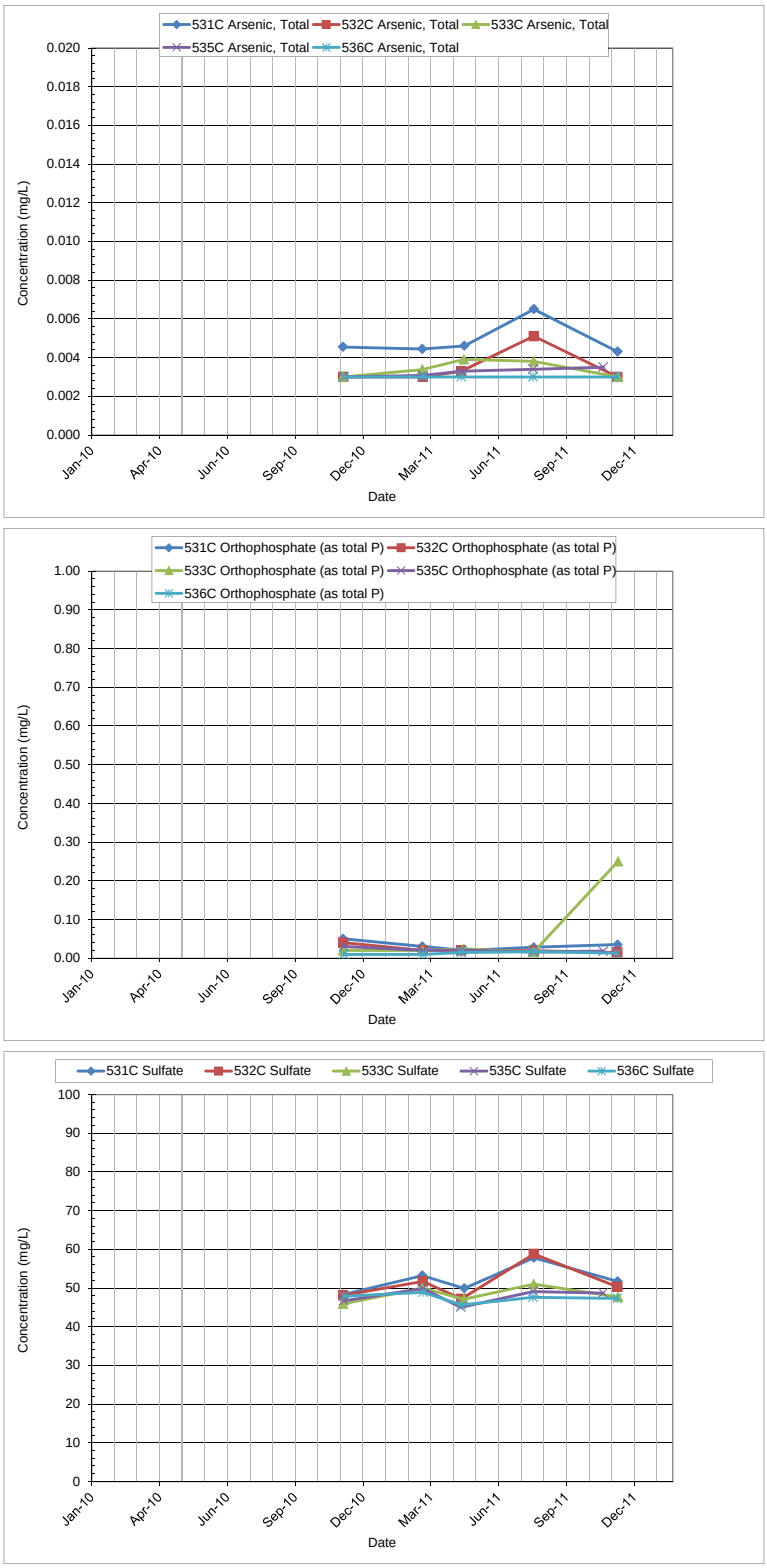


Figure 5-28: Indicator Analytes for wells delineating unaffected groundwater in Lower West and Lower Central Zones

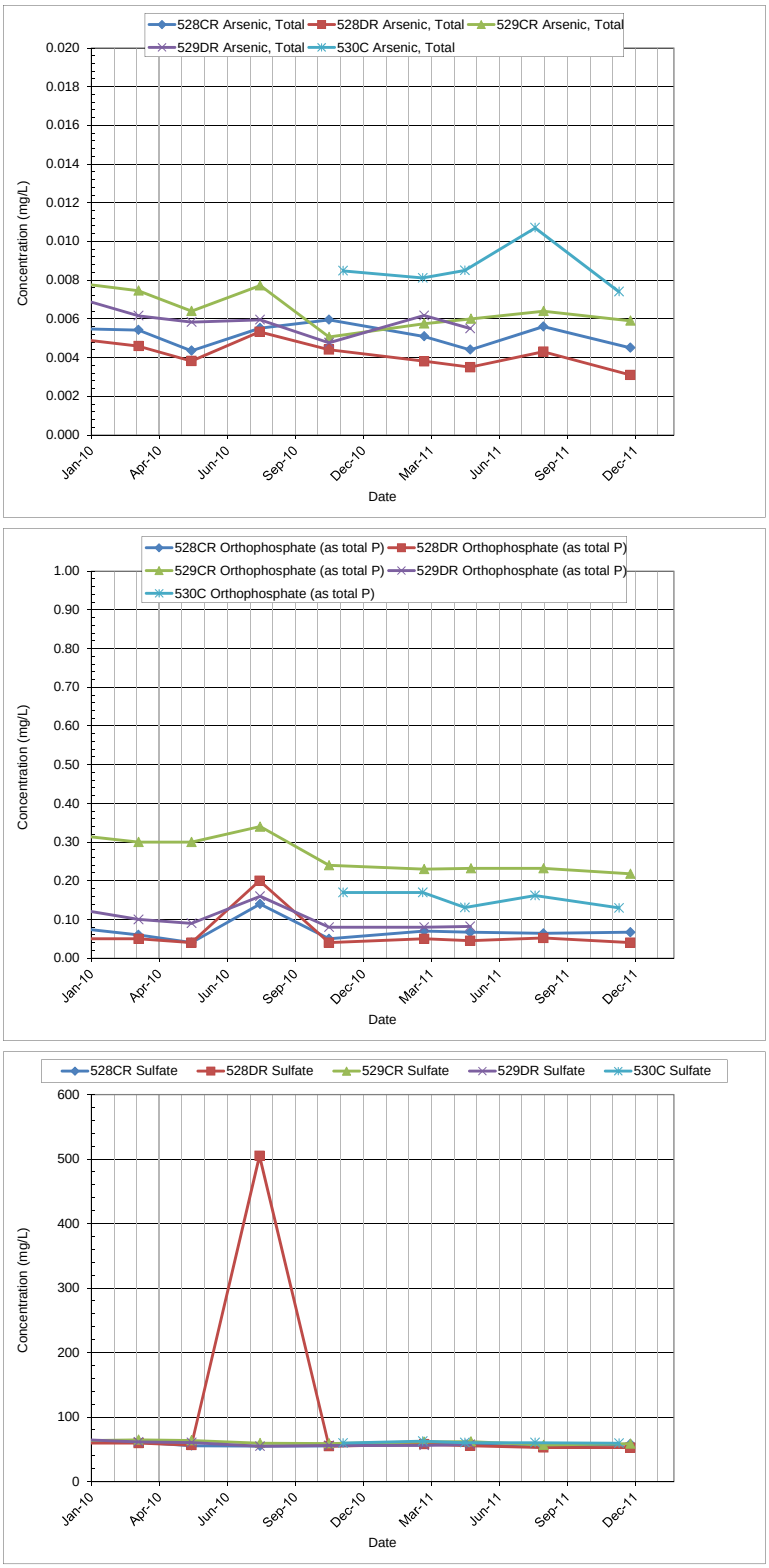


Figure 5-29: Indicator Analytes for wells delineating unaffected groundwater in Lower East Zones

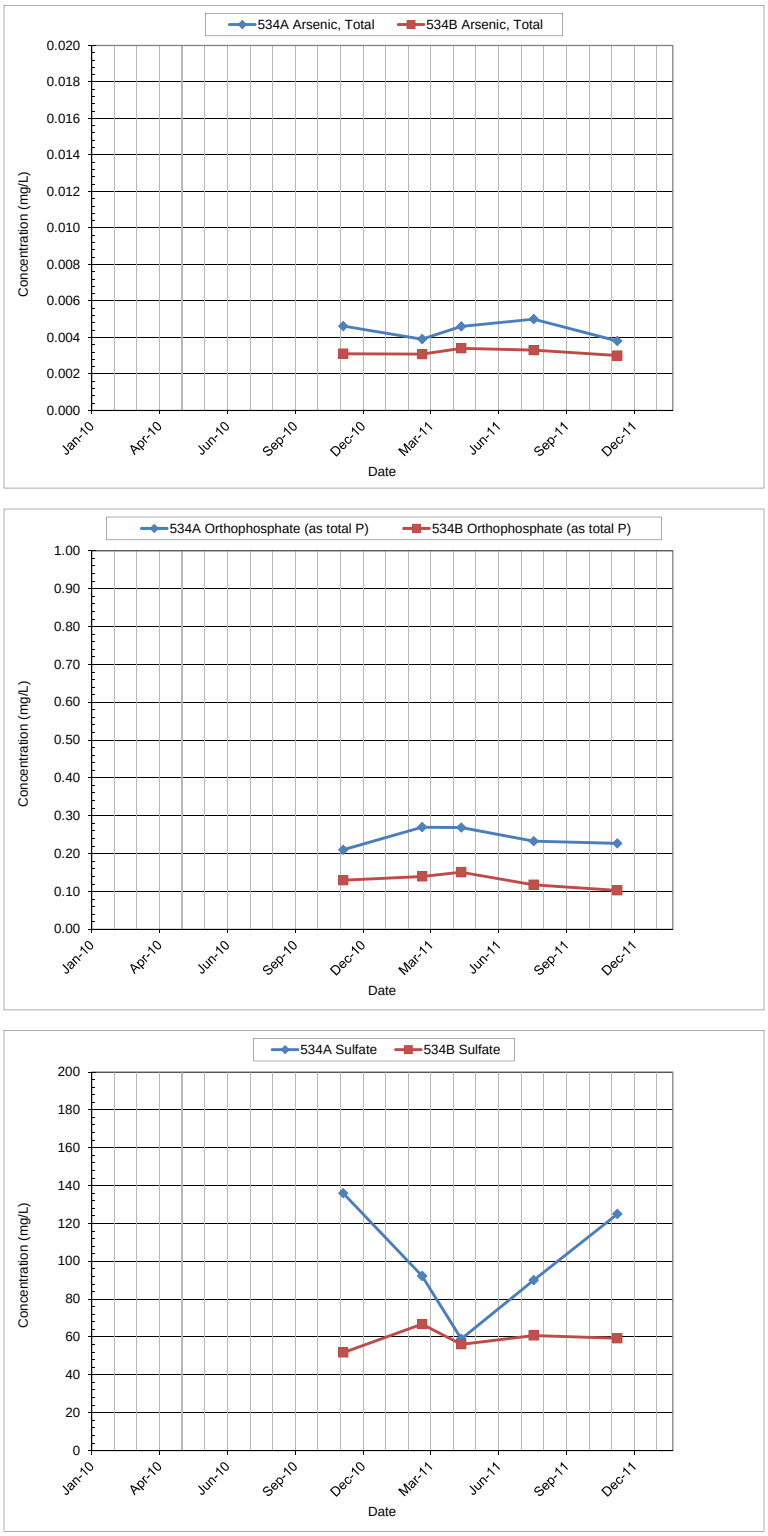


Figure 5-30: Indicator Analytes for wells delineating unaffected groundwater in East Zone near the river

Except for concentrations of arsenic and sulfate at monitoring well 532B, the concentrations of indicator analytes arsenic, phosphorus and sulfate are 35 to 90 percent lower in monitoring

wells north of Highway 30 than in wells in the Target Capture Zones. In deep monitoring wells north of Highway 30, arsenic concentrations in wells 528, 529, 530, 532, 534, and 536 are below 0.010 mg/L, confirming that the vertical extent of affected groundwater is not expanding. Arsenic concentrations below 0.010 mg/L in both shallow and deep monitoring levels at well 534 demonstrate that the lateral extent of affected groundwater is not expanding to the east.

5.3.5 Overall Interpretation of Hydraulic Capture (Step 6)

The results of the analyses provided in the preceding sections can be used collectively to interpret actual capture of the extraction system in 2011 and assess the need for additional characterization and/or extraction. This assessment is summarized in the following sections by target capture zone.

Upper Zone in East Plant Area

In 2011, groundwater extraction was provided by wells 404, 406, 407, 409, 412, 413, 421 and 422 in the Upper Zone in the East Plant Area. Analyses indicate that groundwater extraction did not capture all of the groundwater in the target capture zones in this area. The Upper Zone is thin in this area which makes groundwater extraction difficult. This issue was investigated during the Phase 1 Data Gap Investigation (NewFields 2006a). Additional extraction from the Upper Zone in the East Plant Area has been achieved by incorporating a shallow screen interval into the design of multi-level extraction wells. Four of these wells, 412, 413, 421 and 422 have been installed using this design. Wells 412 and 413 were installed as part of the phase 2 system in 2007 and wells 421 and 422 were installed as part of the phase 3 system in 2011. Analytical capture and numerical particle tracking calculations suggest that these wells have limited zones of capture in the Upper Zone. Groundwater flow and mass flux calculations indicate that the groundwater flow and mass flux is relatively small from these target capture zones and, as described in the Remedial Design Report (Formation 2010e), remedy goals can be met without extracting this groundwater.

Upper Zone in Central Plant

In 2011, groundwater extraction was provided by wells 414, 416, and 419 in the Upper Zone in the Central Plant Area. Analyses indicate that the location of well 414 is not affected by sources within the PAP Area and only stack-affected groundwater is collected. Wells 416 and 419 began operation in late April 2010 and operate in the two areas where PAP-affected groundwater exists in the Target Capture Zone. Calculations, analytical capture, and numerical particle tracking indicate that approximately 80% of the phosphorus load is captured.

This area is well characterized and no significant data gaps remain for assessment.

Lower Zones in East Plant

In 2011, groundwater extraction was provided by wells 410, 411, 412, 413, 421 and 422 in the Lower Zone in the East Plant Area. Analytical capture and numerical particle tracking

calculations indicate that these wells have nearly complete capture in the Lower Zone. Mass flux calculations indicate that the extraction wells are capturing about 80% of the phosphorus load. The well performance data and capture zone analysis indicate that adequate capture of groundwater in this target capture zone is being achieved.

This area is well characterized and no significant data gaps remain for assessment.

Upper Zone and Lower Zones in West Plant

In 2011, groundwater extraction was provided by wells 401, 402, and 415 in the West Plant Area. The subsurface geology in this area is complex. These wells were completed within a paleochannel with the intent of intercepting the maximum saturated stratigraphic thickness for groundwater extraction. Analytical capture and numerical particle tracking calculations indicate that the extent of capture at the downgradient extraction well 415 covers a significant portion of the target capture zone since the materials have a low hydraulic conductivity. Mass flux calculations indicate that there is a relatively small load in this area and that current extraction is capturing about 40% of the phosphorus load.

This area is well characterized and no significant data gaps remain for assessment. Current extraction is sufficient to achieve the design goals.

5.4 Evaluating Reduction in Extent and Concentration of COCs in the Assessment Area

The decision rule for assessing reduction of extent and concentration of COCs in the assessment area is as follows:

> If the concentration of indicator analytes in groundwater down gradient of the extraction system increases significantly after demonstration that the extraction system is operating, then the conditions contributing to that change need to be evaluated and potentially addressed to ensure that the performance standard will be met at the POC.

Groundwater concentration data for 2011 were evaluated with respect to this decision rule and a summary of the assessment is provided in the following paragraphs.

5.4.1 Extent of Indicator Analytes

The extent of arsenic, phosphorus, and sulfate in the Assessment Area at the end of 2011 was similar to that at the end of 2010, including data from the wells installed in fall of 2010. Phosphorus ranged from 0.017 to 0.47 mg/L in well pair 504/505 and the newly installed well 534. These wells are located directly north and east of the effluent ponds, north of Highway 30. Phosphorus in well 519 was below 0.03 mg/L in 2011. This well is located in the Assessment Area, along I-86, a few hundred feet from the springs. Well 539, located in between well 519 and the springs, had phosphorus levels near the level in the springs. Generally, arsenic,

phosphorus, and sulfate concentrations decrease to the north in the Assessment Area. Arsenic and phosphorus concentrations in samples from wells TW-11S, 541, 524, and 525 were very low or below detection limits. Concentrations are typically higher in the shallower intervals in the Assessment Area, as the Lower Zone and Upper Zones merge due to significant upward gradients and the terminus of the AFLB near highway 30. Phosphorus concentrations at the springs were below 2 mg/L in Batiste Road Springs and below 5 mg/L in Batiste Springs in 2011. Shallow well 525 is located less than 200 ft from Batiste Springs, but phosphorus concentrations in groundwater samples are typically lower or below detection limits, suggesting that this location receives little to no groundwater flow from Site-affected areas. The wells installed in the fall of 2010 provide data that completely define the plume extents. Constituent Transport Time

An estimate of transport time was updated for the 2011 conditions. The methodology was presented in Section 5.1.3. Groundwater travel times in the Assessment Area are represented by the calculation zone from Highway 30 to the Portneuf River. Table 5-1 presents the estimated groundwater travel times for the Assessment Area. Groundwater travel times are estimated to take between 0.22 and 0.28 years in the Upper Zone and around 0.08 to 0.11 years in the Lower Zone.

5.4.2 Concentration Trends in Groundwater in the Assessment Area

The locations of monitoring and extraction wells in the Assessment Area are shown in Figure 4-1, Figure 4-2, and Figure 4-3. Time series plots for arsenic, phosphorus, and sulfate for each well are provided in Appendix B.

In 2011, arsenic, phosphorus and sulfate concentrations decreased in wells 530B, 531A and 533A, while arsenic and sulfate concentrations increased and phosphorus concentration decreased in well 532B (Figure 5-31).

