LMS/TUB/S10107

Annual Groundwater Report April 2012 Through March 2013 Tuba City, Arizona, Disposal Site

August 2013

U.S. DEPARTMENT OF ENERGY | Legacy Management

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Annual Groundwater Report,
April 2012 Through March 2013,
Tuba City, Arizona, Disposal Site

The U.S. Department of Energy (DOE) has prepared the *Annual Groundwater Report, April 2012 Through March 2013, Tuba City, Arizona, Disposal Site*. The report has been revised because Section 4.3 was inadvertently omitted in the previous version. **At your request, you are receiving a hard copy of the report.**

The report is also available for your review on the Internet at the DOE Office of Legacy Management (LM) website – http://energy.gov/lm. From the LM website home page, select the LM SITES MAP. Then select the Tuba City Site from the LM SITES list in the right column. The report will be available on the Tuba City Disposal Site page of the LM website under Site Documents and Links.

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Abbreviations

CFR	*Code of Federal Regulations*
DOE	U.S. Department of Energy
ft	feet
GCAP	Groundwater Compliance Action Plan
gpm	gallons per minute
lb	pounds
mg/L	milligrams per liter
NNEPA	Navajo Nation Environmental Protection Agency
TDS	total dissolved solids

Executive Summary

This report evaluates the progress of groundwater remediation at the U.S. Department of Energy (DOE) Office of Legacy Management Tuba City, Arizona, Disposal Site for the period April 2012 through March 2013, and cumulatively since the start of remediation in 2002. The progress of water quality restoration is evaluated and reported annually.

The site is within the Navajo Nation and near Hopi Reservation land. A uranium-ore processing mill operated at the site from 1956 until 1966. DOE conducted surface remedial actions, consisting of encapsulating all solid waste within an onsite engineered disposal cell, between 1988 and 1990. A remnant plume of groundwater contamination, presumed to have originated from process water stored in solar evaporation ponds and slurry-impounded tailings during mill operation, extends beneath and off the site approximately 1,500 feet to the south and southeast in the underlying sandstone aquifer.

The primary contaminants in the groundwater are nitrate, sulfate, and uranium. DOE constructed a pump-and-treat remediation system, operational by mid-2002, to remove these and other site-related contaminants from the aquifer with the objective of achieving water quality restoration targets established in the Groundwater Compliance Action Plan (GCAP; DOE 1999). The GCAP indicated that removal of two pore volumes of groundwater within the contaminant plume, over 20 years of active remediation, would possibly suffice to meet those goals. The GCAP also identified potential limitations to pump-and-treat technology.

The year in summary finds that:

- Maintenance and upgrades led to numerous unplanned shutdowns of the treatment system. Shutdown durations were days to several months. The treatment system was operational for 112 days throughout the review period for an on-stream factor of 31 percent.
- Approximately 14 million gallons of contaminated groundwater were extracted from the aquifer and treated during the period. This compares to about 40 million gallons annual production in years of normal plant operation.
- When fully operational, the extraction system captures the areal extent of maximum groundwater contamination and the full vertical extent to meet design objectives.
- When fully operational, the treatment system achieves design criteria for rate of groundwater extraction and treatment, for distillate quality, and for treatment efficiency (minimal brine-waste production). The infiltration trench is accepting treated groundwater (distillate) without excessive mounding.
- Plume expansion into uncontaminated regions of the aquifer is not evident.
- Consistent with previous annual reporting, after more than 10 years of operation, significant and widespread decreases in contaminant concentrations in groundwater are not apparent. This is despite measureable progress in groundwater treatment, as indicated by the cumulative volume of contaminated groundwater and the cumulative mass of contaminant extracted from the aquifer to date.

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1.0 Introduction

1.1 Background Information

This report evaluates the progress of groundwater remediation at the U.S. Department of Energy (DOE) Office of Legacy Management (LM) Tuba City, Arizona, Disposal Site for the period April 2012 through March 2013, as well as cumulatively since the start of remediation in 2002. The progress of water quality restoration is evaluated and reported annually.

The site is located near Tuba City, Arizona, within the Navajo Nation and near Hopi Reservation land (Figure 1). A uranium-ore processing mill operated at the site from 1956 until 1966. DOE conducted surface remedial actions, consisting of encapsulating all solid waste within an onsite engineered disposal cell, between 1988 and 1990. A remnant plume of groundwater contamination, presumed to have originated from process water stored in solar evaporation ponds and slurry-impounded tailings during mill operation, extends beneath and off the site approximately 1,500 feet (ft) to the south and southeast in the underlying sandstone aquifer.

The primary contaminants in the groundwater are nitrate, sulfate, and uranium. DOE constructed a pump-and-treat remediation system, operational by mid-2002, to remove these and other site-related contaminants from the aquifer with the objective of meeting water quality restoration goals established in the Groundwater Compliance Action Plan (GCAP; DOE 1999; also see Section 1.3 of this report). The GCAP did not define a specific duration of active groundwater remediation to meet those goals; however, the GCAP states that extraction of two pore volumes from the uranium plume could reasonably be expected to restore the aquifer to the established remediation targets.

1.2 Groundwater Remediation System

The groundwater remediation system currently comprises 37 extraction wells completed within the contaminated region of the aquifer. Numerous monitoring wells that are used to track water quality and water level trends are situated within and surrounding the network of extraction wells. Figures 2a through 2c depict the locations of extraction and monitoring wells and the primary features of the site. Figure 2a shows all well locations, Figure 2b shows extraction wells only, and Figure 2c shows monitoring wells only. (These figures may be referred to collectively as Figure 2 in this report.) Figure 3 shows an aerial view of the site, identifying all Tuba City site sample locations and associated sampling frequencies. Corresponding well completion information is provided in Appendix A in tabular and schematic form.

Groundwater extracted from the 37 wells shown in Figure 2b is conveyed in underground piping to an onsite treatment plant, where it is distilled following ion exchange pretreatment to reduce mineral precipitation during the distillation process. The operating capacity of the treatment system is approximately 100 to 120 gallons per minute (gpm). A lined solar evaporation pond receives the waste liquid (brine) and the softener regeneration waste. An infiltration trench located upgradient of the contaminant plume and the onsite disposal cell receives the treated water (distillate), where it is returned to the aquifer. Figure 2 shows the location of the infiltration trench and associated treatment system features.

Six injection wells (wells 1003 through 1008; Figure 2a) were originally installed downgradient of the contaminant plume to receive a portion of the treated water (distillate) and create a hydraulic barrier to further downgradient movement of the contaminant plume. The injection wells remain unused for that purpose because contamination does not extend to the area of those wells and plume movement toward those wells is not observed.

Figures 2 and 3 include the locations of monitoring wells installed by the Navajo Nation Environmental Protection Agency (NNEPA) in September 2010 (iiná bá 2011) to further assess water quality and flow direction in the west and north-northwest areas of the site. The NNEPA wells are identified by the NMW prefix. LM continues to monitor water quality and measure water levels at the NNEPA wells. Monitoring results for those wells are included in the analysis of groundwater contamination extent and groundwater flow direction presented in Section 3.0 of this report.

1.2.1 Groundwater Extraction Well Details

In Figures 2a and 2b, the extraction wells labeled 1101 to 1125, installed in 1999, are constructed of 6-inch-diameter Schedule 40 PVC solid casing and 6-inch, continuous V-wrap stainless-steel screen (0.017-inch slot). A filter pack of 20–40 mesh silica sand fills the 2-inch annulus to 30 or 40 ft above the screen. Screen lengths are 150 ft, extending from the bottom half of Horizon B to the mid-depth of Horizon E, except for wells 1116, 1117, and 1118, which have 100 ft screens to a depth near the base of Horizon D.

Eight extraction wells, wells 1126 through 1133, were installed in fall 2004 to expand the capture zone of the original 25 wells (1101–1125). These more recently installed wells became operational in 2005 and are constructed of 4-inch-diameter casing. Each has a 30 ft to 50 ft screen that is placed across most of Horizon B. The extraction well pumps are generally positioned 10 to 15 ft above the bottom of the well.

Former monitoring wells 935, 936, 938, and 942 (4-inch diameter PVC wells) were converted to extraction wells in summer 2005. The pumps in these wells are at the bottom of the well because these wells are much shallower and so have much less potential drawdown. Refer to Appendix A for well completion details (Tables A-1 and A-2; Figure A-2).

1.2.2 Infiltration Trench Details

The infiltration trench is constructed into bedrock along the north side of the site, upgradient of the contaminant plume and the disposal cell (Figure 2). Distillate enters at the midpoint of the trench and flows toward each end in 8-inch diameter perforated pipe that is embedded in a 3 ft thick gravel pack. The trench is approximately 4 ft wide and extends to a depth of about 6 ft below ground surface. In-line valves allow regulation of flow to either end of the trench to optimally distribute the distillate in the trench. Monitoring wells 284 and 285 are paired with wells 946 and 943 (Figure 2c), respectively, to monitor water table conditions at the contact between the terrace deposits and the Navajo Sandstone immediately downgradient of the trench. Monitoring is also conducted at wells 686, 687, 688, and 945 to evaluate the effects of distillate infiltration on the water table and water quality near the trench.

1.3 Groundwater Compliance Strategy

The groundwater compliance strategy for the Tuba City site, as defined in the GCAP (DOE 1999), is to achieve applicable cleanup levels through active remediation of those portions of the aquifer affected by previous site activities. Cleanup levels for the aquifer consist of restoration standards (requirements of Title 40 *Code of Federal Regulations* Part 192 [40 CFR 192], "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings") and restoration goals (cleanup levels requested by the Navajo Nation but not required by 40 CFR 192).

Groundwater contaminants requiring active remediation at the site are molybdenum, nitrate, selenium, sulfate, and uranium (DOE 1999). The focus of the figures and data analyses presented in this report are nitrate, uranium, and sulfate because these contaminants are most widespread and contribute most to potential risk to human health. Restoration standards correspond to a maximum concentration limit in groundwater as established by Subpart A of 40 CFR 192. Sulfate is not regulated by 40 CFR 192; however, a restoration standard was adopted for sulfate because it is present in site groundwater at concentrations that could cause excess potential risk (DOE 1999). Groundwater remediation standards and goals for the site are presented in Table 1.

Table 1. Groundwater Remediation Standards and Goals

Constituent/Property	Cleanup Level	Baseline Concentrations in Plume
Nitrate[a] as NO_3	44 mg/L as NO_3	840–1,500 mg/L as NO_3
Molybdenum[a]	0.10 mg/L	0.01–0.58 mg/L
Selenium[a]	0.01 mg/L	0.01–0.10 mg/L
Uranium[a]	30 pCi/L (0.044 mg/L) U-234 + U-238	0.3–0.6 mg/L
Sulfate[a]	250 mg/L	1,700–3,500 mg/L
Total Dissolved Solids (TDS)[b]	500 mg/L	3,500–10,000 mg/L
Chloride[b]	250 mg/L	20–440 mg/L
pH[b]	6.5–8.5	6.3–7.6
Corrosivity[b]	not corrosive	not applicable

[a] Restoration standard
[b] Restoration goal
mg/L = milligrams per liter
pCi/L = picocuries per liter

Source: DOE 1999

1.4 Performance Monitoring and Reporting

The effectiveness of the remediation system in removing contaminants from the aquifer and progressing toward cleanup levels is evaluated yearly, mainly on the basis of groundwater monitoring conducted in August and February of each year. During these events, samples are collected at monitoring wells for water quality analysis, and water levels are measured. The data are then compared to baseline conditions determined between 1998 and March 2002 (DOE 2003) to evaluate the capture zone of the extraction system, to evaluate plume movement within the aquifer, and to evaluate contaminant removal rates and concentration trends.

Extraction wells are also sampled during the August event, as are several distal monitoring wells that have no history of contamination. Other information used in evaluating the effectiveness of the groundwater remediation system includes treatment plant operations data,

such as (1) flow metering for each extraction well, (2) flow metering of the bulk influent to the treatment plant, (3) flow metering of the separate outflow streams, (4) approximately weekly chemical analysis of the treatment system influent (bulk groundwater feed) and effluent (distillate and brine waste), and (5) approximately monthly chemical analysis of groundwater composition at each extraction well.

1.5 Hydrogeologic Setting

1.5.1 Site Conceptual Model and Groundwater Flow

The Tuba City site lies on the middle of three alluvial terraces formed during ancestral flow in Moenkopi Wash; the wash is located about 1.5 miles southeast of the former processing site (Figures 2 and 3). The terraces are composed of thin (≤20 ft) surface deposits of coarse, indurated, Quaternary alluvium. Loose, modern dune sand and silt mantle the terraces at most locations. Sandstone bedrock is exposed at ground surface on the middle terrace at some locations. The terrace and dune deposits unconformably overlie the regionally extensive Navajo Sandstone, a massively cross-bedded, friable, fine-grained to very fine-grained sandstone and siltstone of Jurassic age deposited in an arid dune complex or erg. Escarpments that separate the terraces are formed by cliffs of the Navajo Sandstone. The regional dip of the bedrock is about 1 degree to the northeast.

At about 200 ft below ground, the massive eolian dune deposits typifying "classic" Navajo Sandstone become interbedded with fine-grained alluvium more typical of the deeper Kayenta Formation. This "intertonguing interval," reflecting a transition to a more fluvial setting, is 400 to 450 ft thick. Occasional thin (≤2 ft), resistant limestone beds, which are interpreted as deposits from former inter-dune playa lakes, are interspersed, though laterally discontinuous, throughout both the classic and intertonguing intervals. The Kayenta Formation consists primarily of 100 ft or more of less-resistant, thin-bedded, red silt and fine sand and lacks the characteristic cross-beds of the Navajo Sandstone. Figure A-1 in Appendix A depicts a conceptual model of the site hydrogeology to illustrate the relationship of surface topography, subsurface geology, and groundwater flow.

Groundwater beneath the Tuba City site occurs in the regionally extensive "N" multiple-aquifer (Cooley et al. 1969), which in the site area comprises the classic and intertonguing intervals of the Navajo Sandstone. Because of the fine-grained composition of the Kayenta Formation locally, it is not water bearing and is considered the base of the N-aquifer in the site area. The local water table occurs within the Navajo Sandstone; the terrace and dune deposits in the site area are not saturated. Groundwater saturation extends from the water table, about 50 to 60 ft below ground surface on the upper and middle terraces, to the contact with the Kayenta Formation, accounting for a saturated thickness on the order of 500 ft.

Except for the local effects of groundwater withdrawal at the site, groundwater flow is generally south to Moenkopi Wash. At Moenkopi Wash, the Navajo Sandstone is fully penetrated and regional aquifer discharge occurs, expressed as a laterally extensive (10–20 miles) spring zone near the exposed base of the intertonguing interval. Local discharge of groundwater from higher in the formation occurs in some areas, as evidenced by scattered bands of desert phreatophytes that typically occur near the base of the escarpment between the middle and lower terraces. One such area is noted in Figures 2 and 3 as the "greasewood area," where the depth to water is

approximately 20 ft, coincident with the contact between terrace deposits and the upper, weathered bedrock surface.

1.5.2 Vertical Discretization of the N-Aquifer

In the absence of laterally continuous stratigraphic marker beds in the Navajo Sandstone, the subsurface at the site is discretized into 50 ft horizons, each with a letter designation. This designation provides a reference system for evaluating site hydrogeology and extent of contamination in the vertical dimension. Ground surface of the middle terrace, nominally 5,050 ft in elevation, marks the top of the uppermost horizon (Horizon A). Horizons A, B, C, and possibly D span the interval of classic Navajo Sandstone beneath the site. The depths of Horizons E through J vertically span the intertonguing interval. The stratigraphic relationships to aquifer horizons are shown in Figure A-1 of Appendix A.

Horizons K, L, and M include the lower intertonguing interval and possibly the upper portion of the Kayenta Formation. Because of surface topography, the uppermost horizon on the lower terrace progresses from Horizon C to D, north to south (see Figure A-1 of Appendix A). The steep topography at Moenkopi Wash intersects Horizons E through G. Contamination of the aquifer is limited in depth to Horizons A, B, and C; therefore, groundwater remediation at the site focuses primarily on the upper 150 ft of the bedrock aquifer. Groundwater flow and water level drawdown are affected in the deeper horizons by remedial actions and so continue to be monitored.

In Figure 2, color-coding identifies the corresponding horizon in which the midpoint of the well screen is located for extraction wells (round symbols) and monitoring wells (square symbols). Well screen depth in relation to aquifer horizon and elevation for all project wells is shown schematically in Figure A-2 of Appendix A. Tables A-1 and A-2 of Appendix A include additional well completion information such as screen length and screen intake elevations.

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2.0 Treatment System Operating Parameters

2.1 Operations History

Full-scale operation of the groundwater remediation system began in mid-2002 and continued through October 2010 with only minor, short-term interruption (scheduled maintenance and occasional power outages). Operation of the remediation system was suspended in October 2010 to allow upgrading and replacement of treatment system components. At that time, LM also updated the preventive maintenance program and operating procedures. The remediation system resumed operation in September 2011 but has since operated intermittently because of additional maintenance and system repairs and upgrades.

Figure 4 plots annual treatment (extraction, infiltration, and waste) volumes and net plant on-stream rates since the baseline period. Between 2002 and 2009, annual extraction volumes averaged about 40 million gallons. For the period 2009–2010, prior to plant refurbishment, the annual volume extracted was about 30 million gallons. Since then, due to the extended plant shutdown and the intermittent nature of subsequent operations, annual extraction volumes have ranged between 9 and 14 million gallons. Approximately 14 million gallons of contaminated groundwater was extracted from the aquifer during this (2012–2013) reporting period.

Figure 5 plots weekly extraction volumes for three periods: pre-plant shutdown (2003 through September 2010), the extended plant shutdown corresponding to treatment plant upgrades (October 2010 to September 2011), and the period since then. Non-operational periods are evident in Figure 5, including the more recent plant shutdown that extended from late October 2012 through late January 2013. The operating capacity of the treatment system is about 100 to 120 gpm, corresponding to a 1–1.2 million gallon weekly treatment plant capacity.

2.2 Bulk Treatment Parameters and Water Budget

The treatment plant operated for 112 of 365 total days[1] during the current review period (April 2012–March 2013), yielding an on-stream factor of 31 percent. Groundwater extraction occurred at various times during the period while the treatment system was not operating. The water extracted during those times was discharged directly to the solar evaporation pond. This response maintained a degree of remediation while the primary treatment process was in repair. Delivering the extract to the pond also served to prevent dust generation from the solid residue in the pond.

Approximately 13.9 million gallons of water were extracted and treated or placed in the evaporation pond during this period, resulting in a gross treatment rate by distillation and solar evaporation over the 365-day period of approximately 27 gpm. Extraction rates varied widely during the period, ranging between about 10 and 90 gpm (Figure 6).

About 9.2 million gallons (66 percent) of the total feed to the treatment system was returned to the aquifer at the infiltration trench. Treatment system wastewater sent to the evaporation pond normally comprises about 5 percent of the total inflow as brine and about 5 percent as loss

[1] This estimate only reflects those periods when the plant was in service and returning treated water to the aquifer. If the plant was operating for only a portion of the day—e.g., for 12 (vs. 24) hours—that was counted as 0.5 day.

for softener regeneration. Approximately 6 percent (approximately 850,000 gallons) of the feed water extracted during this period was added to the evaporation pond as brine from the treatment plant. Assuming approximately 5 percent loss from softener regeneration, approximately 23 percent (3.7 million gallons) of the extracted groundwater was discharged directly to the evaporation pond while the treatment plant was not in operation.

2.2.1 Extract Feed Rate

Figures 6 and 7 show the feed rate to the treatment plant and the corresponding concentration of nitrate, sulfate, and uranium determined from weekly composite samples since the start of remediation. These figures indicate that while the treatment plant is fully operational, the bulk extraction rate (represented by inflow), although at times highly variable week to week, is sustainable between about 80 and 100 gpm. This extraction rate matches well with the treatment capacity of the distillation process (up to approximately 120 gpm): the rate capacity of the treatment system meets or exceeds that of the extraction system.

The inflow rates plotted in Figures 6 and 7 have decreased over time from about 100 gpm to about 85 gpm while the system is in full operation. This apparent trend corresponds to progressive withdrawal of groundwater from aquifer storage (local dewatering). This expected outcome is also manifest by progressive water level drawdown within the zone of extraction at least until the plant shutdown in October 2010. Until that time, groundwater flow into and from the cone of depression had not reached steady state (outflow exceeded inflow).

2.2.2 Extract Composition and Contaminant Mass Removal

Nitrate concentrations in the bulk extract have remained relatively static at about 400 milligrams per liter (mg/L) throughout the remedial action, while sulfate concentrations have trended slightly upward from about 1,000 mg/L to about 1,250 mg/L. These findings may be due to the fact that nitrate contamination is more uniformly distributed than is sulfate.

Uranium concentrations in the bulk extract decreased from initial values of about 300–350 micrograms per liter (µg/L) to about 200 µg/L by 2008. This trend was followed by rising concentrations that are presently consistent with initial values. This trending parallels that of the bulk extraction rate. The trend of increasing uranium concentrations since 2008–2009 may reflect a rebound effect, whereby during this period of lower and often interrupted extraction, uranium transfer by desorption or from low to high conductivity zones occurs in greater proportion than during times of greater flow rates.

Extracted masses of nitrate, sulfate, and uranium, estimated from the weekly monitoring of bulk inflow to the treatment plant, were (rounded) 29,300 pounds (lb), 95,500 lb, and 26 lb, respectively (Table 2). These quantities are similar to those extracted during the previous reporting period (March 2011–April 2012). By comparison, these quantities are about 20 to 30 percent of the contaminant mass extracted during periods of normal, sustained plant operation.

Table 2. Treatment System Performance Summary, April 2012–March 2013

Contaminant	Mass Removed During Review Period (lb)	Typical Feed Concentration (mg/L)	Average Distillate Concentration (mg/L)	Range of Distillate Concentrations (mg/L)
Nitrate (as NO_3)	29,296	400	8.6	0.7–16.5
Sulfate	95,467	1,328	10.3	0.2–59.1
Uranium	25.5	0.36	0.03	0.002–0.053

Reporting period mean chloride and TDS in distillate: 14.8 and 90.7 mg/L, respectively.

2.3 Distillate Quality

Figures 8a and 8b plot average weekly concentrations of nitrate, sulfate, uranium, chloride, and total dissolved solids (TDS) in the distillate over time. As shown in Table 2, during this review period, nitrate concentrations in the distillate ranged from 0.7 to 16.5 mg/L (8.6 mg/L average), and sulfate concentrations ranged from 0.2 to 59.1 mg/L (10.3 mg/L average). Although the average uranium concentrations in the distillate was 0.03 mg/L, some measurements did exceed the 0.044 mg/L restoration standard (Figure 8b). These elevated distillate concentrations likely result from a brief period in early fall 2012 during which heat exchange elements within the distillation unit had partially deteriorated. These elements were replaced in November 2012, and distillate concentrations decreased significantly. These same elements required replacement several times previously, for example in May 2008, as noted in Figures 8a and 8b by the concentration peaks followed by abrupt decreases. Periodic replacement of the heat exchange elements, within which the vaporized groundwater feed is condensed to form the distillate, is an expected maintenance activity.

During this period, chloride concentrations in the distillate ranged from 1 to 43.8 mg/L (14.8 mg/L average), and TDS concentrations ranged from 10 to 180 mg/L (90.7 mg/L average).

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3.0 Groundwater Capture Analysis

3.1 Extent of Groundwater Contamination

The "a" series figures in Figures 9a through 17a illustrate the concentrations of nitrate (as NO_3), sulfate, and uranium in groundwater in the respective aquifer horizons before the start of remediation (baseline period). The "b" series figures in Figures 9b through 17b show contaminant distribution in August 2012 or February 2013 for the respective contaminant and aquifer horizon. Corresponding analytical results are tabulated in Appendix B for August 2012, February 2013, and the baseline period.[2] Most of the baseline period data are from sample collection in March 2002, but data for some locations are from 1999 or 2001.

In Figures 9 through 17, each well location sampled for the respective period is shown, but a concentration value is posted only when the applicable remediation goal or standard was exceeded. In comparing the "a" series figures (representing baseline conditions) with the "b" series counterparts (plotting the most recent results), the area of contamination in the various horizons does not appear significantly different from that established for baseline conditions, indicating no expansion (or shrinkage) of the contaminant plume. Section 4.0 provides additional information regarding contaminant concentration trends.

To complement Figures 9b through 17b, which display contaminant distributions as "spot plots," Figures C-1, C-2, and C-3 are provided in Appendix C to represent the distributions of nitrate, sulfate, and uranium during the current review period as plume maps using concentration contours. The contours were generated by computer interpolation of monitoring results focusing on Horizons A and B on the middle terrace and Horizons C and D on the lower terrace. These intervals were chosen because contamination is generally limited to those horizons beneath the respective terraces, and incorporating results from deeper horizons in the contouring analysis would distort the plume definition. Consistent with previous annual reporting, the plume geometry and, in general, the magnitude of contaminant concentrations have not changed significantly in response to the groundwater remedial action.

3.1.1 Extent of Contamination on Middle Terrace

Prior to and since groundwater treatment began, the vertical extent of groundwater contamination beneath the middle terrace was and is generally limited to Horizons A, B, and C. Except for nitrate and sulfate in lower terrace well 1003 (see discussion below), contamination of Horizon D is confined to the disposal cell and evaporation pond area where groundwater extraction is most focused (Figures 10b, 13b, and 16b). Apparent contamination in Horizon D at monitoring wells in these areas is generally limited to well 275 (Horizon D; installed in 2004), which is located within the area of greatest water table depression. Apparent contamination by nitrate, sulfate, and uranium at that location likely results from downward movement of contaminated groundwater from Horizons A and B and possibly C in response to groundwater withdrawal at nearby extraction wells. The nearby extraction wells have intakes 150 ft in length that span the lower half of Horizon B through most of Horizon E.

[2] Appendix B also documents analytical results for molybdenum and selenium, the two remaining contaminants of concern listed in Table 1. Remediation of molybdenum and selenium is not addressed in this report because the magnitude and extent of contamination from these constituents is low relative to that of the primary contaminants (nitrate, sulfate, and uranium).

Elevated concentrations of nitrate, sulfate, and uranium observed at the extraction wells in these areas (Figures 10b, 13b, and 16b) are not interpreted to represent widespread contamination of groundwater at the depths of Horizons C and D. This is because, except for well 275, water quality analyses for local monitoring wells screened in those depths indicate that the groundwater is not contaminated. Instead, samples collected at the extraction wells (well intakes centered in Horizon C or D) are a blend of contaminated groundwater drawn downward from the upper horizons and uncontaminated water from the lower horizons.

Contamination in Horizon E (see Figures 11b, 14b, and 17b) beneath the middle terrace remains limited to the location of well 268. Contamination was absent at that location through 2004. Nitrate concentrations subsequently rose and stabilized at about 20 mg/L (as NO_3) for several years before sharply rising to the present value of 177 mg/L. Sulfate and uranium concentrations over time show a pattern similar to that of nitrate, such that each presently exceeds, although only marginally, the respective remediation target (approximately 360 mg/L sulfate and 0.082 mg/L uranium, February 2013).[3] These increases are anomalous because significant plume migration deep into the aquifer at this single location over a short time relative to preceding decades of plume development is unlikely. Alternatively, these increases are not a concentration rebound effect, because baseline values are low and consistent with background concentrations. Instead, a compromised annular seal is suspected that would allow downward movement of contaminated water from Horizons A and B into the well intake. Except for well 268, contamination is absent in the deeper horizons (Horizons F, G, and I) beneath the middle terrace.

Figure 18 shows the distribution of uranium at all monitoring wells and all horizons for the period July 2012 through February 2013. (Extraction wells are excluded given the well density at the site.) As shown in this figure and the preceding horizon-specific spot plots (Figures 17a through 17c), the depth of groundwater contamination is generally limited to Horizons A, B, and C beneath the middle terrace. Contamination of Horizon D is limited to the areas nearest the disposal cell and evaporation pond where groundwater extraction is most focused. Apparent contamination in Horizon D in these areas may be the effect of downward movement of groundwater from upper horizons induced by groundwater withdrawal at nearby extraction wells. Uranium concentrations below Horizon D are less than the 0.044 mg/L restoration standard, as are uranium concentrations in groundwater underlying the lower terrace. As of February 2013, uranium was detected above the remediation standard on the lower terrace only at well location 691 (0.08 mg/L).

3.1.2 Extent of Contamination on Lower Terrace

Groundwater contamination beneath the lower terrace is also generally absent—with few exceptions, constituent concentrations are still below remediation goals (as was the case for baseline conditions; see "a" series figures). However, nitrate continues to exceed the 44 mg/L (as NO_3) restoration standard at several locations—at Horizon C wells 903 (75 mg/L), 930 (110 mg/L), and more significantly at Horizon C well 691 (320 mg/L) and paired (Horizon D) well 1003 (310 mg/L; Figure 10b). These paired wells (wells 691 and 1003) are the only locations on the lower terrace where the 250 mg/L sulfate restoration goal has been and is presently exceeded (530 and 640 mg/L, respectively; Figure 13b).

[3] For additional information, refer to Section 4.1, "Contaminant Concentration Trends at Monitoring Wells," and Appendix E, Figures E-13 through E-15.

Historically, uranium has exceeded the 0.044 mg/L restoration standard on the lower terrace only at well 691. Concentrations of 0.056 and 0.077 mg/L uranium were measured, respectively, in the August 2012 and February 2013 samples (Figure 16b shows the most recent snapshot). Figure E-12 in Appendix E shows a very sensitive response to groundwater withdrawals in reducing uranium concentration at well 691 to about 0.015 mg/L (2005 to 2009) and in the subsequent concentration rebound to baseline values since about 2009 when treatment plant shutdowns became more frequent. Nitrate and sulfate concentrations at that location exhibit a pattern identical to that of uranium. Drawdowns in the area encompassing well 691 are relatively large in response to groundwater withdrawal from the extraction wells (see Section 4.1 for additional trending information). The coincidence of relatively large drawdowns and the isolated occurrence of contaminated groundwater at well 691 may imply a hydraulic connection to the disposal cell area by way of a fracture zone.

3.1.3 NNEPA Investigation

Conclusions drawn above regarding contaminant plume containment and geometry were confirmed in an independent investigation conducted by NNEPA in 2010 (iiná bá 2011). In cooperation with LM, NNEPA installed nine groundwater monitoring wells (shallow and deep) into the aquifer west and north of the site in fall 2010. Locations are shown in Figure 2c and Figure 3. These wells were first sampled by iiná bá in December 2010 and February 2011. Since then, LM has sampled the wells in February 2011 and 2012 and, for this reporting period, in both August 2012 and February 2013. Five of the NNEPA wells—NMW-1A, -6S, -7D, -8S, and -9D—are located adjacent to the site to the west (Figure 3). Background conditions were confirmed at northernmost wells NMW-2A, -3A, and -4A, indicating no adverse impacts to groundwater to the north of the LM site. The combined results of NNEPA's and LM's previous sampling efforts indicate that no site-related contaminants exceeded respective 40 CFR 192 maximum concentration limits or NNEPA aquifer restoration goals, and that water quality at those locations is consistent with background conditions (e.g., see DOE 2011).

Monitoring results for NNEPA wells NMW-1A, -6S, -7D, -8S, and -9D (west of the site) for the current reporting period (April 2012 through March 2013) are consistent with previous results for those locations, confirming closure of the western margin of the contaminant plumes. LM also continues to monitor water quality at NMW-2A, -3A, and -4A (north of the disposal site). Monitoring results for the current review period confirm that background conditions prevail to the north of the site.

The ninth well installed during the 2010 NNEPA investigation (well NMW-5) is located several miles west of the LM site (location shown in Figure 3). That well was installed for a monitoring objective of NNEPA that is not related to the LM site. Monitoring results for that well indicate nitrate, sulfate, and uranium concentrations are well below the respective water quality target established for the LM site. Of note is that, of all NNEPA wells, uranium concentrations have been highest in this most distal well. Whereas uranium concentrations in NNEPA wells adjacent to the site have been about 0.001 to 0.002 mg/L, levels measured in NMW-5 have been about 0.005 mg/L.

3.1.4 Surface Water Quality

Groundwater discharge from the Navajo Sandstone aquifer is the primary source of baseflow in Moenkopi Wash. Ongoing water quality monitoring by LM of groundwater seepage to the wash at the locations shown in Figure 3 indicates that the water is not contaminated by site-related constituents. The contaminant plume associated with past site activities terminates more than 1 mile upgradient of the surface water sampling locations at Moenkopi Wash. Additional presentation of surface water monitoring results is therefore not warranted in this report, which instead focuses on the progress of aquifer restoration. Complete water quality data for surface water monitoring is provided in the data validation reports.

3.1.5 Data Validation Reports

LM prepares data validation reports following each sampling event as a quality control measure to ensure that water quality samples are collected, analyzed, and reported in accordance with LM and contract laboratory protocol (e.g., see DOE 2012; DOE 2013). Although those reports include time-trend graphs for all surface water and groundwater samples collected under the Sampling and Analysis Plan for the site, they provide no interpretive information regarding site hydrogeology and do not evaluate the progress of the groundwater remedial action.

3.2 Water Table Configuration

3.2.1 Water Table Contours

Figure 19 shows the estimated water table for the baseline period (August 2001) using water levels in Horizons A and B monitoring wells for the middle terrace and Horizon C wells for the lower terrace. On the middle terrace, water levels at deeper wells are not representative of water table conditions because of pronounced vertical hydraulic gradients (see Section 3.5) and so are not appropriate for constructing a water table map. On the lower terrace, the water table occurs within Horizon C nearest the escarpment and progresses to deeper horizons, mimicking surface topography eastward. The water table contours depicted in Figure 19 imply that the horizontal direction of groundwater flow was predominantly south during the baseline period. A steeper hydraulic gradient at the escarpment (Figure 19), separating the middle and lower terraces, also mimics surface topography.

Figure 20 shows the estimated water table for February 2013. The monitoring wells and corresponding water table elevations used to generate the water table contours are identified in the figure. In previous annual reports, prior to the interruption of active groundwater treatment in October 2010, comparison of Figures 19 and 20 indicated that operation of the extraction wells had depressed the water table by up to several tens of feet within the central regions of extraction to the south and east of the disposal cell. The implied direction of groundwater flow was inward to the extraction wells, encompassing a large areal extent of the contaminant plume. Discharge of distillate to the infiltration trench accounted for as much as 25 ft of groundwater mounding along the axis of the trench.

The February 2013 (Figure 20) water table depicts an instantaneous view of groundwater flow conditions during a transitory period of treatment system operation beginning in October 2010 and continuing through the current reporting period (April 2012 through March 2013). Groundwater flow directions appear to vary considerably on a local scale within and near the extraction wells. Flow gradients continue to indicate southerly flow toward Moenkopi Wash with distance from the extraction wells. Additional information regarding aquifer response during these periods of suspended or intermittent operation of the remediation system follows in Section 3.3 of this report.

3.2.2 Groundwater Flow West of the Disposal Cell

The February 2013 water table depicted in Figure 20 includes data obtained at eight monitoring wells installed to the north and west of the disposal cell by NNEPA in September 2010. These wells were installed because of NNEPA concern that monitoring did not fully characterize the direction of groundwater flow and the extent of groundwater contamination west of the disposal cell. Water level data obtained from these wells indicates a southerly to southeast flow direction. These results, in addition to those obtained for water quality analyses (see Section 3.1), dispelled concerns of extended contaminant migration to the west from the disposal cell.

3.2.3 Water Table at Alluvium/Navajo Sandstone Contact at Infiltration Trench

Monitoring wells 0284 and 0285 are paired with wells 0946 and 0943, respectively, to monitor water table conditions at the contact between terrace alluvium and the Navajo Sandstone immediately downgradient of the infiltration trench (see Figure 2b for well and trench locations). Wells 0284 and 0285, screened across the alluvium–sandstone contact, have remained dry since installation in 2004, indicating that groundwater mounding has not over-topped the trench to saturate the overlying alluvium.

The water table before groundwater treatment was suspended was closest to the alluvium–sandstone contact at well 946, rising to within about 6 ft of the contact in late 2007. The water table elevation at this location has since decreased by about 20 ft since October 2010. Water level hydrographs for wells completed in the aquifer in the area of the trench are presented as Figure D-1 in Appendix D. This graph indicates that the water table near the infiltration trench has responded uniformly to the transient stresses posed by cessation and subsequent intermittent operation of the remediation system. This graph also indicates that the large-scale fluctuations of the water table observed historically near the infiltration trench are not related to background conditions, as characterized by relatively static water levels (although on a slightly increasing trend) observed at wells 901, 910, and 947.

3.3 Aquifer Response to Groundwater Extraction and Distillate Infiltration

Figure 21 illustrates the effect of groundwater extraction and infiltration by showing the difference in water levels in Horizons A and B between the baseline period and February 2013. Figures 22 and 23 plot the water level differences between the same periods for the deeper horizons. Positive values identify locations where the water level in February 2013 is less than the baseline value. Negative values, such as those at the wells surrounding the infiltration trench (Figure 21), indicate that water levels at the respective locations are presently higher than during the baseline period.

3.3.1 Radial Groundwater Flow Pattern

Prior to October 2010 when active treatment was suspended, and as presented in previous annual reports, the pattern of water level drawdown in the area of groundwater extraction reflected three-dimensional converging flow to the extraction wells: the greatest drawdown (as much as 70 ft, Horizon E) was observed at the monitoring wells nearest to the extraction well intakes, both horizontally and vertically. That pattern is also apparent in Figures 21 through 23 for February 2013, although the effect is less pronounced and less well developed because of the recent history of suspended or intermittent groundwater extraction.

3.3.2 Water Level Drawdown at Distance

The drawdown data for February 2013, and as presented in previous annual reports, indicate significant water level drawdown at great distance from the extraction wells. For example, drawdowns of 6 to 7 ft are indicated at several lower terrace wells (Figure 21) at distances of 500 to 1,000 ft from the nearest extraction well. Greater drawdowns were recorded at these locations before the interruption of groundwater extraction. The pattern of large drawdowns extending over these distances at a relatively low extraction rate suggests an aquifer with properties of low hydraulic conductivity and low storage capacity.

3.3.3 Capture Zone Stability

Well hydrographs provided in Appendix D depict water level variation over time at selected monitoring wells. These hydrographs indicate that, since the start of groundwater remediation and through 2008, the predominantly downward trend in groundwater levels indicated an expanding groundwater capture zone (or cone of depression), particularly in the shallow horizons (for example, see Figures D-2 and D-3). Subsequent water level increases through most of 2011 demonstrate aquifer response to the increased frequency of operational shutdown period or complete system shutdown (October 2010 through September 2011) for system repairs (e.g., see Figure 5). Large variations since operation resumed in September 2011 reflect aquifer response to intermittent plant operation.

3.3.4 Water Level Drawdown and Recovery

Between October 2010 and late 2011 when the treatment system was not in operation, the water table in the areas of maximum drawdown recovered by 10 to 20 ft, or approximately by 50 percent of the drawdown observed during peak operation of the plant. Water level recovery during and since that time may be augmented several feet by a regional rise in the water table as indicated at background monitoring wells 901, 910, and 947 (Figure D-1). Water level response since intermittent operation began in late 2011 has been highly variable and location specific. A general observation is that water level drawdown and recovery rates are most rapid within the central portion of the cone of depression and decrease with distance outward from the extraction wells. No other attempt is made to correlate aquifer response by location for the period of intermittent operation.

3.3.5 Water Table at Infiltration Trench

Disposal of treatment plant distillate to the infiltration trench raised the local water table by as much as approximately 25 ft during full-scale plant operation. This effect resulted in a symmetrical, elongate, east-northeast-trending groundwater mound along the axis of the trench. The latest depiction of the fully developed groundwater mound along the infiltration trench during full-scale operation of the treatment plant is shown in Figure 16 of the April 2009–March 2010 Annual Groundwater Report (DOE 2010; the reporting period for that report was through March 2010; full-scale treatment was interrupted in October 2010). The groundwater mound was observed to diminish by about 5 to 10 ft in elevation while the remediation system was not operating. The mound has continued to dissipate by several feet since October 2011, when intermittent operation resumed.

3.4 Horizontal Capture

Figure 24 depicts the estimated zone of groundwater capture in lateral extent in Horizons A and B, where the bulk of contamination resides. In this figure, which was generated using groundwater elevation data obtained before the remediation system was shut down in October 2010, all groundwater within the blue line (the inner line), the approximate extent of plume capture, is predicted to flow to an extraction well. This prediction is based on slope analysis of the water table using the computer program SURFER, a grid-based interpolation and contouring application for irregularly spaced three-dimensional data. The capture line (inner line) in Figure 24 corresponds to the division between the vectors that converge inward to the extraction wells and those that do not. Extrapolated to field conditions, the capture line represents a groundwater flow divide: water within the line flows to an extraction well; water outside the line escapes capture, although the direction of flow may be locally altered.

The slope analysis of the 2010 water level data indicated that the full width of the contaminant plume along the south edge of the disposal cell was within the capture zone, suggesting that flow of contaminated groundwater from the site was eliminated by the remediation system. The capture zone encompasses the region of greatest contamination; however, the area encompassing extraction wells 1126 through 1129 apparently escapes capture (the outer line in Figure 24 represents the approximate extent of groundwater contamination in map view). As reported in 2010 and previously, water level drawdown in this area is significant and was increasing before the remediation system was shut down (Figures D-4, D-5, and D-6 in Appendix D). Contamination in this area is limited in vertical extent to Horizons A and B and is generally at lower concentrations than within the primary capture zone shown in Figure 24.

The capture analysis was completed using the 2010 data to illustrate the capture zone during full and sustained operation of the treatment system. Cessation of groundwater extraction and treatment beginning in October 2010 and intermittent operations since September 2011 is not expected to have significantly compromised plume management. This is because (1) the plume developed over a long period (decades) relative to the shutdown period (1 year); (2) the plume presumably developed under an artificial, exaggerated hydraulic driving force that is now absent (recharge by infiltration of contaminated process water); (3) the low hydraulic conductivity of the aquifer does not promote rapid groundwater movement; (4) significant residual drawdown remained in the plume capture area, allowing water to return to storage rather than flow farther

downgradient; and (5) downgradient plume movement is not apparent in the subsequent monitoring data.

3.5 Vertical Capture

Hydrographs included in Appendix D for selected sets of co-located monitoring wells illustrate that, at a given location, the hydraulic head in the aquifer is a function of well-intake depth. This relationship, whereby the hydraulic head measurably differs in adjacent wells screened at different depths, identifies vertical flow components throughout the monitored thickness of the aquifer, both before and since the start of groundwater remediation. As in the horizontal plane, the potential for vertical groundwater flow is directed from high to low hydraulic head.

With few exceptions, vertical flow potentials during the baseline period were downward throughout the monitored thickness of the aquifer. Since that time (about mid-2002), and until remediation was suspended in October 2010, the magnitude of downward flow in Horizons A, B, and C generally increased, as exemplified by the greater vertical separation in the hydrographs for the respective locations of well pairs 263/264, 265/266, 909/932, and 908/912 (see Figures D-4 through D-7 in Appendix D). In the main region of contamination, the increased gradients during active remediation imply capture of groundwater from the upper, most-contaminated horizons of the aquifer (Horizons A, B, and C).

Relative to the baseline condition, groundwater extraction has generally induced upward vertical gradients from the deeper horizons to the extraction well intakes. For example, the vertical flow potentials reversed to upward between Horizons M, I, and E at co-located wells 268/256/257 (Figure D-8; wells 256 and 257 were decommissioned in August 2005). A similar trend for Horizons E and I is apparent at the location of wells 251/252 (see Figure D-9) until active remediation was suspended in October 2010, at which time the gradient direction reverted to pre-remediation conditions. Flow reversal generally did not occur in response to groundwater extraction at co-located wells 948 (Horizon B), 912 (Horizon C), and 913 (Horizon G), where the flow gradient is predominantly downward (Figure D-7). Horizon C at this location (well 912) contains minor sulfate and nitrate contamination (uranium contamination is not present); however, the deeper well (913) remains uncontaminated.

A downward flow potential was present between Horizon I and M into 2005 at paired wells 254/255 (Figure D-10; wells 254 and 255 were co-located with well 941 [Horizon B] until decommissioned in August 2005). Groundwater elevation data for well 273, installed in August 2004 near the location of former wells 254 and 255, imply vertically upward flow from Horizon I to D (Figure D-10). Groundwater extraction has reduced but not reversed the downward flow gradient between Horizons D and G at wells 915 and 916 (Figure D-11). However, because this region of the aquifer is not contaminated, a downward flow potential is presently of no concern as a path for contaminant migration.

Flow potentials in lower terrace groundwater were downward, extending possibly through Horizon I, during and since the baseline period, as exemplified at the lower terrace well cluster identified in Figure D-12. At that location, groundwater extraction resulted in increasing the downward hydraulic gradient between Horizons C and E and decreasing the potential between Horizons E and I (Figure D-12), owing to the greater water level drawdown in Horizon E (well 920). Despite the predominant downward flow potential on the lower terrace, with and

without groundwater extraction, the slight amount of contamination in lower terrace groundwater has been and remains limited primarily to Horizon C. Deeper groundwater horizons do not appear to be at risk of contamination.

Although flow potentials were predominantly downward throughout the entire monitored thickness of the aquifer during the baseline period, and presumably during the time of plume development, groundwater contamination was and remains generally limited to about the upper 100 to 150 ft of the aquifer. Because the observed vertical influence of the extraction wells extends deeper than the presumed depth of contamination, it is likely that the remediation system captures the full vertical extent of the contaminant plume.

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4.0 Remediation Progress

Remediation progress is assessed in the following sections by (1) evaluating time trending of contaminant concentrations toward meeting established remediation goals (Sections 4.1 and 4.2), and (2) evaluating the cumulative removal of contaminant mass from the aquifer (Section 4.3).

4.1 Contaminant Concentration Trends at Monitoring Wells

Appendix E contains time-series graphs of nitrate (Figure E-1), sulfate (Figure E-2), and uranium (Figure E-3) concentrations in groundwater at selected monitoring wells located throughout the project area. In each figure, the data are plotted only for monitoring wells completed in Horizons A and B, the corresponding depths at which the bulk of the contamination is thought to reside.

Middle Terrace Horizon A and B Monitoring Wells

A visual, qualitative examination of these time-series plots may suggest that although contaminant concentrations can fluctuate widely at a given monitoring well, uniform trending, particularly in a downward direction, is not apparent for these analytes. Instead, contaminant concentrations are seen to increase, decrease, or remain static over time at concentrations that in many cases are well above the respective remediation goal. Persistent and widespread contaminant trending, upward or downward, is not evident for the major contaminants.

Groundwater monitoring is conducted at the site with the use of dedicated sampling pumps and strict purge criteria. Therefore, the observed concentration fluctuations are less likely related to a sampling procedural bias than to the possibility of variable, non-steady groundwater movement in response to non-uniform pumping rates among the extraction wells (ranging between approximately 0.1 to 5 gpm) and non-uniform distribution of contamination in the aquifer.

Sentinel Monitoring Wells: Middle and Lower Terrace

Horizon A, B, and C wells 271, 683, 684, 914, and 929 are located beyond but near the downgradient or crossgradient extent of contamination (Figure 2). At these "sentinel" wells, groundwater has generally not been contaminated since monitoring began in 1999 (Figures E-4 through E-6). For this annual report, three new wells have been added to the previous sentinel well network: wells 689 and 692 (Horizons C and D), located on the lower terrace and upgradient of the greasewood area, and NMW-1A (Horizon B), which bounds the site to the west. As shown in Figures E-4 through E-6, contamination is absent at all sentinel wells except well 929, where minor nitrate contamination of about 1.5 to 2 times the remediation target remains. Nitrate levels in this well continue to vary widely (Figure E-4). The general and continued absence of contamination at the sentinel wells indicates that migration of the contaminant plume to the respective locations is not significant.

Middle Terrace Horizon C and D Monitoring Wells

On the middle terrace, contaminant concentrations remain generally stable and below remediation standards in most Horizon C and D wells (Figures E-7 through E-9; see Figure 2b for monitoring well locations). Exceptions are those wells located along the disposal cell or site boundary—wells 251, 268, 273, 289, and 912—within the denser portion of the extraction well network. This distribution over time indicates that the plume is not expanding southward at the corresponding depths of Horizons C and D in the aquifer. In Figures E-7 and E-8, historically

elevated nitrate and sulfate concentrations at well 912 (Horizon C) appeared to be trending downward over time (between 2002 and 2006) but have risen slightly since then. Uranium concentrations, although still below the 0.044 mg/L restoration standard, parallel this trend, as shown in Figure E-9.

Lower Terrace Monitoring Wells

Figures E-10 through E-12 show time-series plots for nitrate, sulfate, and uranium for selected lower terrace monitoring wells. As discussed in Section 3.1 (also refer to graduated symbol plots, Figures 9 through 17), groundwater contamination beneath the lower terrace is limited in lateral and vertical extent, and where present is of relatively low magnitude. That is, with the exception of paired wells 691 and 1003 (latest results are 320 and 310 mg/L), nitrate exceeds the 44 mg/L remediation standard only slightly, and only in a few wells. Nitrate concentrations are observed to have fluctuated widely between 2003 and 2009 at this location (Figure E-10), for which a cause has not been determined.

Sulfate and uranium contamination is absent in lower terrace wells except at wells 691 (Horizon C) and paired well 1003 (Horizon D). Similar to nitrate, concentrations of sulfate and uranium at this location show a similar behavior whereby a large decrease in concentration occurred between about 2003 through 2007, followed by steep increases to approach pre-2003 levels. Contaminant concentrations measured in these wells, although historically highly variable, have increased markedly since 2009. The most recent (February 2013) uranium result for well 691, 0.077 mg/L, is the historical maximum.

As discussed in Section 3.1.2, drawdowns in the area of wells 691 and 1003 in response to groundwater remediation withdrawals are relatively large at such distance from the extraction wells. This may imply a very low storage capacity of the aquifer and, given the isolated occurrence of contamination, the possibility of fracture-dominated flow with a general north to south orientation in this region and connection to the disposal cell area.

Monitoring Wells Completed Below Horizon D

Figures E-13 through E-15 (Appendix E) show that contaminant concentrations at monitoring wells screened below Horizon D on both the middle and lower terrace remain stable and below remediation standards except at well 268. This Horizon E well is located just south of the evaporation pond within the prominent drawdown cone created by the extraction well withdrawals (see Figure 20 for water table configuration and Figure 23 for computed drawdowns in map view). At this well, contaminant concentrations increased between 2004 and 2006, remained stable until August 2011, but then increased markedly based on the 2012–2013 sampling results. The most recent nitrate, sulfate, and uranium (177, 360, and 0.082 mg/L) concentrations exceed respective remediation standards. As discussed in Section 3.1, these recent increases are not attributed to concentration rebound that could occur in response to intermittent operation of the treatment plant. This is primarily because the magnitude of the rebound would far surpass all previous concentrations measured at this location. Rather, a compromised annular seal is suspected that would allow downward movement of contaminated water from Horizons A and B into the well intake.

4.1.1 Mann-Kendall Trend Analysis

To buttress this analysis, contamination trends were evaluated statistically for all monitoring wells using the Mann-Kendall test (see Gilbert 1987). This test, a nonparametric test in that it does not depend upon the underlying distribution of data, is used to determine if an upward trend, a downward trend, or no trend exists.[4] Although Mann-Kendall tests were run on nitrate and sulfate as well (generally confirming the absence of consistent trending for these constituents), this discussion, and the associated data presentation, focuses on uranium because it is likely to be the most limiting constituent at the site from a groundwater remediation standpoint.

Tables 3 and 4 document the trend analysis results for uranium for middle terrace wells. In Table 3, Horizons A and B wells are distinguished by spatial region (e.g., wells at or near the site boundary versus distal wells). Results in Table 4 are also segregated by spatial region or depth horizon. These tables also include summary statistics and graphical summaries (sparklines) to facilitate review (see notes following Table 3). Although sparkline graphical summaries plot all data since February 1999, the Mann-Kendall test was run only on data through July 2010, the last sampling before the October 2010 plant shutdown. This approach was used because the 1999–July 2010 time frame corresponds to a period of fairly consistent plant operation (see Figure 4), thus avoiding potential sample bias resulting from variable groundwater flow conditions and from a concentration rebound effect when operations ceased or became intermittent. Subsequent data are not considered reliable indicators of treatment progress due to the low ($\leq$ 31 percent) on-stream rates since then.

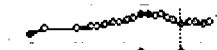
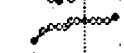
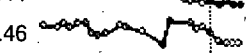
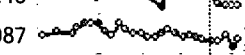
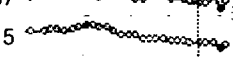
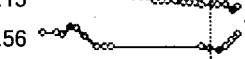
Overall, despite measureable progress in groundwater treatment (Section 4.3), trend analysis results indicate no widespread decreases in uranium concentrations in groundwater at the site (Tables 3 and 4). Significant decreases in contaminant concentrations are found in three Horizon A/B wells: wells 908 and 934, located in the southwestern portion of the site near the site boundary, and well 282, in the central distal portion of the middle terrace.

Decreases in contaminant concentrations at wells 908 and 934 are apparent in the baseline and current-condition plots in Figures 9a/b, 12a/b, and 15a/b. However, uranium concentrations in wells 908 and 934 remain elevated (0.087 and 0.15 mg/L). The maximum concentration of uranium at well 0282 (0.054 mg/L) only marginally exceeds the restoration goal and was detected just after installation of the well. Uranium levels then rapidly decreased and stabilized at concentrations below the restoration goal (latest result is 0.01 mg/L). The Mann-Kendall test statistic (Table 3) supports a downward trend at this location. However, the trend is probably not a significant indicator of water quality improvement because of the low concentrations involved and because the initial sample result may be biased high due to aquifer disturbance during well drilling.

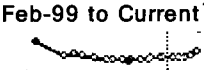
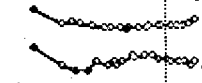
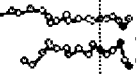
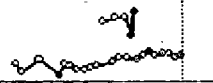
[4] The Mann-Kendall test generates all possible differences between pairs of sequential observations; however, the *relative magnitude of the difference* is not considered. Rather, any difference, large or small, is assigned either a positive or negative direction (refer to Gilbert [1987] for additional information).

Table 3. Uranium Trends in Middle Terrace Groundwater, Horizon A and B Monitoring Wells:

Wells at or near the Site Boundary

	Summary Statistics: Uranium (mg/ L)					Sparklines	Mann-Kendall Test Results: Baseline – July 2010			
Well ID	***n***	**Baseline**	**Minimum**	**Maximum**	**Current**	**Feb-99 to Current**	***n***	**Test Value (S)**	***p*-value**	**Test Interpretation**
0262B	21	0.38	0.13	1.40	0.88		15	75.0	0.0001	Upward Trend
0286B	12	0.365[a]	0.004	0.52	0.40		7	Wells installed in March 2007. Insuffient number of observations for trend analysis.		
0287B	12	0.106[a]	0.11	0.27	0.27		7			
0288B	12	0.034[a]	0.011	0.034	0.011		7			
0906A	22	0.95	0.42	1.00	0.46		12	6.0	0.37	No Trend
0908B	27	0.12	0.072	0.12	0.087		18	(90.0)	0.0003	Downward Trend
0934B	28	0.31	0.13	0.36	0.15		18	(128.0)	<0.0001	Downward Trend
0940A	15	0.55	0.39	0.67	0.56		5	Insufficient data for trend analysis.		
0941A	27	0.089	0.049	0.27	0.25		15	59.0	0.002	Upward Trend

Distal Middle Terrace Wells

	Summary Statistics: Uranium (mg/ L)					Sparklines	Mann-Kendall Test Results: Baseline – July 2010			
Well ID	***n***	**Baseline**	**Minimum**	**Maximum**	**Current**	**Feb-99 to Current**	***n***	**Test Value (S)**	***p*-value**	**Test Interpretation**
0263B	20	0.49	0.10	0.49	0.26		15	(28.0)	0.084	No Trend
0265B	20	0.09	0.045	0.09	0.062		15	34.0	0.046	Upward Trend
0267B	26	0.073	0.06	0.11	0.071		17	(37.0)	0.076	No Trend
0281B	17	0.006[b]	0.005	0.009	0.005		12	9.0	0.32	No Trend
0282B	17	0.054[b]	0.004	0.054	0.01		12	(64.0)	<0.0001	Downward Trend
0283B	5	0.027[b]	0.023	0.030	Dry		5	Insufficient data for trend analysis.		
0909B	23	0.039	0.018	0.063	Dry		18	91.0	0.0003	Upward Trend

0.004 Value < 0.044 mg/ L restoration standard.

n = number of samples. Consistent with Figure 15a, baseline values listed in the third column are the most recent for the period February 1999 through March 2002. Sparklines (see notes below) plot all baseline period results (i.e., since February 1999).

[a] In lieu of baseline data, result from May 2007

[b] February 2005 result

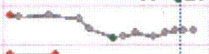
Notes:

Well IDs are followed by a letter denoting depth horizon. Summary statistics are from the beginning of the baseline period (February 1999) through the current reporting period (August 2012 or February 2013). The sparklines shown in the center column are simple well-specific line charts that have no axes or date scale (in contrast, refer to the grouped time-trend plots in Appendix E). The purpose of these small line charts is to show, for individual wells, general concentration trends over time. In these plots, the *x*-axis is hidden but corresponds to a common date scale for all wells—February 1999 through February 2013. The gray markers correspond to individual measurements; minimum and maximum results are denoted by green and red markers, respectively. In all cases, the *y*-axis is condensed, and scales are unique to each well. Therefore, magnitudes of temporal trends are somewhat masked and should not be compared across wells. The vertical dashed line bisecting the sparklines corresponds to the August 2010 time frame, just before the extended (Oct 2010 to Sept 2011) plant shutdown.

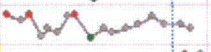
Trend analysis was performed using the Mann-Kendall test (see Gilbert 1987) using ProUCL version 4.1 http://www.epa.gov/osp/hstl/tsc/software.htm. The test was used only for data through July 2010, the last sampling before the October 2010 plant shutdown, as this corresponds to a period of fairly consistent plant operation (e.g., see Figure 4). Subsequent data are not considered reliable indicators of treatment progress due to the low (≤31%) on-stream rates since then. Under the Test Interpretation column, "No Trend" means insufficient evidence to identify a significant trend at the specified level of significance ($p < 0.05$). Upward and downward trends mean statistically significant evidence of an increasing or decreasing trend at the $p < 0.05$ level. The S-statistic is conventional output from the Mann-Kendall test: the higher the absolute value, the more significant the result. Negative S test values are listed in parentheses.