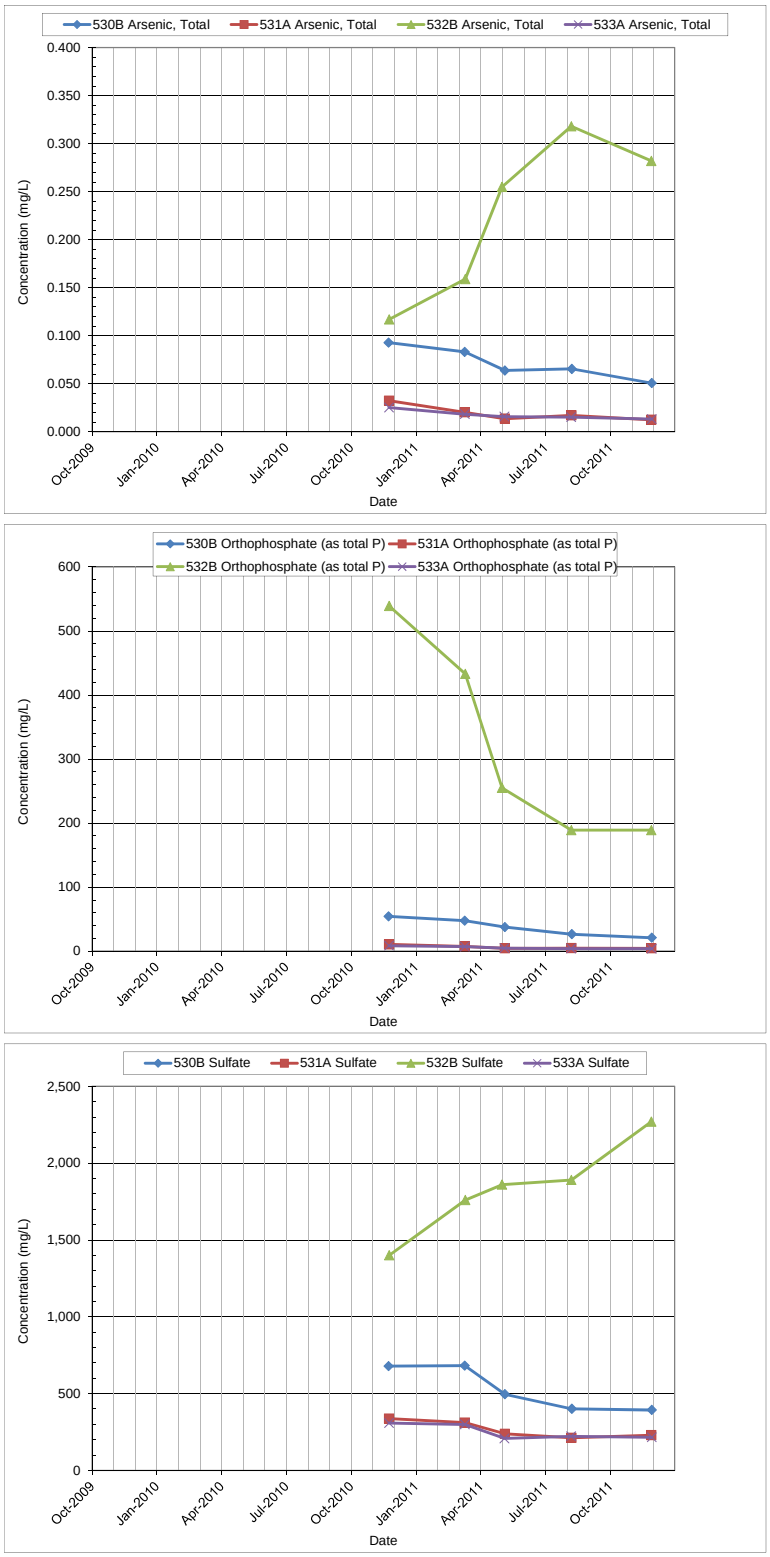


Figure 5-31: Increasing or decreasing concentration trends in Assessment Area

5.5 Evaluate Performance Using Interim Target Concentrations in the Assessment Area

The Groundwater and Surface Water Plan provides a means of assessing groundwater concentrations up gradient of the Compliance Area as an additional way to identify conditions that may result in applicable standards being exceeded at the point of compliance (POC). In the plan, an interim target concentration (C_{IT}) is established for the plume of affected groundwater where the plume crosses Highway 30 in the southern portion of the Assessment Area. However, in order to establish the C_{IT}, source controls must be in place, the effect on groundwater concentrations in the Assessment Area must be realized, and groundwater concentrations must meet standards at the POC. Comparing the average concentration in the plume at Highway 30 to the C_{IT} then acts as a type of early warning system as part of the long-term monitoring strategy. Concepts for the development of the interim target concentration are discussed in detail in the Groundwater and Surface Water Monitoring Plan in Section 3.5.

A complete profile of the plume of affected groundwater can now be obtained using groundwater quality data from monitoring wells installed in 2010 in a line just north of Highway 30 in the southern portion of the Assessment Area. The average plume concentration at this line (C_{AA}) can then be compared to the average plume concentration in the Compliance Area (C_{CA}) to understand constituent mass flux and the influence of dilution and attenuation processes. A dilution and attenuation factor between the two areas is calculated as follows:

$$DAF = \frac{C_{AA}}{C_{CA}}$$

where:

DAF = Dilution and attenuation factor
C_{AA} = Average plume concentration in the Assessment Area (line at Highway 30)
C_{CA} = Average plume concentration in the Compliance Area

Mass flux calculations are included in Appendix E and results are summarized in Table 5-8. The values in Table 5-8 are based on sample results from four quarterly groundwater monitoring events in 2011.

Table 5-8: Summary of Down Gradient Mass Flux Estimate, 2011

	Q (gpm)	Mean P (mg/L)	P Load (lb/day)	Mean SO4 (mg/L)	SO4 Load (lb/day)	Mean As (mg/L)	As Load (lb/day)
Assessment Area (Hwy 30)	4,364	4.0	209	112	5,833	0.014	0.75
Compliance Area	8,440	2.0	199	90	9,070	0.007	0.73
DAF		2.00		1.24		2.00	

The calculations indicate the following:

- The flow rate of affected groundwater increases substantially between the line of assessment at Highway 30 and the Compliance Area
- Sulfate load increases at the Compliance Area are due to the contribution of background groundwater.
- The load of phosphorous and arsenic in groundwater is unchanged between the Highway 30 Assessment Area and the Compliance Area downgradient at the river.

5.6 Evaluate Source Control System Prevention in the Migration into the Off-Plant OU at Concentrations above the MCL or RBC

The decision rule for assessing the prevention of migration into the Off-Plant area is as follows:

> If the 95% upper confidence limit (UCL) on the mean of the concentration in groundwater samples collected from all monitoring well intervals within the plume of affected groundwater is less than the MCL, then the groundwater remedy is effective in achieving the remedial action objectives.

During 2011, samples from the wells and springs in the Compliance Area were analyzed for the expanded analyte list. A comparison of the results for 2011 to the water quality standards is provided in Table 5-9 including the new nested wells 534, 537, 538, and 539. Comparison of the 95% UCL on the mean is only meaningful for locations and constituents with a long enough record.

Table 5-9: Risk-based and Maximum Contaminant Level for Groundwater COCs and Compliance Area well results during 2011 (results in mg/L).

Contaminant of Concern[1]	Units	Maximum Contaminant Level (MCL)	Risk-Based Conc. (RBC)	504				505				524				525				534A			
				Q1	*Q2*	*Q3*	*Q4*	*Q1*	*Q2*	*Q3*	*Q4*	*Q1*	*Q2*	*Q3*	*Q4*	*Q1*	*Q2*	*Q3*	*Q4*	*Q1*	*Q2*	*Q3*	*Q4*
Antimony	mg/L	0.006		0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U
Arsenic[2]	mg/L	0.01		0.003 U	0.0035	0.003	0.003 U	0.00448	0.0054	0.0043	0.003	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.0039	0.0046	0.005	0.0038
Beryllium	mg/L	0.004		0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Boron	mg/L	NA	1.36	0.098	0.099	0.088	0.097	0.134	0.133	0.132	0.148	0.09	0.089	0.094	0.085	0.097	0.098	0.099	0.088	0.103	0.088	0.122	0.158
Cadmium	mg/L	0.005		0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Chromium	mg/L	0.1		0.006 U	0.006 U	0.006 U	0.006 U	0.006 U	0.006 U	0.006 U	0.006 U	0.006 U	0.006 U	0.006 U	0.006 U	0.006 U	0.006 U	0.006 U	0.006 U	0.006 U	0.006 U	0.006 U	0.006 U
Fluoride	mg/L	4		1.07	0.83	0.88	0.7	0.623	0.3	0.35	0.26	0.67	0.73	0.63	0.63	0.682	0.8	0.65	0.66	2.09	1.48	1.76	1.56
Manganese	mg/L	NA	0.077	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
Mercury	mg/L	0.002		0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Nickel	mg/L	NA	0.299	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Nitrate	mg/L	10		1.47	1.54	1.44	1.73	2.47	2.77	3.03	3.34	1.96	1.7	1.84	2.55	2.03	2	2.01	2.87	0.899	0.106	1.94	2.79
Phosphorus	mg/L	NA	NA[3]	0.02	0.021	0.017	0.035	0.47	0.453	0.347	0.3	0.01	0.011	0.015	0.02	0.01	0.01 U	0.018	0.02	0.27	0.269	0.233	0.234
Selenium	mg/L	0.05		0.002 U	0.002 U	0.002 U	0.003 U	0.002 U	0.002 U	0.002 U	0.003 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.003 U
Thallium	mg/L	0.002		0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Uranium	mg/L	0.03	NA	0.00173	0.0017	0.0017	0.00182	0.00162	0.00169	0.00186	0.00195	0.00203	0.00209	0.00192	0.00209	0.00208	0.00236	0.00215	0.00231	0.00261	0.002	0.00186	0.00223
Vanadium	mg/L	NA	0.001	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Zinc	mg/L	NA	0.108	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U

Contaminant of Concern[1]	Units	Maximum Contaminant Level (MCL)	Risk-Based Conc. (RBC)	534B				537A				537B				538A				538B			
				Q1	*Q2*	*Q3*	*Q4*	*Q1*	*Q2*	*Q3*	*Q4*	*Q1*	*Q2*	*Q3*	*Q4*	*Q1*	*Q2*	*Q3*	*Q4*	*Q1*	*Q2*	*Q3*	*Q4*
Antimony	mg/L	0.006		0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U
Arsenic[2]	mg/L	0.01		0.00308	0.0034	0.0033	0.003 U	0.0238	0.0158	0.0217	0.0206	0.003 U	0.003 U	0.003 U	0.003 U	0.0276	0.0158	0.0228	0.0209	0.00362	0.003 U	0.0052	0.0035
Beryllium	mg/L	0.004		0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Boron	mg/L	NA	1.36	0.122	0.112	0.119	0.137	0.191	0.155	0.154	0.159	0.087	0.077	0.087	0.077	0.161	0.15	0.145	0.15	0.088	0.076	0.087	0.077
Cadmium	mg/L	0.005		0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.00027	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.00044	0.00028	0.00029	0.0003	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Chromium	mg/L	0.1		0.006 U	0.006 U	0.006 U	0.006 U	0.006 U	0.006 U	0.006 U	0.006 U	0.006 U	0.006 U	0.006 U	0.006 U	0.006 U	0.006 U	0.006 U	0.006 U	0.006 U	0.006 U	0.006 U	0.006 U
Fluoride	mg/L	4		0.61	0.65	0.41	0.28	0.694	0.45	0.45	0.48	0.266	0.25	0.3	0.25	0.749	0.54	0.53	0.66	0.435	0.28	0.38	0.29
Manganese	mg/L	NA	0.077	0.0063	0.004 U	0.004 U	0.004 U	0.0174	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
Mercury	mg/L	0.002		0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Nickel	mg/L	NA	0.299	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Nitrate	mg/L	10		2.11	1.6	2.53	3.2	5.7	3.57	2.7	3.57	1.79	1.73	1.64	1.85	3.45	3.14	2.32	3.01	2.09	2.13	1.85	2.11
Phosphorus	mg/L	NA	NA[3]	0.14	0.151	0.118	0.103	6.63	5.01	6.55	7.23	0.02	0.021	0.034	0.02	11	5.33	8.53	7	0.88	0.253	1.39	0.499
Selenium	mg/L	0.05		0.002 U	0.002 U	0.002 U	0.003 U	0.00229	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Thallium	mg/L	0.002		0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Uranium	mg/L	0.03	NA	0.0018	0.00178	0.00176	0.0019	0.001 U	0.00127	0.001 U	0.001 U	0.00212	0.00212	0.002	0.00203	0.00106	0.00166	0.00111	0.00121	0.00203	0.00197	0.00177	0.00194
Vanadium	mg/L	NA	0.001	0.005 U	0.005 U	0.005 U	0.005 U	0.0069	0.0066	0.0061	0.0072	0.005 U	0.0052	0.005 U	0.0052	0.0081	0.0067	0.0064	0.0062	0.0051	0.0052	0.005 U	0.005
Zinc	mg/L	NA	0.108	0.005 U	0.005 U	0.005 U	0.005 U	0.00523	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.00538	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U

Contaminant of Concern[1]	Units	Maximum Contaminant Level (MCL)	Risk-Based Conc. (RBC)	539A				539B				539C				BRS				BTS			
				Q1	*Q2*	*Q3*	*Q4*	*Q1*	*Q2*	*Q3*	*Q4*	*Q1*	*Q2*	*Q3*	*Q4*	*Q1*	*Q2*	*Q3*	*Q4*	*Q1*	*Q2*	*Q3*	*Q4*
Antimony	mg/L	0.006		0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003	0.003 U	0.003 U	0.003 U	0.003	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U
Arsenic[2]	mg/L	0.01		0.00842	0.0069	0.0074	0.006	0.0144	0.0062	0.0088	0.0068	0.003 U	0.003	0.003	0.003 U	0.0062	0.0044	0.0063	0.0053	0.00845	0.0157	0.0121	0.0127
Beryllium	mg/L	0.004		0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002	0.002 U	0.002 U	0.002 U	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Boron	mg/L	NA	1.36	0.159	0.144	0.151	0.153	0.156	0.119	0.125	0.136	0.095	0.084	0.086	0.084	0.124	0.122	0.133	0.147	0.12	0.156	0.117	0.125
Cadmium	mg/L	0.005		0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002	0.0002 U	0.0002 U	0.0002 U	0.0002	0.0002 U	0.0002 U	0.0002 U	0.00024	0.0002 U	0.0002 U
Chromium	mg/L	0.1		0.006 U	0.006 U	0.006 U	0.006 U	0.006 U	0.006 U	0.006 U	0.006 U	0.006 U	0.006	0.006 U	0.006 U	0.006 U	0.006	0.006 U	0.006 U	0.006 U	0.006 U	0.006 U	0.006 U
Fluoride	mg/L	4		0.64	0.4	0.47	0.54	0.57	0.42	0.44	0.51	0.317	0.28	0.3	0.27	0.399	0.45	0.4	0.36	0.907	0.75	0.6	0.7
Manganese	mg/L	NA	0.077	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004	0.0052	0.004 U	0.004 U	0.004	0.0057	0.004 U	0.004 U	0.0164	0.004 U	0.0074
Mercury	mg/L	0.002		0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002	0.0002 U	0.0002 U	0.0002 U	0.0002	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Nickel	mg/L	NA	0.299	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01	0.01 U	0.01 U	0.01 U	0.01	0.01 U	0.01 U	0.01 U	0.01	0.01 U	0.011
Nitrate	mg/L	10		3.07	3.86	3.66	3.57	2.18	2.5	2.27	2.68	1.94	1.9	1.8	2.12	2.95	2.66	3.14	3.53	4.01	5.86	4.31	6.24
Phosphorus	mg/L	NA	NA[3]	1.44	1.35	1.3	1.08	3.84	1.64	2.14	1.59	0.04	0.022	0.045	0.026	0.72	0.698	1.09	0.733	2.24	4.8	2.86	2.67
Selenium	mg/L	0.05		0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002	0.002 U	0.002 U	0.002 U	0.002	0.002 U	0.003 U	0.00305	0.0043	0.0029 U	0.00386
Thallium	mg/L	0.002		0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001	0.001 U	0.001 U	0.001 U	0.001	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Uranium	mg/L	0.03	NA	0.00227	0.00201	0.00176	0.00197	0.00189	0.00195	0.00165	0.00202	0.00225	0.00214	0.00201	0.002	0.00175	0.00189	0.00168	0.00196	0.00139	0.00118	0.0012	0.00147
Vanadium	mg/L	NA	0.001	0.0067	0.0064	0.005 U	0.0062	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.0053	0.005 U	0.0052	0.005 U	0.005	0.005 U	0.005 U	0.0055	0.0072	0.0054	0.0055
Zinc	mg/L	NA	0.108	0.005 U	0.005 U	0.0066	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005	0.005 U	0.005 U	0.005 U	0.0062 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U

[1] From ROD Table 36. Only values shown where there is not an MCL.
[2] The MCL for Arsenic was revised to be 0.010 mg/L in 2006.[3] The MCL and MCLG for nickel were remanded on February 9, 1995
[3] The RBC for phosphorus will be determined as described in Section III.7.d of the SOW.
Concentrations highlighted in yellow exceed the MCL and concentrations highlighted in green exceed the RBC.

Table 5-10: UCLs of arsenic mean concentrations at Compliance Area monitoring locations.

Well	Date Range	No. Outliers Removed	No. Data Points Used	Percent ND	Distribution	95% UCL (mg/L)	Type	Arsenic MCL (mg/L)	Greater than MCL?
504[1]	2010-2011	0	8	75.00%	---	0.00322	95% KM (t) UCL	0.01	N
505	2010-2011	0	8	0.00%	Normal	0.00508	95% Student's-t UCL	0.01	N
524[2]	2010-2011	0	8	100.00%	---	---	---	---	---
525[2]	2010-2011	0	8	100.00%	---	---	---	---	---
534A	2010-2011	0	5	0.00%	Normal	0.00487	95% Student's-t UCL	0.01	N
534B	2010-2011	0	5	20.00%	Normal	0.00334	95% KM (t) UCL	0.01	N
537A	2010-2011	0	5	0.00%	Normal	0.0258	95% Student's-t UCL	0.01	Y
537B[2]	2010-2011	0	5	100.00%	---	---	---	---	---
538A	2010-2011	0	5	0.00%	Normal	0.0294	95% Student's-t UCL	0.01	Y
538B[1]	2010-2011	0	5	20.00%	---	0.00425	95% KM (BCA) UCL	0.01	N
539A	2010-2011	0	5	0.00%	Normal	0.00854	95% Student's-t UCL	0.01	N
539B	2010-2011	0	5	0.00%	Normal	0.0159	95% Student's-t UCL	0.01	Y
539C[1]	2010-2011	0	5	60.00%	---	0.00319	95% KM (t) UCL	0.01	N
BRS	2010-2011	0	8	0.00%	Normal	0.00779	95% Student's-t UCL	0.01	N
BTS	2010-2011	0	8	12.50%	Normal	0.0124	95% KM (t) UCL	0.01	Y

Table 5-11: UCLs of phosphorus mean concentrations at Compliance Area monitoring locations.

Well	Date Range	No. Outliers Removed	No. Data Points Used	Percent ND	Distribution	95% UCL (mg/L)	Type	MCL (mg/L)	Greater than MCL?
504[1]	2010-2011	0	8	12.5%	---	0.0302	95% KM (Chebyshev) UCL	---	---
505	2010-2011	0	8	0%	Normal	0.487	95% Student's-t UCL	---	---
524	2010-2011	0	8	25%	Normal	0.0207	95% KM (t) UCL	---	---
525[2]	2010-2011	0	8	25%	---	---	---	---	---
534A	2010-2011	0	5	0%	Normal	0.267	95% Student's-t UCL	---	---
534B	2010-2011	0	5	0%	Normal	0.146	95% Student's-t UCL	---	---
537A	2010-2011	0	5	0%	Normal	7.783	95% Student's-t UCL	---	---
537B[1]	2010-2011	0	5	0%	----	0.0289	95% Student's-t UCL	---	---
538A	2010-2011	0	5	0%	Normal	11.75	95% Student's-t UCL	---	---
538B	2010-2011	0	5	0%	Normal	1.154	95% Student's-t UCL	---	---
539A	2010-2011	0	5	0%	Normal	1.502	95% Student's-t UCL	---	---
539B	2010-2011	0	5	0%	Normal	4.225	95% Student's-t UCL	---	---
539C	2010-2011	0	5	0%	Normal	0.0704	95% Student's-t UCL	---	---
BRS	2010-2011	0	8	0%	Normal	1.416	95% Student's-t UCL	---	---
BTS	2010-2011	0	8	0%	Normal	3.748	95% Student's-t UCL	---	---

[1] *No discernable distribution is present.*

[2] *Too few distinct detected values. A data distribution could not be estimated.*

6.0 SURFACE WATER MONITORING

As specified in the VCO/CA, the objective of the surface water monitoring program is to collect sufficient data of adequate quality to verify that remedial actions successfully limit Don Plant impacts to surface water in the Portneuf River per the concentration-based requirements set out in Section 2.1 of the Groundwater and Surface Water Monitoring Plan. The monitoring strategy will also provide a mechanism to identify when additional contingency actions are required, and shall measure progress toward achieving final surface water RBCs as measured at the locations approved by EPA.