Table 4. Uranium Trends in Middle Terrace Groundwater, Horizons C and Deeper

Horizon C–D Wells South of the Disposal Cell

	Summary Statistics: Uranium (mg/ L)					Sparklines	Mann-Kendall Test Results: Baseline – July 2010			
Well ID	***n***	**Baseline**	**Minimum**	**Maximum**	**Current**	**Feb-99 to Current**	***n***	**Test Value (S)**	***p*-value**	**Test Interpretation**
0258D	18	0.002	0.001	0.002	0.001		13	21.0	0.13	No Trend
0272D	17	0.0001[a]	0.001	0.002	0.002		12	18.0	0.13	No Trend
0273D	17	0.056[a]	0.028	0.086	0.044		12	6.0	0.37	No Trend
0274C	17	0.001[a]	0.001	0.002	0.002		12	32.0	0.016	Upward Trend**
0289C	12	0.068[b]	0.012	0.068	0.013		7	Insufficient data for trend analysis.		
0912C	13	0.034	0.020	0.035	0.024		9	(10.0)	0.18	No Trend
0915D	11	0.002	0.000003	0.002	0.000004		8	(22.0)	0.002	Downward Trend**
0261D	13	0.002	0.001	0.003	0.001		9	2.0	0.46	No Trend
0264D	20	0.003	0.003	0.004	0.004		15	30.0	0.07	No Trend
0266D	20	0.002	0.0012	0.002	0.002		15	47.0	0.01	Upward Trend**
0932C	28	0.002	0.001	0.004	0.002		18	27.0	0.17	No Trend
0251E	28	0.048	0.001	0.048	0.002		18	39.0	0.076	No Trend
0913G	13	0.002	0.00091	0.002	0.00120		9	0.0	0.54	No Trend
0916G	10	0.001	0.00001	0.001	0.00002		8	(24.0)	0.001	Downward Trend**
0252I	27	0.002	0.001	0.004	0.002		19	2.0	0.47	No Trend

Uranium Trends in Monitoring Wells East of the Disposal Cell

	Summary Statistics: Uranium (mg/ L)					Sparklines	Mann-Kendall Test Results: Baseline – July 2010			
Well ID	***n***	**Baseline**	**Minimum**	**Maximum**	**Current**	**Feb-99 to Current**	***n***	**Test Value (S)**	***p*-value**	**Test Interpretation**
0290B[c]	12	0.0034[b]	0.001	0.06	0.06		7	Insufficient data for trend analysis.		
0275D	17	0.44[a]	0.160	0.52	0.420		12	25.0	0.058	No Trend
0276C	17	0.0013[a]	0.001	0.002	0.002		12	16.0	0.155	No Trend
0683C	18	0.0012	0.0009	0.0017	0.0012		11	8.0	0.27	No Trend
0684C	17	0.0019	0.001	0.0026	0.0013		11	2.0	0.44	No Trend
0685C	17	0.0012	0.001	0.0016	0.0012		11	11.0	0.22	No Trend
0268E	27	0.0014	0.0014	0.085	0.082		19	68.0	0.008	Upward Trend**

0.056 Value ≥ 0.044 mg/ L restoration standard (formatting different from Table 3, given intent to highlight exceptions within well groups).

n = number of samples. Consistent with Figures 15a, 16a and 17a, baseline values listed in the third column are the most recent for the period February 1999 through March 2002. Sparklines plot all results since February 1999.

[a] In lieu of baseline data, result from February 2005; [b] May 2007 result

[c] Although screened in Horizon B, well 290 is included in this table given collocation with other evaporation pond area wells.

**Although significant, these results must be considered within the context of the relative magnitude of change (very low in the case of 916G) or against criteria levels (e.g., relative to the 0.044 mg/L restoration standard).

Note:
See detailed notes following Table 3. Table partitions in the uppermost table separate Horizon C–D wells at or near site or disposal cell boundary (upper portion), lower middle terrace Horizon C–D wells (middle portion), and wells screened in the deepest zones (Horizons E or deeper, bottom portion).

At the same time, upward trends are found in four Horizon A/B wells: 262, 265, 909, and 941 (Table 3). These wells are located to the east and south of the wells showing decreases (Figure 2b). Of all wells with "significant" trending results, wells 909 and 265 are closest to the middle terrace escarpment. Significant trending is not apparent in remaining Horizon A/B wells (Table 3).

No trending is apparent for wells screened in Horizons C or D. Some results in Table 4 are deemed significant based on Mann-Kendall output. However, these results must be considered within the context of the relative magnitude of change or against criteria of relevant levels or concentrations. Most uranium concentrations in Horizons C and D wells are less than the 0.044 mg/L remediation standard, and some are at or near the detection limit (see notes following Table 4).

Although Mann-Kendall tests were run for sentinel and lower-terrace wells, with the exceptions noted previously, contamination in these wells is generally absent (refer to Appendix E, Figures E-4 through E-7 and E-10 through E-13). Given the potential for trending artifacts (stemming from low concentrations), test results are not reported here. Appendix E provides time-trend plots to facilitate review and interpretation of all Mann-Kendall test findings. In summary, trend analysis results indicate no widespread decreases in uranium concentrations in groundwater at the site (Tables 3 and 4). These conclusions are also true for nitrate and sulfate.

4.1.2 Breakthrough from the Infiltration Trench

The arrival of distillate from the infiltration trench to the extraction wells may eventually enhance the evaluation of the aquifer flushing process and restoration time. Breakthrough of the distillate is expected to be evident as a relatively abrupt decline in dissolved solids and contaminant concentrations at monitoring and extraction wells nearest the downgradient side of the disposal cell. Such a decline is not yet apparent.

Application of Darcy's Law predicts that the travel time from the infiltration trench to well 940 is about 17 years, based on the inferred water table gradient (0.04 ft/ft) beneath the disposal cell during full-time operation of the remediation system, a hydraulic conductivity of 1 ft per day (from DOE 1998), and assuming 25 percent porosity. With these inputs, the average linear flow velocity computes to about 60 ft/yr. Based on this calculation, which ignores hydrodynamic dispersion, the estimated travel time (17 years) exceeds the cumulative remediation period to date. This means that, assuming that dispersion is negligible, breakthrough of the distillate by advective transport is not expected within the next 5 years.

4.2 Contaminant Concentration Trends at Extraction Wells

Figures 25 to 27 illustrate concentration trends at the extraction wells for nitrate, sulfate, and uranium. Each figure comprises three separate time series plots to show the trends in different areas of the extraction well field. The well field is separated into the area east of the disposal cell (figure "a"), the area immediately south of the disposal cell (figure "b"), and the area encompassing the southernmost portion of the plume (figure "c"). Because the pumps at 13 extraction wells—0936, 0938, 0942, 1102, 1109, 1115, 1121, 1122, 1126, 1127, 1128, 1130, and 1131—were not functioning at the time of the August 2012 sampling, the following discussion is similar to that provided in the previous annual report. Although former monitoring

wells 935, 936, 938, and 942 (converted to extraction wells in August 2005) are sampled semiannually, remaining extraction wells (1101–1133) are sampled annually.

Figures 25a and 26a indicate no significant temporal trends for nitrate or sulfate in the eastern area of the extraction well field. As is true for monitoring wells, nitrate concentrations are highly variable. Between February 2003 and 2007, nitrate concentrations in many of these wells declined, but later rebounded (Figure 25a). As discussed in previous annual reports, only wells 1121 and 1123 show notable declines approaching the 44 mg/L remediation standard; nitrate concentrations have been nominal in well 1125 historically. Nitrate concentrations in remaining eastern area extraction wells range between approximately 200 and 800 mg/L, averaging at about 350–400 mg/L (about an order of magnitude above the remediation standard). Sulfate concentrations in eastern area extraction wells are highly variable and no trends are apparent; concentrations in most wells range between 1,000 and 2,500 mg/L, remaining well above the 250 mg/L remediation goal.

Uranium concentrations in eastern area extraction wells have decreased relative to baseline conditions—from a global average of 0.5 mg/L (baseline) to about 0.25 mg/L (Figure 27a). The most significant decreases are apparent in wells 1120, 1121, and 1122. These downward trends are also apparent in Figure 28, which provides a simple schematic of baseline versus July 2010 uranium trends in extraction wells by spatial region. Consistent with the approach used for the Mann Kendall test, 2010 measurements were considered the best recent indicators of treatment progress given subsequent extended plant shutdown periods. Although called "slopegraphs," the lines in Figure 28 are *not* trend lines, so any interpretations must consider the temporal variation shown in preceding figures.

As has been the case historically, contaminant concentrations are much more variable in the area immediately south of the disposal cell (Figures 25b, 26b, and 27b). Nitrate and sulfate concentrations rose slightly in the southernmost portion of the extraction well field at the onset of remediation but have since stabilized in most wells (Figures 25b, 26b). Overall, there has been very little change in nitrate and sulfate concentrations in these boundary extraction wells when comparing baseline to current conditions, and concentrations remain well above remediation goals. No definitive conclusions can be drawn regarding uranium concentrations trends in this area. Much variation is apparent and decreases in some wells are offset by increases in others (e.g., see Figures 27b and 28). At wells 1104 and 1106, uranium concentrations increased during the 2010–2011 plant shutdown period. Because data for that period are limited, it is not known whether these increases are attributable to cessation of pumping.

As true for other regions of the extraction well network, nitrate and sulfate levels in the southernmost extraction wells are more variable and no trending is apparent (Figures 25c and 26c). Notable exceptions are found for wells 1129 and, in particular, 1130, where concentrations of nitrate, sulfate, and uranium increased during the nonpumping (plant shutdown) period. However, uranium concentration trends in most remaining southernmost extraction wells have been relatively stable (Figures 27c and Figure 28).

In summary, except for declines in nitrate and uranium concentrations in the eastern area and some boundary/disposal cell area wells, no temporal trends are evident for most extraction wells. Table 5 lists the extraction wells where a primary contaminant concentration was below the remediation standard in the extract during this reporting period. For this review period

(acknowledging the lack of recent measurements for some wells), wells 1116 and 1125 were the only extraction wells where all three primary contaminants were below corresponding remediation standards. This has not been the case historically for southern well 1116, where previously nitrate concentrations have always exceeded the remediation standard. However, contaminant concentrations have always been low in well 1125, located at the eastern margin of the contaminant plume.

Table 5. Extraction Wells with Contaminant Concentrations in Extract Less Than a Remediation Standard, February 2013 Samples

Extraction Well[a]	Nitrate	Sulfate	Uranium
1116	X	X	X
1117			X
1121	X		X
1125	X	X	X
1133		X	

[a] This table shows only those extraction wells where the remediation standard was not exceeded for at least one contaminant.

5.0 Year in Review Summary

- The treatment system was operational for 112 days throughout the review period, corresponding to a net on-stream factor of 31 percent. Maintenance and upgrades led to numerous unplanned shutdowns of the treatment system; shutdown durations were days to over 3 months.
- The gross treatment rate for the period was approximately 27 gpm. By comparison, the yearly on-stream factor approaches 90 percent when the treatment system is fully operational (includes brief periods of planned shutdowns) and sustains an effective treatment rate of about 80 gpm (including periods of planned shutdowns).
- Aquifer yield has decreased from about 100 gpm in previous years to about 85 gpm presently due to release of groundwater from storage.
- Approximately 14 million gallons of contaminated groundwater was extracted from the aquifer during the period. This compares to about 40 million gallons treated annually in previous years.
- Treatment system shutdowns were partially offset by discharging the extracted groundwater directly to the solar evaporation pond for evaporative treatment.
- The treatment system achieves design criteria for quality of the distillate.
- The treatment system achieves design criteria for waste-stream percentage of total feed.
- The infiltration trench is accepting distillate without excessive mounding.
- When fully operational, the extraction system captures the lateral region of maximum groundwater contamination and the full vertical extent to meet design objectives.
- Anomalous recent concentration increases at well 268 (Horizon E) merit examining the integrity of the well casing and screen using a down-hole camera. Other deep monitoring wells at the site with anomalous data were found to have compromised annular seals, evidenced by grout invasion of the screen.
- Consistent with previous annual reporting, after more than 10 years of operation, significant and widespread decreases in contaminant concentrations in groundwater are not apparent. This is despite the measureable progress in groundwater treatment, as indicated by cumulative contaminant mass and volumes extracted from the aquifer.
- The absence of widespread decreases in contaminant concentrations does not represent a poorly designed or failed remediation system. Instead numerous, naturally occurring geochemical and flow-related factors affecting solute transport in the subsurface are likely responsible in limiting the progress of aquifer restoration.

When fully operational, the groundwater remediation system meets design objectives for targeting and capturing the bulk of the groundwater contaminant plume at extraction and treatment rates that are in balance with the capacity of the aquifer to transmit water (i.e., the extraction rate is aquifer limited). Subsequent treatment of the contaminated groundwater by distillation also meets design objectives for treatment rate and contaminant removal. Except for brief periods preceding equipment replacement, the distillate, which is returned to the aquifer, has been of high quality, and excess waste byproduct is not generated.

Despite measurable removal of contaminant mass from the aquifer, persistent elevated contaminant concentrations in the groundwater suggest a prolonged or indefinite period of active remediation, requiring the removal of multiple pore volumes from the contaminant plume for treatment and disposal. Recent episodes of down-time for unscheduled repairs of the treatment system testify to another limitation of pump-and-treat remediation: the systems cannot operate indefinitely without periodic and potentially major repair, despite a proactive maintenance plan.

6.0 References

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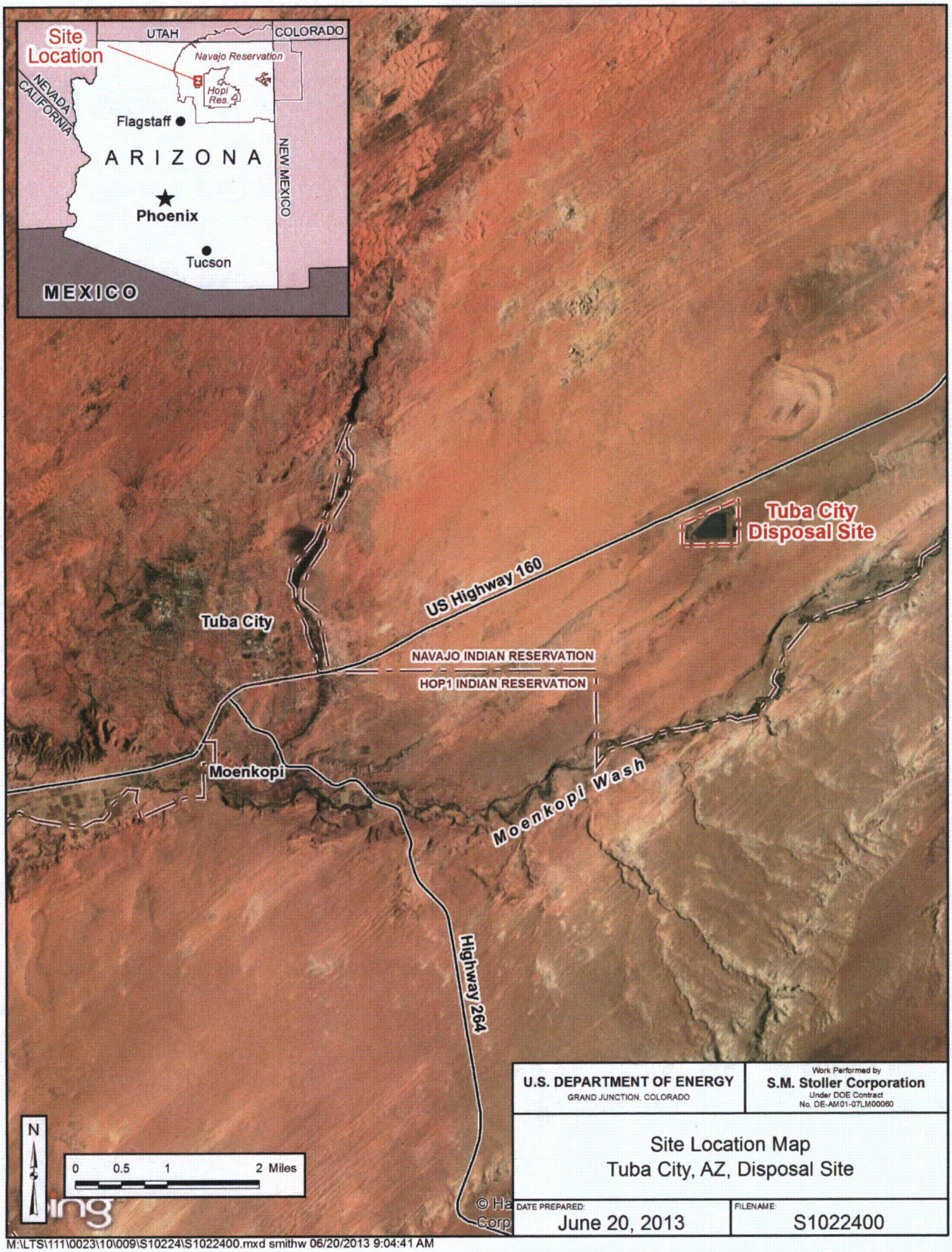

Figure 1. Tuba City Site Location Map

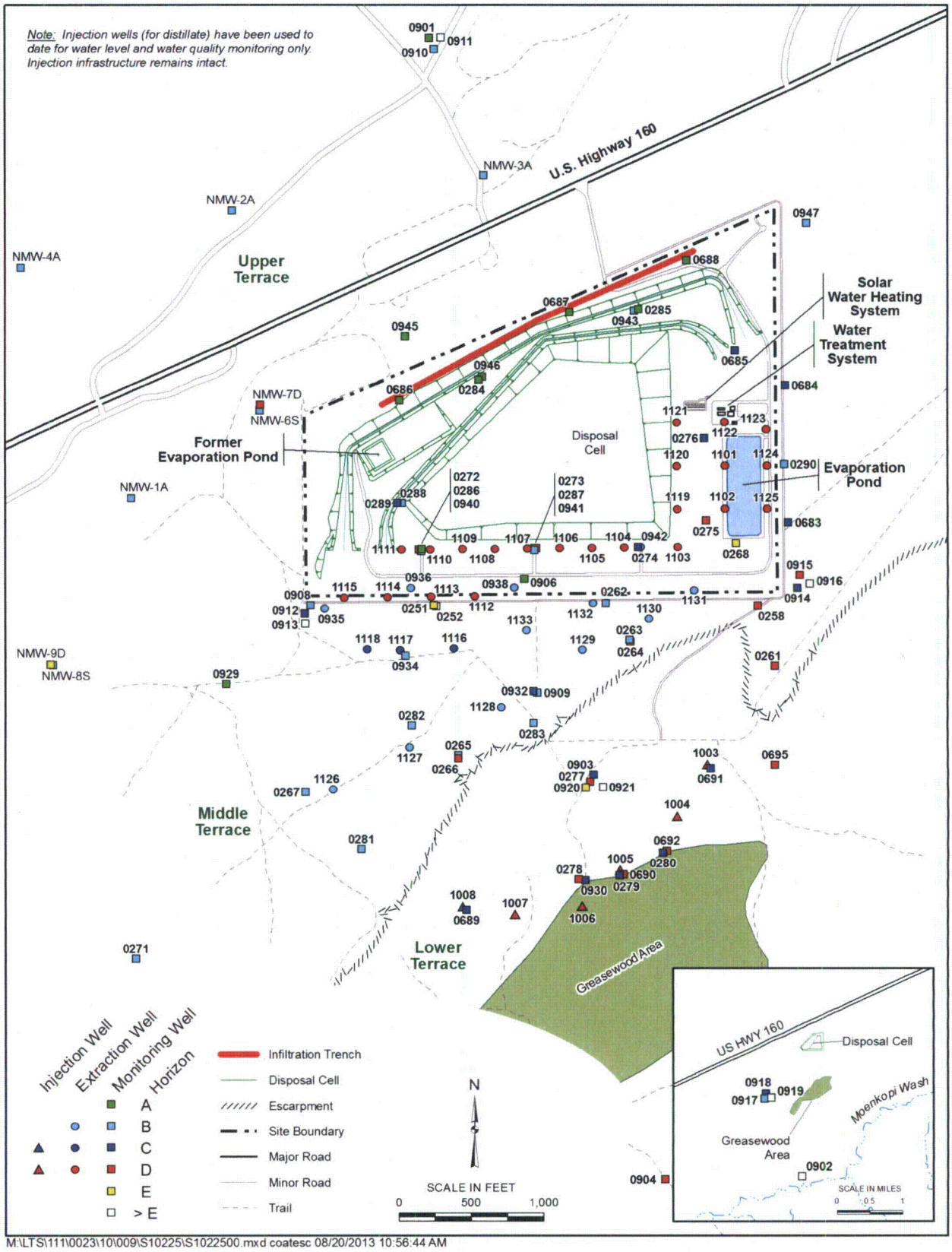

Figure 2a. Tuba City Site Features and Well Locations

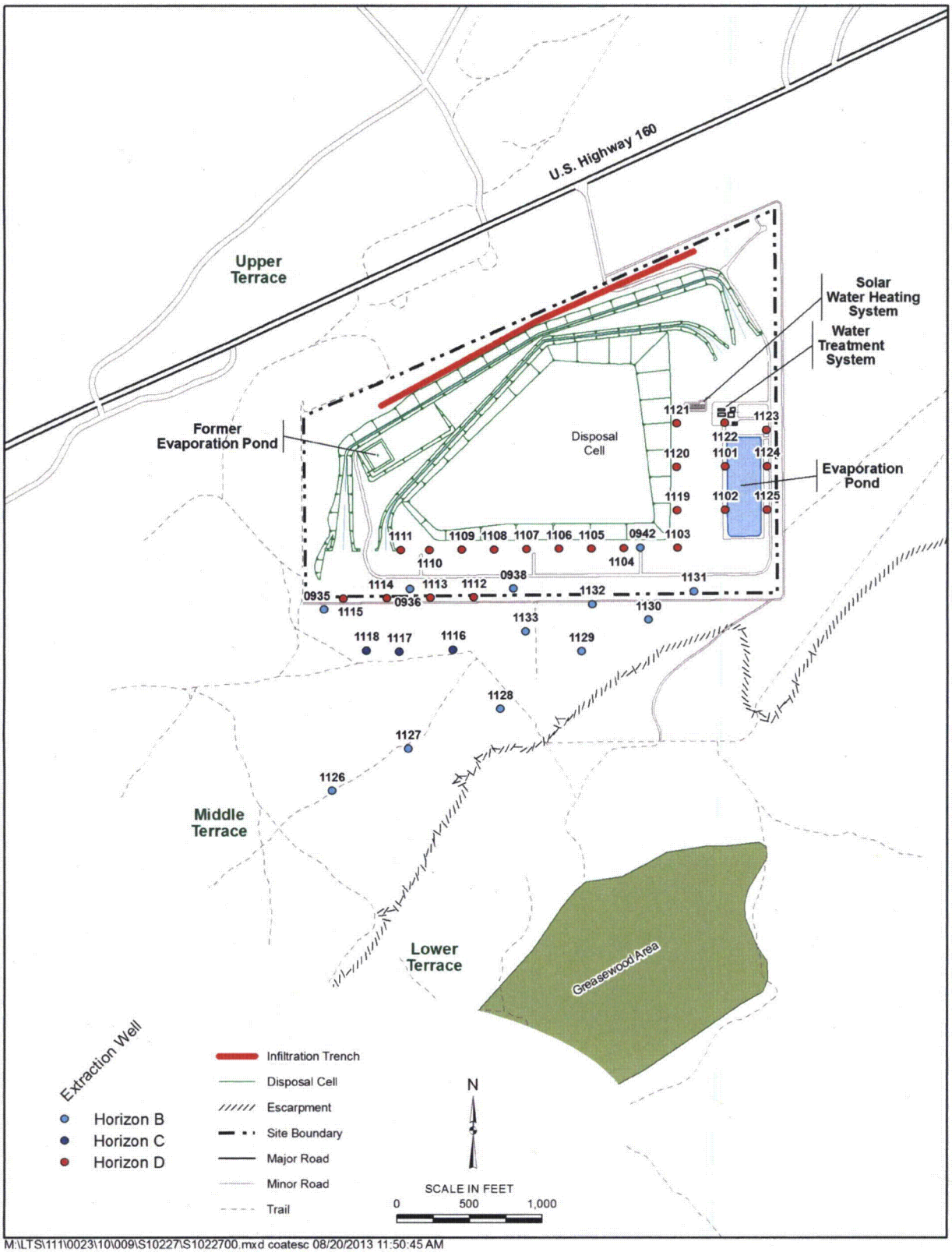

Figure 2b. Tuba City Site Features and Well Locations—Extraction Wells Only

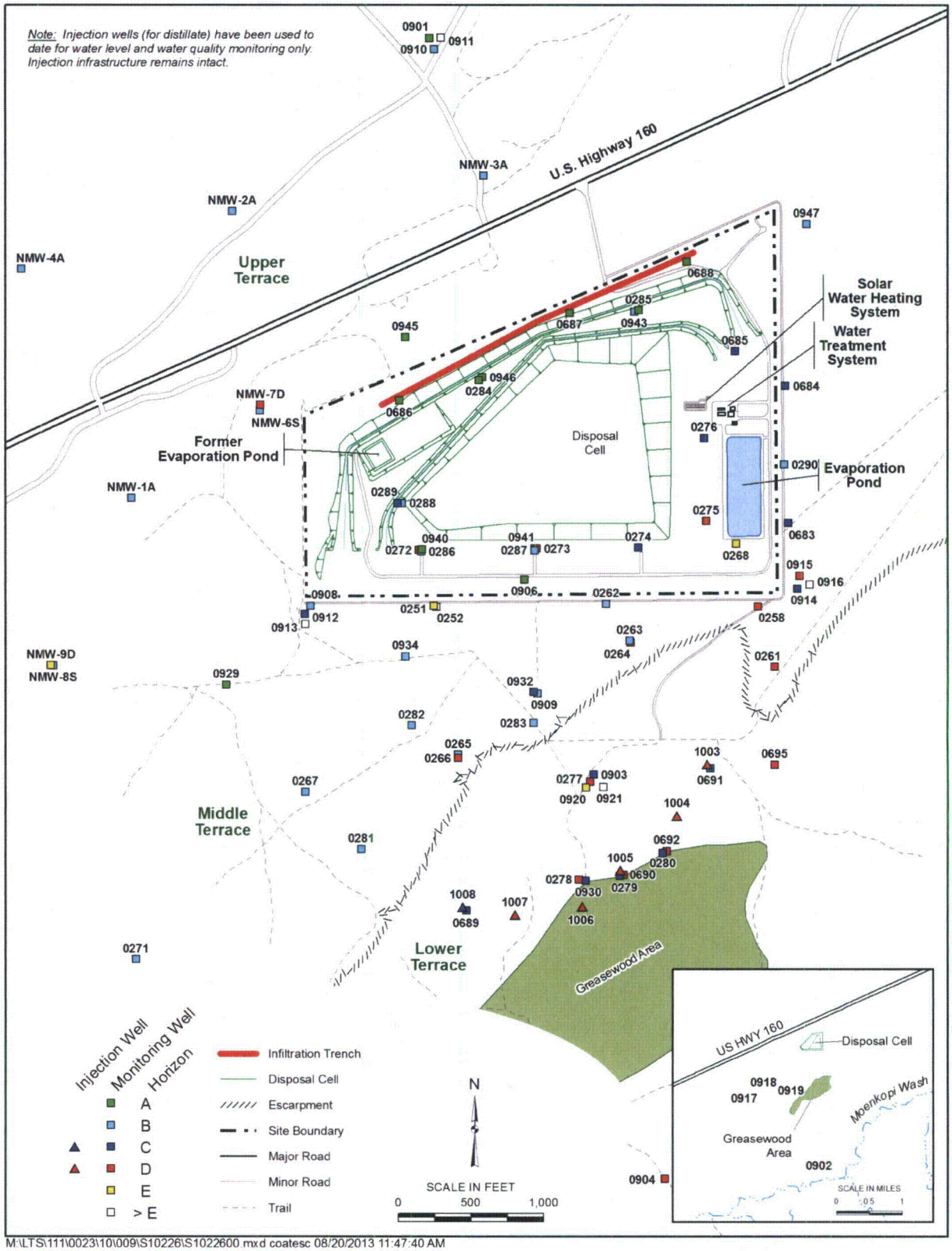

Figure 2c. Tuba City Site Features and Well Locations—Monitoring Wells Only

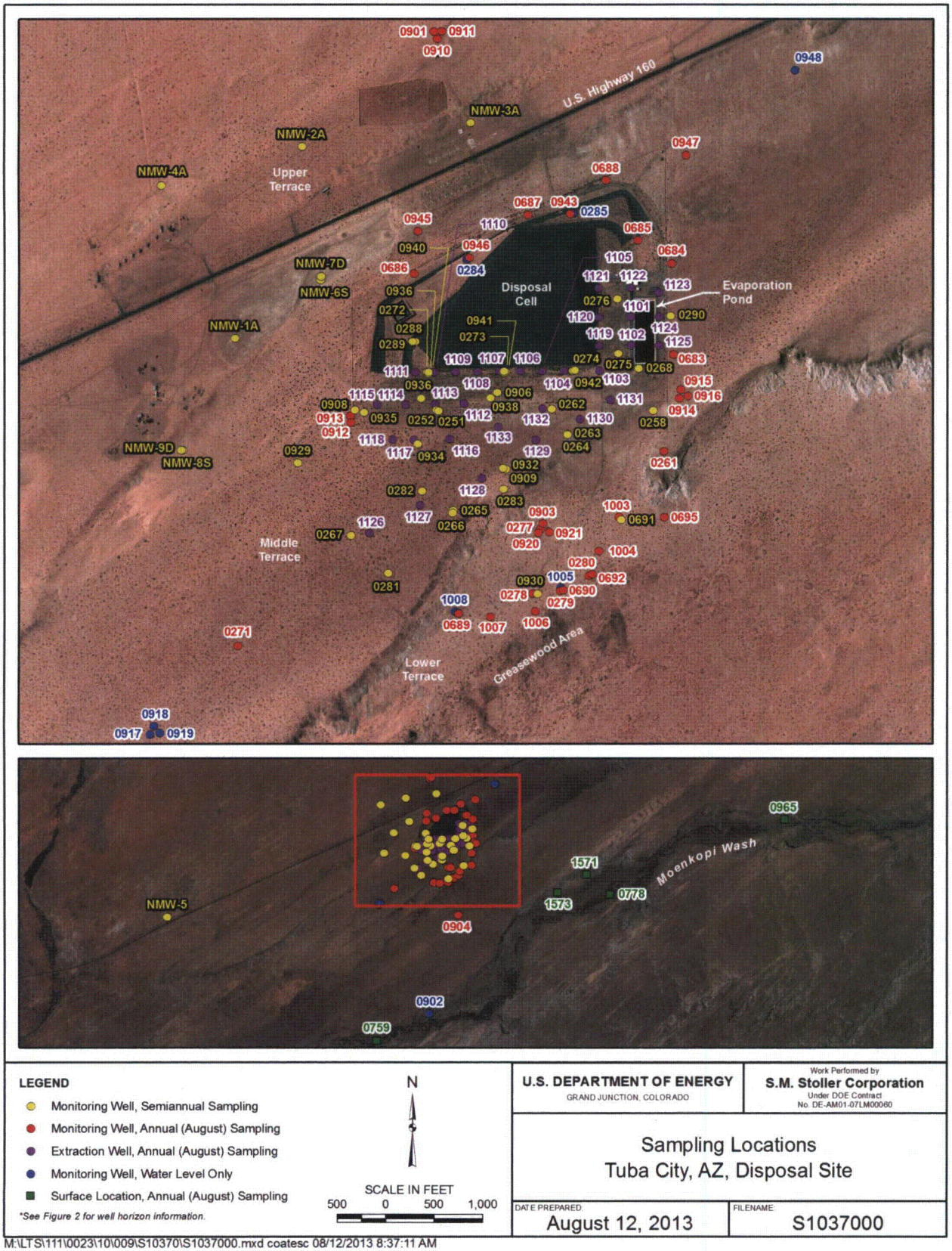

Figure 3. 2012–2013 Sampling Locations

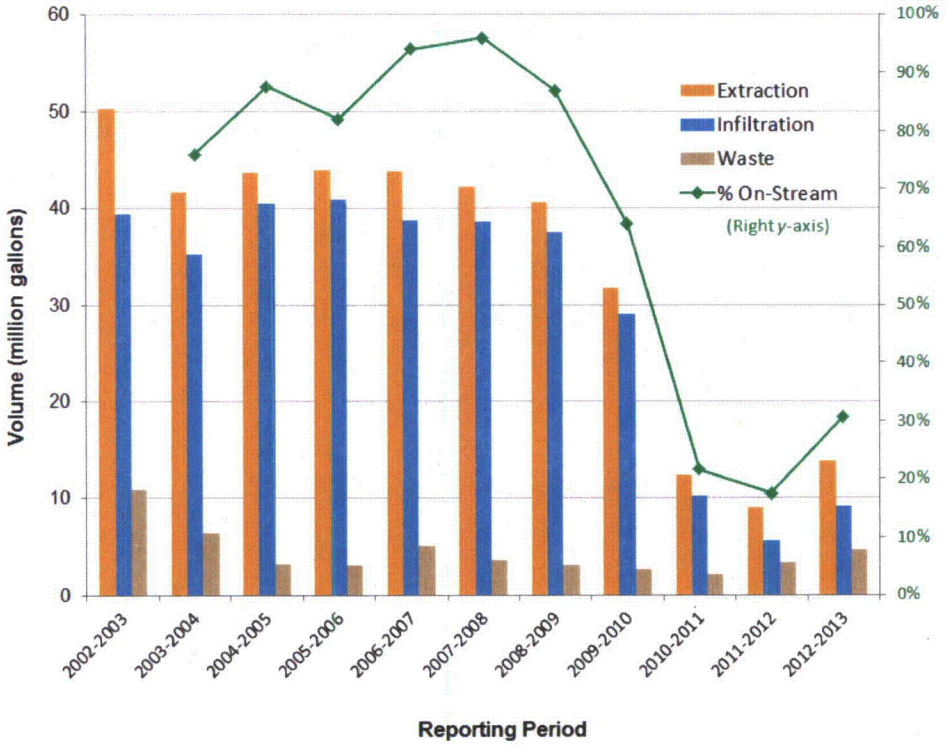

Figure 4. Annual Treatment Volumes and On-Stream Rates Since the Baseline Period

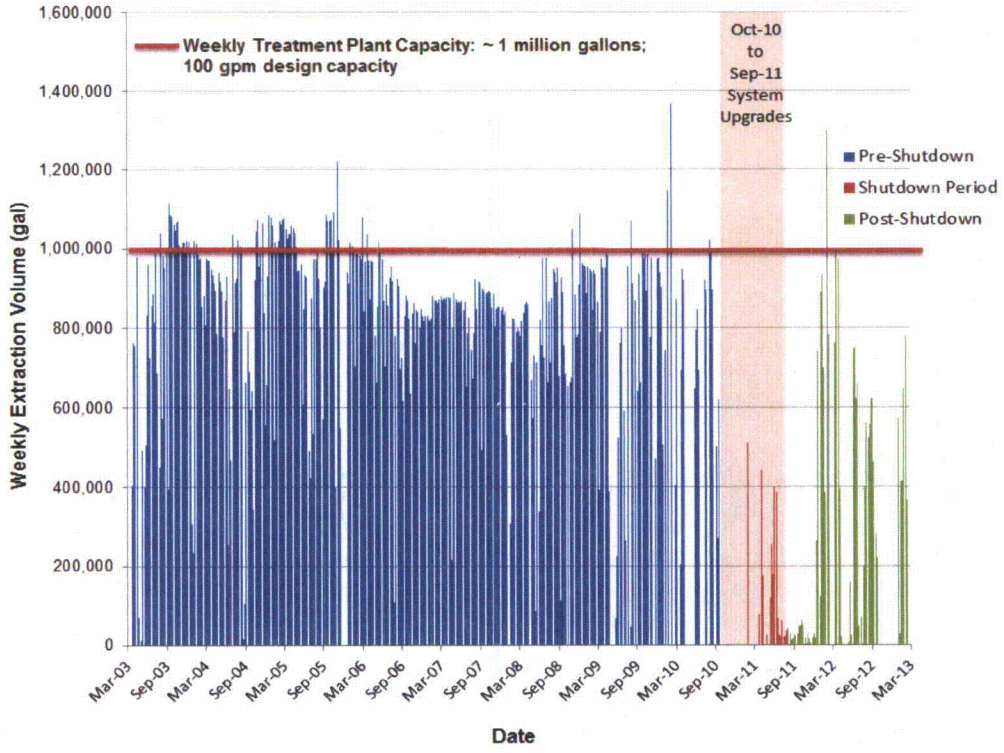

Figure 5. Weekly Extraction Volumes Since Baseline Period

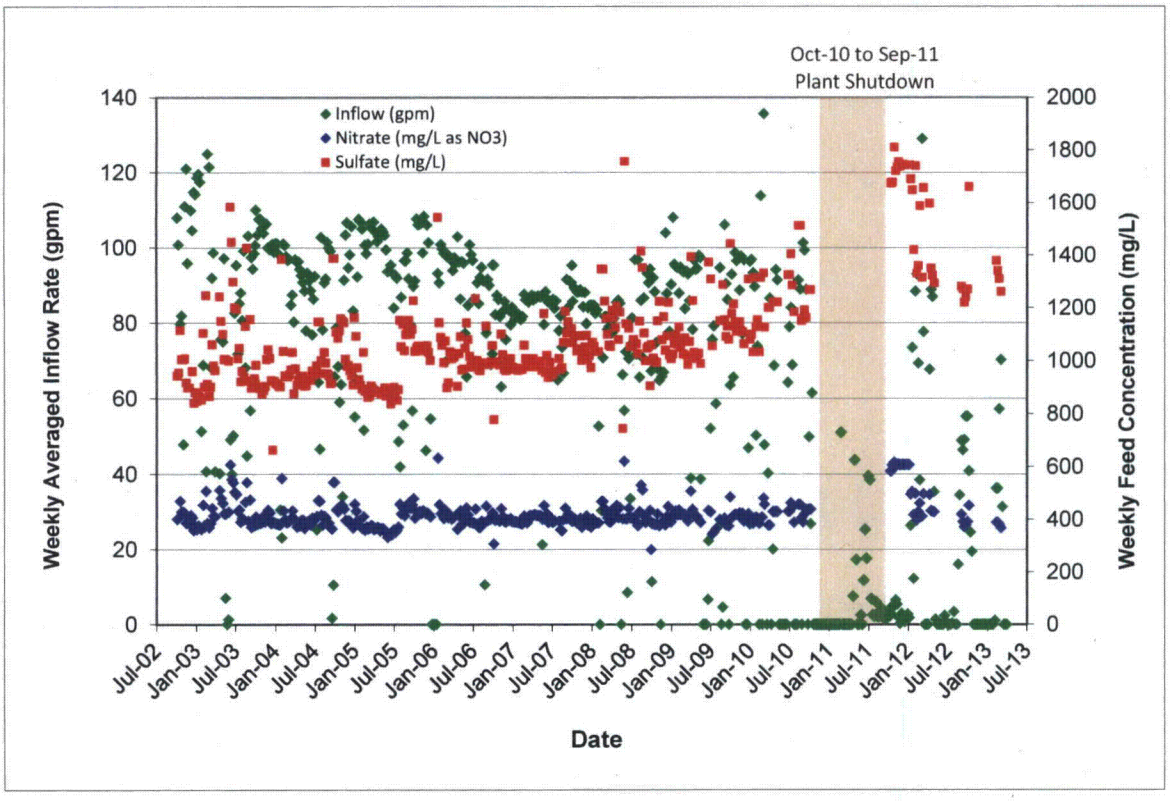

Figure 6. Treatment Plant Inflow Rates and Nitrate and Sulfate Concentrations

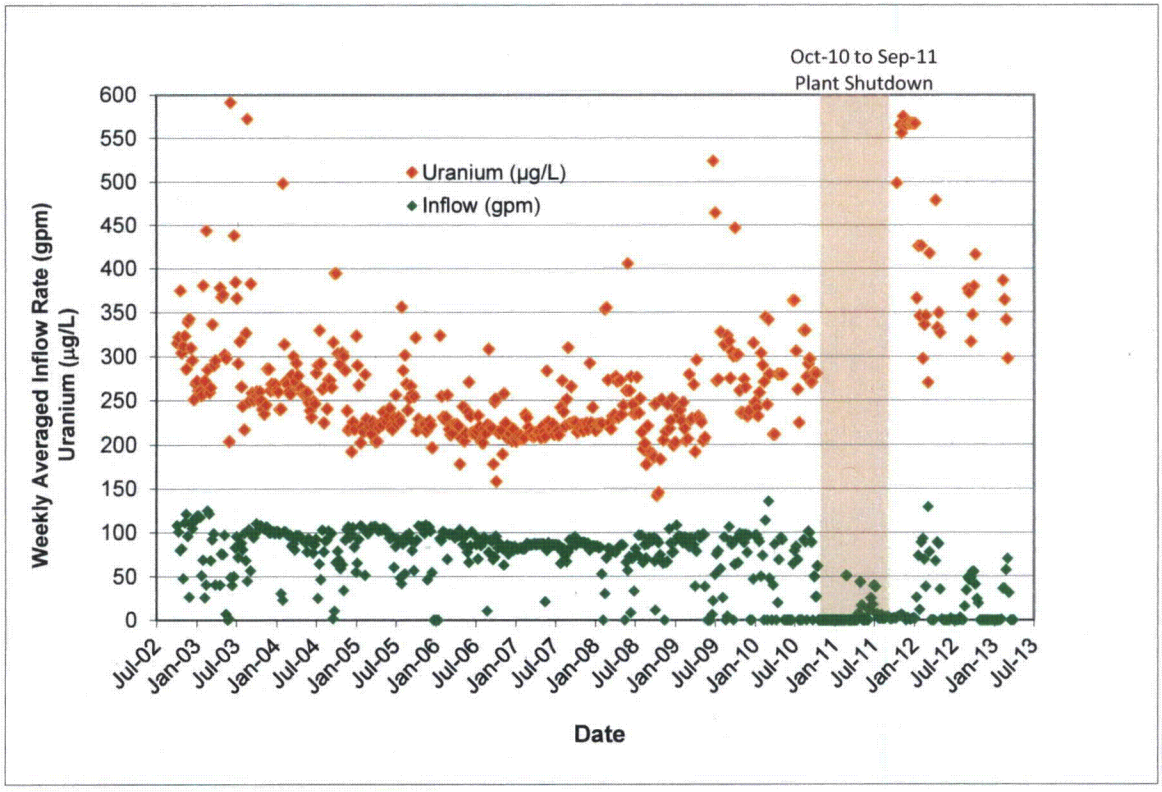

Figure 7. Treatment Plant Inflow Rates and Uranium Concentrations

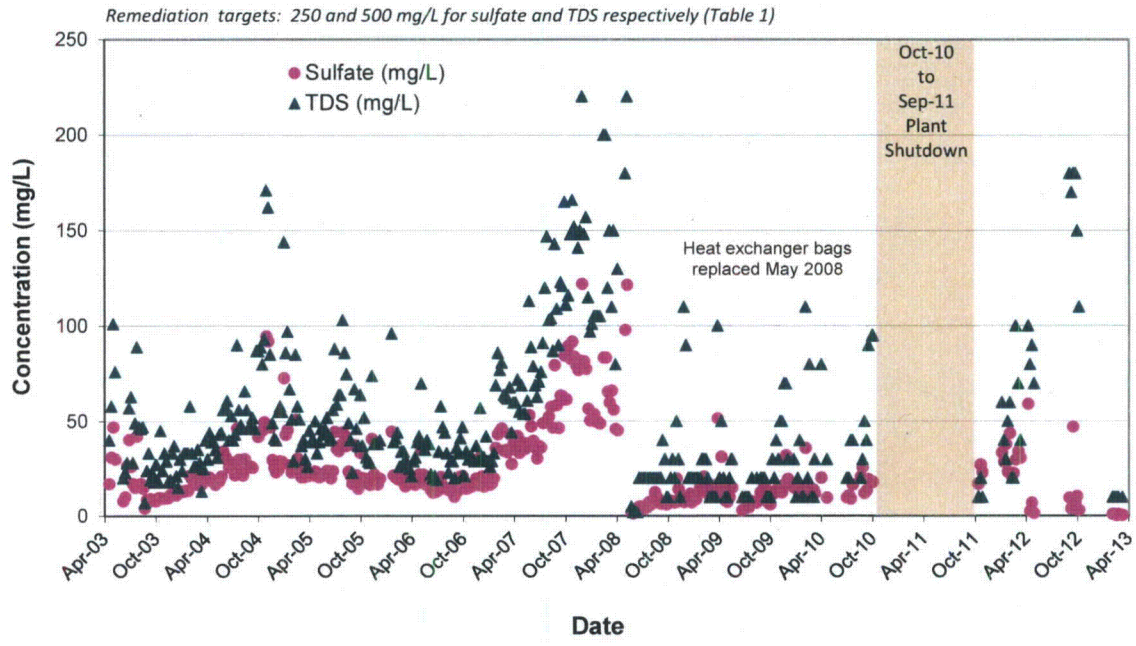

Figure 8a. Treatment Plant Distillate Quality—Sulfate and TDS

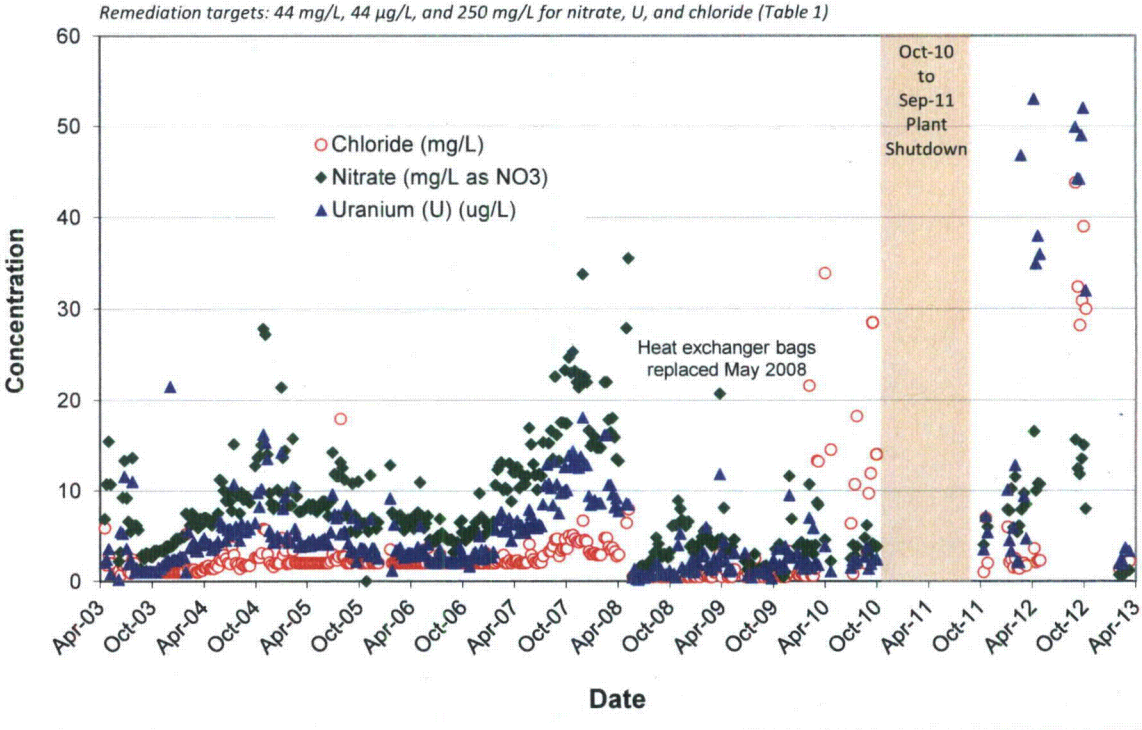

Figure 8b. Treatment Plant Distillate Quality—Nitrate, Uranium, and Chloride

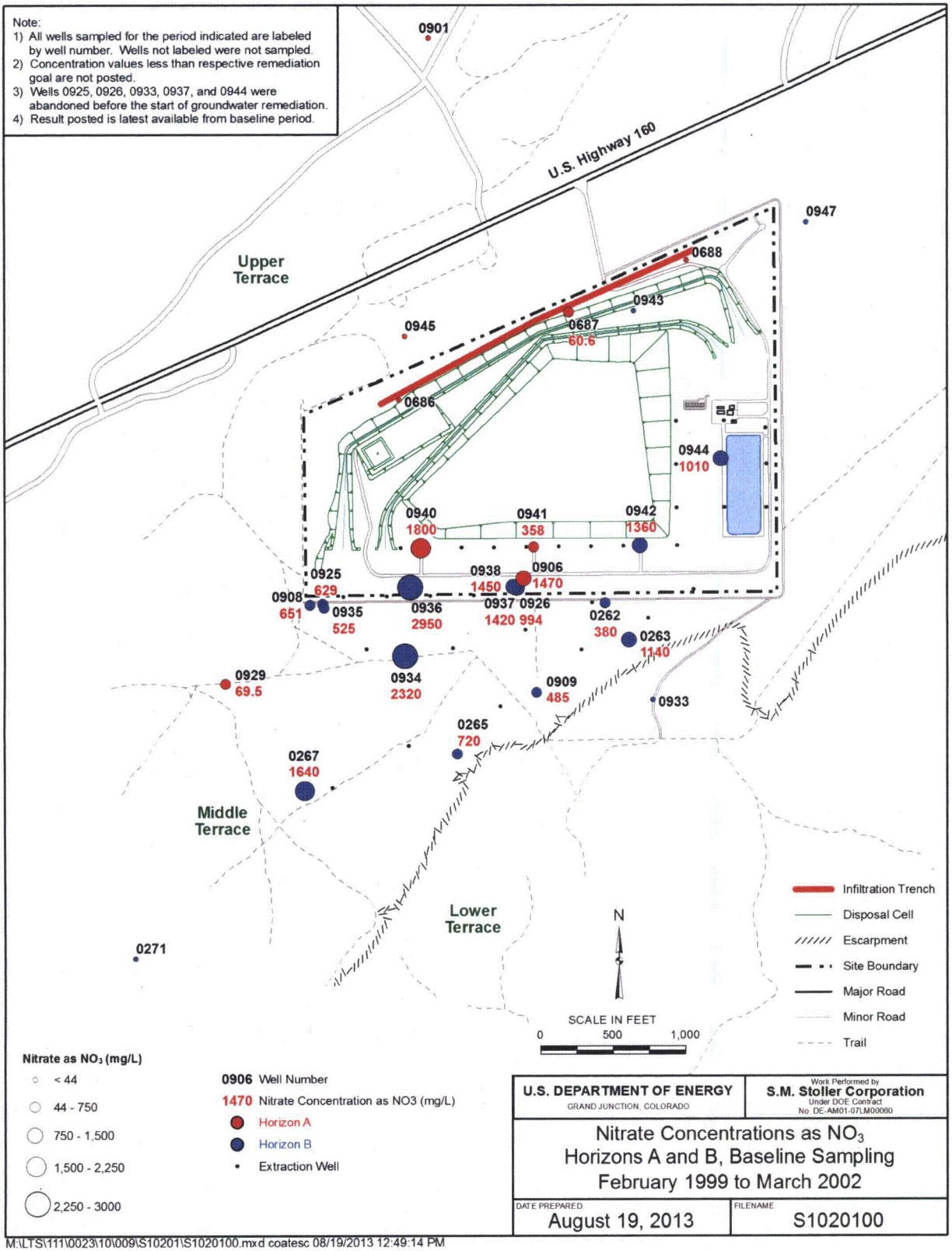

Figure 9a. Nitrate Concentrations as NO_3, Horizons A and B, Baseline Period