The VCO/CA sets out the required monitoring locations, as follows:

- IDEQ (accompanied by a Simplot representative when possible) will collect samples at the point of compliance (Siphon Road) to determine the concentration of phosphorus in the Portneuf River on a monthly basis. The calculation basis for compliance shall be the annual median of monthly values.

Simplot or DEQ will perform monthly sampling at the following three locations:

- Batiste Road; located on the downstream side of Batiste Road Bridge crossing, 50 ft west of the City of Pocatello Wastewater Treatment Facility and 50 ft north of Interstate 15 West. This location is used for background values for comparison to Siphon Road and T2B.

- A location approximately 300-400 meters north of Batiste Road at site T2B (as defined in IDEQ 2004).

- Batiste Springs at Wood Bridge; A new sampling location incorporated in January of 2010 in the Batiste Springs Channel.

The sampling locations are shown in Figure 6-1.

Figure 6-1: Portneuf River sampling locations.

6.1 Surface Water Sampling Activities

Three main sampling methods take place at the monitoring stations. Physical and chemical conditions are monitored monthly, water quality parameters are measured continuously at Batiste and Siphon Roads, and river flow is measured both continuously and monthly through water level recorders. The Portneuf River Quality Assurance Project Plan (IDEQ 2009) provides details of sampling procedures and protocols. Surface water samples have been analyzed monthly for the parameters shown in Table 6-1.

Table 6-1: Analyte list for monthly surface water samples.

	Method	Reporting Limit (RL) or Sensitivity	Units
Turbidity	A2130; E180.1	0.01	NTU
Alkalinity, Total as CaCO3	A2320 B	4.0	mg/L
Chloride	300.0	0.02	mg/L
Sulfate	300.0	0.3	mg/L
Nitrogen, Ammonia (as N)	350.1	0.05	mg/L
Nitrogen, Nitrate + Nitrite (as N)	353.2	0.05	mg/L
Nitrogen, Kjeldahl, Total (as N)	351.2	0.1	mg/L
Phosphorus, Total	365.1	0.005	mg/L
Dissolved Phosphorus	365.1	0.005	mg/L

In addition to the monthly sampling events, continuous water quality monitoring takes place at Batiste and Siphon Roads. The equipment consists of YSI 5920 multiparameter water quality sondes with records of temperature, specific conductance, pH, dissolved oxygen, and turbidity. Measurements are recorded every 10 minutes during ice free conditions.

The flow at Batiste Road, T2B, and the Batiste Spring channel at the wood bridge (BSWB) is measured monthly as part of the monthly monitoring program. For Siphon Road, the flow is calculated using data from the USGS station number 13075910, Portneuf River at Tyhee gage, with irrigation records from the Fort Hall Pump station measured by the Idaho Department of Water Resources (IDWR). The amount of water pumped out of the Portneuf River at the Fort Hall Pump station is added into the flow measured at the Tyhee gage to calculate the estimated flow at Siphon Road.

6.2 Data Review and Quality

Data review and quality is described in detail in the Portneuf River Quality Assurance Project Plan (IDEQ 2009). The plan summarizes quality control for field sampling, the continuous monitoring system, and laboratory analysis as well as the procedures to follow for exceedance of a quality control limit. Surface water data are provided in Appendix H.

6.3 Results

The goals of the data analysis are to:

- Assess the flow at each monitoring location for seasonal variations and groundwater inflow.
- Validate Batiste Road as an effective background sampling location.

- Compare the surface water chemistry and water quality of Siphon Road and T2B to Batiste Road and evaluate goals for:
  - Phosphorus Concentration
  - Phosphorus Loads
  - Dissolved Oxygen
  - Turbidity
  - Total Suspended Solids
  - pH
  - Temperature

6.3.1 River Flow

River flow is measured along the Lower Portneuf River and at point source locations (i.e. the Pocatello Waste Water Treatment Plant (POTW)) in order to evaluate the loads of contaminants entering the river, analyze seasonal variations, and also to evaluate the influx of regional and EMF groundwater. A simple conceptual model of sources and monitoring locations for the Lower Portneuf River is presented in Figure 6-2.

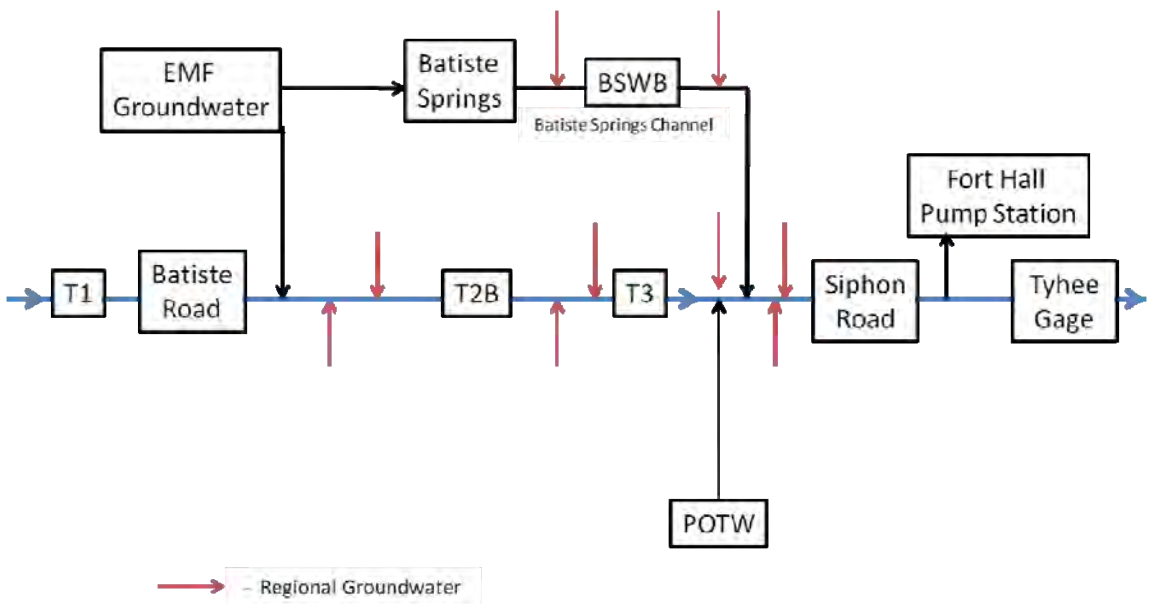


Figure 6-2: Conceptual model of inputs for the lower Portneuf River.

This model indicates where point source inputs are located with respect to other sources and the estimated influx locations for non-point sources. Table 6-2 shows the average monthly flow

for 2011 measured along the Lower Portneuf River (Batiste Road, T2B, BSWB, Siphon Road, and Tyhee) as well as point source flows removed (Fort Hall).

Table 6-2: The monthly average measured flow along the lower Portneuf River for 2011.

	Batiste Road	T2B	BSWB	Siphon Road	Fort Hall Pump	Tyhee Gage
January	503	588	35	460	0	460
February	205	305	25	441	0	441
March	296	400	23	549	0	549
April	734	--	33	804	0	804
May	1,271	--	51	1,211	88	1,128
June	914	--	44	1,151	171	980
July	219	295	22	495	175	320
August	106	180	14	364	114	250
September	179	271	22	365	89	276
October	266	331	24	521	12	510
November	257	327	24	513	0	530
December	188	309	23	472	0	472
Annual Average	428		28	612	108	560

Note: Flows in CFS
Siphon Road flows calculated.
-- Measurements not available due to high flow.

Flow in the Portneuf River at Batiste Road, T2B, Siphon Road, and Tyhee is highest during springtime runoff and lowestin August and September. The location with the greatest difference between high springtime runoff flows and late summer flows is upstream at Batiste Road (decrease of approximately 90% at Batiste Road and 70% at Siphon Road, and 73% at T2B in 2009 - 2010). Groundwater influx between Batiste Road and T2B and between T2B and Siphon Road reduces the difference between springtime and summer flow in the river. Groundwater influx into the Batiste Springs channel is impacted to a much smaller degree during springtime. The influx from the POTW is assumed to steady, with an average of 10.6 cfs. The Fort Hall Pump removes water from the river only during the growing season.

To evaluate the influx of groundwater between Batiste Road and T2B, the flow measured at Batiste Road is subtracted from the flow at T2B. For the influx between Batiste Road and Siphon Road, the flow measured at Batiste Road and the flow from the POTW is subtracted from the flow estimated at Siphon Road. The flow at Siphon Road is estimated by adding in the removed river water from the Fort Hall pump to the flow measured at the Tyhee gage. Figure 6-3 shows these flow differences.

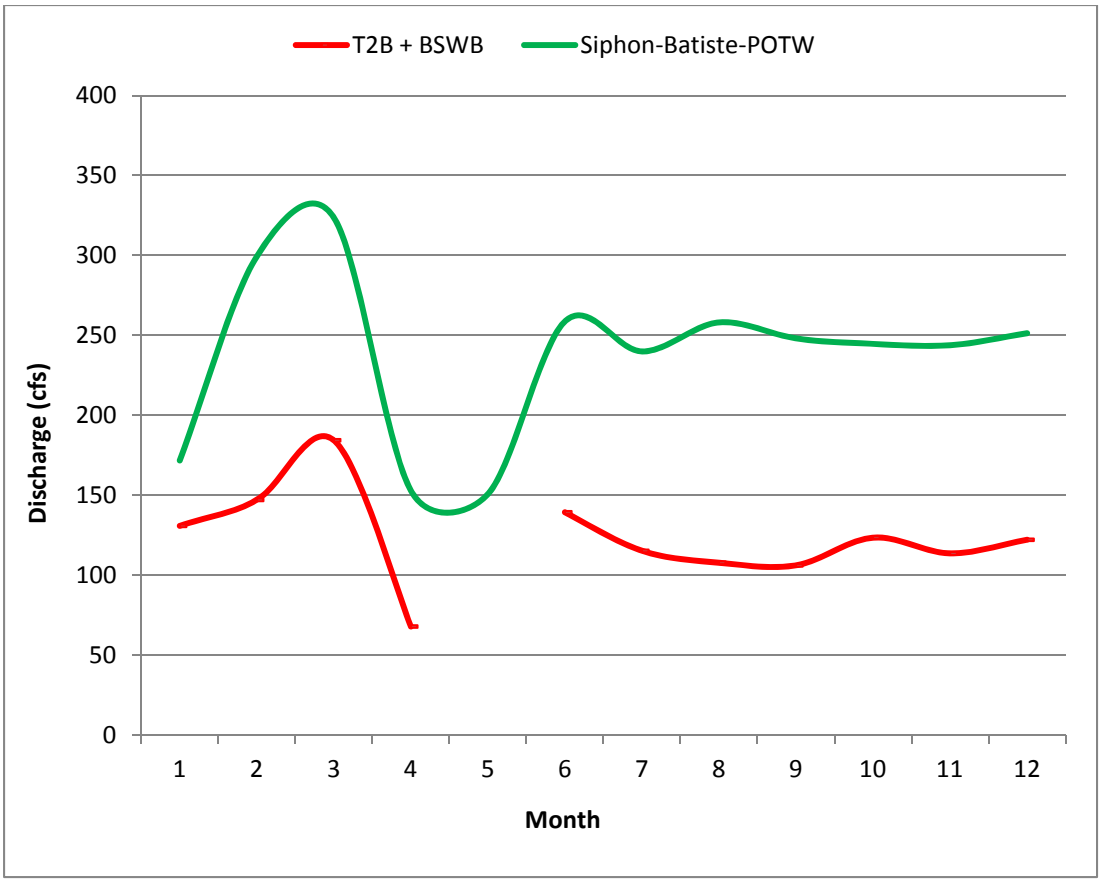


Figure 6-3: The average monthly difference in flow between Batiste Road and T2B (2008 – 2011), Batiste Road, POTW, and Siphon Road (2003 – 2011).

The yearly average groundwater influx from Batiste Road to station T2B is approximately 100 cfs. The yearly average groundwater influx from Batiste Road to Siphon Road is 250 cfs.. To show the seasonal variations in flow at each location, the monthly flow was averaged for the years of measurement at Batiste Road, Siphon Road, and T2B (Figure 6-4).

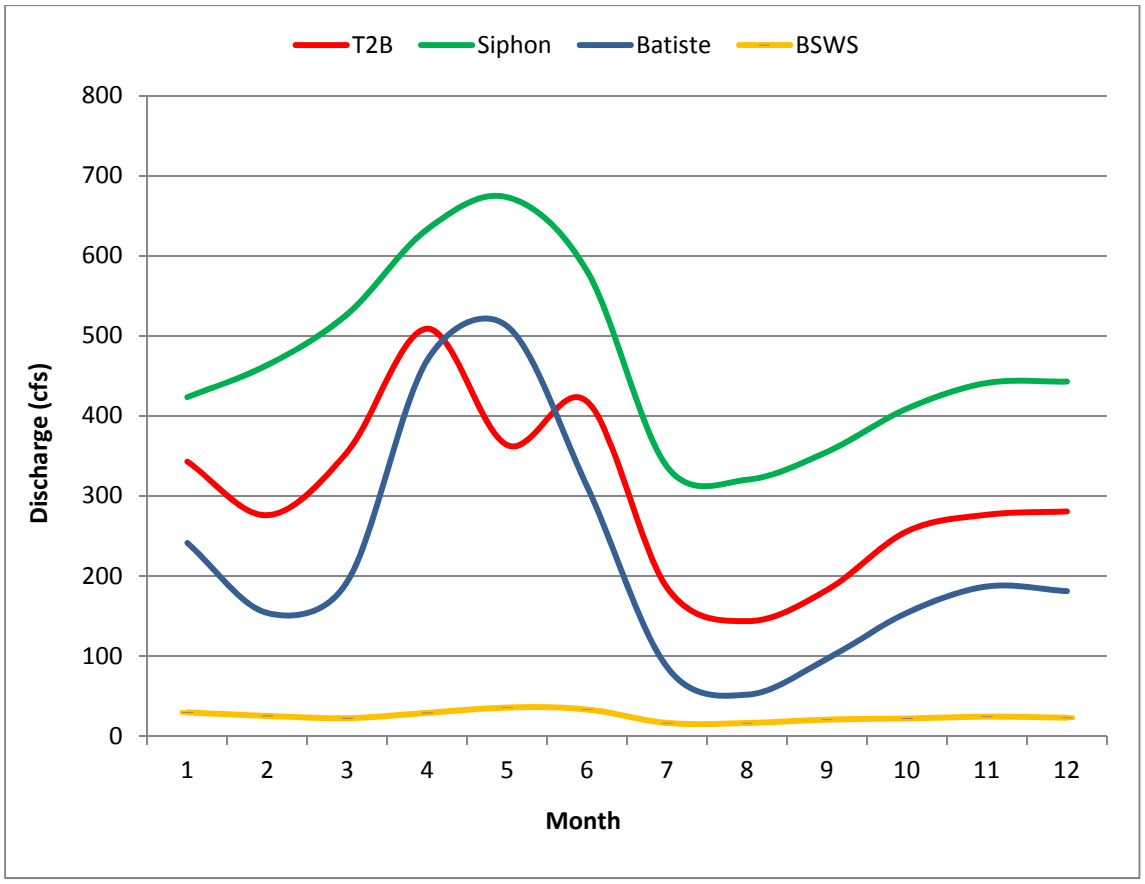


Figure 6-4: The average monthly flow for Batiste and Siphon Roads (2003 – 2011), T2B (2008 – 2011), and BSWB (2011).

The annual variations at the stations demonstrate highest flows during spring runoff and lowest flows in late summer, except for station BSWB, which is fed by groundwater influx. To further show the flow at Siphon Road, the yearly average, minimum, and maximum estimated flows are shown in Table 6-3.

Table 6-3: Siphon Road flow (cfs).

Year	Average	Minimum	Maximum
2003	354	245	491
2004	356	275	537
2005	494	379	836
2006	597	306	1423
2007	430	258	845
2008	418	277	617
2009	496	320	876
2010	446	262	622
2011	612	364	1211
Average	467	298	829

In summary:

- Groundwater influx downstream of Batiste Road helps reduce the springtime to summer flow variations.
- The yearly average groundwater influx is approximately 100 cfs between Batiste Road and T2B and 250 cfs between Batiste Road and Siphon Road.
- The exceptionally high and late peak in the Portneuf River hydrograph likely had an impact on groundwater hydraulics in April-May 2011.
- In 2011, average and peak flow at Siphon Road was high when compared to previous years back to 2003.

6.3.2 Batiste Road Evaluation

Phosphorus concentrations at Batiste Road were compared to the Highway 30 sampling site between March 2005 and February 2008 (data range for Highway 30) in order to evaluate whether Batiste Road is being affected by EMF groundwater (Figure 6-5).

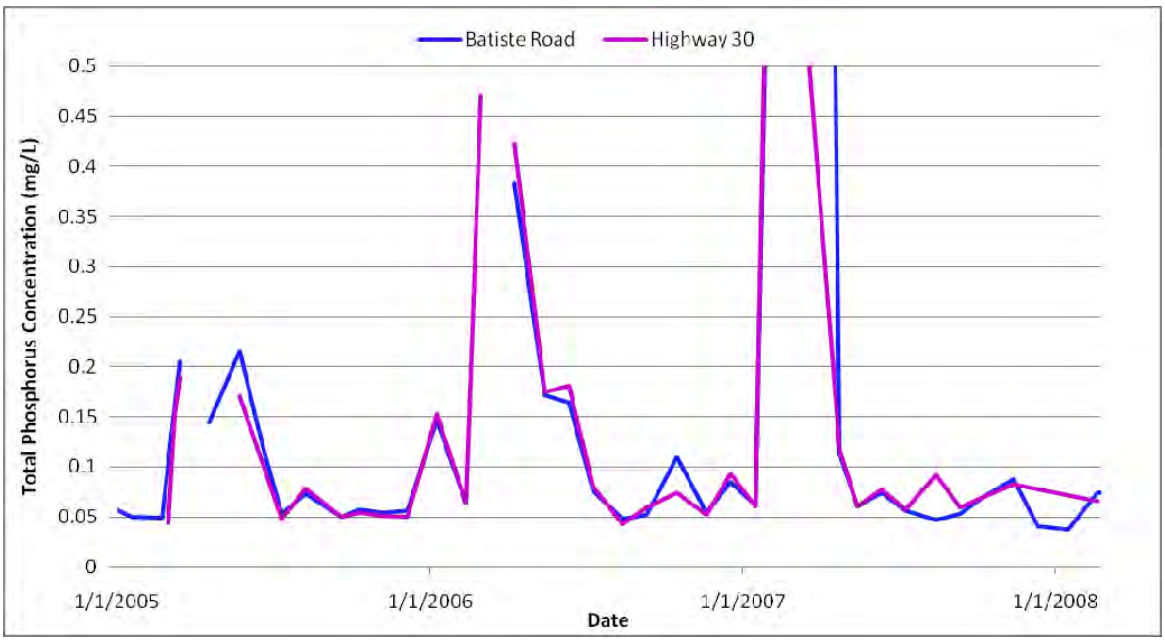


Figure 6-5: Comparison of Highway 30 and Batiste Road monitoring sites on the Portneuf River.

This indicates that Batiste Road is essentially identical in phosphorus concentration to Highway 30, which is farther upstream and out of the influence of regional groundwater influx. Using the concentration comparison of these two locations, it is clearly shown that Batiste Road is not affected by EMF groundwater and can be used as a background monitoring location for the EMF Site.

6.3.3 Surface Water Chemistry and Water Quality

This section describes the water chemistry and quality of the Lower Portneuf River. The chemistry evaluation is focused phosphorus and the quality evaluation is focused on dissolved oxygen, turbidity, total suspended solids, pH, and temperature.

6.3.3.1 Total phosphorus concentration

The monthly phosphorus concentrations at Siphon Road, T2B, and Batiste Road are plotted below in Figure 6-6.

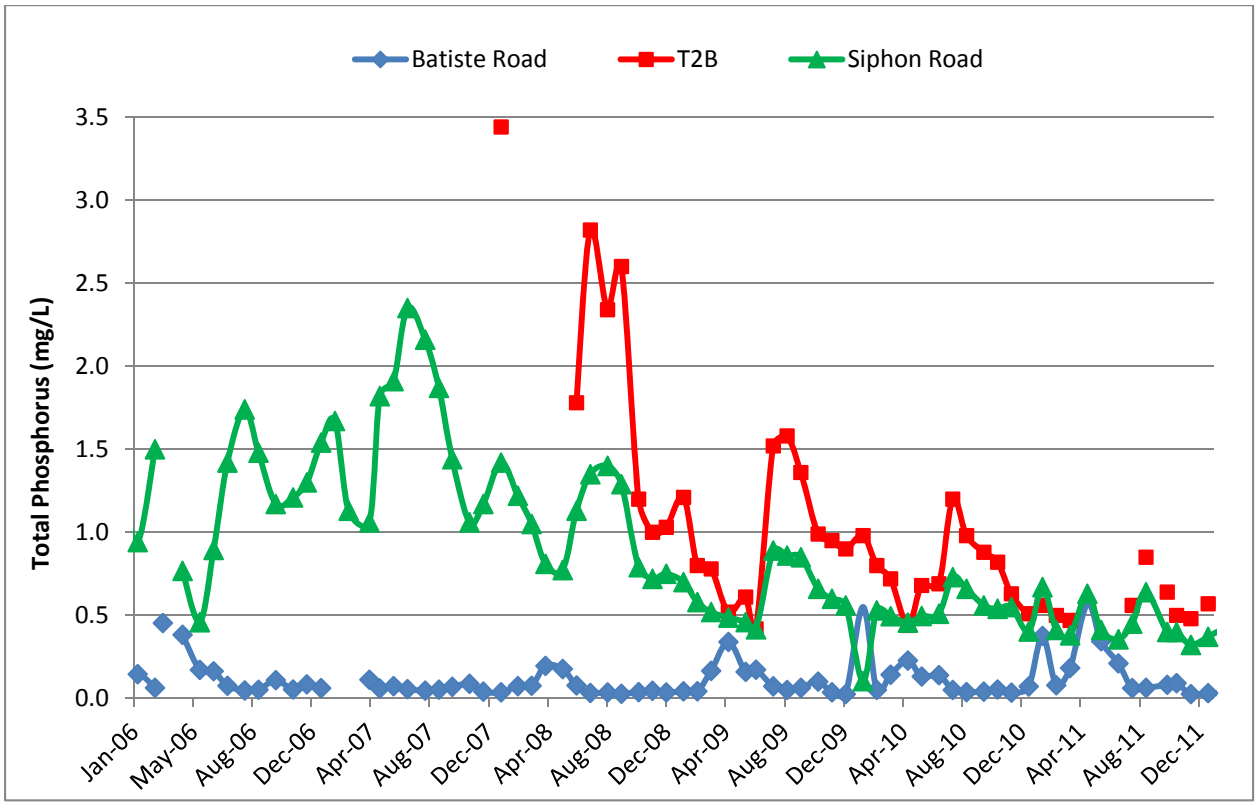


Figure 6-6: Phosphorus concentrations in the Portneuf River for the last 6 years.

The phosphorus concentrations at Siphon Road have been decreasing since 2007. Phosphorus concentrations upstream of Siphon Road at station T2B are higher due to lower flow at T2B. Station T2B was selected as the location of highest impact from EMF groundwater. Data available since 2008 indicate that phosphorus concentrations at this location have been decreasing as well.

High total phosphorus concentrations are also related to extremely high turbidity during springtime runoff throughout the Portneuf River. Total phosphorus concentrations measured at stations upstream of Batiste Road are tabulated in Table 6-4 for years 2007 through 2011 and are plotted in Figure 6-7. The tabulated measurements of turbidity and total phosphorus

upstream of Batiste Road indicate that conditions at Batiste Road are influenced by conditions upstream. The data plotted in Figure 6-7 indicate that total phosphorus correlates strongly with turbidity upstream of the EMF Site during springtime runoff events. This is expected, because the primary source of upstream phosphorus is mobilization of soils.

Table 6-4: The high phosphorus and turbidity levels at upstream stations during peak runoff through 2011.

Analyte	Year	Batiste Road	Fichter Park	Marsh Creek	Guthries	Topaz
		PBATR	PFICH	MTRIP	PGUTH	PZMVC
Miles Upstream from Batiste Road		-	9.1	n.a.	20.1	35.5
Turbidity (NTU)	Feb-07	551	323	151	130	49
	Apr-08	66	85	28	29	30
	Jun-09	67	55	35	47	28
	Apr-10	55	48	35	19	12
	Apr-11	175	138	83	140	108
Total Phos. (mg/L)	Feb-07	1.24	0.97	0.59	0.68	0.37
	Apr-08	0.20	0.24	0.70	0.14	0.11
	Jun-09	0.17	0.16	0.17	0.16	0.12
	Apr-10	0.23	0.24	0.18	0.09	0.07
	Apr-11	0.57	0.43	0.26	0.39	0.49

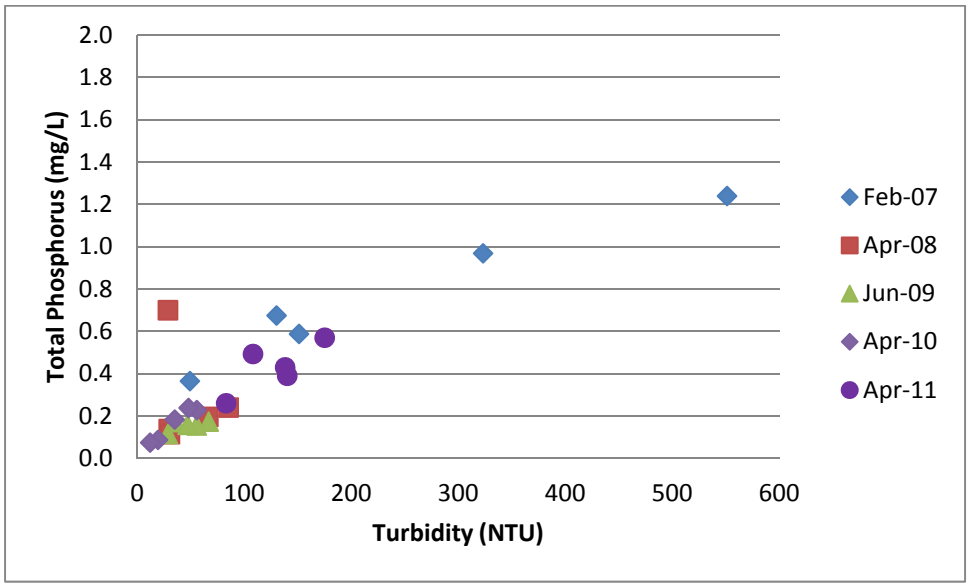


Figure 6-7: High phosphorus and turbidity levels in the lower Portneuf River upstream of the EMF Site during peak runoff, 2007 through 2011.

At Siphon Road, total phosphorus concentration in the Portneuf River is depressed at the peak of the hydrograph during springtime runoff events and is elevated at the low point of the hydrograph during low flow conditions in the summer months. This relationship is plotted in Figure 6-8 for 2011.

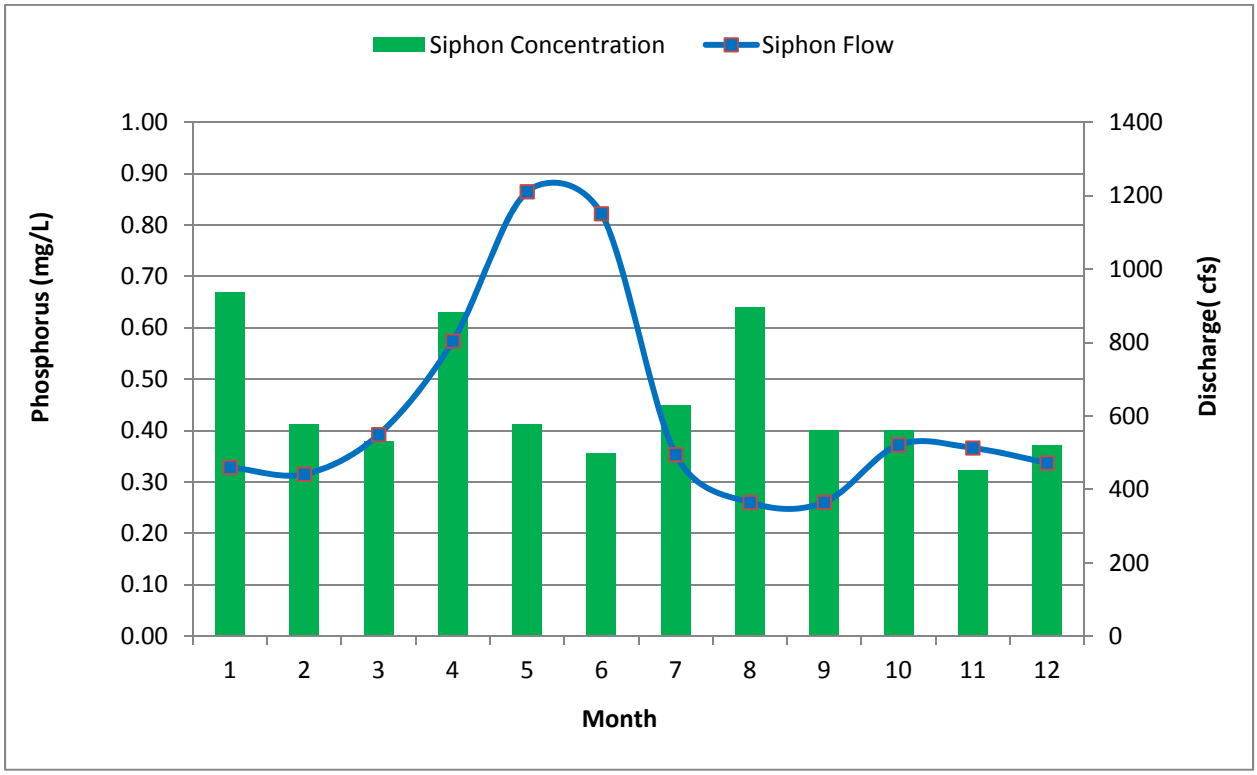


Figure 6-8: The monthly average phosphorus concentration and flow at Siphon Road (2011).

Total phosphorus concentrations at Siphon Road in 2011 are at or below 0.40 mg/L when the hydrograph returns to average rates (450 to 500 cfs) late in the year, indicating that load reduction is continuing to have a beneficial effect on water quality.

To compare the phosphorus concentrations with the TMDL goal at Siphon Road of 0.07 mg/L (low flow) and 0.125 mg/L (high flow) (IDEQ 2009), the monthly phosphorus concentrations measured by IDEQ for the calendar year were tabulated and the median of the results calculated for direct comparison to the concentration targets. Figure 6-9 shows the phosphorus concentrations measured at Siphon Road and the median concentration for the current and previous 11 concentration points. The median and average concentration for each year since 2003 is summarized in Table 6-5.

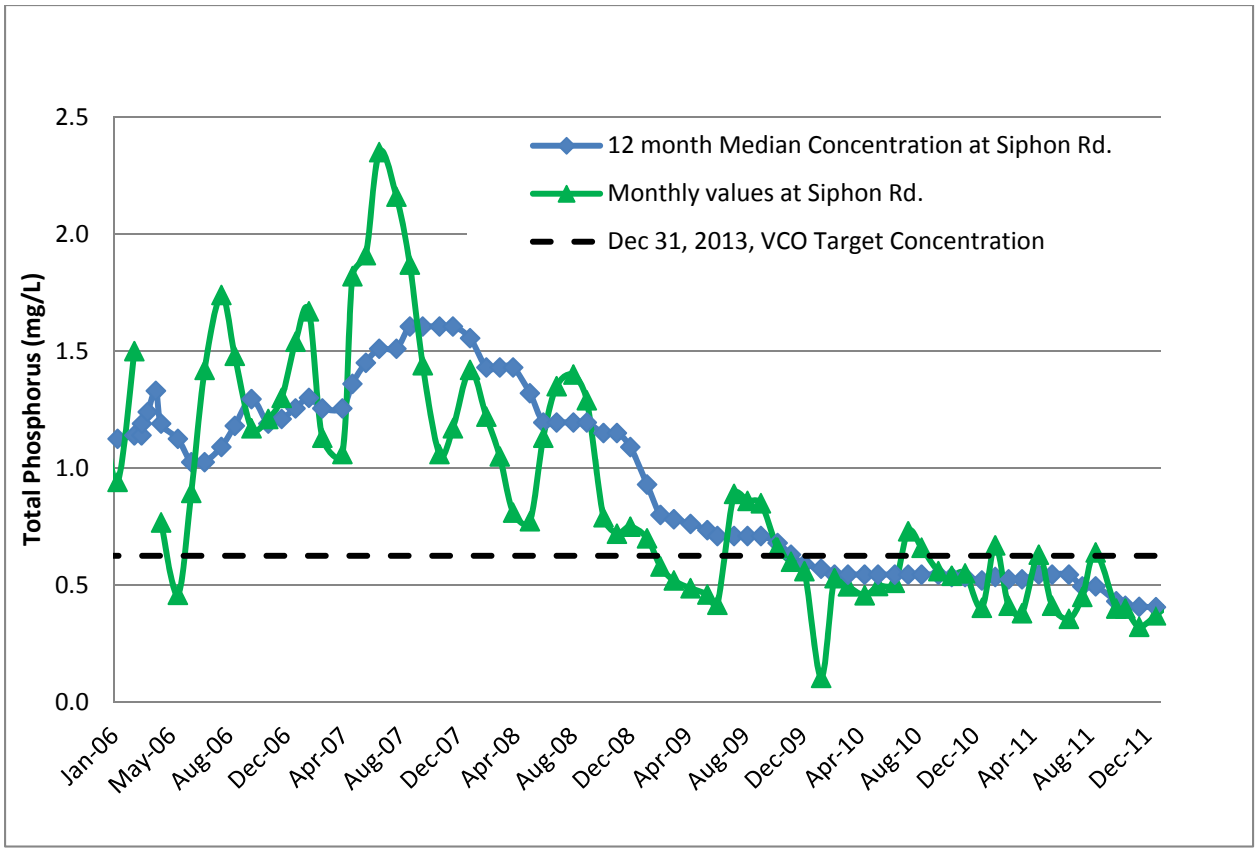


Figure 6-9: Phosphorus concentration and rolling annual median concentration for Siphon Road with the December 31st, 2013 VCO Target Concentration.

Table 6-5: Siphon Road yearly median and average phosphorus concentrations.

Year	Median	Average
2003	0.94	0.97
2004	1.14	1.12
2005	1.19	1.18
2006	1.17	0.99
2007	1.61	1.60
2008	1.09	1.06
2009	0.59	0.63
2010	0.52	0.50
2011	0.41	0.36
2013 Target	0.625	-

As of December 2011, the 12-month median concentration was 0.41 mg/L. This represents a 67% reduction from the IDEQ baseline of 1.25 mg/L and is lower than the December 31st, 2013 VCO/CA target concentration of 0.625 mg/L.

In summary:

- Phosphorus concentrations at Siphon Road have significantly decreased since 2007
- Varying seasonal concentrations can be attributed to changes in flow
- The reduction in total phosphorus concentrations at Siphon Road in 2011 was primarily due to reduced loading from EMF, however, higher flow volumes also had an effect
- The 12-month median phosphorus concentration for 2011 was 0.41 mg/L.

6.3.3.2 Phosphorus load

Since the total phosphorus concentrations measured in the river vary seasonally due to the changes in flow amounts, the phosphorus loads in the Portneuf River were analyzed at Siphon Road, T2B, and Batiste Road to evaluate the effectiveness of remedial actions at the EMF Site. Figure 6-10 shows the load trends at each station and the calculated mass input from the EMF site from 2007 through 2011.

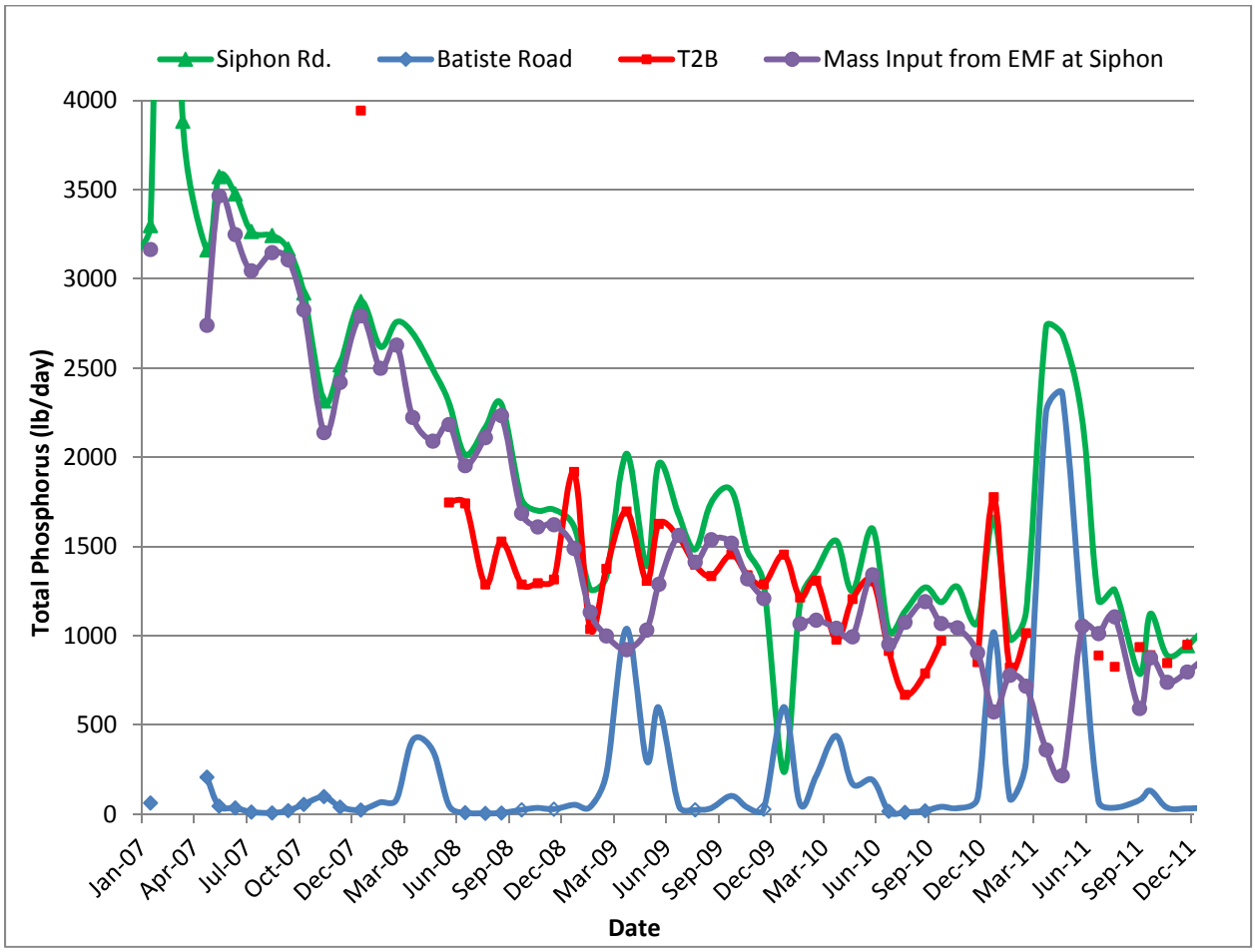


Figure 6-10: The phosphorus loads, in pounds per day, at Batiste Road, T2B, and Siphon Road.