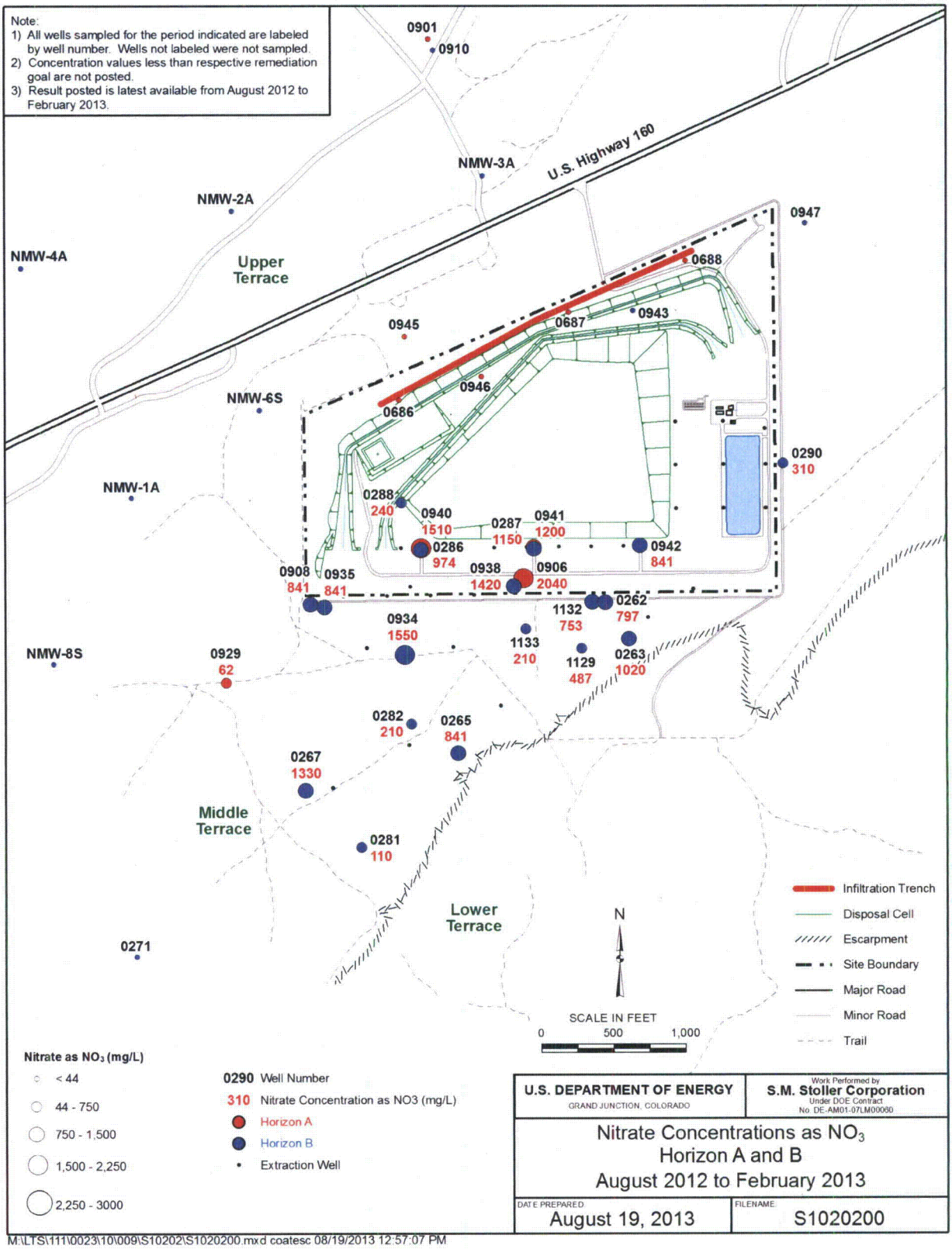

Figure 9b. Nitrate Concentrations as NO_3, Horizons A and B, February 2013

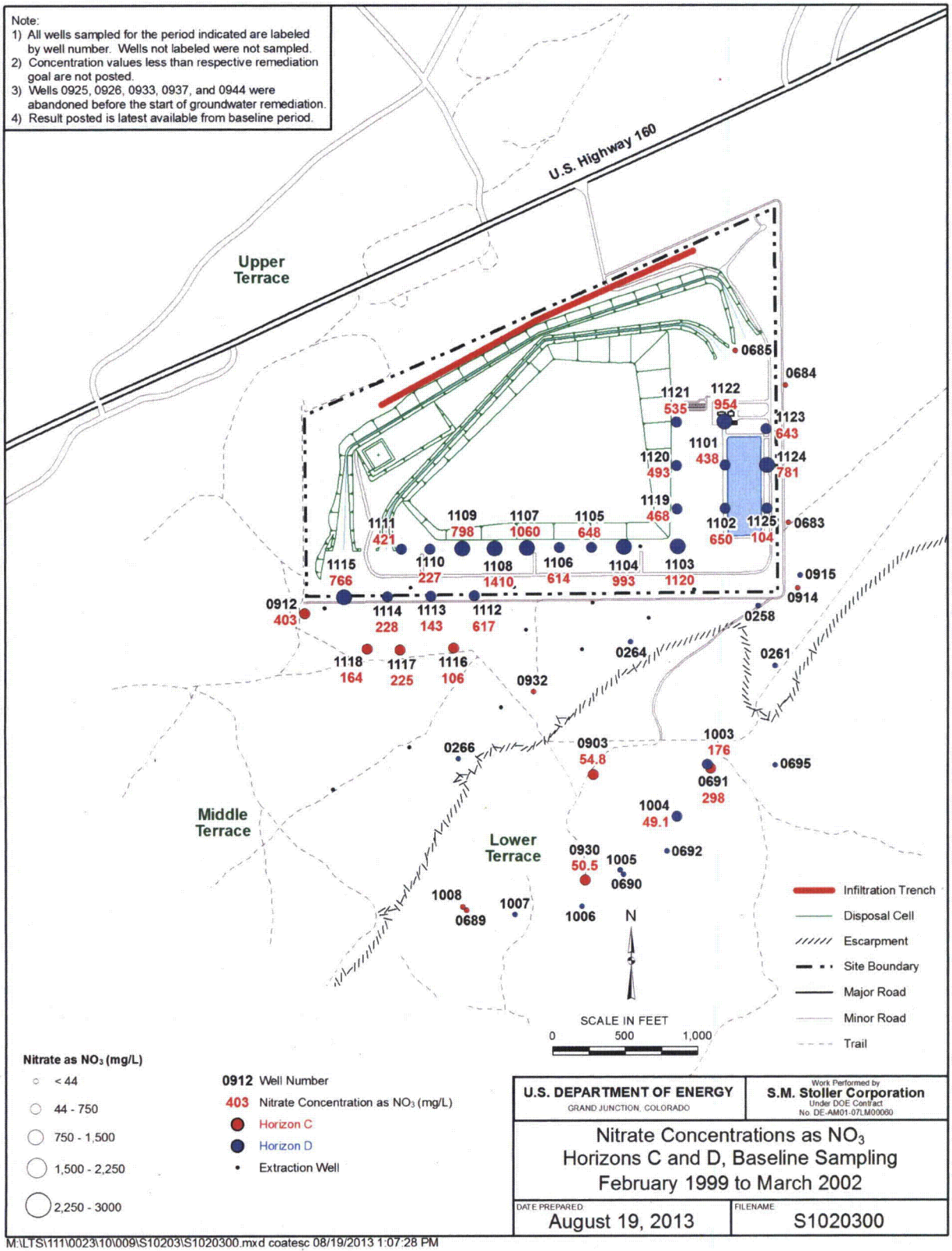

Figure 10a. Nitrate Concentrations as NO_3, Horizons C and D, Baseline Period

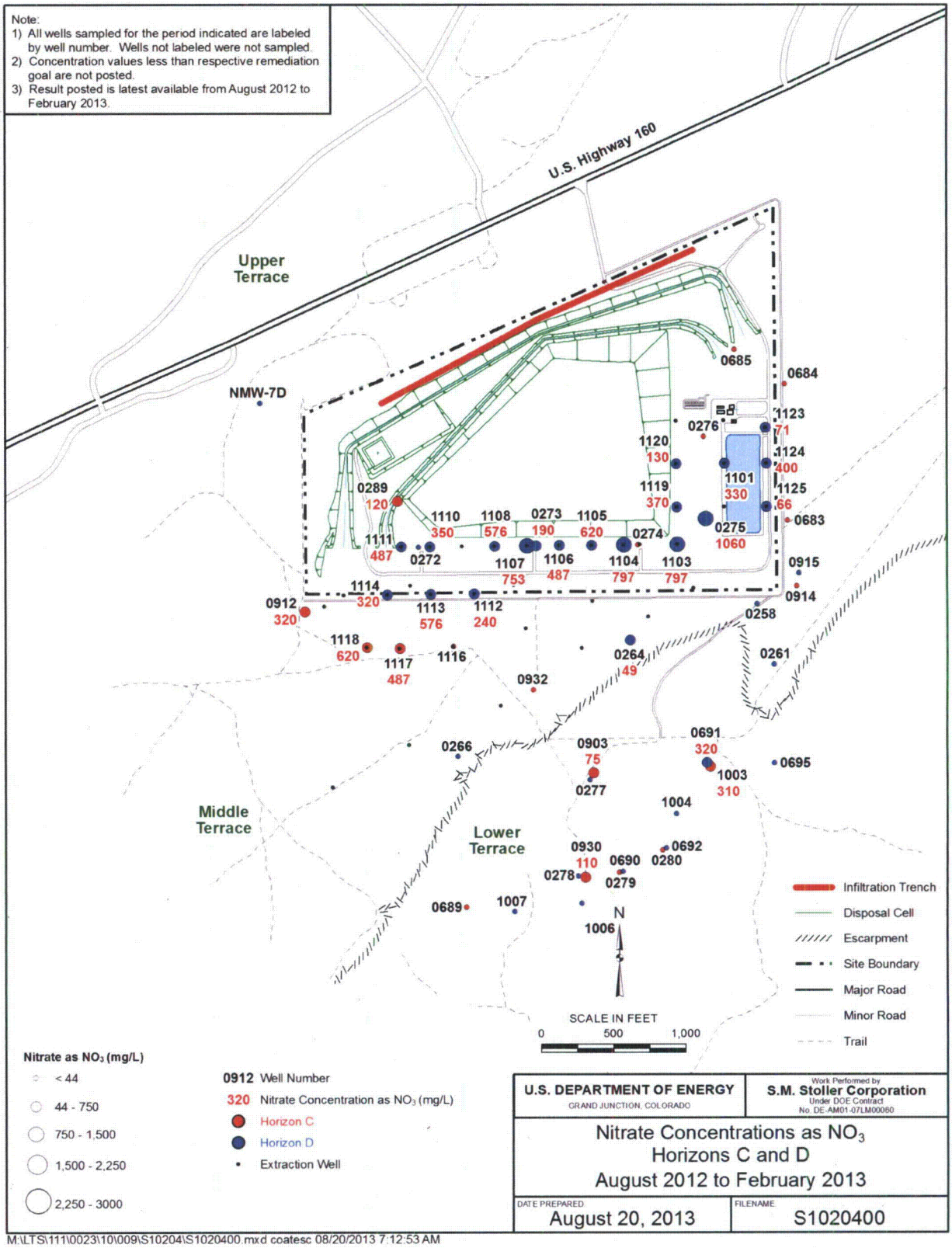

Figure 10b. Nitrate Concentrations as NO_3, Horizons C and D, February 2013

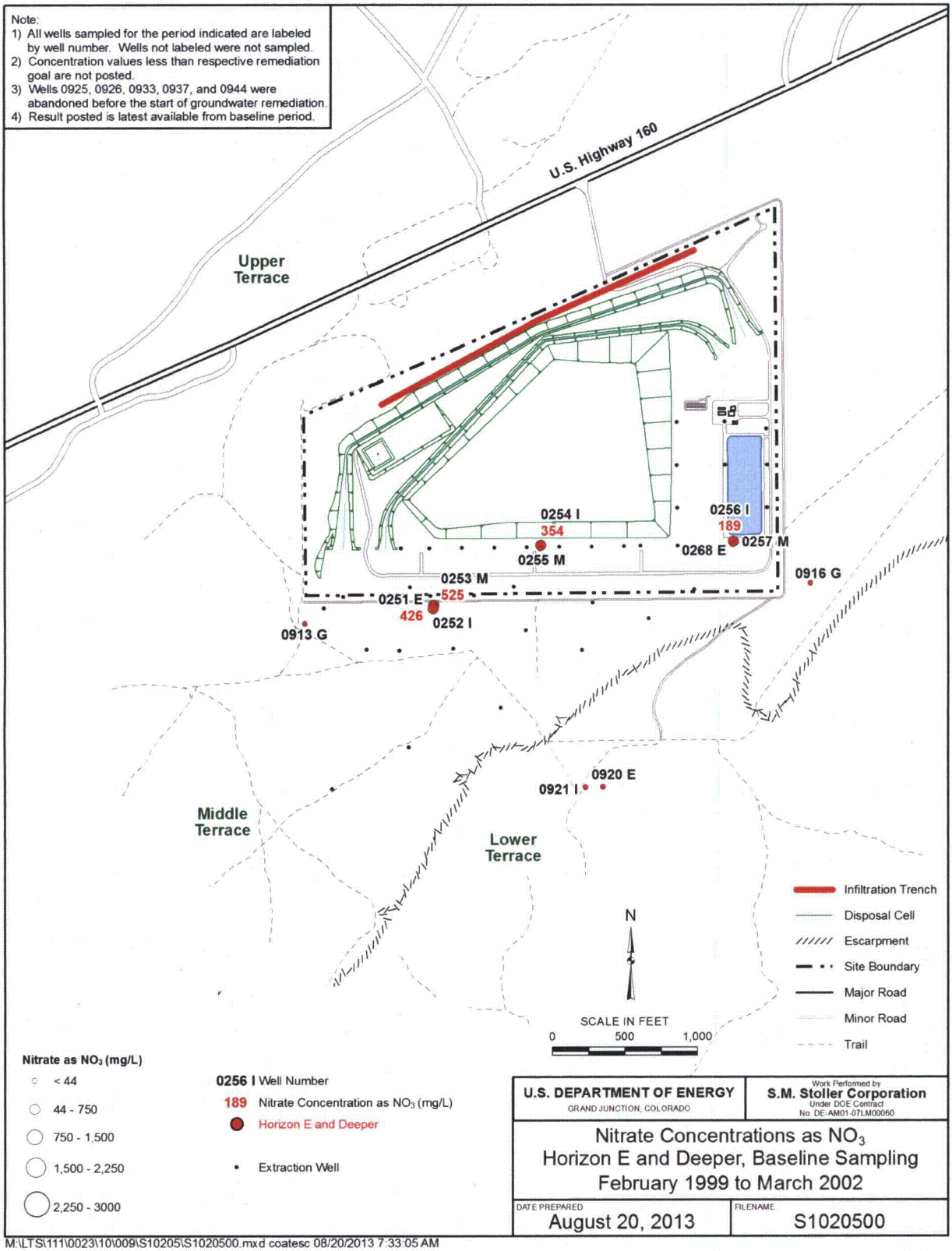

Figure 11a. Nitrate Concentrations as NO_3, Horizons E and Deeper, Baseline Period

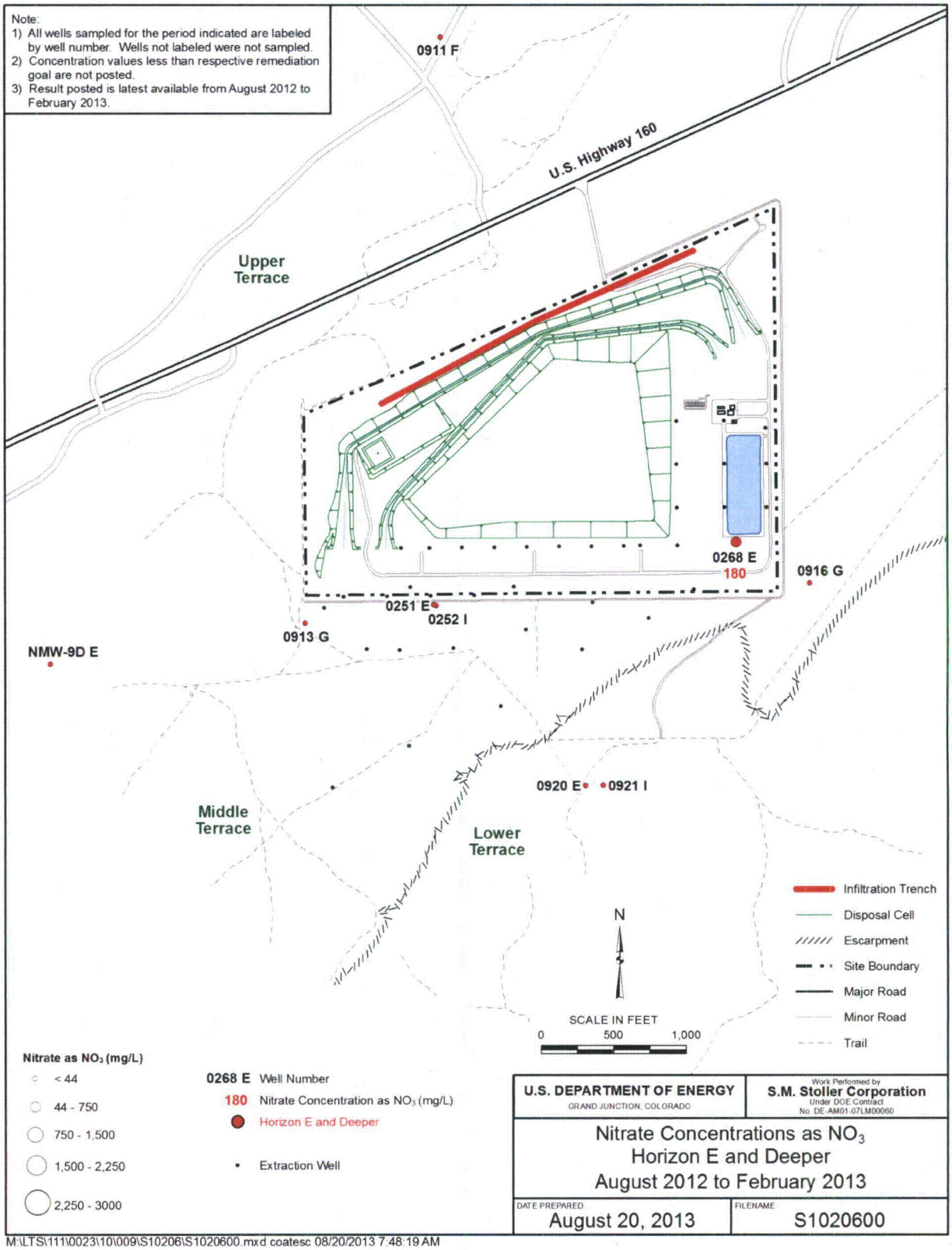

Figure 11b. Nitrate Concentrations as NO_3, Horizons E and Deeper, February 2013

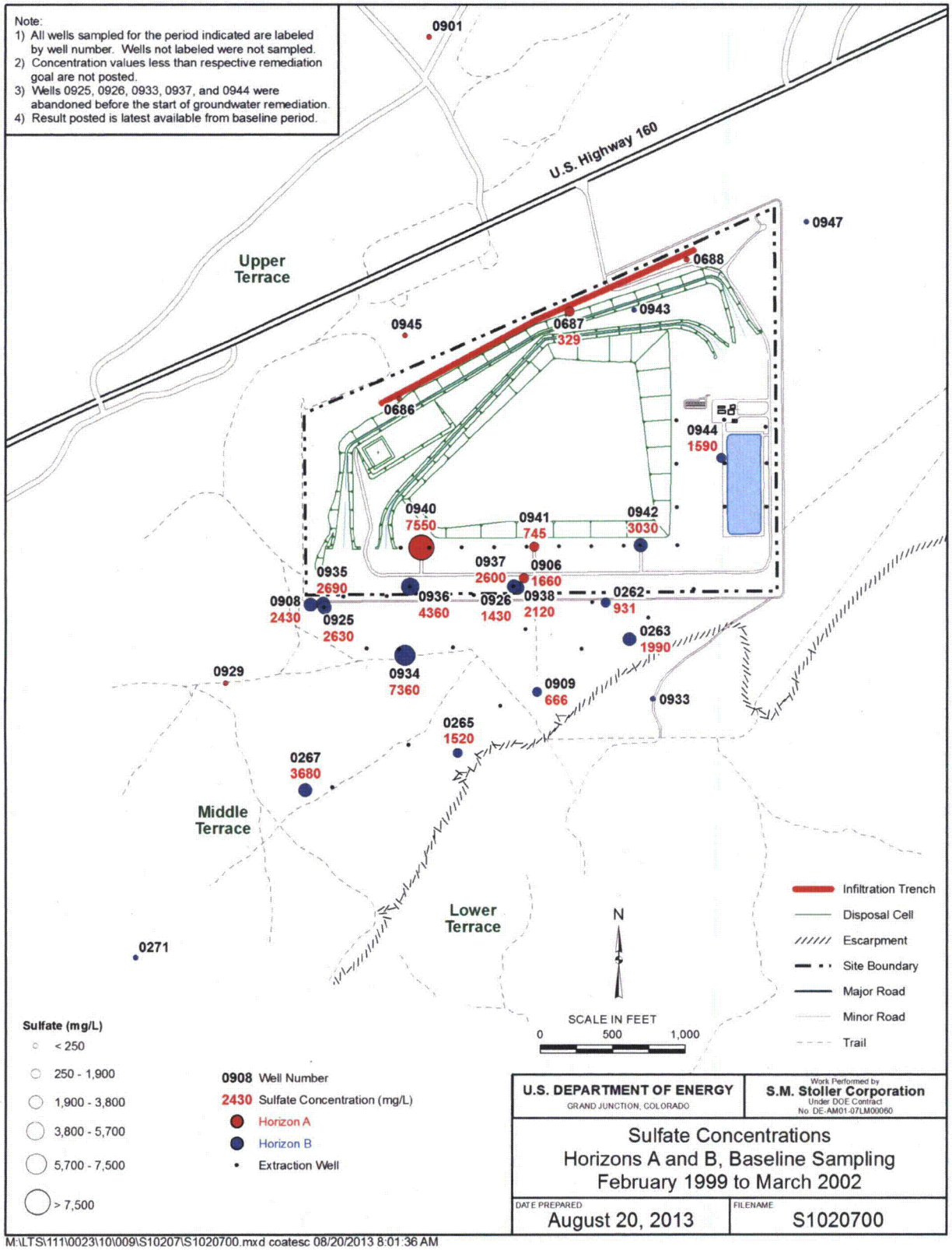

Figure 12a. Sulfate Concentrations in Groundwater, Horizons A and B, Baseline Period

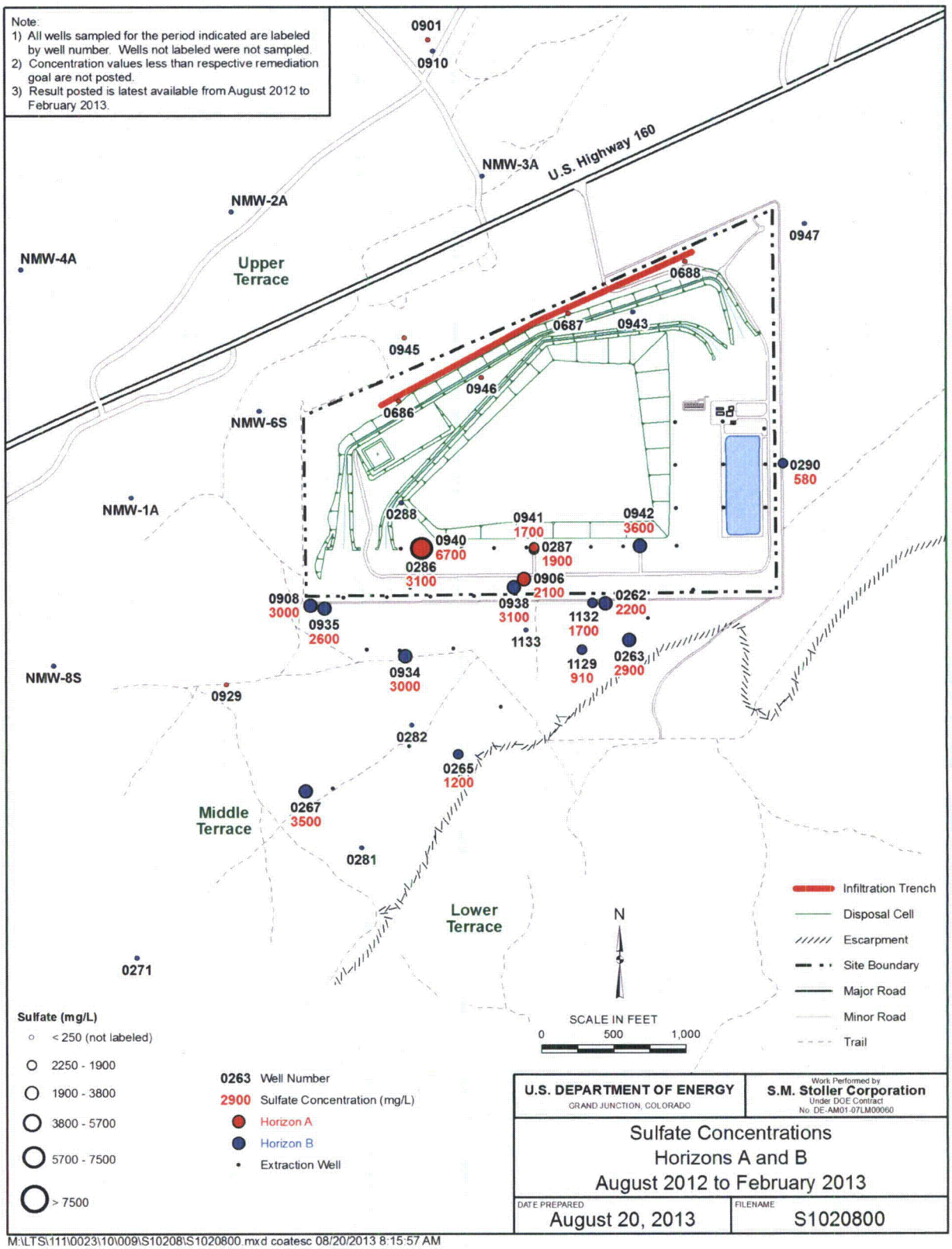

Figure 12b. Sulfate Concentrations in Groundwater, Horizons A and B, February 2013

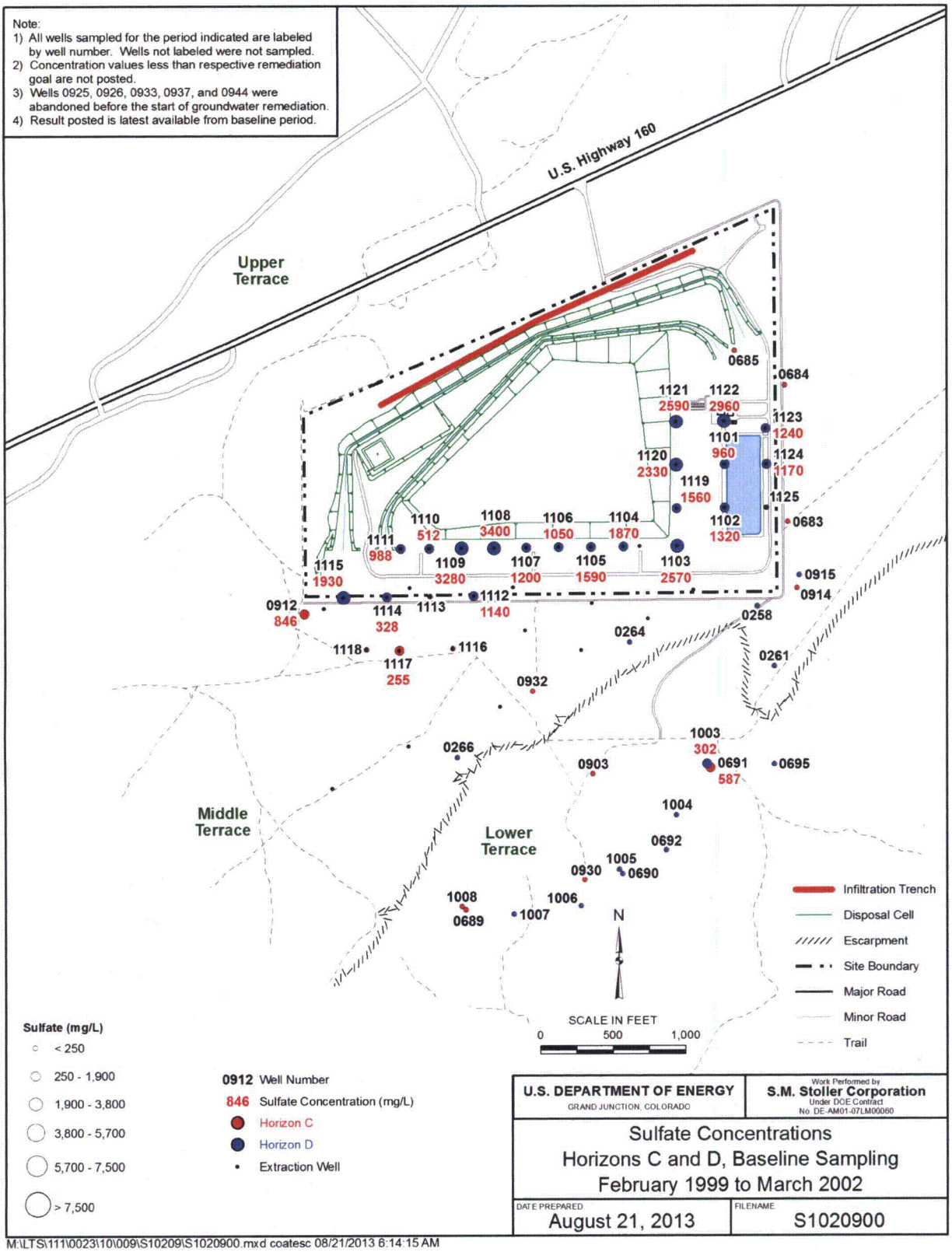

Figure 13a. Sulfate Concentrations in Groundwater, Horizons C and D, Baseline Period

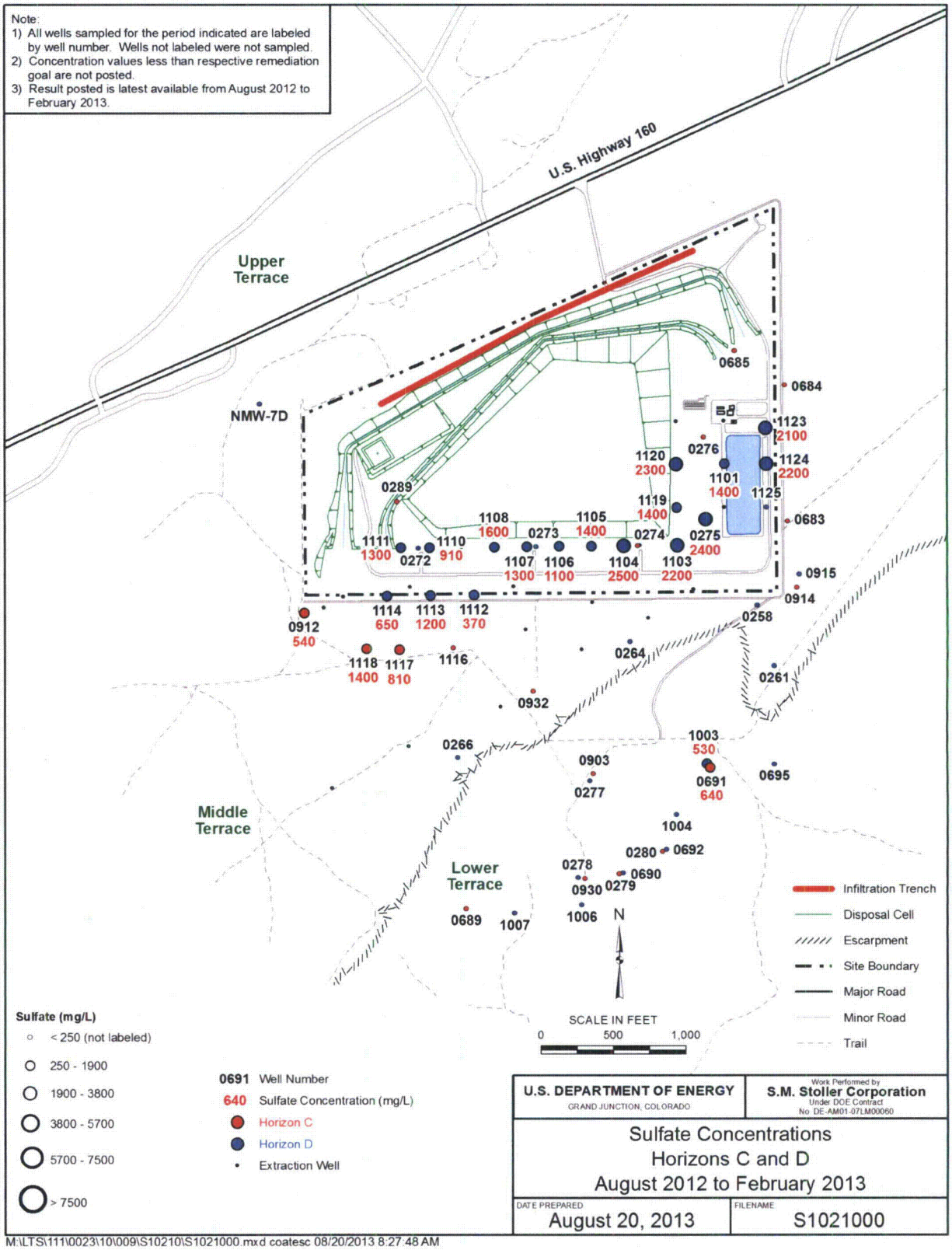

Figure 13b. Sulfate Concentrations in Groundwater, Horizons C and D, February 2013

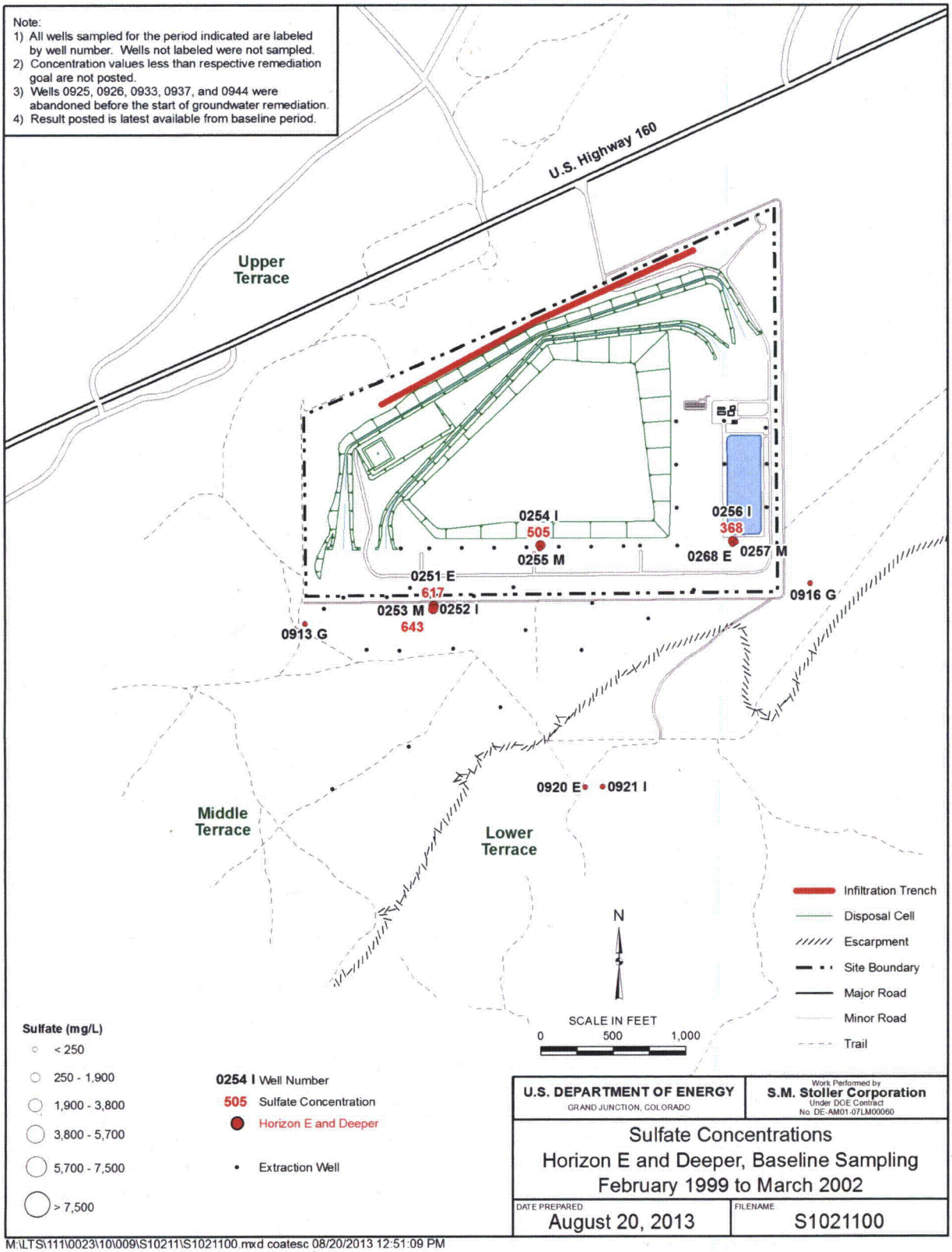

Figure 14a. Sulfate Concentrations in Groundwater, Horizon E and Deeper, Baseline Period