The decrease in load at Siphon Road is clearly evident. Load at Batiste Road has remained relatively steady since 2004, except for spring run-off events.

To evaluate the estimated load of phosphorus to the river from EMF groundwater, the calculated loads at Batiste Road and the estimated loads from the POTW and unaffected groundwater were subtracted from the calculated load at Siphon Road. Estimated load amounts of 76 and 10 pounds per day were used for the POTW and regional groundwater, respectively (IDEQ 2004).

Monthly phosphorus load at Siphon Road in 2011 is plotted in Figure 6-11. Higher than usual head in the Portneuf River at the peak of the hydrograph in April and May of 2011 likely limited groundwater flux from the site to the river and resulted in lower load at Siphon Road at this time.

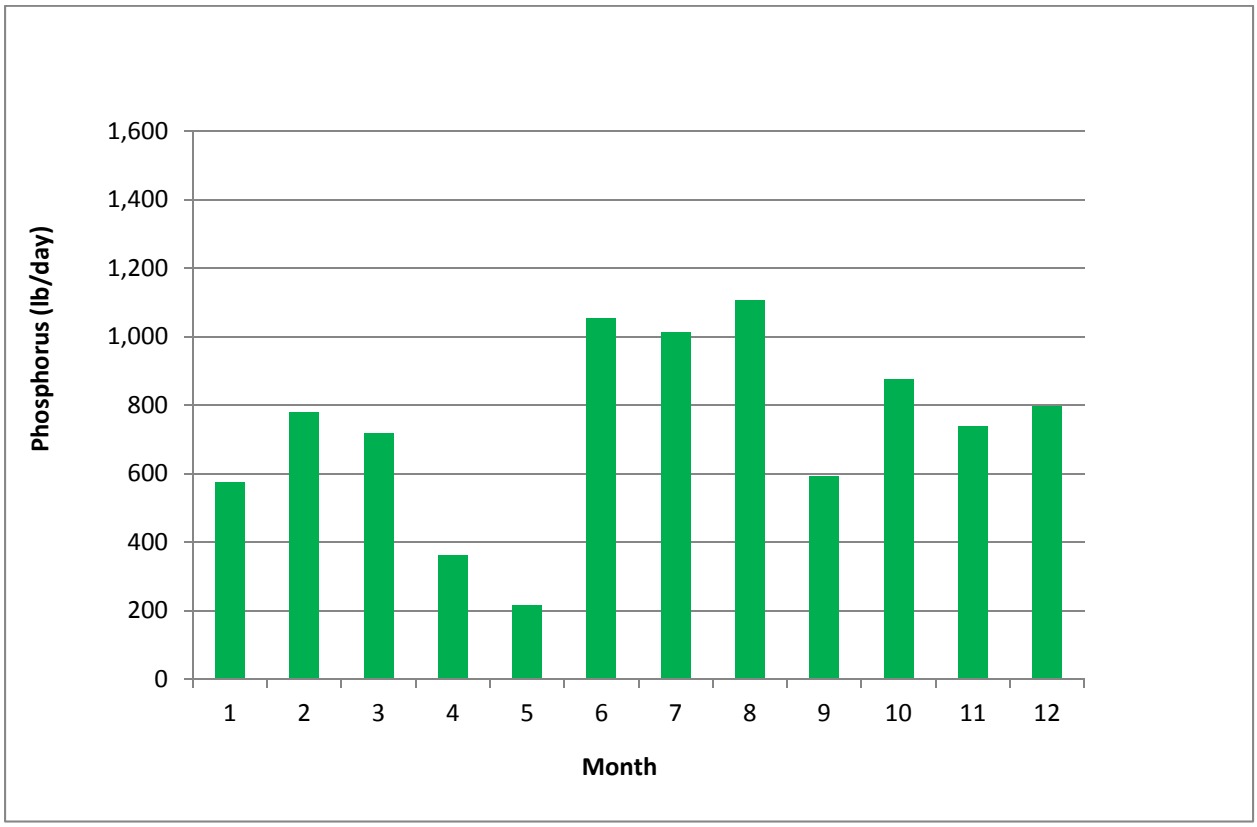


Figure 6-11: The monthly estimated EMF phosphorus load at Siphon Road.

Estimated monthly phosphorus load from EMF groundwater for years 2006 through 2011 are plotted in Figure 6-12. Annual average phosphorus load from EMF groundwater for years 2003 through 2011 are summarized in Table 6-6. These data further illustrate that phosphorus load from EMF groundwater continues to decrease each year and that load reduction is not due to variable seasonal conditions along the river.

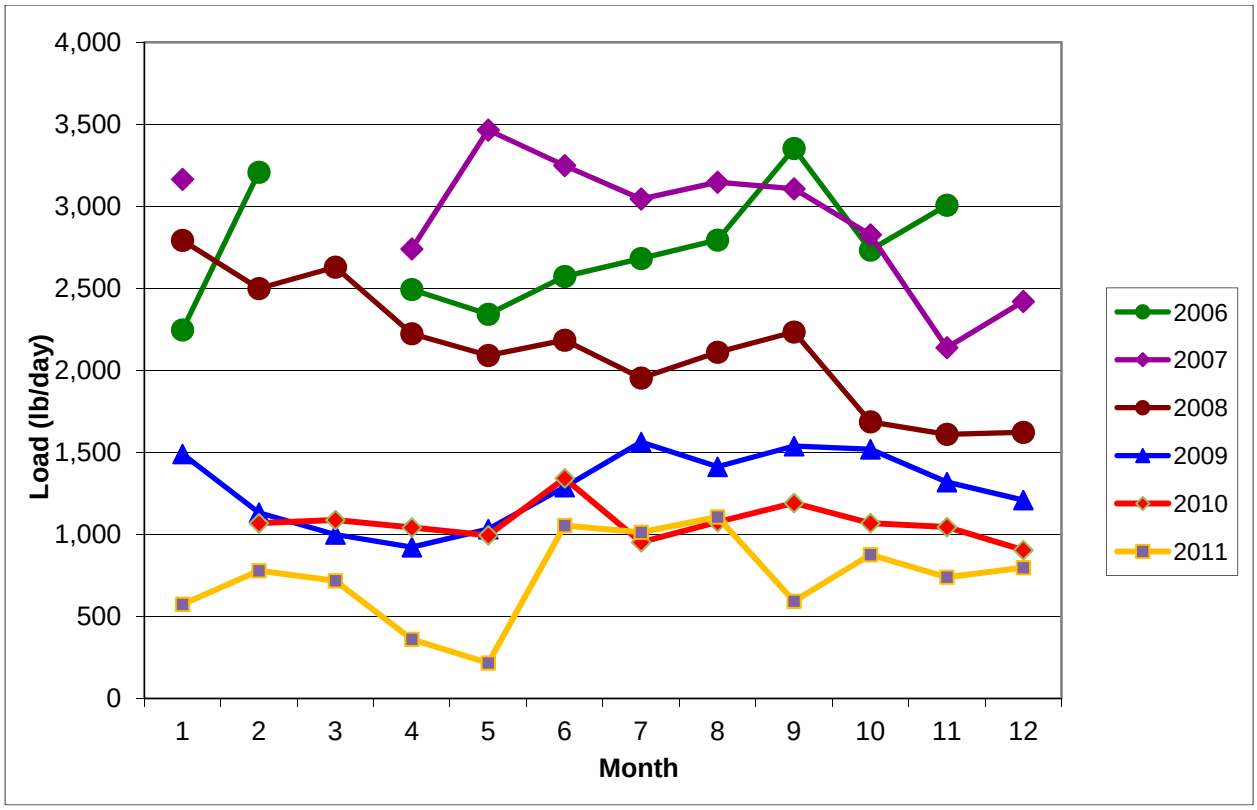


Figure 6-12: Estimated phosphorus loads from EMF groundwater at Siphon Road by year.

Table 6-6: The estimated yearly average phosphorus load at Siphon Road from EMF groundwater.

Year	Average Load (lb/day)
2003	1734
2004	1816
2005	2747
2006	2743
2007	2930
2008	2136
2009	1286
2010	1070
2011	736

The estimated phosphorus loads from EMF groundwater at Siphon Road have reduced to a yearly average of 736 lb/day in 2011. This is the lowest average over the last 9 years and represents a 75% reduction from the 2007 average (Table 6-6).

The difference in EMF phosphorus loads between T2B and Siphon Road was evaluated in order to determine the amount of EMF load entering the Portneuf River above T2B, and the potential capture by the Batiste Springs side channel (Figure 6-13).

Table 6-7 indicates the differences in load amounts between Siphon Road and T2B plus BSWB from estimated EMF groundwater.

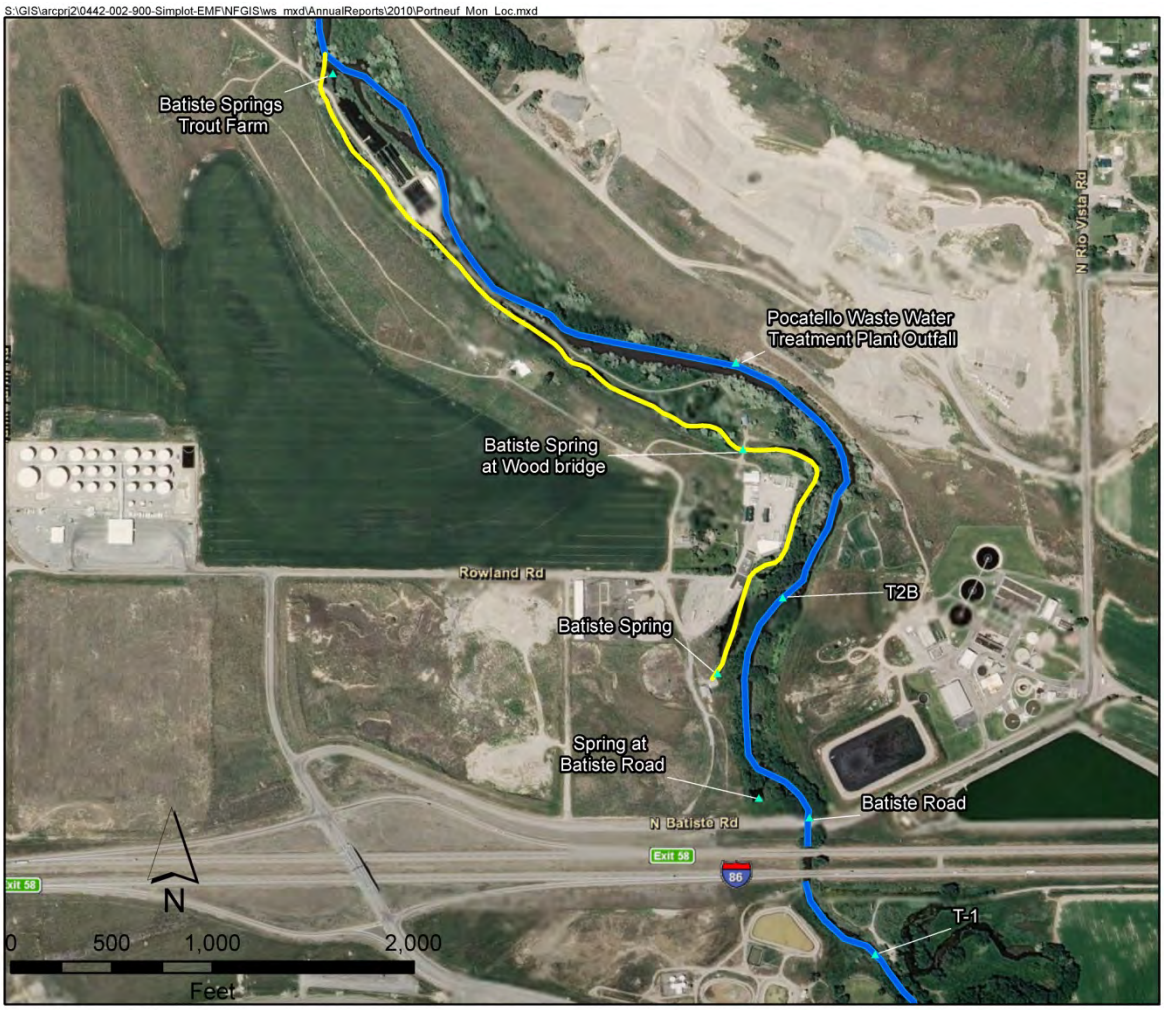


Figure 6-13: The location of the Batiste Springs channel (yellow) and monitoring stations.

Table 6-7: The difference between loads (lbs/day) from EMF groundwater at Siphon Road and T2B (negative indicates higher loading at T2B over Siphon Road).

Date	Estimated EMF input at Siphon Road	Estimated EMF input at T2B + BSWB	Difference
January-11	574	882	308
February-11	779	770	-9
March-11	718	778	60
April-11	361	--	--
May-11	217	--	--
June-11	1,054	--	--
July-11	1,013	860	-153
August-11	1,106	805	-301
September-11	593	896	303
October-11	877	828	-48
November-11	739	881	142
December-11	797	961	163

The EMF-loads at T2B and BSWB were added in order to compare the loads in the river just downstream of the Site to those measured at Siphon Road. The loads in the side channel are small (average of 50 lb/day for 2011). The data indicate seasonal changes in where EMF groundwater enters the river and that a portion may enter downstream of T2B/BSWB. This monitoring will continue.

In summary:

- The reduced phosphorus load at Siphon Road is a reflection of the reduced load from EMF groundwater.
- The estimated phosphorus load from EMF groundwater was relatively constant in 2011, except during the unusually-high springtime runoff event in April and May. During this period, high water levels in the river slow the migration of EMF groundwater and temporarily reduce the phosphorus load.
- The estimated phosphorus loads from EMF groundwater at Siphon Road have reduced to a yearly average of 736 lb/day in 2011. This is the lowest average over the last 9 years and represents a 75% reduction from the 2007 average load.

6.3.3.3 Dissolved Oxygen

The dissolved oxygen (DO) level in the lower Portneuf River is a concern due to the effects it can have on biological activity in the river system. DO is affected by many different factors, one of which is high algae activity, which tends to reduce DO at night and increase DO during the day. Large-scale diel swings in DO are indicative of excessive plant and algae growth and potential nutrient impacts. High algae activity may increase due to high nutrient loading (i.e. phosphorus). Figure 6-14 shows a plot of average daily minimum DO and log average summer

(June 21 – September 21) phosphorus levels for 2003 through 2011 for Batiste and Siphon Roads.

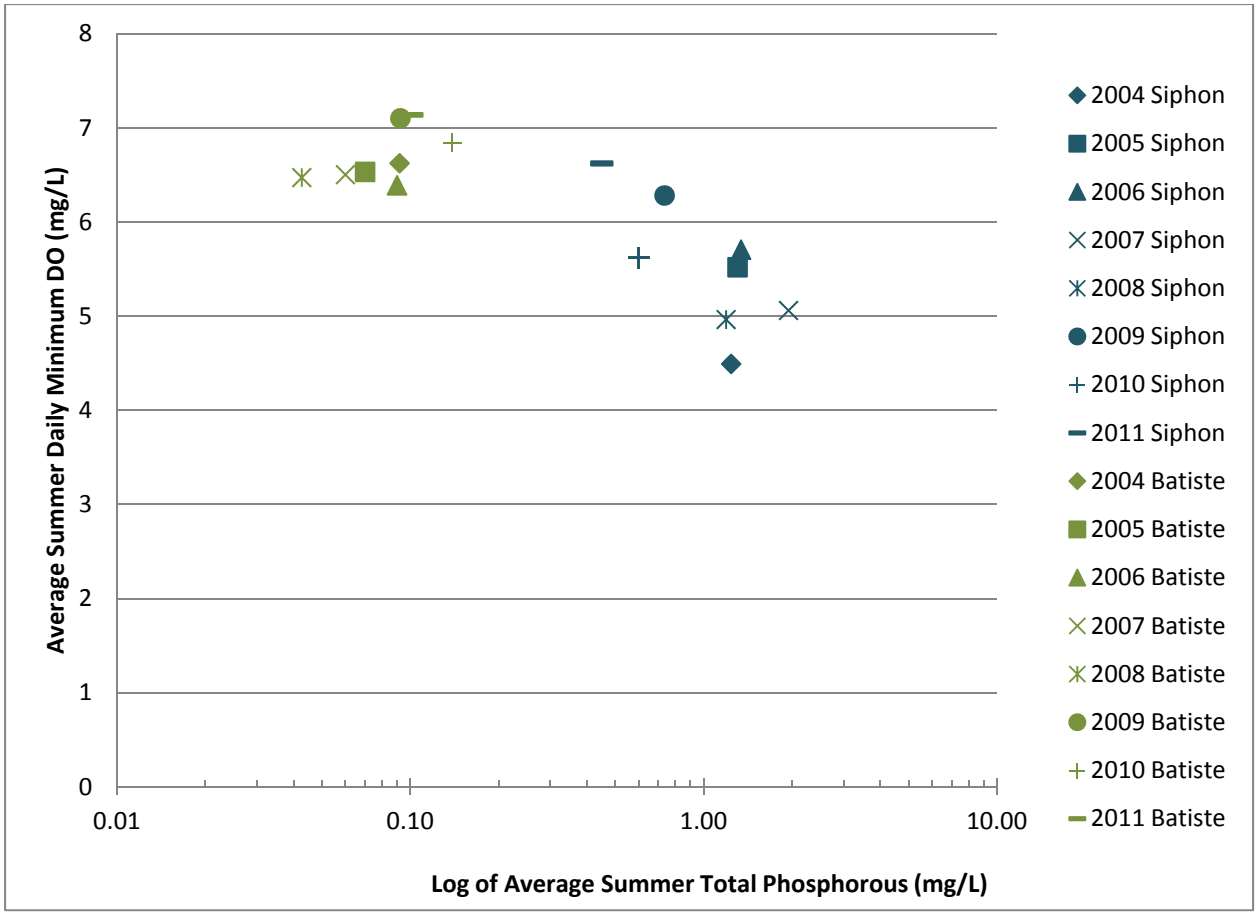


Figure 6-14: The relationship between dissolved oxygen and phosphorus (summer months).

The data show that the minimum DO values at Siphon Road have increased as the nutrient concentration decreased. In 2011, the average summer daily minimum DO at Siphon Road was in the range of values for Batiste Road. Figure 6-15 shows DO data collected at Batiste Road and Siphon Road during summer months, and Figure 6-16 shows DO. data collected at Siphon Road for summer of 2009, 2010, and 2011. A summary of average observed data at both sites is presented in Table 6-8. Figure 6-17 shows the yearly average trend for both sites from 2004 through 2011.

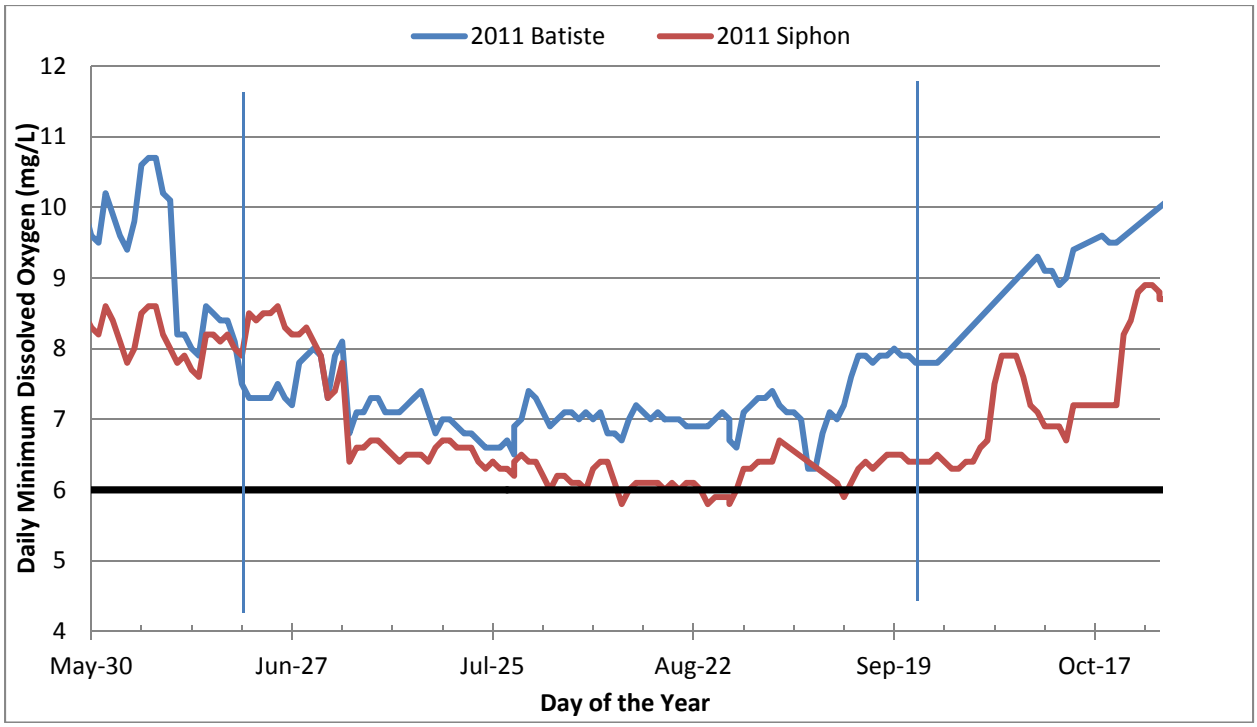


Figure 6-15: Summary of DO at Batiste Road v. Siphon Road (Summer 2011).

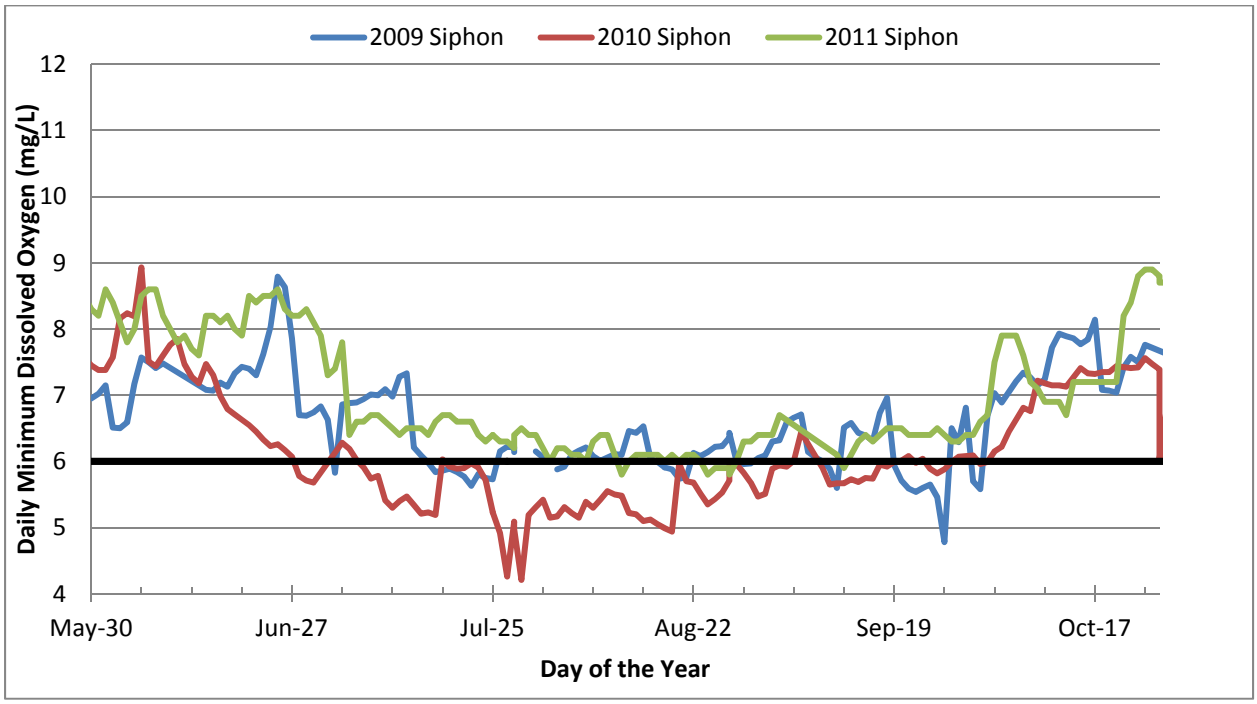


Figure 6-16: Summary of DO at Siphon Road (2009 - 2011).

Table 6-8: Summary of summer average data at Batiste Road verse Siphon Road (2005 - 2011).

		Batiste	Siphon
2005	Avg Daily Min DO (mg/L)	6.54	5.51
	Avg Daily Min pH	8.40	7.40
	Avg Daily Max Temp (degC)	20.7	17.0
	Avg total Phos (mg/L)	0.07	1.35
	Avg Nitrate+Nitrite (mg/L)	0.13	2.37
2006	Avg Daily Min DO (mg/L)	6.38	5.71
	Avg Daily Min pH	8.33	7.40
	Avg Daily Max Temp (degC)	20.5	17.0
	Avg total Phos (mg/L)	0.09	1.38
	Avg Nitrate+Nitrite (mg/L)	0.34	2.48
2007	Avg Daily Min DO (mg/L)	6.57	4.98
	Avg Daily Min pH	8.32	7.35
	Avg Daily Max Temp (degC)	21.3	16.9
	Avg total Phos (mg/L)	0.06	2.07
	Avg Nitrate+Nitrite (mg/L)	0.18	2.80
2008	Avg Daily Min DO (mg/L)	6.51	4.96
	Avg Daily Min pH	8.30	7.43
	Avg Daily Max Temp (degC)	20.0	16.8
	Avg total Phos (mg/L)	0.04	1.29
	Avg Nitrate+Nitrite (mg/L)	0.13	2.66
2009	Avg Daily Min DO (mg/L)	7.12	6.29
	Avg Daily Min pH	8.30	7.50
	Avg Daily Max Temp (degC)	20.3	17.2
	Avg total Phos (mg/L)	0.09	0.75
	Avg Nitrate+Nitrite (mg/L)	0.18	2.67
2010	Avg Daily Min DO (mg/L)	6.76	5.62
	Avg Daily Min pH	8.11	7.44
	Avg Daily Max Temp (degC)	20.2	16.7
	Avg total Phos (mg/L)	0.07	0.62
	Avg Nitrate+Nitrite (mg/L)	0.15	2.24
2011	Avg Daily Min DO (mg/L)	7.16	6.64
	Avg Daily Min pH	8.25	7.59
	Avg Daily Max Temp (degC)	20.1	17.2
	Avg total Phos (mg/L)	0.10	0.46
	Avg Nitrate+Nitrite (mg/L)	0.30	1.80

Note: DO, pH and Temp averages come from continuous datasets. Total Phos and Nitrate+Nitrite averages come from discrete datasets where samples were collected approximately once per month. DO, pH, Temp, total Phos, and Nitrate+Nitrite measurements were averaged over the summer season (June - September).

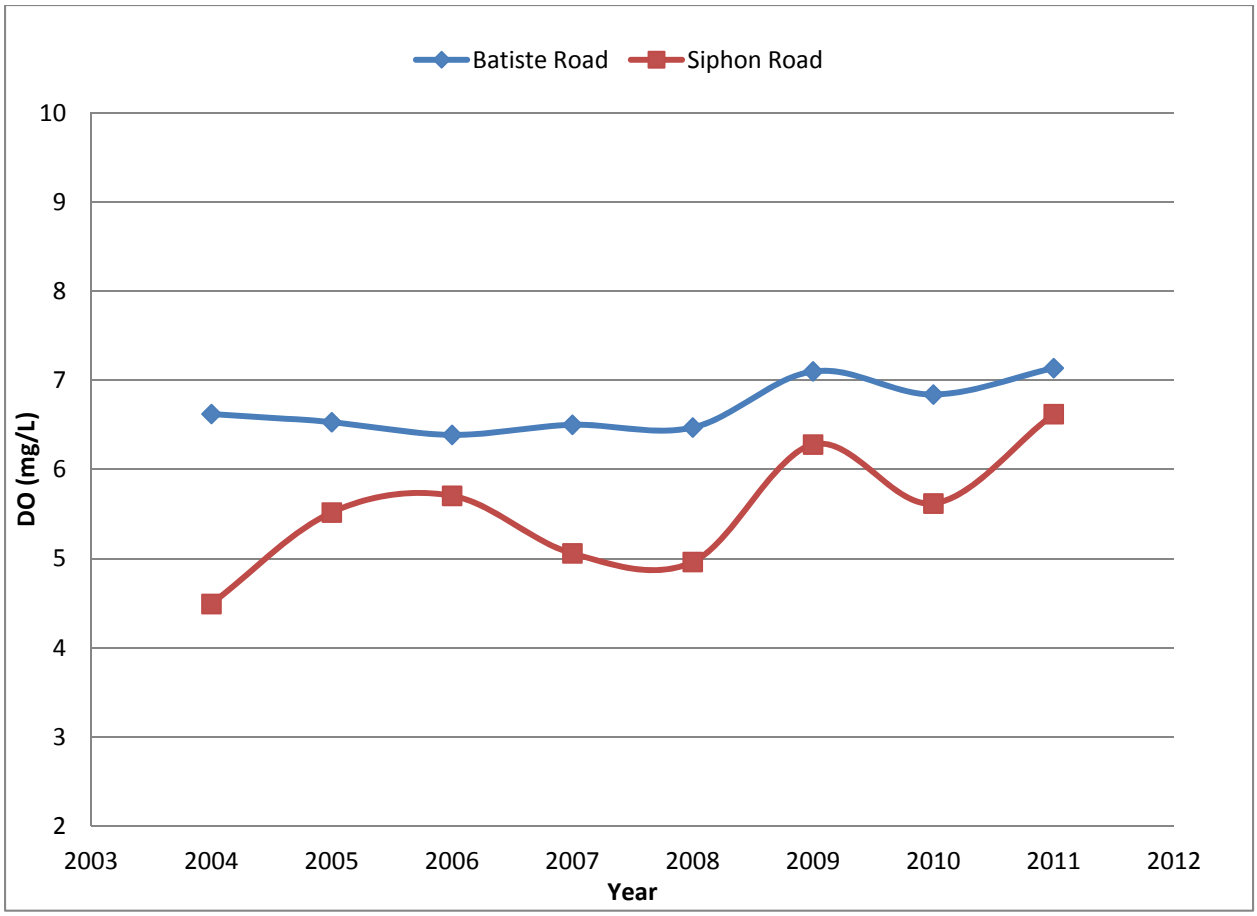


Figure 6-17: The average of summer daily minimum dissolved oxygen trend for Batiste Road and Siphon Road.

Table 6-9: The number of days at Siphon Road with dissolved oxygen levels under 6.0 mg/L.

Date	Days
2004	71
2005	80
2006	79
2007	113
2008	102
2009	33
2010	82
2011	7

Dissolved oxygen levels are also inversely related to water temperature due to decreasing oxygen solubility in water with increasing temperature. Data collected at ten-minute intervals at Batiste Road and Siphon Road bear this out. Mid-day measurements of DO are plotted against temperature for both locations in Figure 6-18.

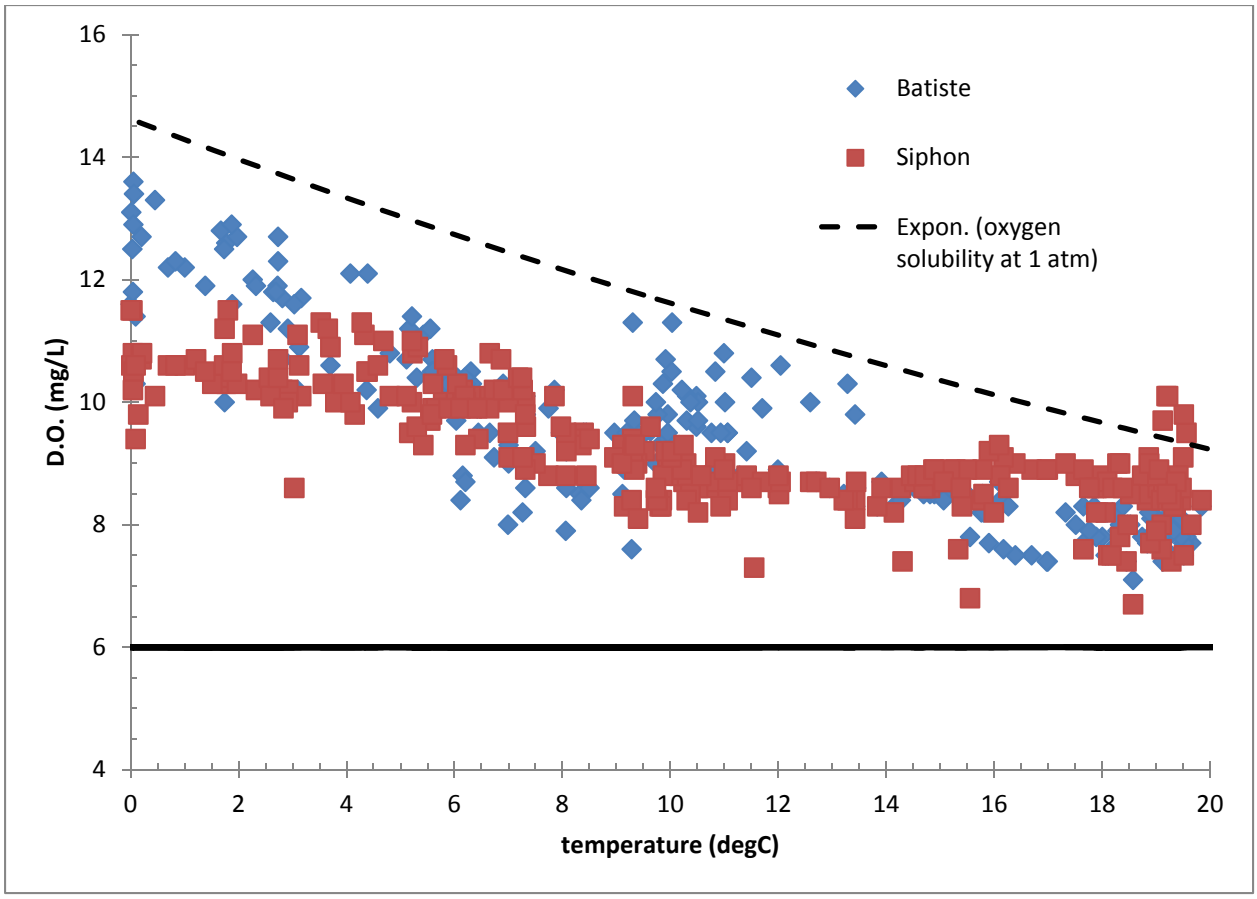


Figure 6-18: The relationship between dissolved oxygen and water temperature.

There are other sources of pollutants and other activities that occur between Batiste Road and Siphon Road that could explain, at least in part, some of the differences in dissolved oxygen observed between these sites. These include regional groundwater inflow, discharge from the Pocatello Wastewater Treatment Plant, septic tanks, fish hatchery operations, runoff from agricultural areas, and changing flow volumes. Dissolved oxygen concentrations are affected by multiple factors, including sediment oxygen demand, re-aeration, temperature, pH, flow, and oxygen-demanding materials; in addition to nutrient-related eutrophication effects.

In summary:

- Dissolved oxygen concentrations at Siphon Road were under 6 mg/L on 82 days in 2010 and only 7 days in 2011, representing a significant improvement in water quality.
- Dissolved oxygen concentrations are affected by multiple processes other than nutrient loading.

6.3.3.4 Turbidity

This section is reproduced from the 2010 annual report. It is included to provide information to support the site conceptual model.

Turbidity is monitored continuously at both Batiste and Siphon Roads. To further analyze the potential differences between Batiste and Siphon Roads and compare levels to the TMDL goals, the maximum daily turbidity level was determined. The water quality standards for turbidity "shall not exceed background by more than 50 NTU instantaneously or more than 25 NTU for more than 10 consecutive days" (IAC 2009 [58.01.02.250]). Background levels were calculated using a 20 day rolling median value.

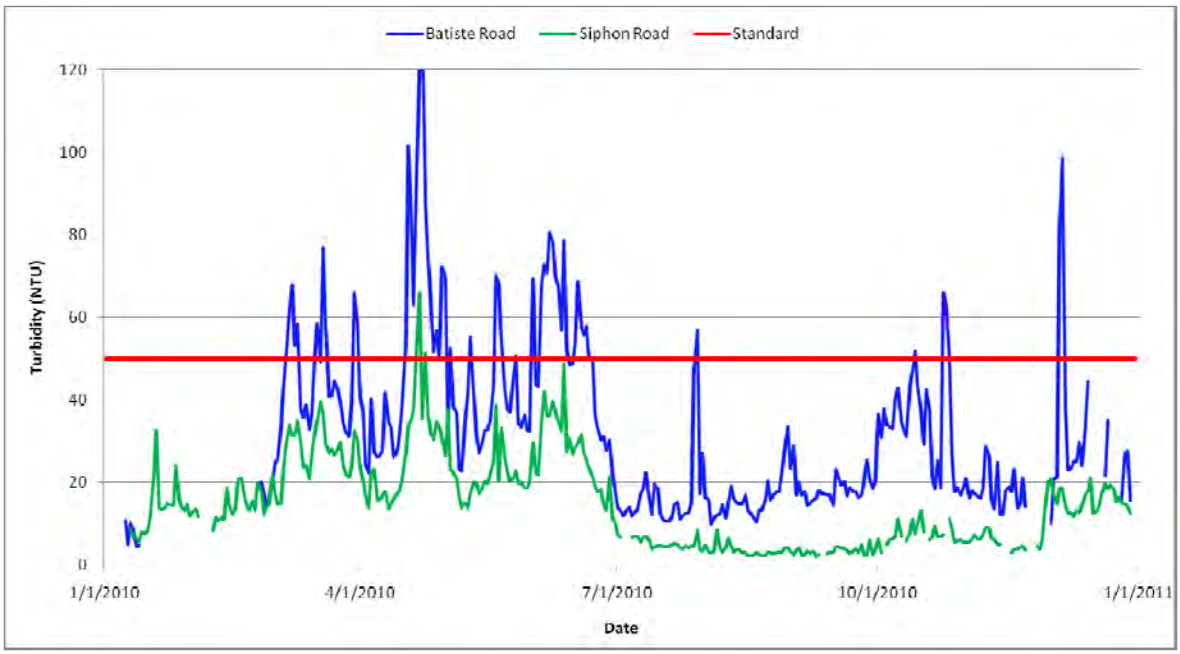


Figure 6-19: The daily maximum turbidity minus background levels for Batiste and Siphon Roads with the 50 NTU standard.