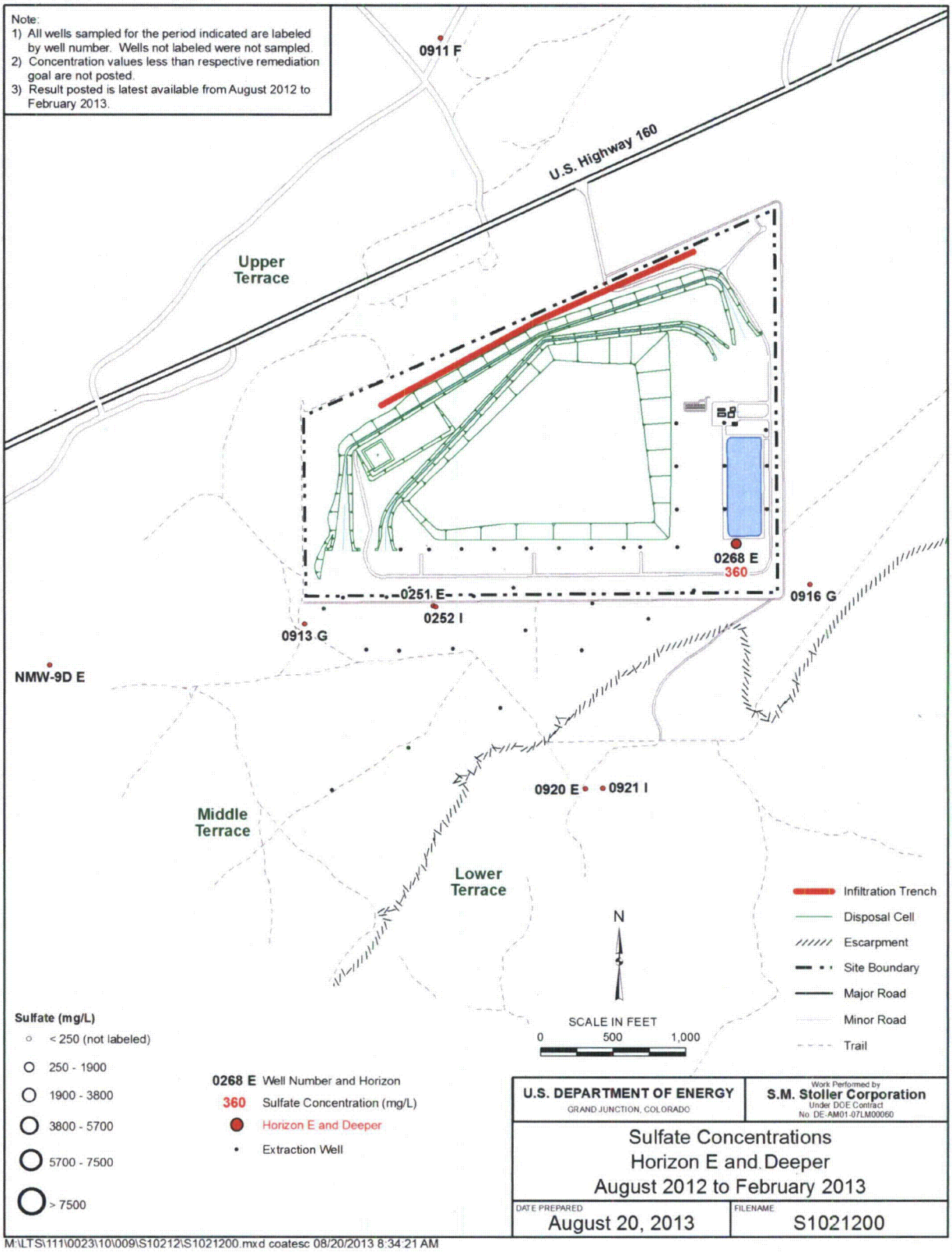

Figure 14b. Sulfate Concentrations in Groundwater, Horizon E and Deeper, February 2013

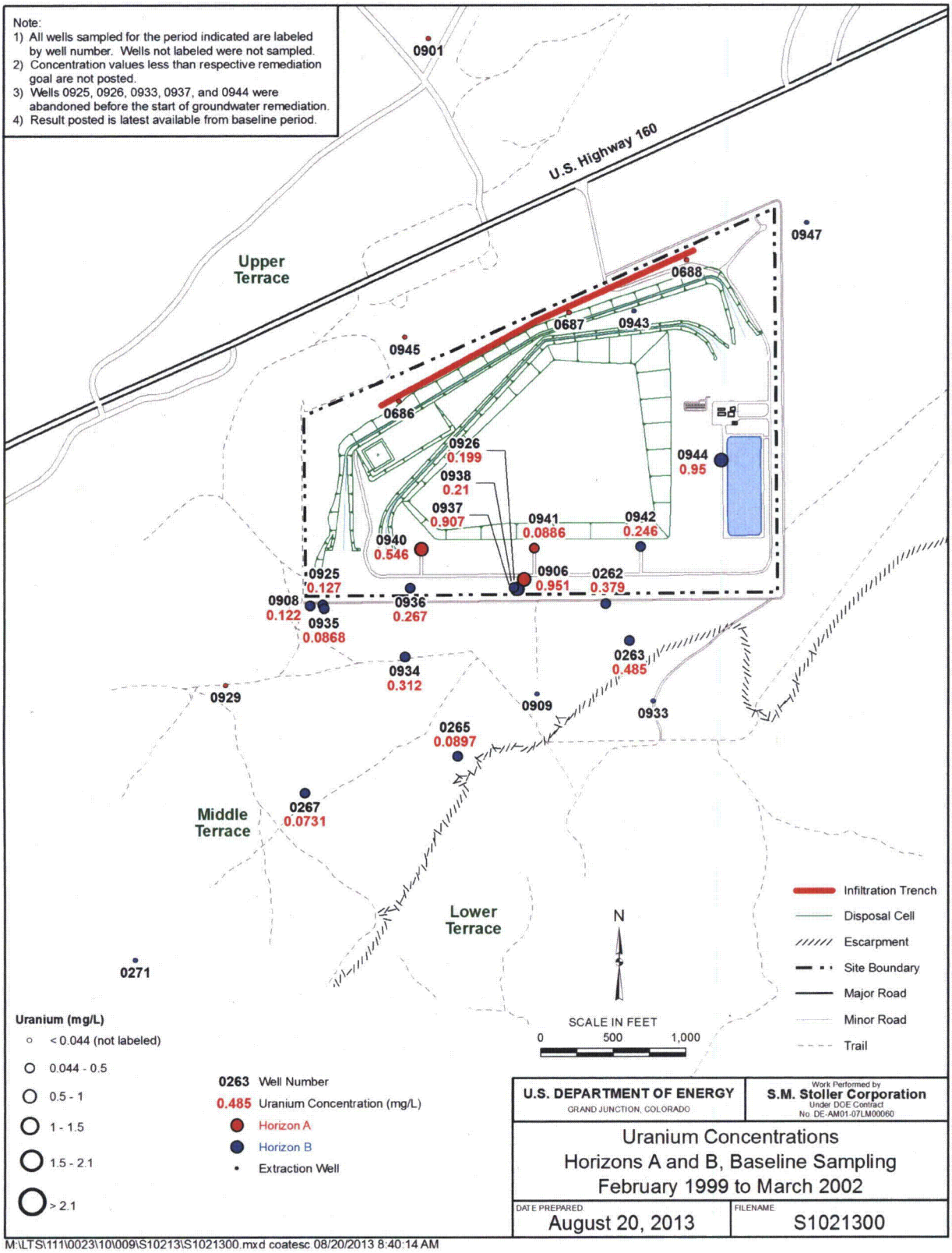

Figure 15a. Uranium Concentrations in Groundwater, Horizons A and B, Baseline Period

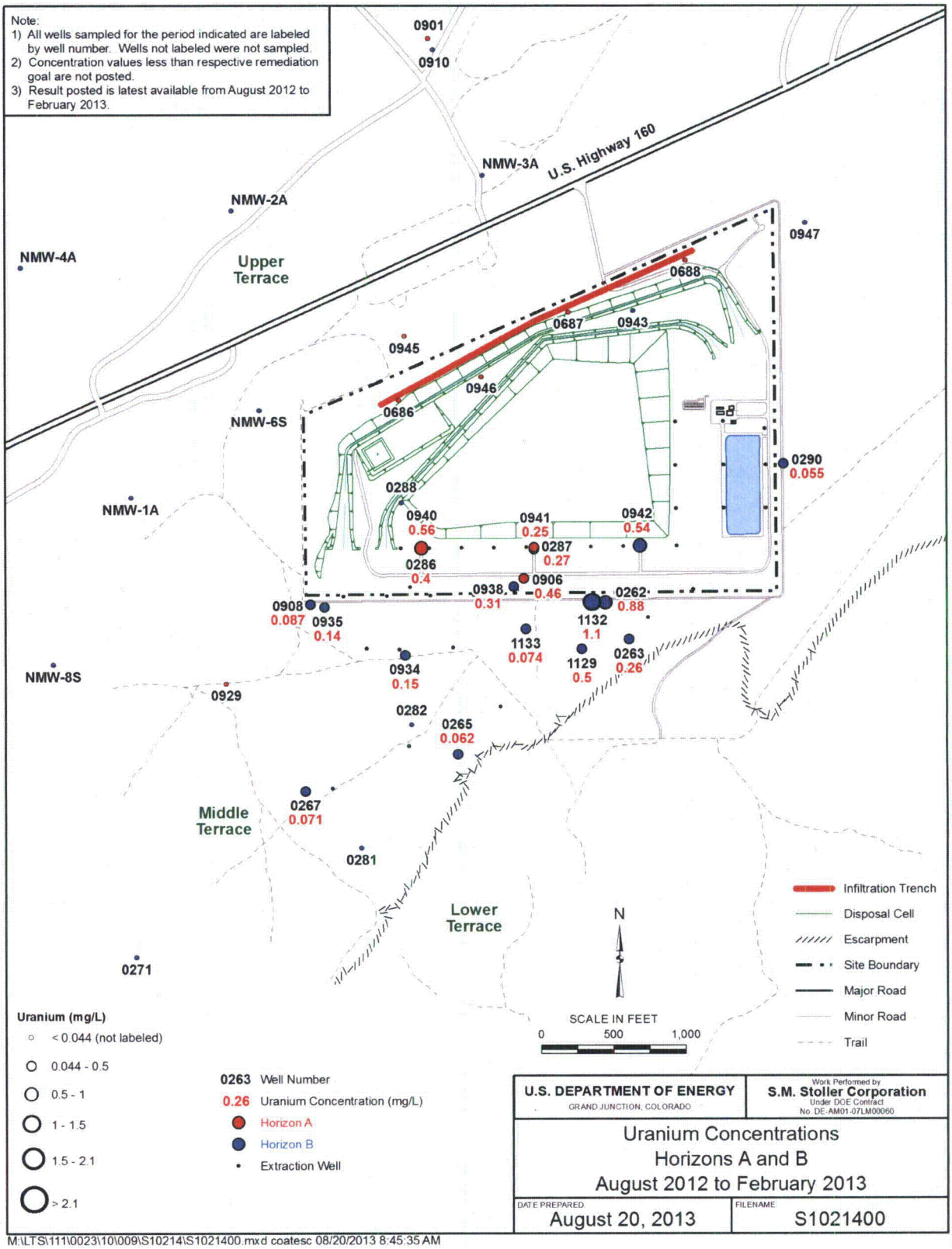

Figure 15b. Uranium Concentrations in Groundwater, Horizons A and B, February 2013

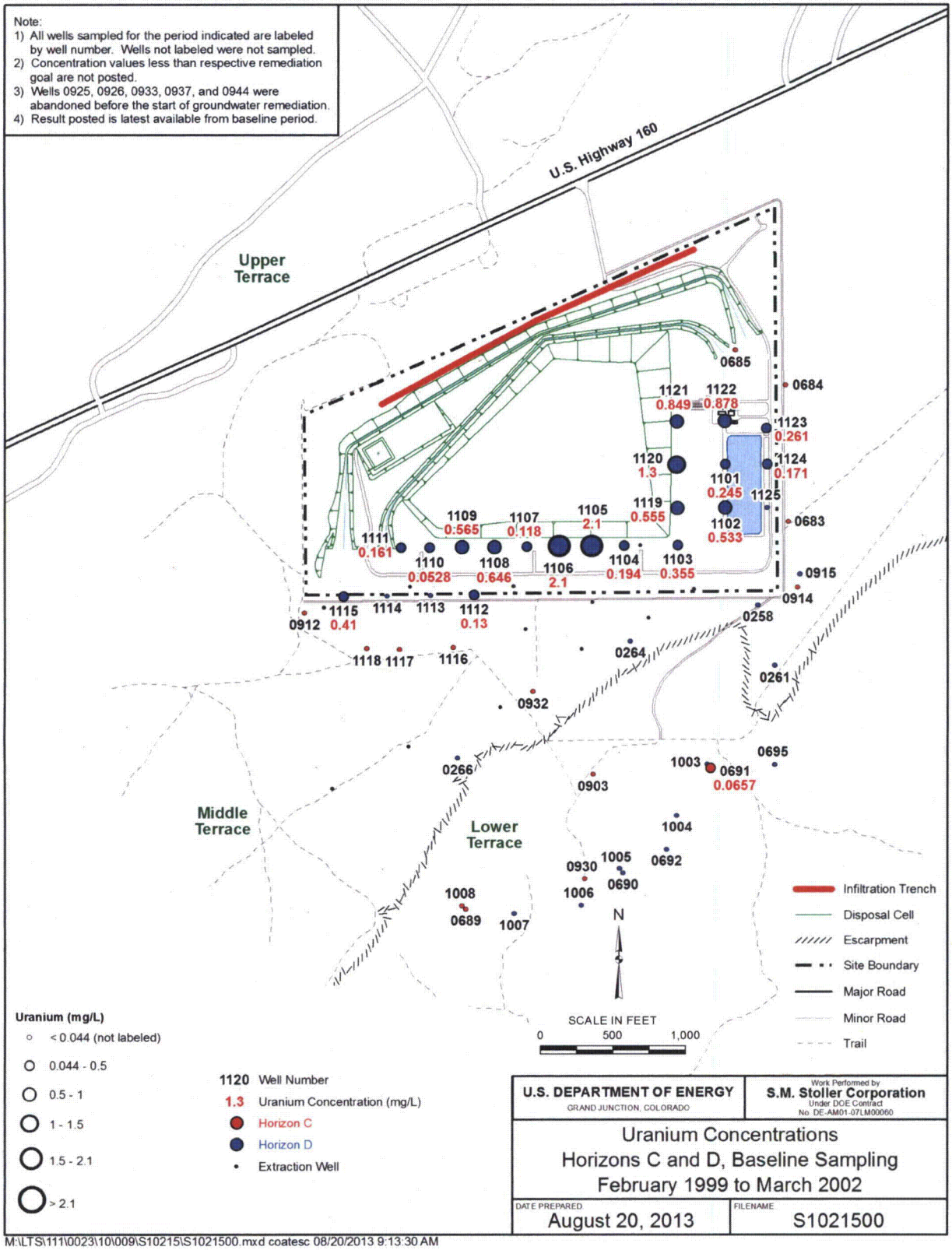

Figure 16a. Uranium Concentrations in Groundwater, Horizons C and D, Baseline Period

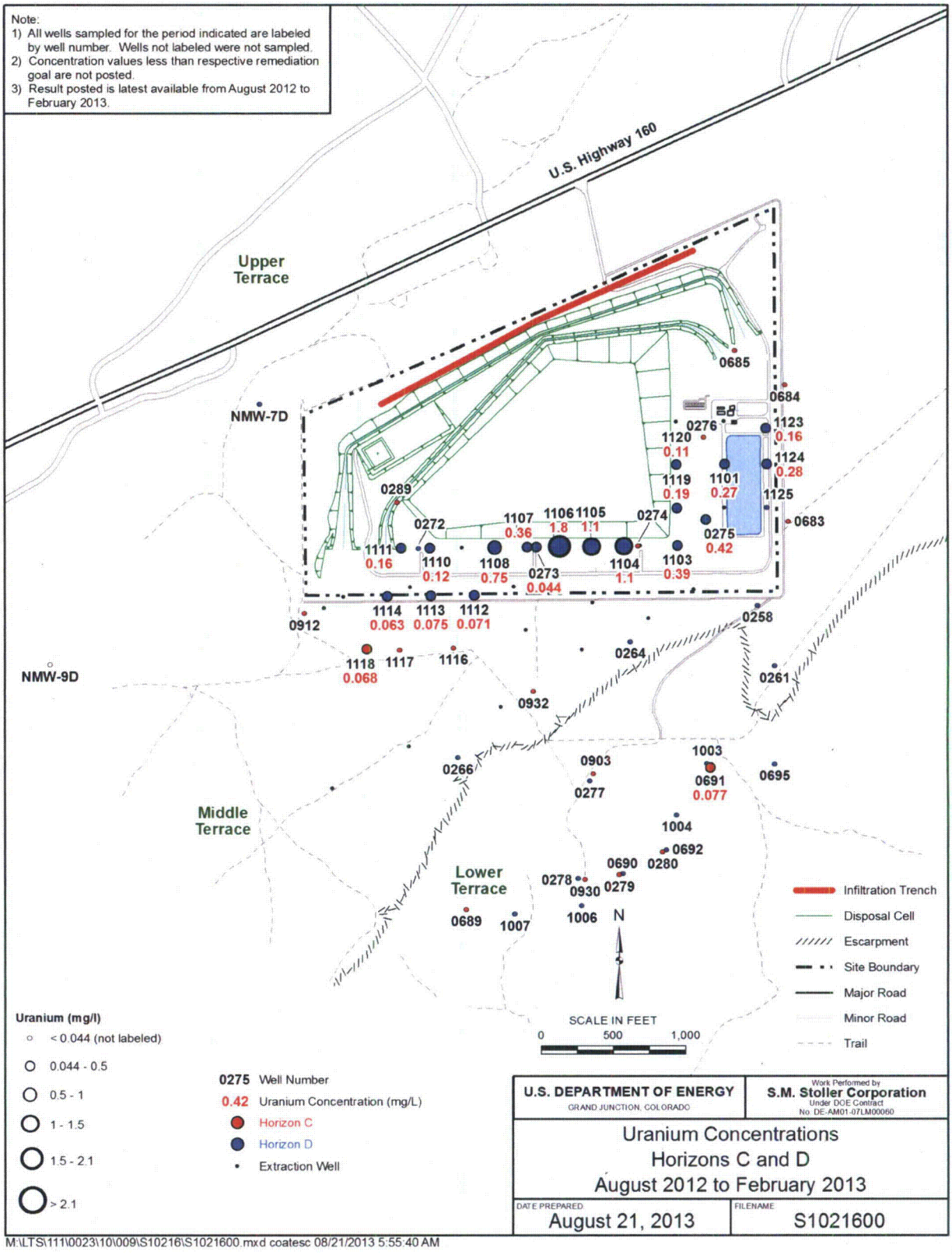

Figure 16b. Uranium Concentrations in Groundwater, Horizons C and D, February 2013

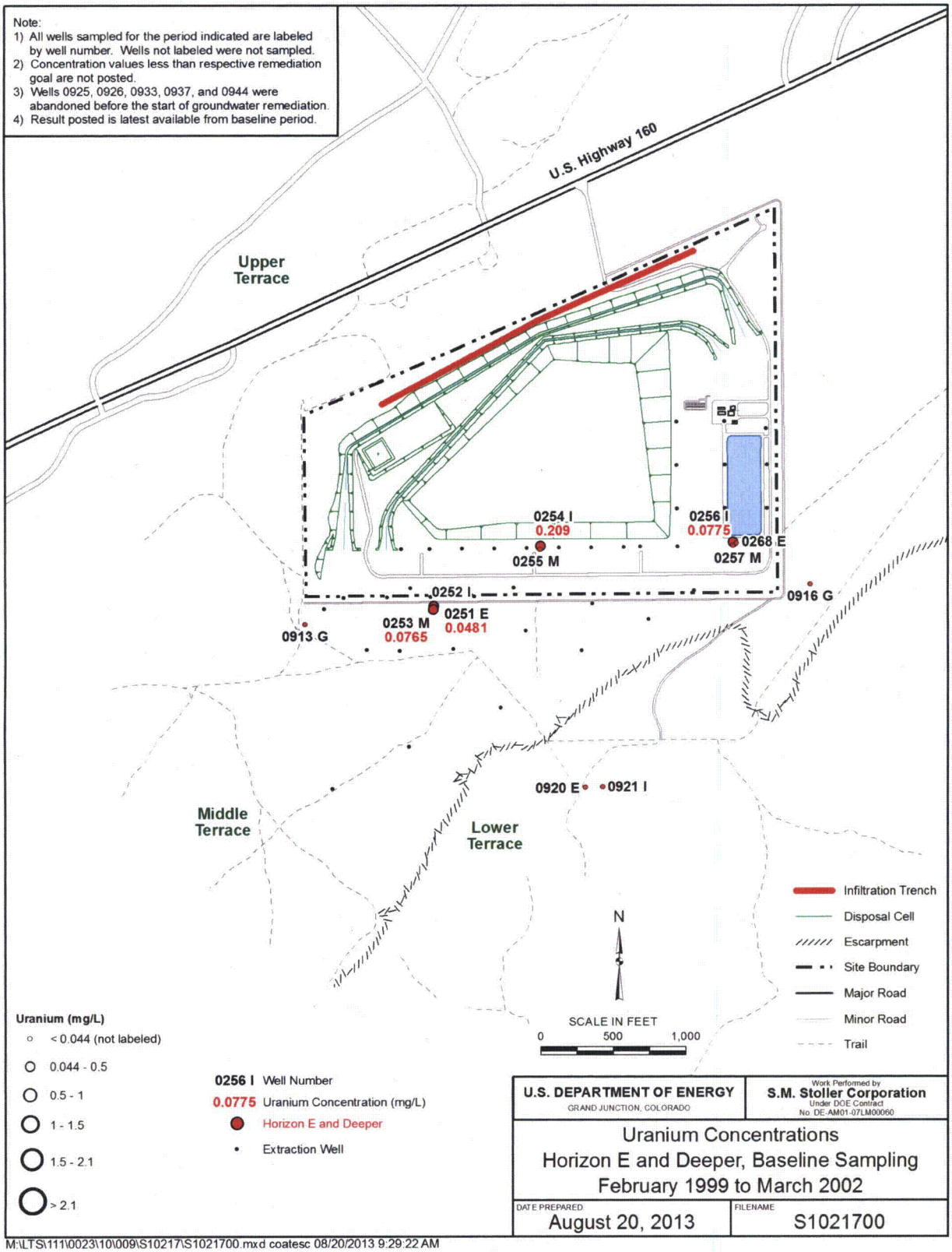

Figure 17a. Uranium Concentrations in Groundwater, Horizon E and Deeper, Baseline Period

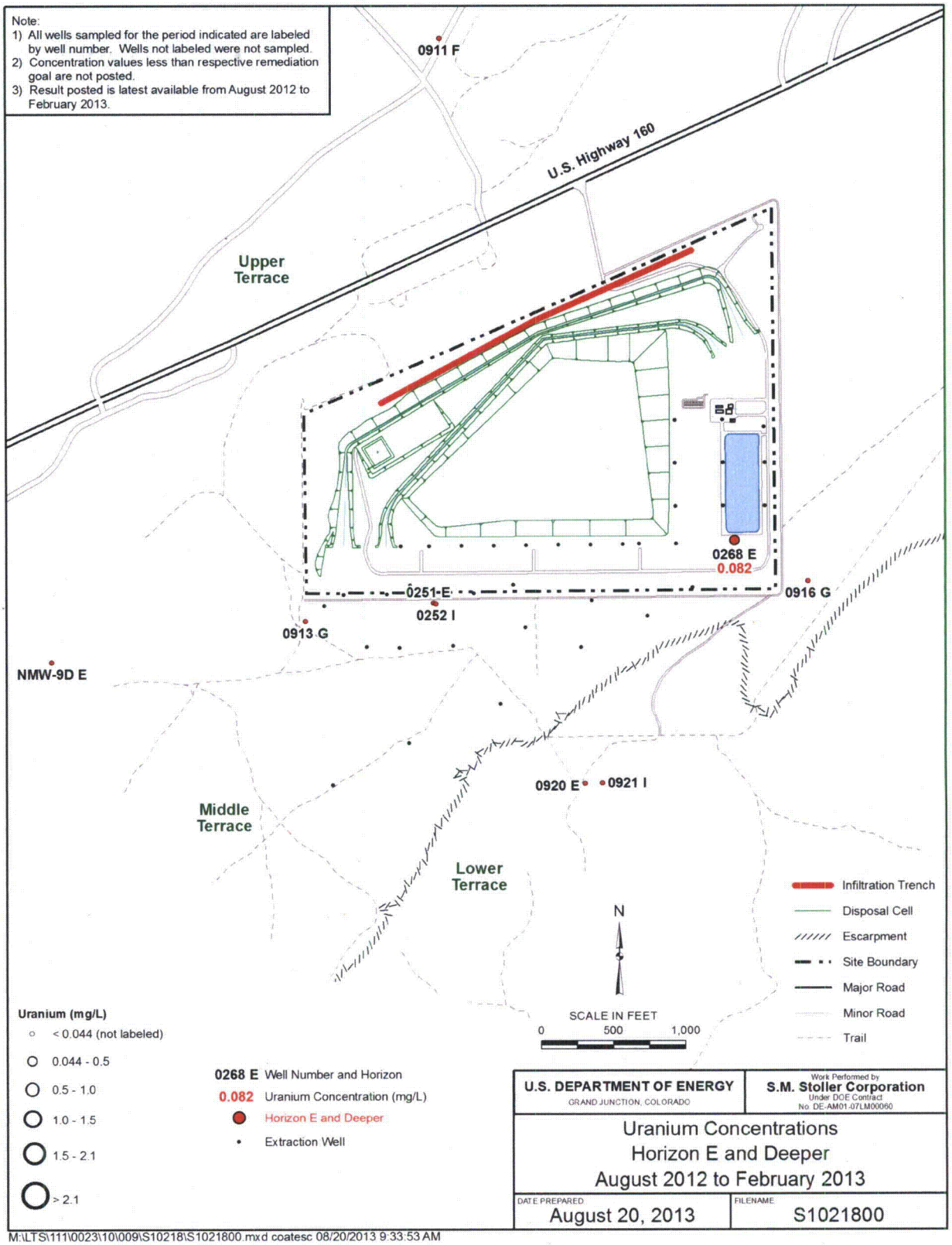

Figure 17b. Uranium Concentrations in Groundwater, Horizon E and Deeper, February 2013

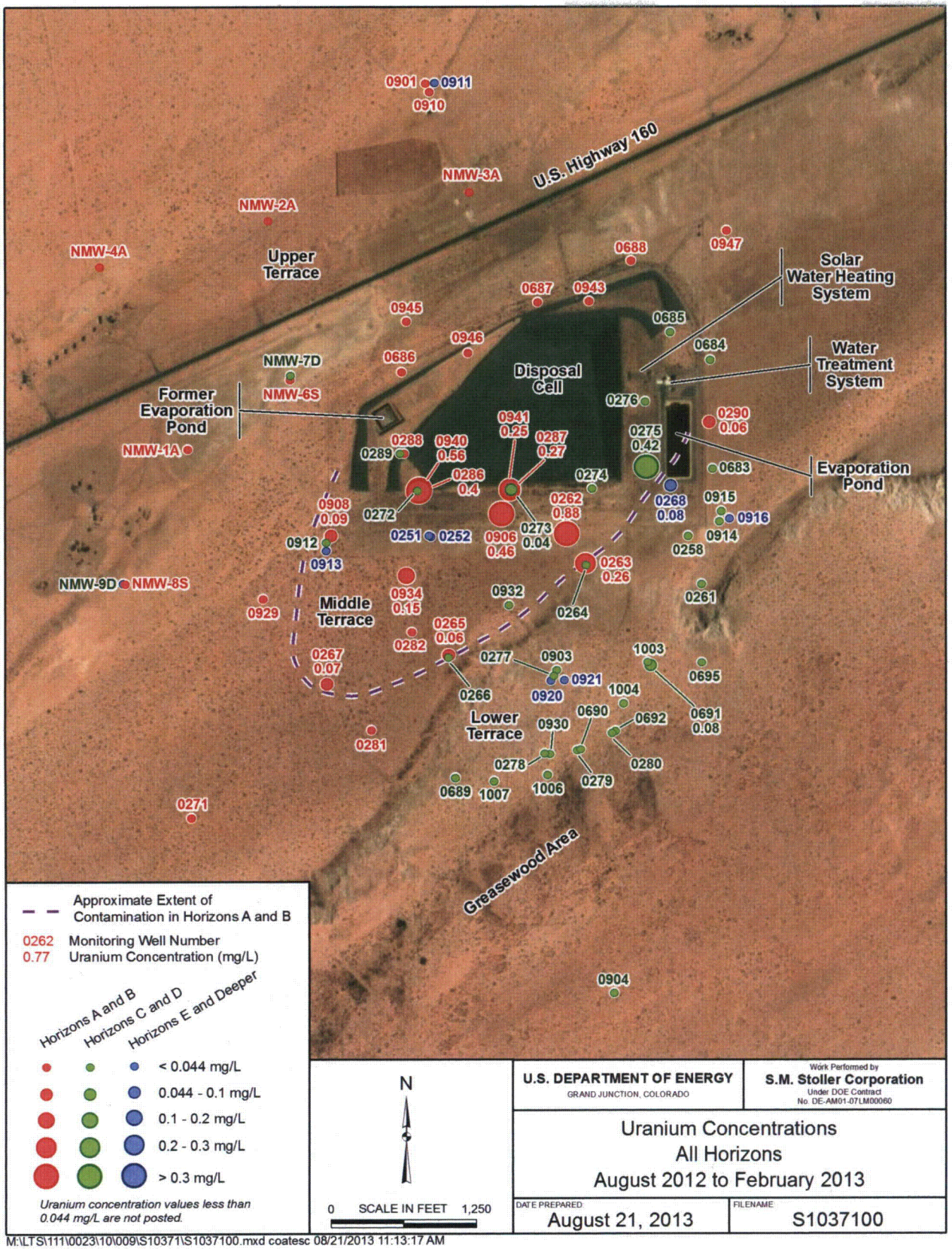

Figure 18. Uranium Concentrations in all Monitoring Wells (All Horizons), August 2012–February 2013