Figure 6-19 shows that Batiste Road demonstrated 53 days with greater than 50 NTU over background levels while Siphon Road measured only 3 days with greater than 50 NTU over background levels. The lower turbidity levels at Siphon Road are most likely due to the large groundwater influx in-between the two sites including EMF groundwater which has low turbidity levels. To show the trends for turbidity at each site, the number of days over 50 NTU were divided by the days of measurement to estimate a percentage of days exceeding the turbidity standard.

Table 6-10: The estimated percentage of days over 50 NTU above background turbidity for Batiste and Siphon Roads.

Location	2004	2005	2006	2007	2008	2009	2010
Batiste	20.5%	33.6%	38.3%	23.9%	9.2%	33.6%	17.3%
Siphon	8.4%	15.9%	18.9%	10.1%	3.2%	10.9%	0.9%

Table 6-10 shows that Siphon Road has less days above 50 NTU consistently for the last 7 years compared to Batiste Road. Overall the water quality for turbidity is better at Siphon Road than upstream.

The daily maximum turbidity was then compared to phosphorus in order to assess the correlations between these data quality parameters (Figure 6-20: The turbidity and phosphorus relationship at Batiste Road (2004 – 2010).Figure 6-20 and Figure 6-21).

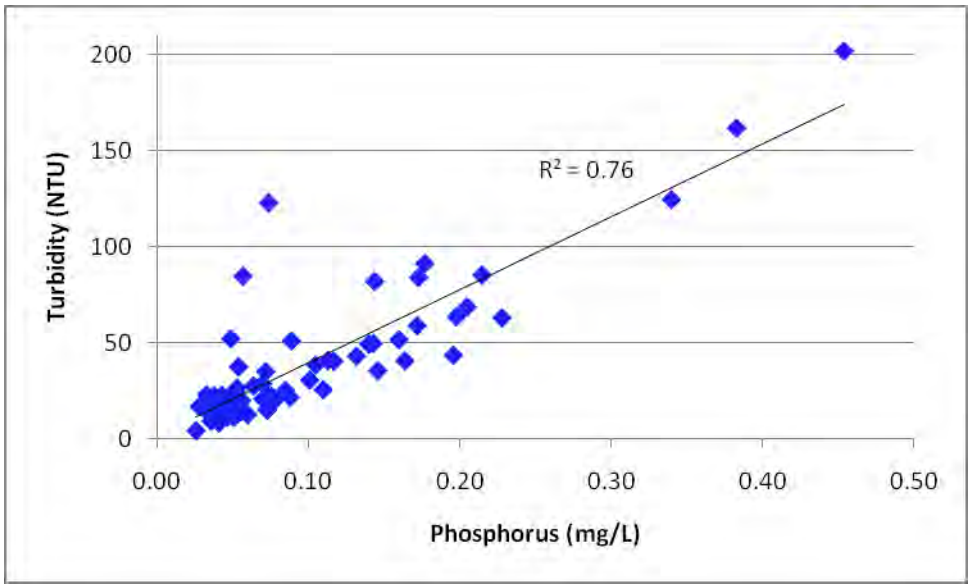


Figure 6-20: The turbidity and phosphorus relationship at Batiste Road (2004 – 2010).

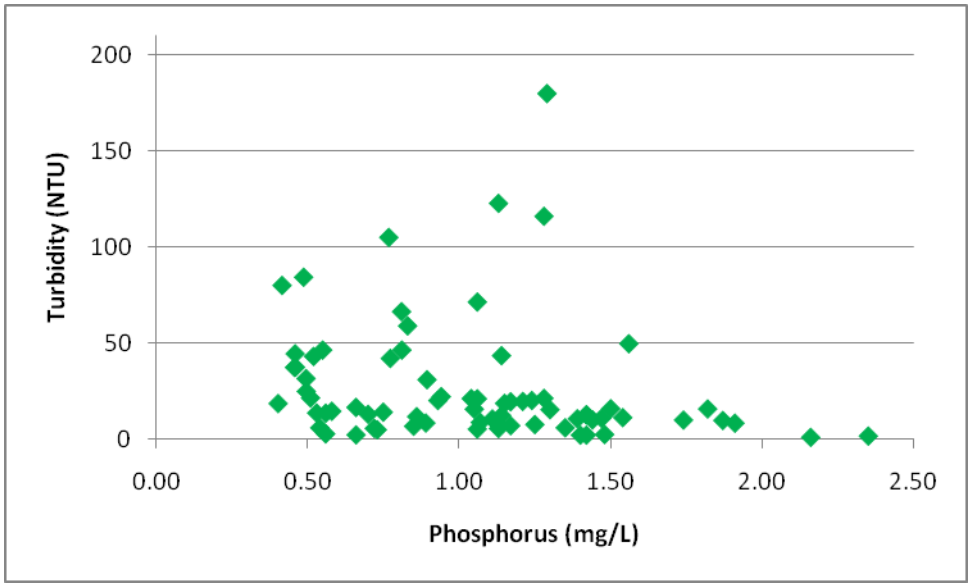


Figure 6-21: The turbidity and phosphorus relationship at Siphon Road (2004 - 2010).

The correlation between turbidity and phosphorus at Batiste Road is high (R^2=0.76) while there is no trend evident at Siphon Road. This is likely due to the high groundwater influx, including EMF groundwater containing dissolved phosphorus, before Siphon Road.

In summary:

- Water quality for turbidity is higher at Siphon Road compared to Batiste Road.
- The trend between phosphorus concentration and turbidity is strong at Batiste Road while no trend exists at Siphon Road.

6.3.3.5 Temperature and pH

Temperature and pH that have an influence on a river system and these parameters are measured continuously at both Batiste and Siphon Roads. pH data were tabulated as the daily minimum for comparison to water quality while the temperature was averaged daily (Figure 6-22 and Figure 6-23).

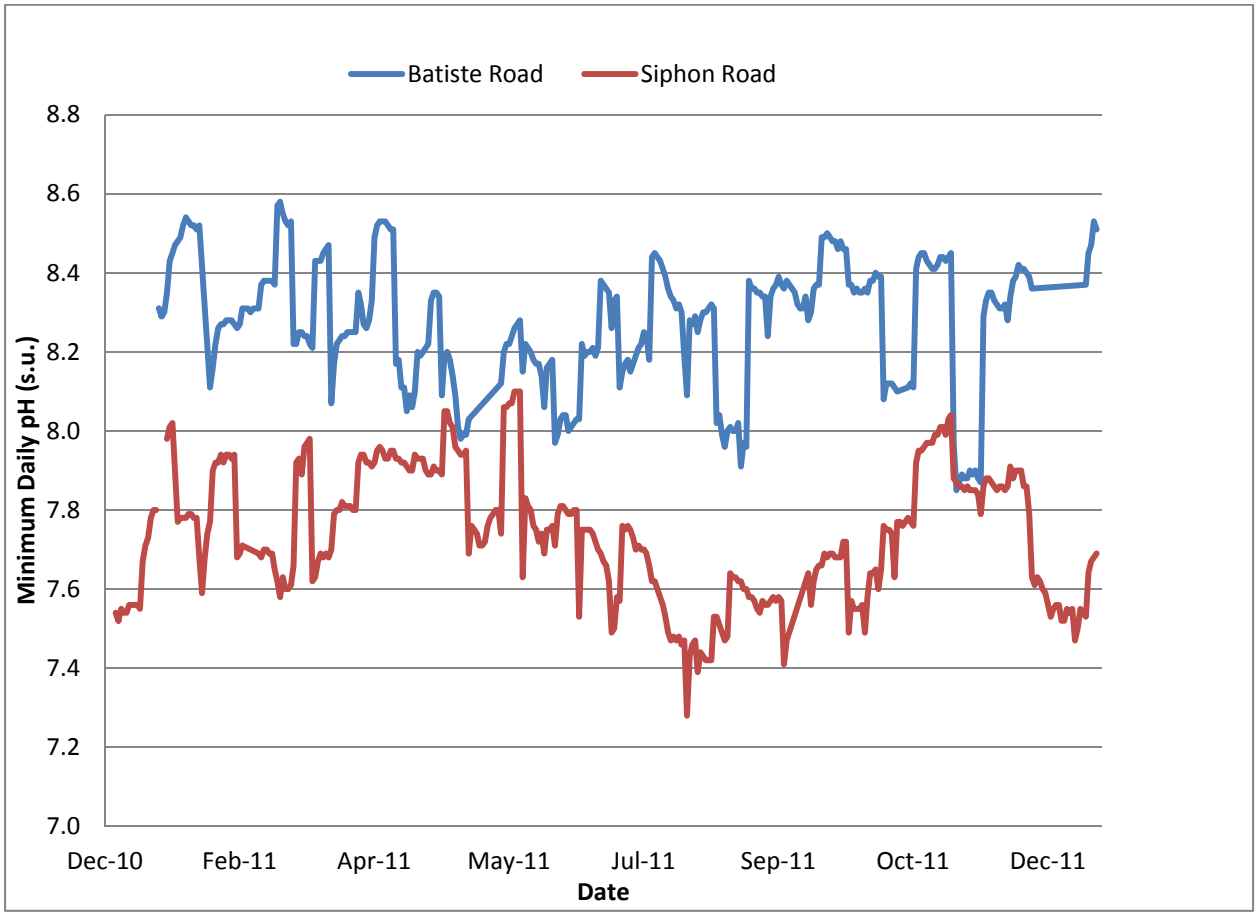


Figure 6-22: The daily minimum pH for Batiste Road and Siphon Road (2011).

The water quality standard for pH is to be in the range of 6.5 to 9.0 units (IAC 2009 [58.01.02.250]). pH upstream of the EMF Site at Batiste Road is higher (approaching the maximum end of the allowable range) than at Siphon Road.

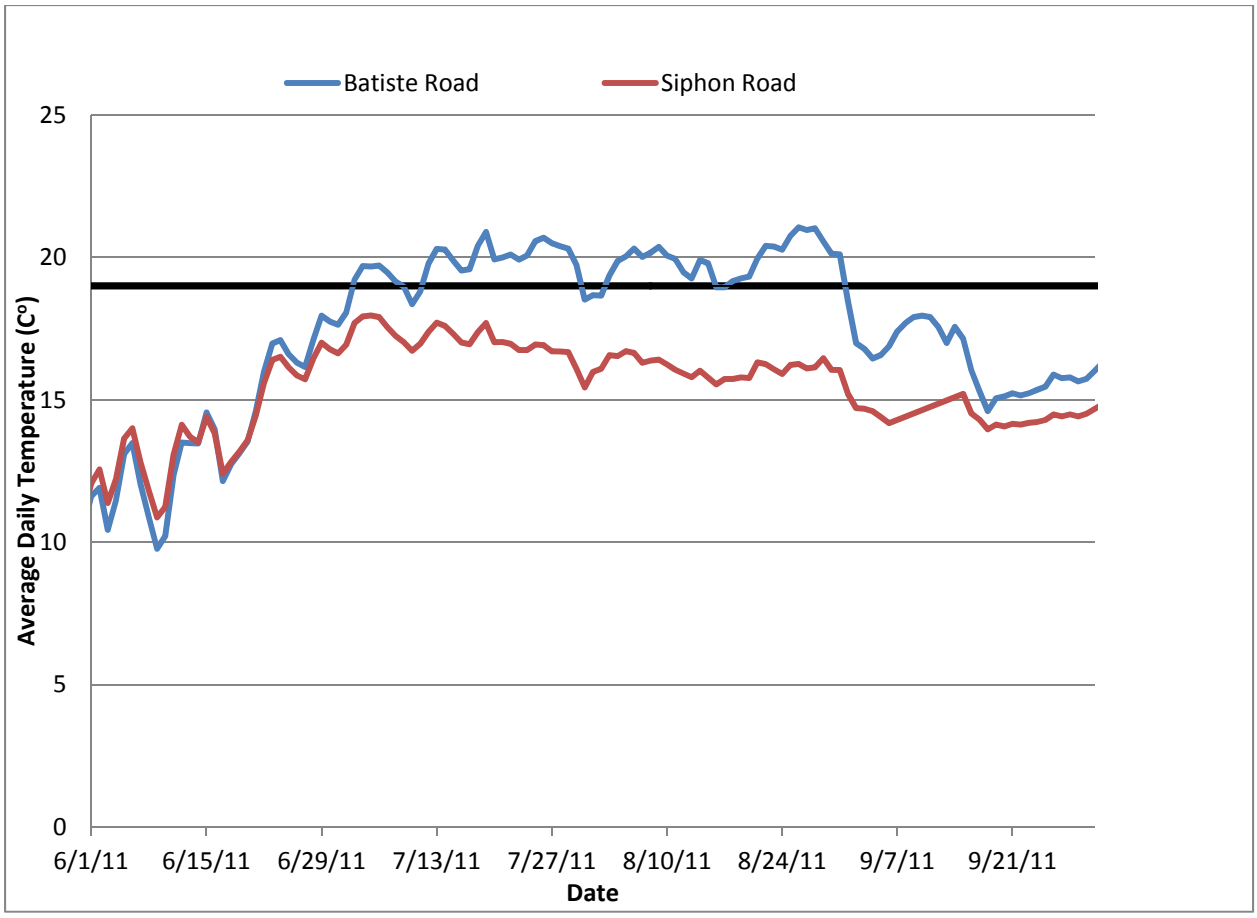


Figure 6-23: Daily temperature comparison - Batiste Road v. Siphon Road (Summer 2011).

The corresponding temperature standard for the Portneuf River on a daily average basis is 19 degrees C for protection of cold water biota (note: 22 degrees C is the instantaneous standard) (IAC 2009 [58.01.02.250]). Average daily temperature values frequently exceed the temperature standard at Batiste Road, while the standard is always met at Siphon Road due to the large influx of regional groundwater with temperature typically in the range of 12 to 13 degrees C.

For water temperature and maximum pH (which is also related to increased algal activity), the general trend is substantial improvement in quality at Siphon Road compared to Batiste Road. The substantially cooler water temperatures at Siphon Road are related to groundwater that enters the river downstream of Batiste Road. Regional groundwater in the valley just north of the EMF facilities has a relatively constant temperature year-round, typically between 12 and 13 degrees C and relative constant pH, typically 7.4 to 7.8 su (EMF wells 524 and 525, data record from 2000 to present). Approximately 30 cfs of this groundwater originates from the EMF Site and has a pH ranging from 6.5 to 7.8 su (Batiste Spring and the Spring at Batiste, quarterly data since 2000, Figure 6-13) and is not elevated in temperature. Thus, regional groundwater tends to reduce the pH and cool the river downstream of Batiste Road and is believed to have a significant influence on river conditions at Siphon Road.

In summary:

- pH upstream of the EMF Site at Batiste Road is typically higher than at Siphon Road. pH values are always within standard limits.
- Average daily temperature values frequently exceed the temperature standard at Batiste Road, while the standard is always met at Siphon Road.

6.4 Conclusions

The results of the surface water monitoring program for the lower Portneuf River through 2011 are summarized below.

- The yearly average groundwater influx is approximately 100 cfs between Batiste Road and T2B and 250 cfs between Batiste Road and Siphon Road and is relatively steady throughout the year.
- Flow at Siphon Road in 2011 was higher than in previous years during springtime runoff, but returned to typical flow rates late in 2011. Reduced concentrations of total phosphorus at Siphon Road at the end of the year are not due to higher flows, but primarily due to reduced loads from EMF groundwater.
- Batiste Road is not affected by EMF groundwater and can be used as a background monitoring location.
- Concentrations at Siphon Road have significantly decreased starting in 2007 with the 12-month median phosphorus concentration for 2011 equal to 0.41 mg/L. This is lower than the December 31st, 2013 VCO goal.
- The reduced phosphorus load at Siphon Road is a reflection of the reduced load from EMF groundwater. The estimated phosphorus load from EMF groundwater at Siphon Road averaged of 736 lb/day in 2011. This is the lowest average in the last 9 years.

There continues to be uncertainties related to the question of how much of the observed impairment in the lower Portneuf is due to excess nutrients and how much is due to other factors such as elevated temperatures, low water levels/flow regulation, groundwater influences, oxygen-demanding materials or land uses. Additional monitoring of key parameters will help to reduce these uncertainties. However, as the phosphorus loads decrease, future monitoring should focus on whether the river is responding to these improvements. Monitoring should evolve from defining the problem (that is, assessing the current chemical and biological status of the river) to measuring improvements related to TMDL implementation.

7.0 REMEDY PERFORMANCE

This section provides a summary of the overall performance of the remedy in 2011. The performance of the remedy components, source control, and groundwater extraction, are examined in terms of effectiveness near the point of implementation. The overall performance is assessed in terms of influence on groundwater and surface water quality at the point of compliance for groundwater in the Portneuf River.

7.1 Direct Effects of Remedy Implementation

7.1.1 Gypsum Stack Source Control

Source control for the gypsum stack will be achieved by lining the entire stack with a high density polyethylene liner in multiple phases of work. Phase I consisted of Decant Pond construction and lining of the lower stack. The Decant Pond is necessary for water management during the operation of a lined stack. The Decant Pond construction was completed in October 2009, and the lined-lower stack was brought into operation in July 2011. The second and third phases of work include lining the upper west stack and the upper east stack, respectively. The upper west stack will be split into two sub-compartments to allow each to be completed within one construction season. The design of the upper west stack has been submitted to the Agencies and construction is planned to begin in 2012. After each phase of lining, seepage through the gypsum to groundwater will be significantly reduced. Predicted seepage reduction from the gypsum stack is shown in Figure 7-1 (Simplot 2009b).