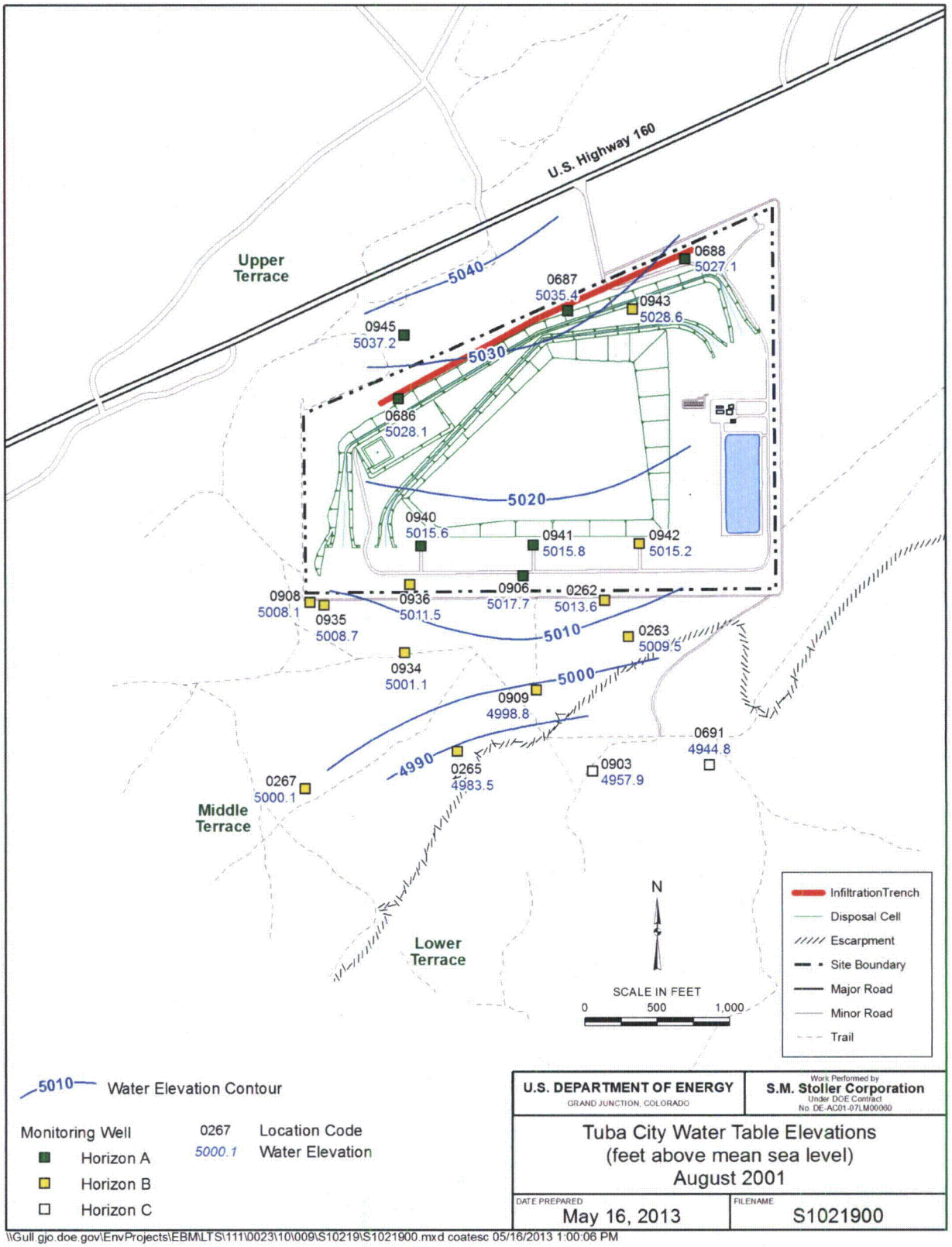

Figure 19. Water Table Elevations, Tuba City Site, August 2001

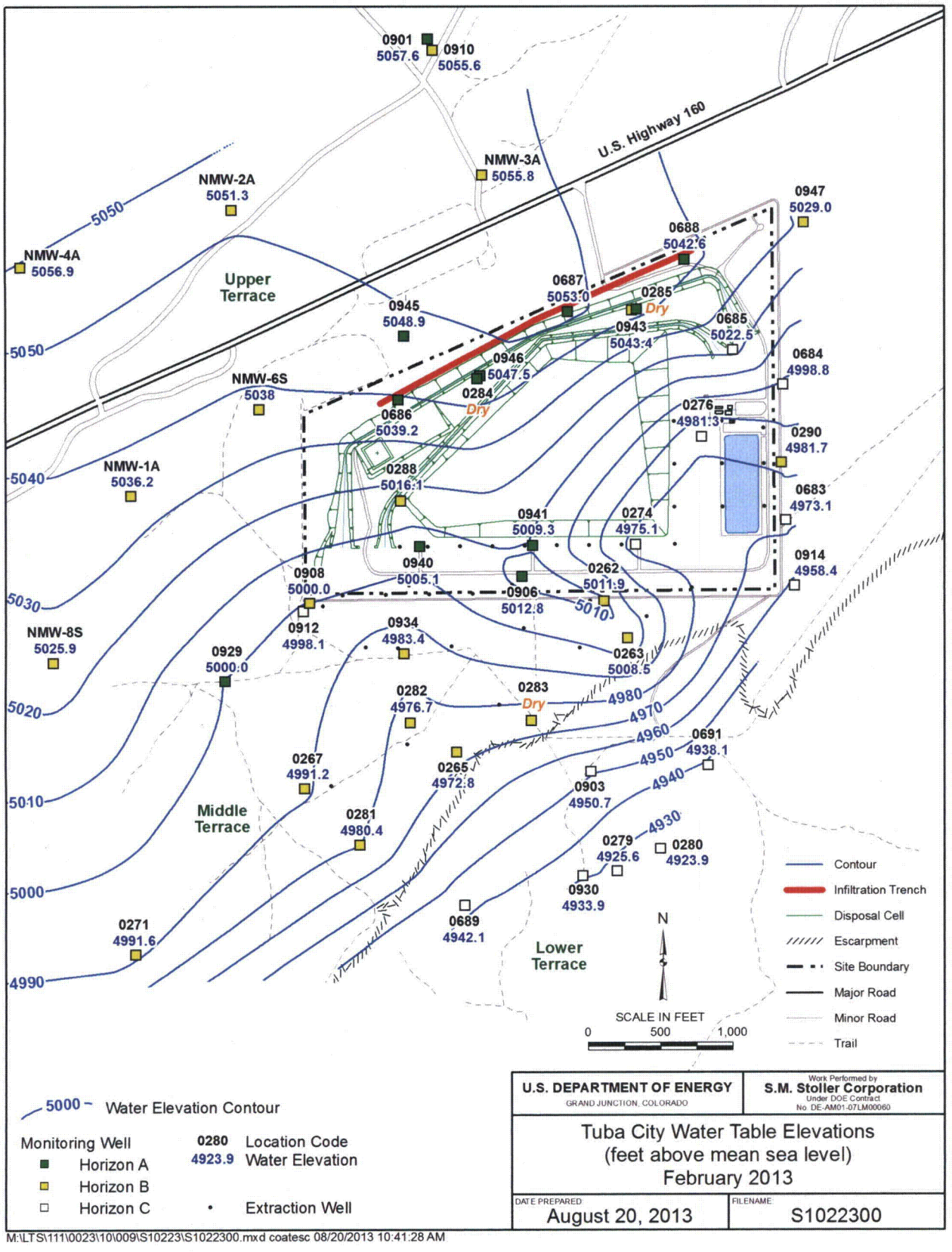

Figure 20. Water Table Contour Map, Tuba City Site, February 2013

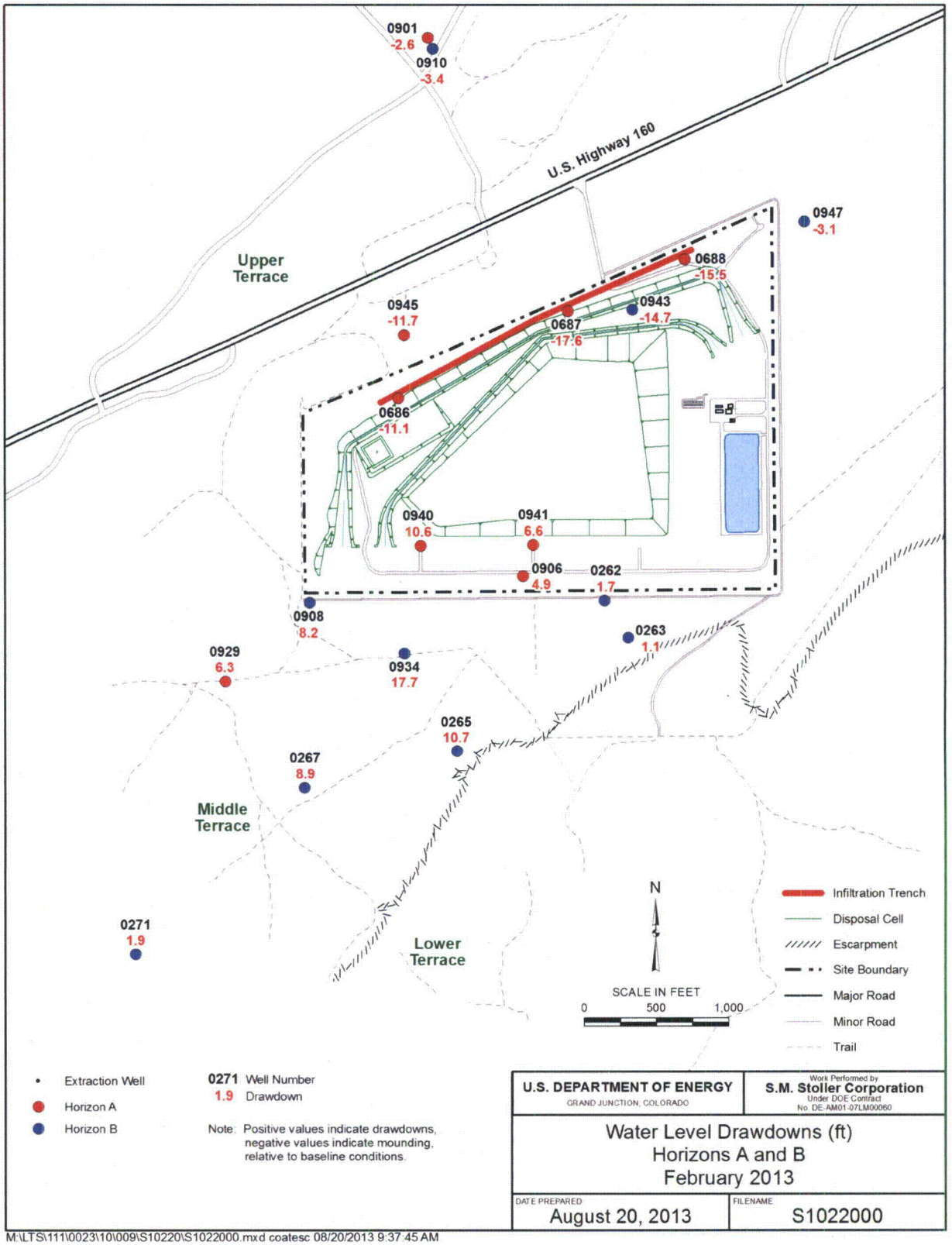

Figure 21. Water Level Drawdowns, Horizons A and B, February 2013

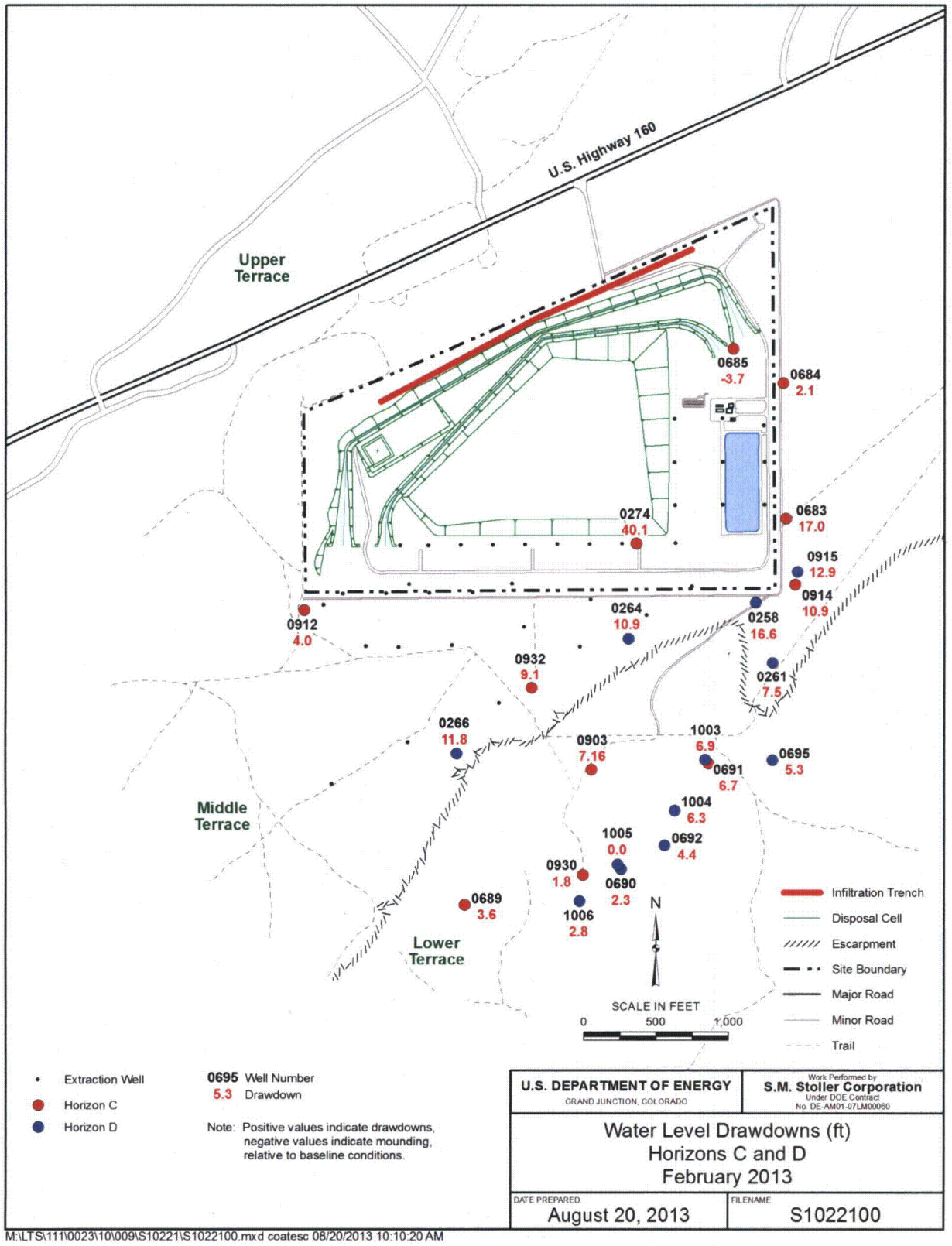

Figure 22. Water Level Drawdowns, Horizons C and D, February 2013

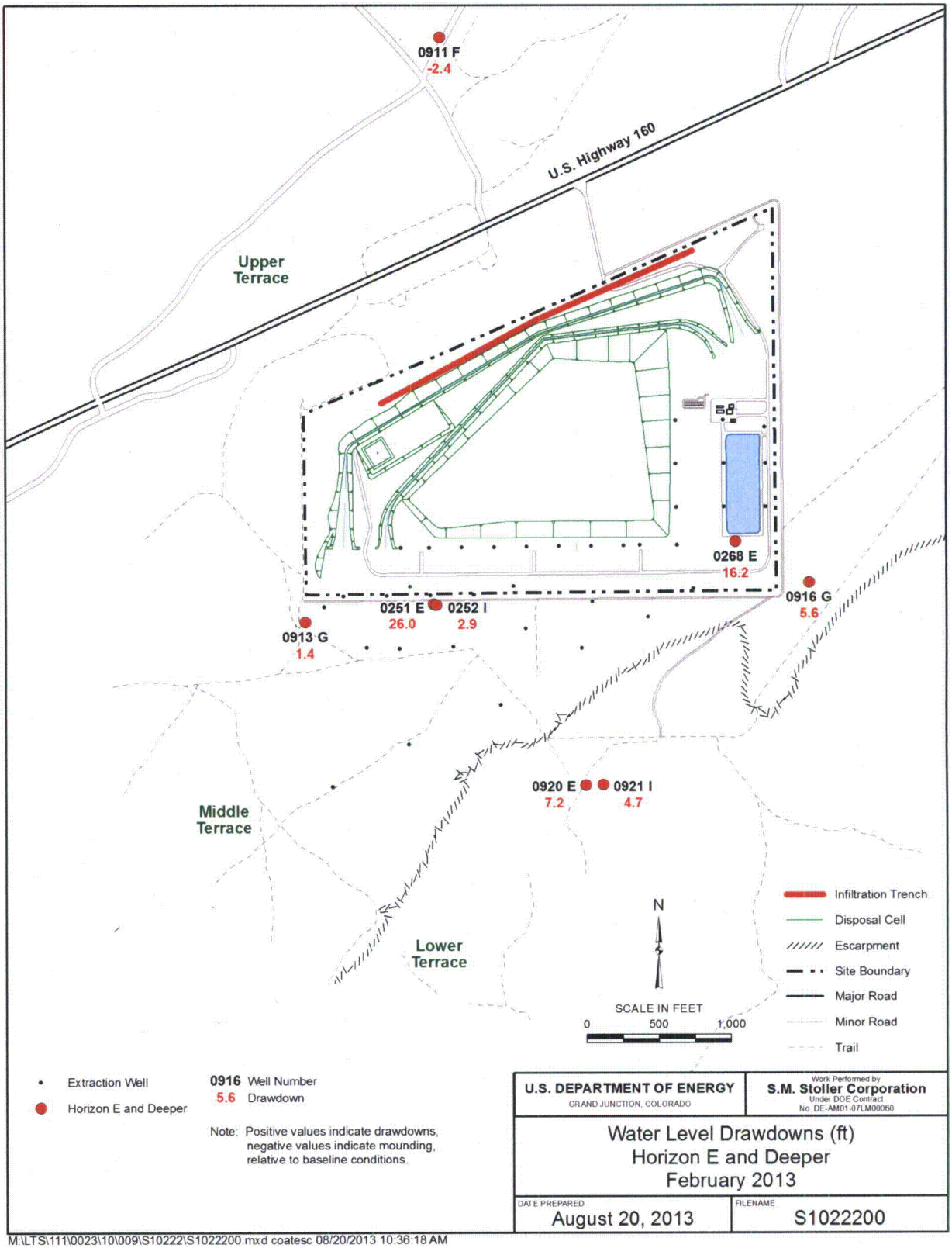

Figure 23. Water Level Drawdowns, Horizons E and Deeper, February 2013

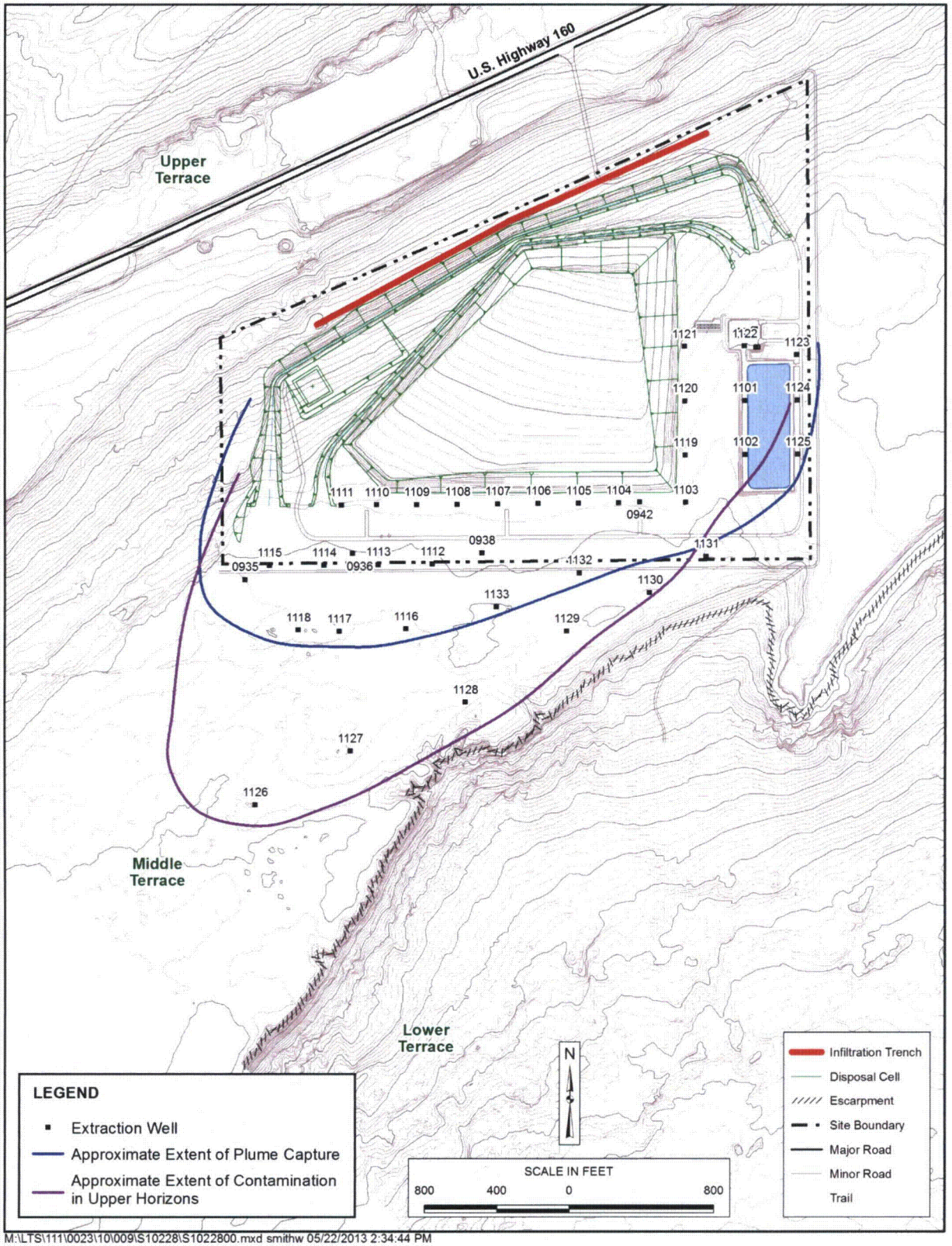

Figure 24. Approximate Extent of Groundwater Contamination and Extraction System Capture Zone, Horizons A and B

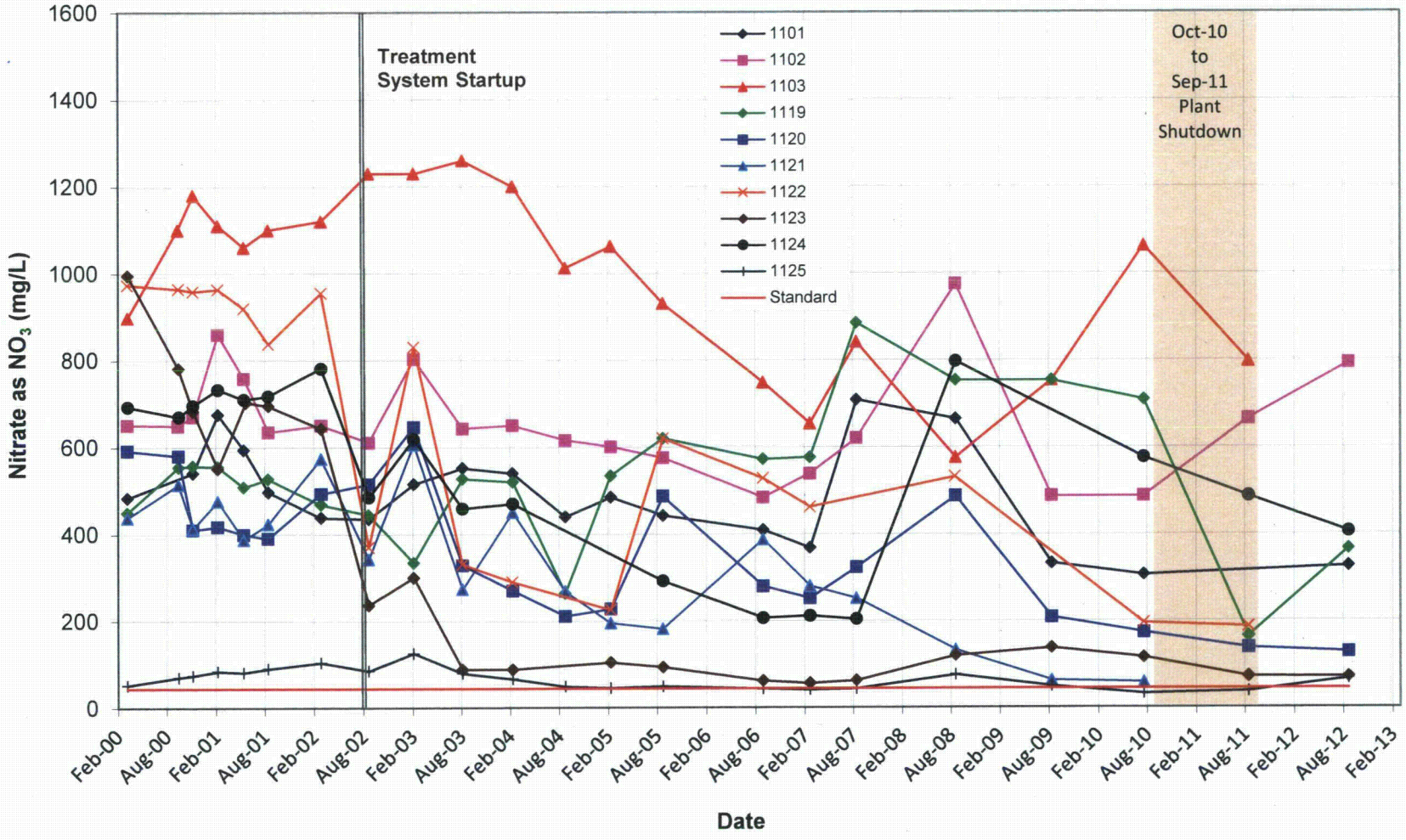

Figure 25a. Nitrate Concentration Trends at Extraction Wells 1101–1103, 1119–1125 (East of Disposal Cell)

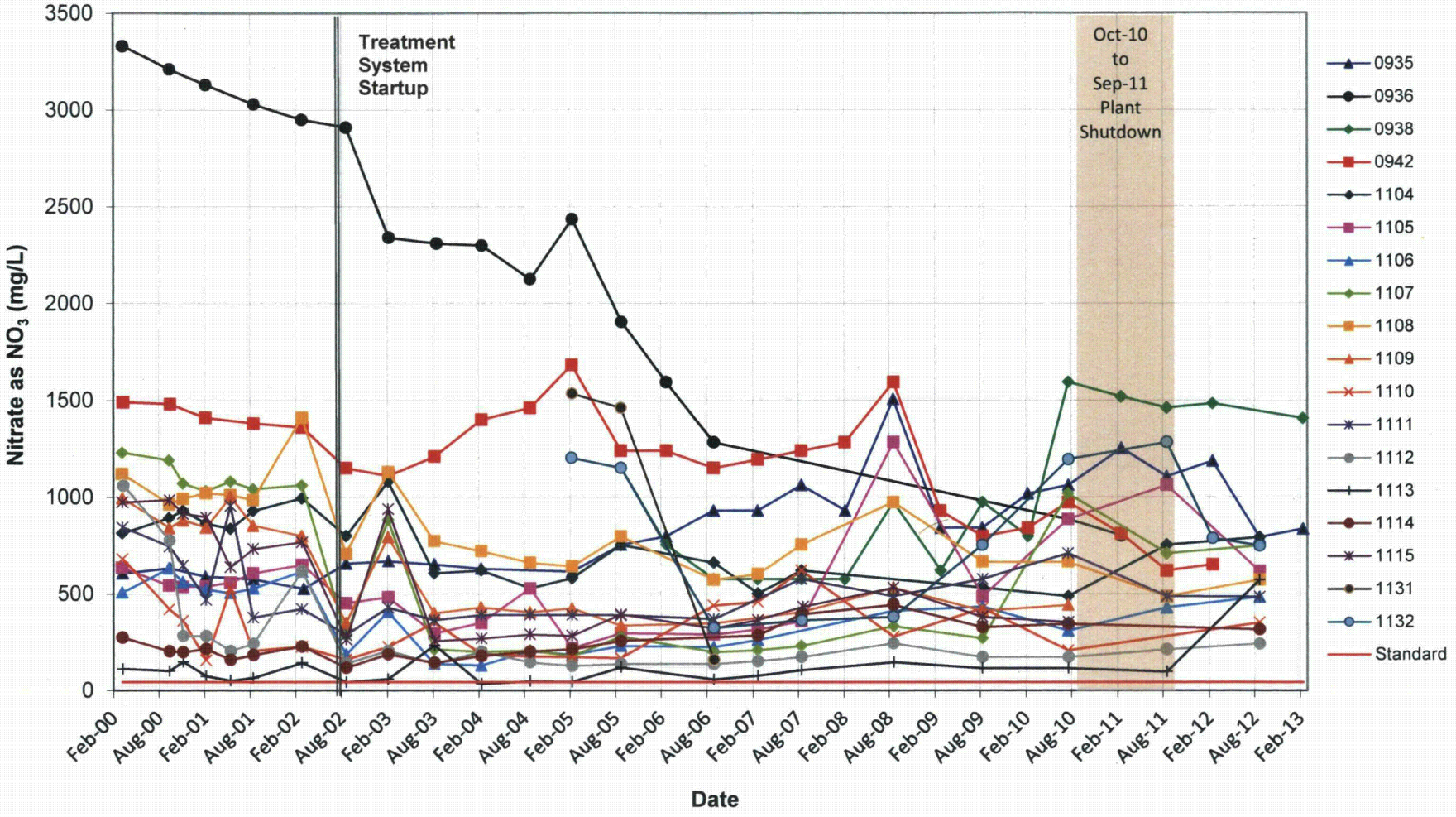

Figure 25b. Nitrate Concentration Trends at Extraction Wells 935–936, 938, 942, 1104–1115, 1131–1132 (South of Disposal Cell at or within Site Boundary)