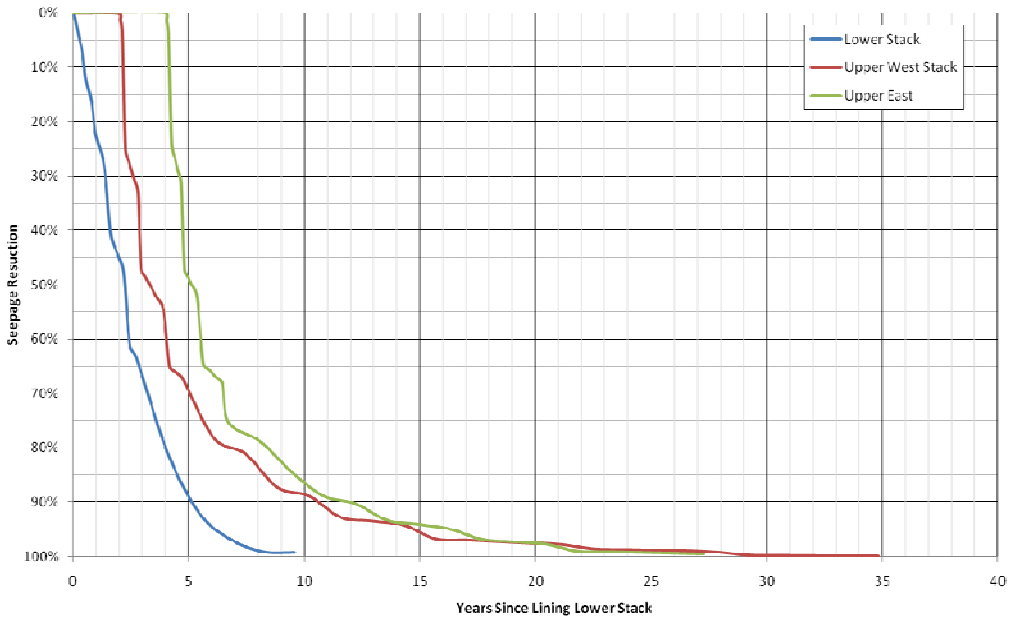


Figure 7-1: Estimated seepage reduction at each of the gypsum stack compartments.

7.1.2 PAP Area Source Control

The total phosphorus load attributable to the PAP Area can be evaluated by calculating the phosphorus mass flux in groundwater upgradient and downgradient of the PAP Area. A detailed description of the calculation methodology is provided in Technical Report No. 1 (Simplot 2009b). Calculations of the estimated phosphorus load gained in the PAP Area are summarized in Table 7-1. Detailed calculations are provided in Appendix H of the Quarterly Groundwater/Surface Water Remedy Monitoring Reports.

The concentration of phosphorus in groundwater upgradient of the PAP Area is represented by the Upper Zone wells 325, 334, and 341, which are monitored quarterly. The mean phosphorus concentration was 12.5 mg/L in well 325, 207 mg/L in well 334 and 24.6 mg/L for well 341 for 2011. Downgradient phosphorus concentrations at wells 340, 367, 369, 370, 374 and 419 are greater than upgradient concentrations at wells 325, 334 and 341. Since 2009, phosphorus concentration trends in downgradient wells are flat or have decreased significantly (Figure 5-7). The highest phosphorus concentrations in wells downgradient of the PAP Area are at wells 340 and 419. Concentrations in groundwater samples from both of these wells have decreased as the result of infrastructure improvements in the PAP Area. Resulting estimated mass flux rates in the PAP Area have decreased from 358 lb/day in the fourth quarter of 2009 to 110 lb/day by fourth quarter 2011. This corresponds to a 70% reduction through 2011.

Table 7-1: Estimated pounds of phosphorus gained through the PAP Area, before extraction.

Quarter	lb/day
2009 Q4	358
2010 Annual	175
2011 Annual	114

It is noted that all groundwater affected by PAP sources is captured by the extraction system.

7.1.3 Groundwater Extraction System

A comprehensive assessment of the performance of the groundwater extraction system for 2011 is provided in Section 5. This assessment indicates that additional groundwater extraction is necessary to meet the arsenic MCL in the Compliance Area. A quantitative summary of the effectiveness of the groundwater extraction system is shown in Tables 7-2 through 7-4, using mass flux and mass removal calculations for the target capture zones. By the end of 2011 it is estimated that the groundwater extraction system is removing approximately 54% of the phosphorus load, 58% of the sulfate load, and 60% of the arsenic load that passes through the target capture zones. The total mass removed for 2011 was approximately 802,300 lbs of phosphorus. This amount is greater than previous years with 2010 having removed 780,000 pounds and 2009 seeing 700,000 pounds removed.

Table 7-2: The phosphorus load estimated from the gypsum stack, the phosphoric acid plant, and the load removed by the extraction system.

Quarter	Estimated Gypsum Stack Loads (lb/day)	Estimated PAP Load (lb/day)	Load Removed from extraction (lb/day)	Load Passed (lb/day)	Mass Reduction (Load Removed/Total Load)(%)
Q1	4,080	118	2,108	2,090	50%
Q2	4,337	118	2,214	2,241	50%
Q3	3,937	111	2,288	1,760	57%
Q4	3,551	110	2,180	1,481	60%
Average 2011	3,976	114	2,198	1,893	54%

Table 7-3: The sulfate load estimated from the gypsum stack, the phosphoric acid plant, and the load removed by the extraction system.

Quarter	Estimated Gypsum Stack Loads (lb/day)	Estimated PAP Load (lb/day)	Load Removed from extraction (lb/day)	Load Passed (lb/day)	Mass Reduction (Load Passed/Load Removed)(%)
Q1	33,046	116	18,640	14,522	56%
Q2	31,703	21	17,275	14,449	54%
Q3	31,070	22	19,251	11,841	62%
Q4	31,282	23	18,694	12,611	60%
Average 2011	31,775	46	18,465	13,356	58%

Table 7-4: The arsenic load estimated from the gypsum stack, the PAP Area, and the load removed by the extraction system.

Quarter	Estimated Gypsum Stack Load (lb/day)	Estimated PAP Load (lb/day)	Load Removed from extraction (lb/day)	Load Passed (lb/day)	Mass Reduction (Load Passed/Load Removed)(%)
Q1	3.54	0.01	2.15	1.40	61%
Q2	3.52	0.00	1.88	1.64	53%
Q3	3.63	0.00	2.22	1.41	61%
Q4	3.11	0.00	1.97	1.14	63%
Average 2011	3.45	0.00	2.06	1.40	60%

7.2 Remedy Performance in the Groundwater Compliance Area and at the Portneuf River

7.2.1 Comparison of COC Concentrations with MCLs in the Compliance Area

Comparison of COC concentrations in the Compliance Area to GWPS/MCLs is performed annually, as noted in the Groundwater and Surface Water Monitoring Plan (Formation 2010d) and is presented here in Section 6. The method for comparison is described in Section 5.2.2 of the Groundwater and Surface Water Monitoring Plan.

Wells in the Compliance Area include wells 504, 505, 524, and 525, and four new multi-level wells, 534, 537, 538 and 539 installed in 2010. Statistical comparisons were conducted for each existing well independently (EPA 2009). For arsenic, ten of the fifteen wells tested showed that COC migration above the MCL to the Off-Plant Area is prevented. The 95% UCL of arsenic for existing wells ranged from 0.003 to 0.030 mg/L. The 95% UCL of total phosphorus ranged from 0.02 to 11.8 mg/L, however, the RBC for phosphorus has not yet been determined.

The new monitoring wells in the Compliance and Assessment Areas will aid in assessing the migration of COCs above GWPS in the Off-Plant area.

7.2.2 Phosphorus Loads to the Portneuf River

The loads measured in the Portneuf River at Siphon Road, as discussed in Section 7, have significantly decreased since 2007. Figure 7-2 shows this decreasing trend, indicating that the reduced load at Siphon Road is a reflection of the reduced load amount from EMF groundwater.

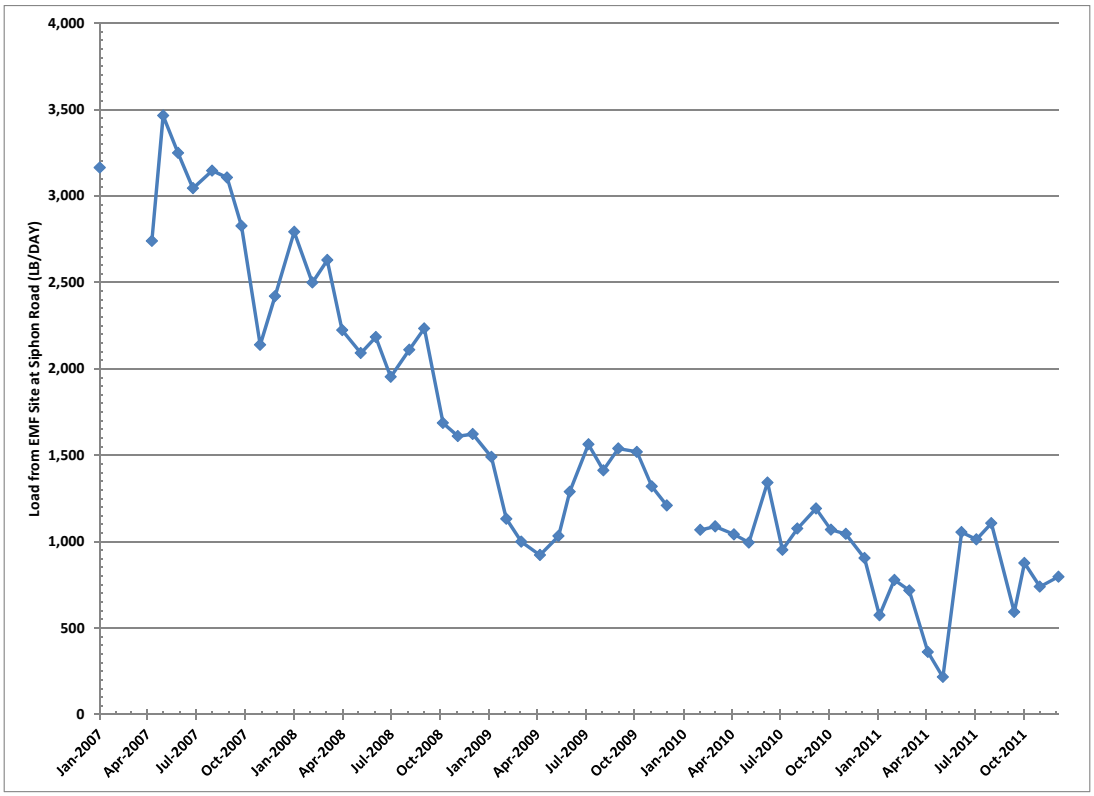


Figure 7-2: The total phosphorus load (lb/day) from EMF Site to Portneuf River at Siphon Road

Table 7-5 provides the average EMF groundwater loads of total phosphorus measured at Siphon Road for 2009 and 2010 and quarterly for 2011. The decrease in load is 334 pounds per day average reduction for total phosphorus between 2010 and 2011.

Table 7-5: The EMF groundwater loads measured in 2011 at Siphon Road in pounds per day.

Quarter	Total Phosphorus
2009	1,286
2010	1,070
2011 Q1	690
2011 Q2	544
2011 Q3	904
2011 Q4	804
Average 2011	736

7.3 Phosphorus Concentrations in the Portneuf River

Figure 7-3 shows the effectiveness of source controls and the extraction system on phosphorus concentrations to the river.

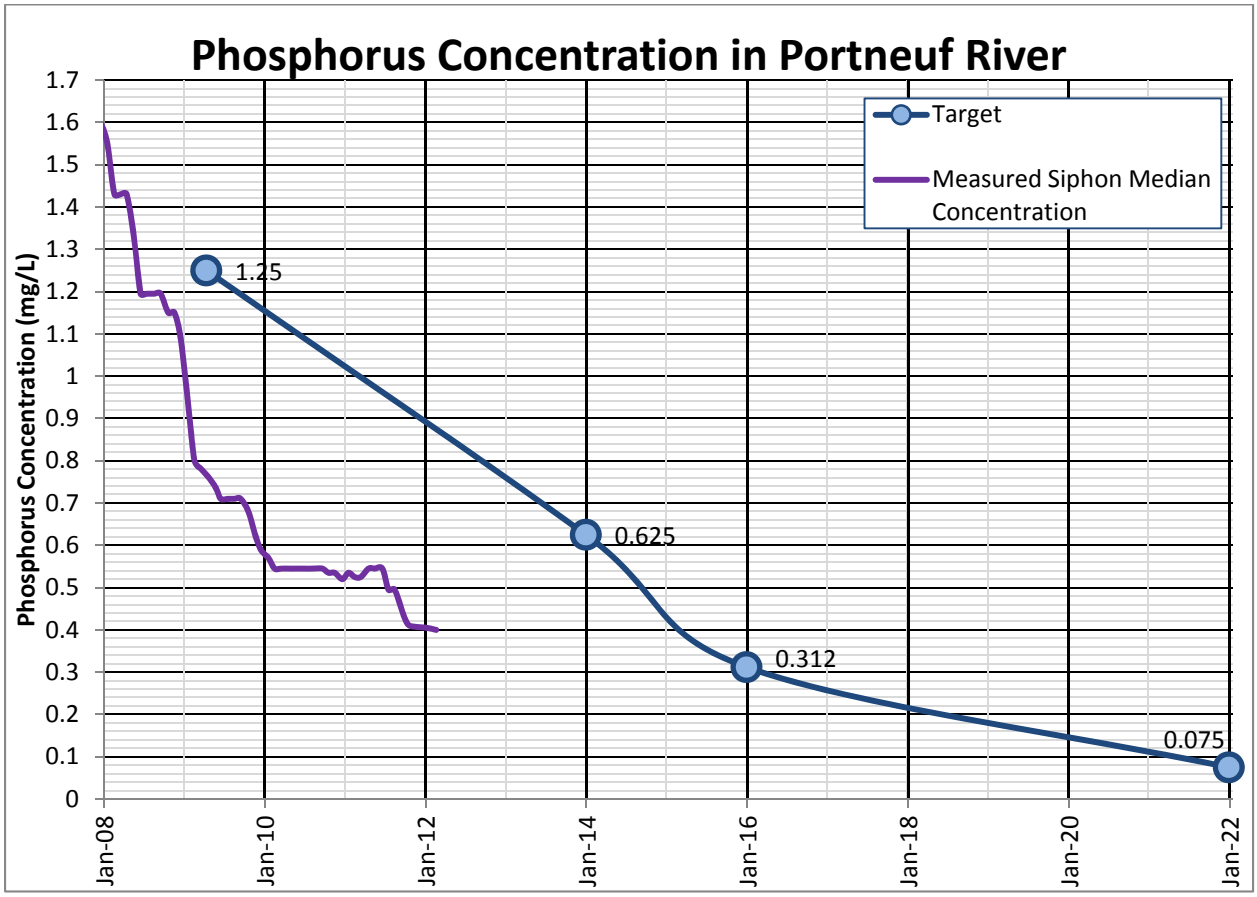


Figure 7-3: VCO/CA Target Concentrations with estimated and measured Phosphorus concentrations in the Portneuf River.

This shows that the recent phosphorus concentrations in the river are below levels predicted by design modeling. This demonstrates that either increased source controls, higher attenuation rates, or less mass loading of the system from Simplot sources are contributing to the reduced concentration at the point of compliance. The concentrations are already below the December 31st 2013 VCO goal, and continue to decrease.

8.0 REMEDY COMPONENTS PLANNED FOR 2012

Remedy components planned for 2012 are described in the Remedial Action Plan (Simplot 2009a), the Remedial Action Work Plan (Formation 2010a), and the Phosphorus Source Control Program (Simplot 2011a). The tasks planned for 2012 are summarized in the following sections.

8.1 Groundwater Extraction System

Fourteen groundwater extraction wells were active through the first three quarters of 2011. These wells were in installed in two prior phases of work; phase 1 in 2003-2004, and phase 2 in 2007-2008. The third and final planned phase of extraction well installation was completed in 2011. Well 410 was taken off line and two additional wells (421 and 422) were brought on line in September 2011. A total of fifteen extraction wells were in service by the fourth quarter of 2011. No additional extraction well installation is planned.

8.2 Lining of the Gypsum Stack

Lining of the existing gypsum stack is being performed as a source control action to reduce seepage and loading of phosphorus to groundwater beneath the stack. As a result, the stack lining is expected to eventually reduce concentrations of phosphorus in the plant area below levels of concern. When verified by the groundwater monitoring system this may allow the extraction system operation to be modified in the future.

A preliminary schedule was presented in Section 3 of this report. Elements that are scheduled for completion in 2012 include:

<u>Upper West Stack</u>:

- Complete lining of the northern sub-compartment

<u>Upper East Stack</u>:

- Begin preparation for lining of the northern sub-compartment

8.3 PAP Area Source Control

Source control in the PAP Area is achieved through a comprehensive sump, pad, and tank inspection program; routine maintenance and repairs; and capital projects. Plans for

infrastructure improvement projects in 2012 are detailed in a letter to DEQ and EPA (Simplot 2012). These projects and their current status are listed in Table 8-1.

Table 8-1: Priority projects planned for 2012 in the PAP process zones and their current status.

Project	Construction Planned	Current status
#4 Sump and Pad Replacement	2012	Engineering
SPA Aging Tank Floor Upgrade Phase 2	2012	Engineering
SPA Aging Tank Pad Upgrade	2012	Engineering
On-going Tank, Pad and Sump Inspections	N/A	On-going

9.0 SUMMARY AND CONCLUSIONS

This report provides a description of the groundwater/surface water remedy implementation and performance in 2011 in the Simplot OU of the EMF Superfund Site near Pocatello Idaho.

A groundwater/surface water remedy has been designed to meet the requirements of a Record of Decision issued by EPA in 1998 and an Interim Record of Decision Amendment for the Simplot Operable Unit issued by EPA in February 2010. The remedy and monitoring also meets the requirements of a VCO/CA between IDEQ and the J.R. Simplot Company intended to fulfill Simplot's obligations for the Portneuf River TMDL. The two projects are intertwined because groundwater affected by Simplot sources discharges to the Portneuf River, resulting in phosphorus concentrations above TMDL targets.

The remedy contemplated under Superfund and the VCO/CA has the same basic elements:

- Installation of a high density polyethylene liner on top of the existing gypsum stack with continued placement of gypsum on the liner;
- Control of sources of phosphorus to groundwater in the PAP Area;
- Extraction of groundwater downgradient of the gypsum stack and PAP Area; and
- Groundwater and surface water monitoring to assess the performance of the remedial actions.

Overall, Simplot implemented significant source control actions in the PAP Area and successfully operated the groundwater extraction system in 2011. Groundwater data indicate significant reduction in phosphoric acid plant sources, but that some sources may still continue. Identifying and addressing these is the focus of the source control improvements continuing in 2012. Mass flux modeling predicts that the current groundwater extraction system will come close to meeting arsenic MCLs in groundwater near the Portneuf River. Modifications to extraction rates will be evaluated in 2012. This remedy element provides environmental improvement in advance of gypsum stack source controls.

Lining of the lower compartment gypsum stack was completed in 2011. Lining of the upper stack is scheduled to begin in 2012. As a result of extraction system operation and source control activities, the phosphorus load from Simplot groundwater to the Portneuf River has been significantly reduced. This has resulted in a significant reduction in phosphorus concentrations in the river. In fact, by the end of 2009 the median monthly average phosphorus concentration in the river at Siphon Road was already lower than the target set out in the VCO/CA for December 31st 2013 with continuing decreasing concentrations through 2010 and 2011. This indicates that remedial actions are resulting in greater and faster water quality improvements than previously predicted.

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APPENDIX A: 2011 Groundwater Data

APPENDIX B: Groundwater Chemistry Time-Series Graphs

APPENDIX C: Hydraulic Gradient Calculation

APPENDIX D: Phosphoric Acid Plant Specific Data

APPENDIX E: Mass Flux Calculations

APPENDIX F: Analytical Capture Zone Calculations

APPENDIX G: Groundwater Modeling and Particle Tracking

APPENDIX H: Surface Water Data

APPENDIX I: Statistics Calculations

Included on Disc