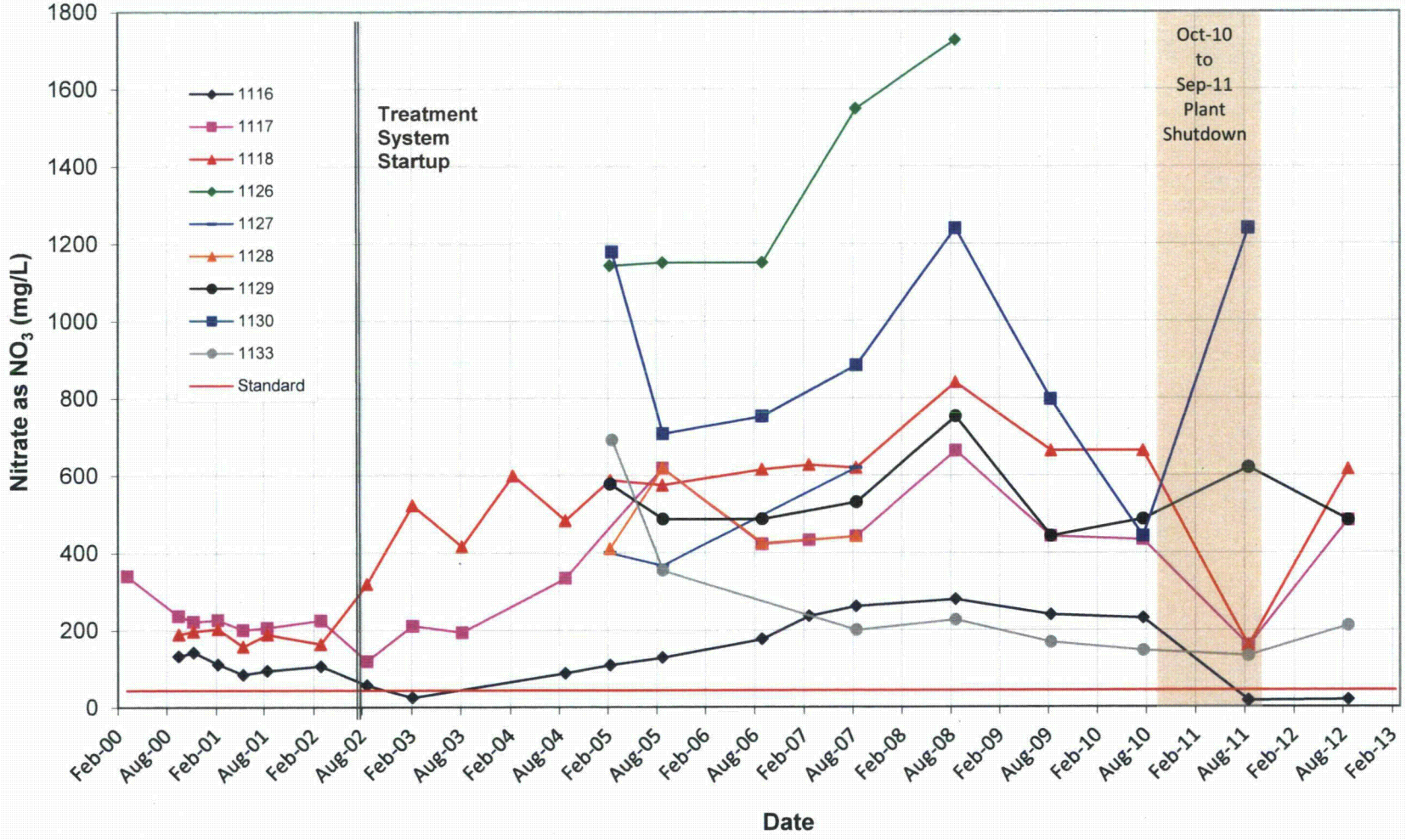

Figure 25c. Nitrate Concentration Trends at Southernmost Extraction Wells 1116–1118, 1126–1130, 1133

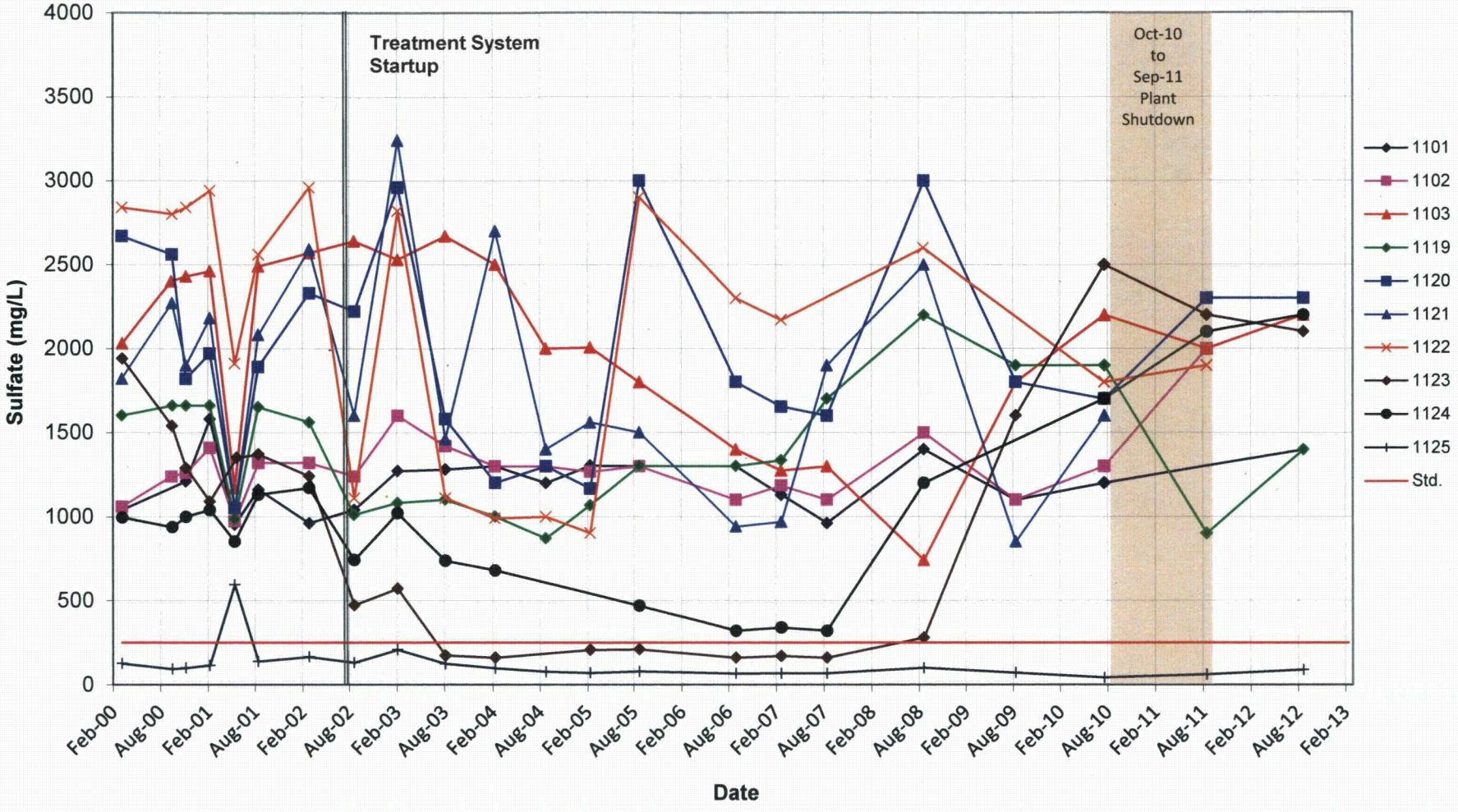

Figure 26a. Sulfate Concentration Trends at Extraction Wells 1101–1103, 1119–1125 (East of Disposal Cell)

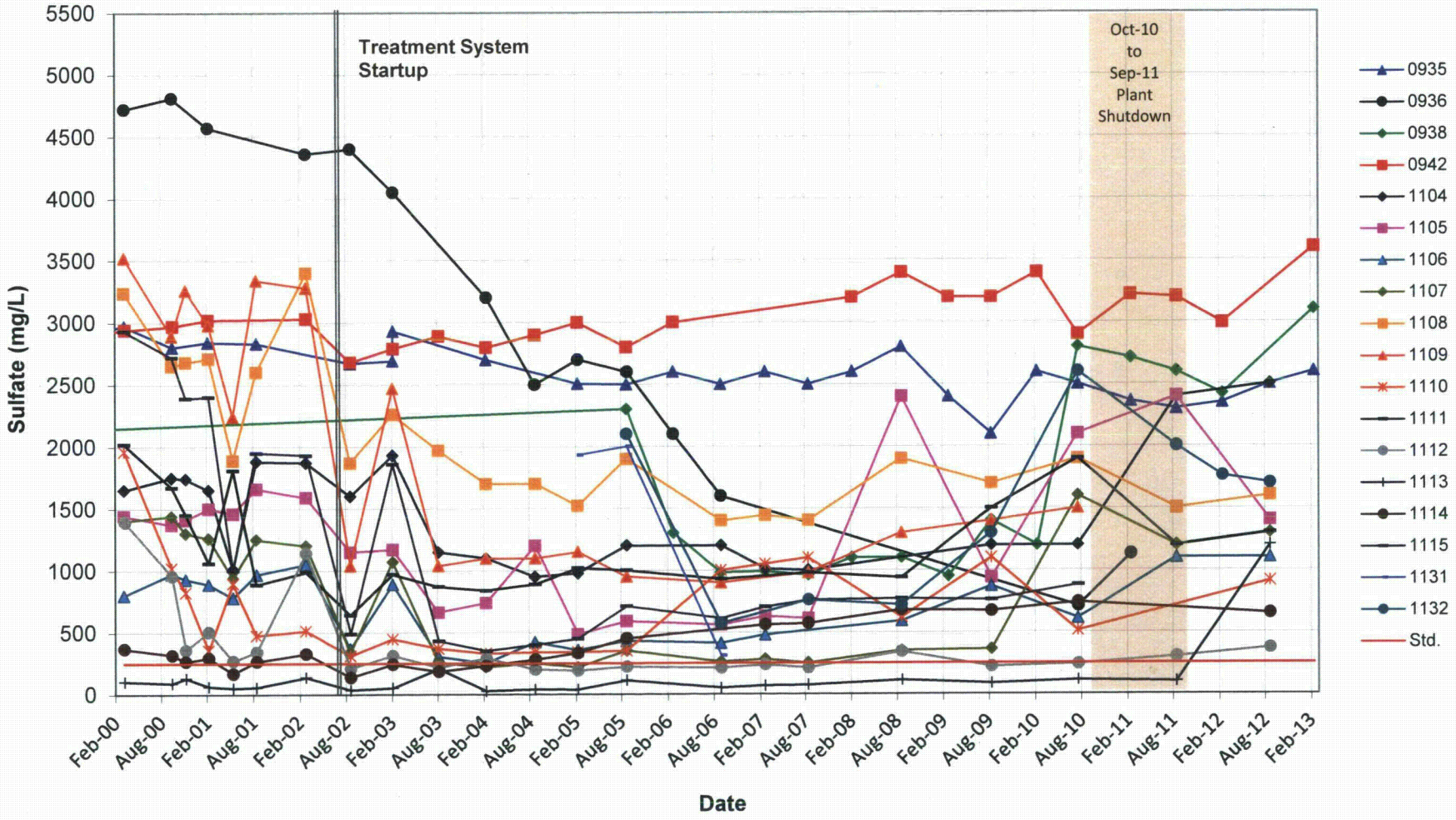

Figure 26b. Sulfate Concentration Trends at Extraction Wells 935–936, 938, 942, 1104–1115, 1131–1132 (South of Disposal Cell at or within Site Boundary)

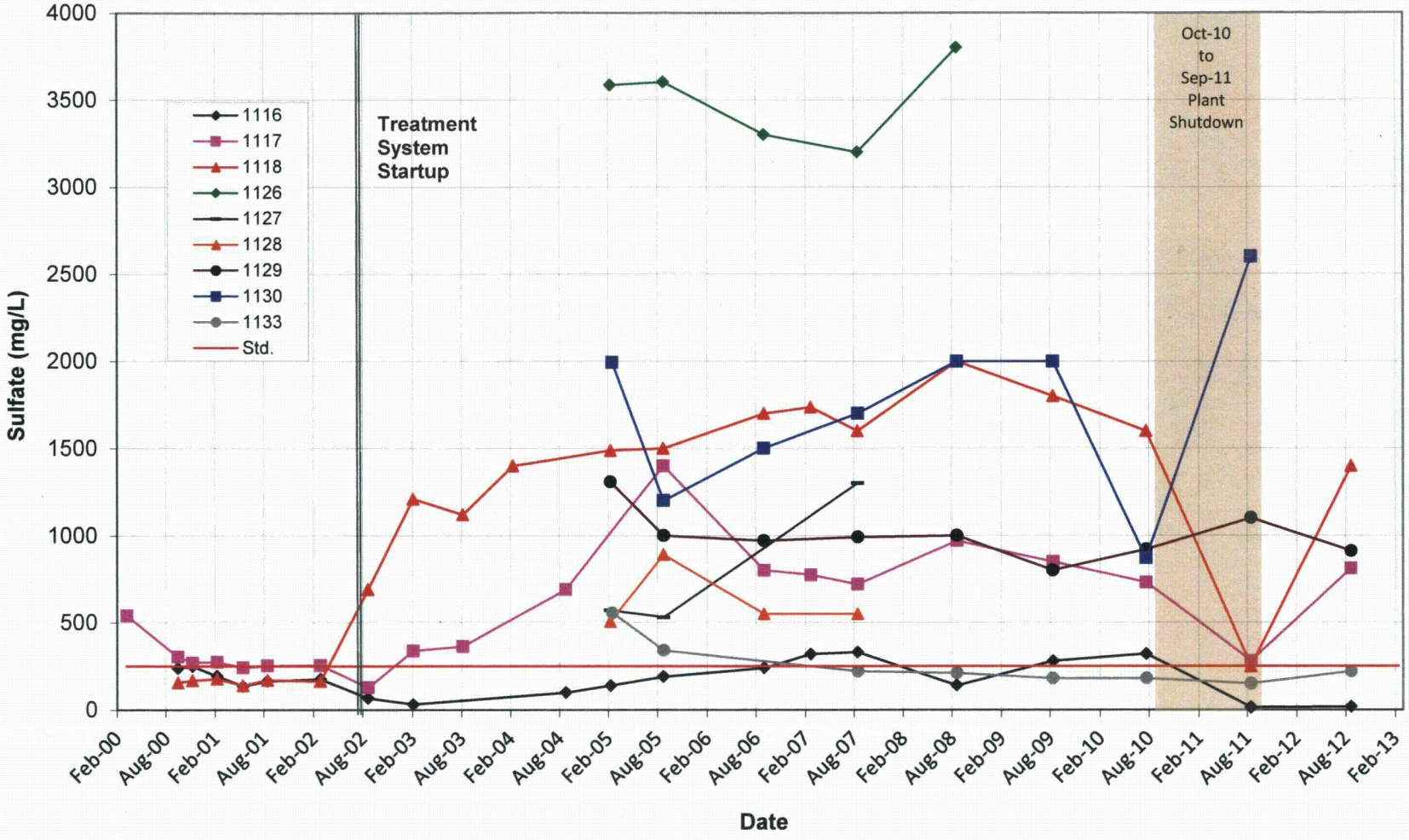

Figure 26c. Sulfate Concentration Trends at Southernmost Extraction Wells 1116–1118, 1126–1130, 1133

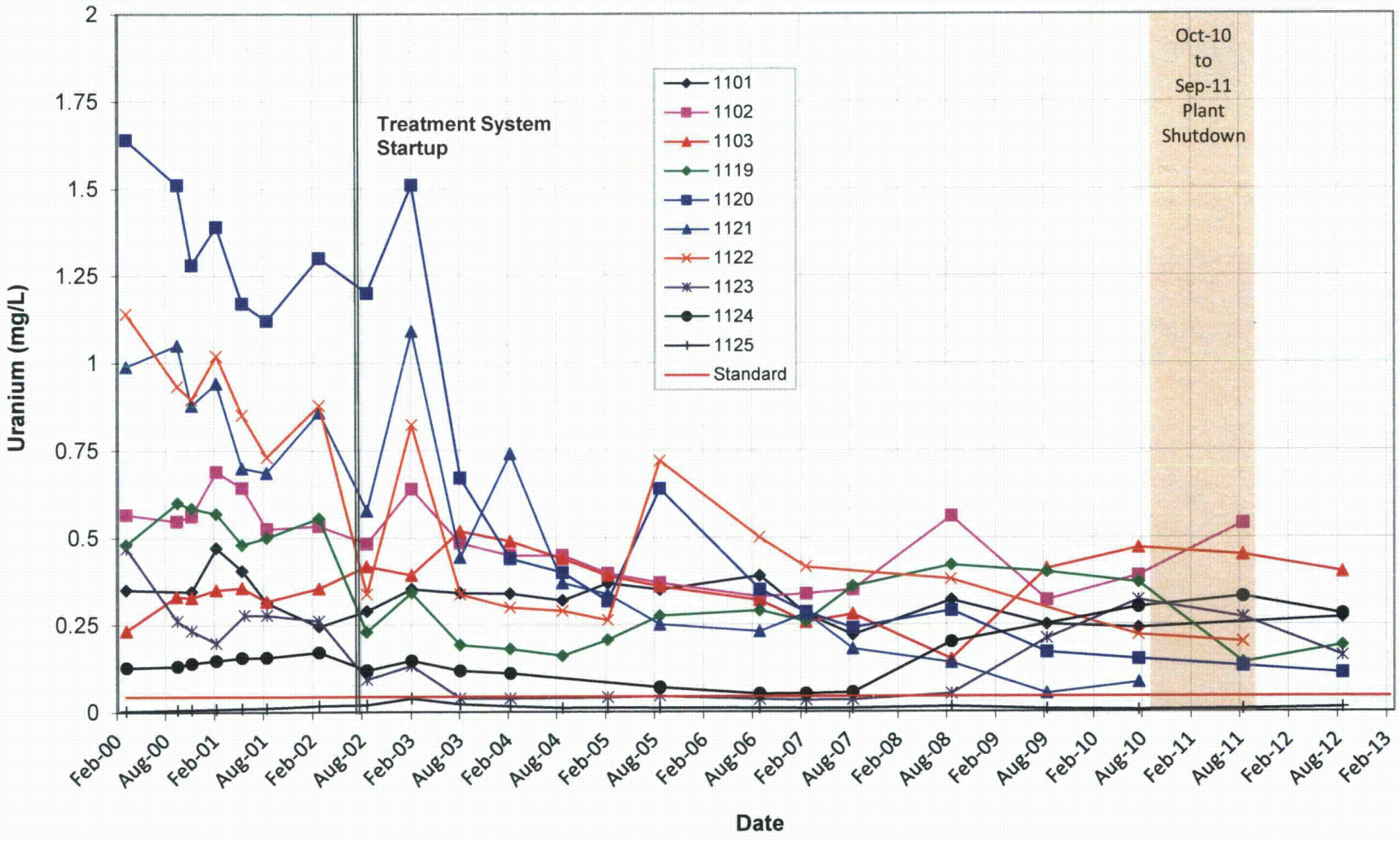

Figure 27a. Uranium Concentration Trends at Extraction Wells 1101–1103, 1119–1125 (East of Disposal Cell)

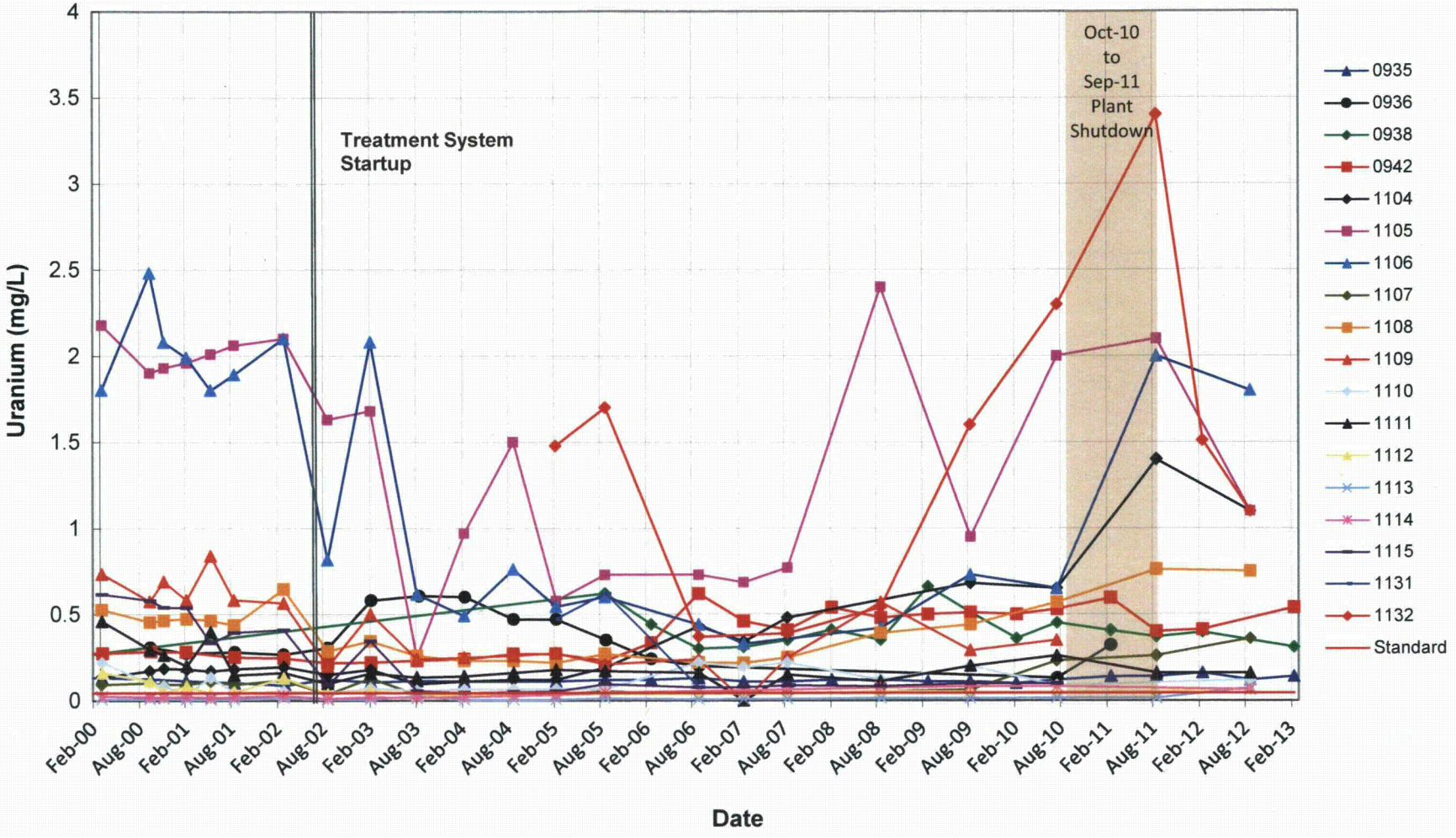

Figure 27b. Uranium Concentration Trends at Extraction Wells 935–936, 938, 942, 1104–1115, 1131–1132 (South of Disposal Cell at or within Site Boundary)

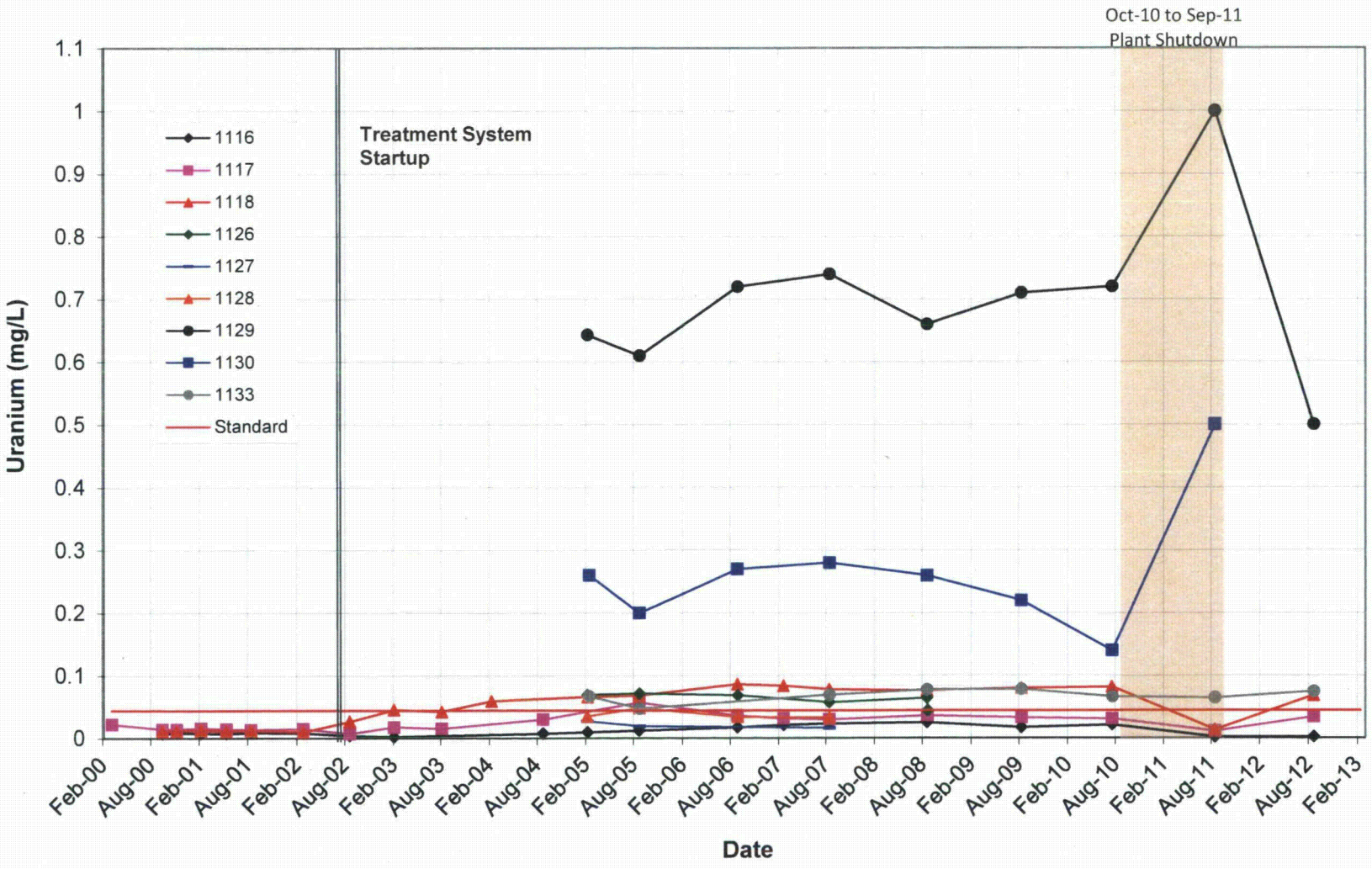

Figure 27c. Uranium Concentration Trends at Southernmost Extraction Wells 1116–1118, 1126–1130, 1133

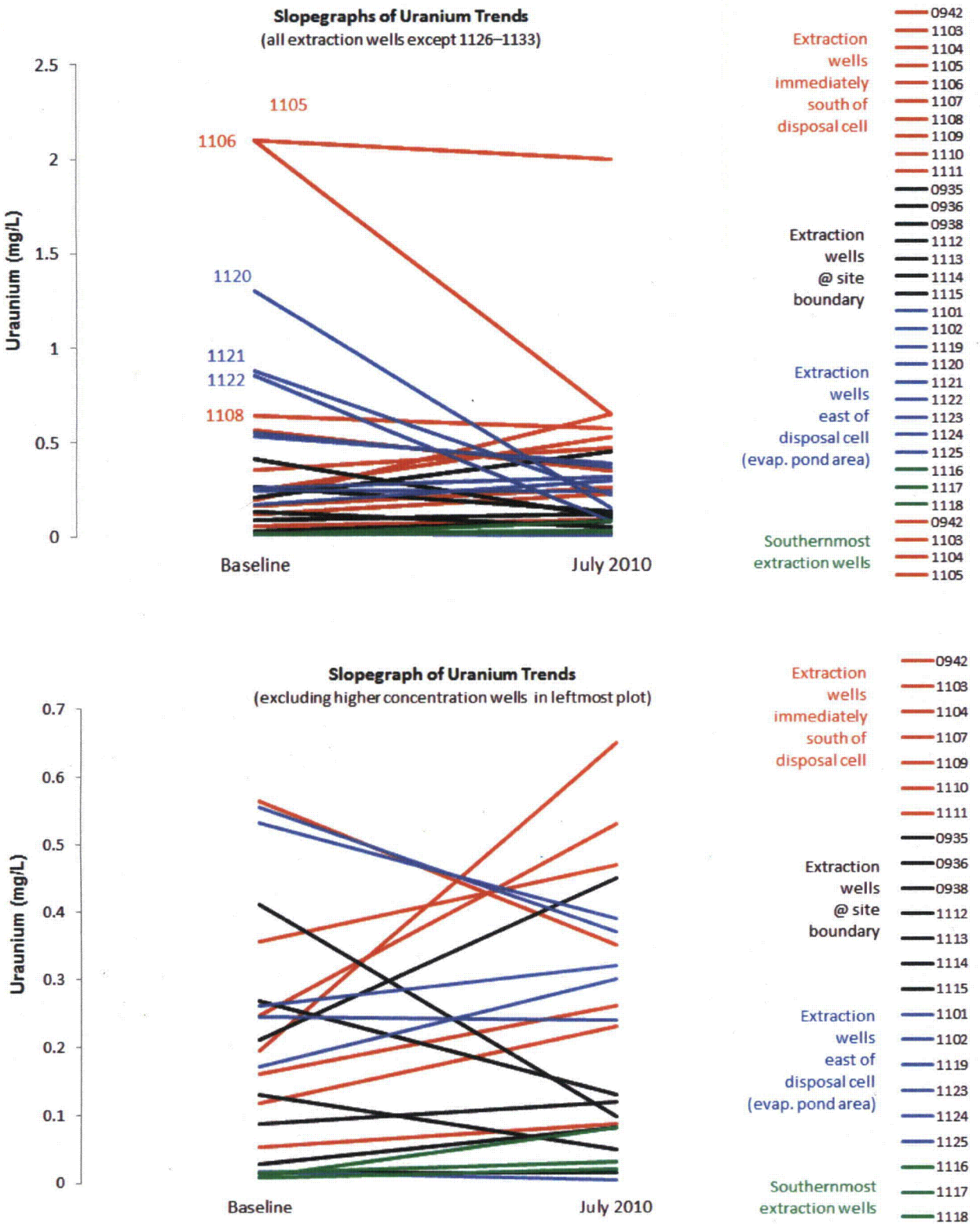

Figure 28. Slopegraph Overview of Trends at Extraction Wells: Baseline vs. Current Concentrations

Appendix A

Well Completion Information and Conceptual Site Model

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Figures

Table

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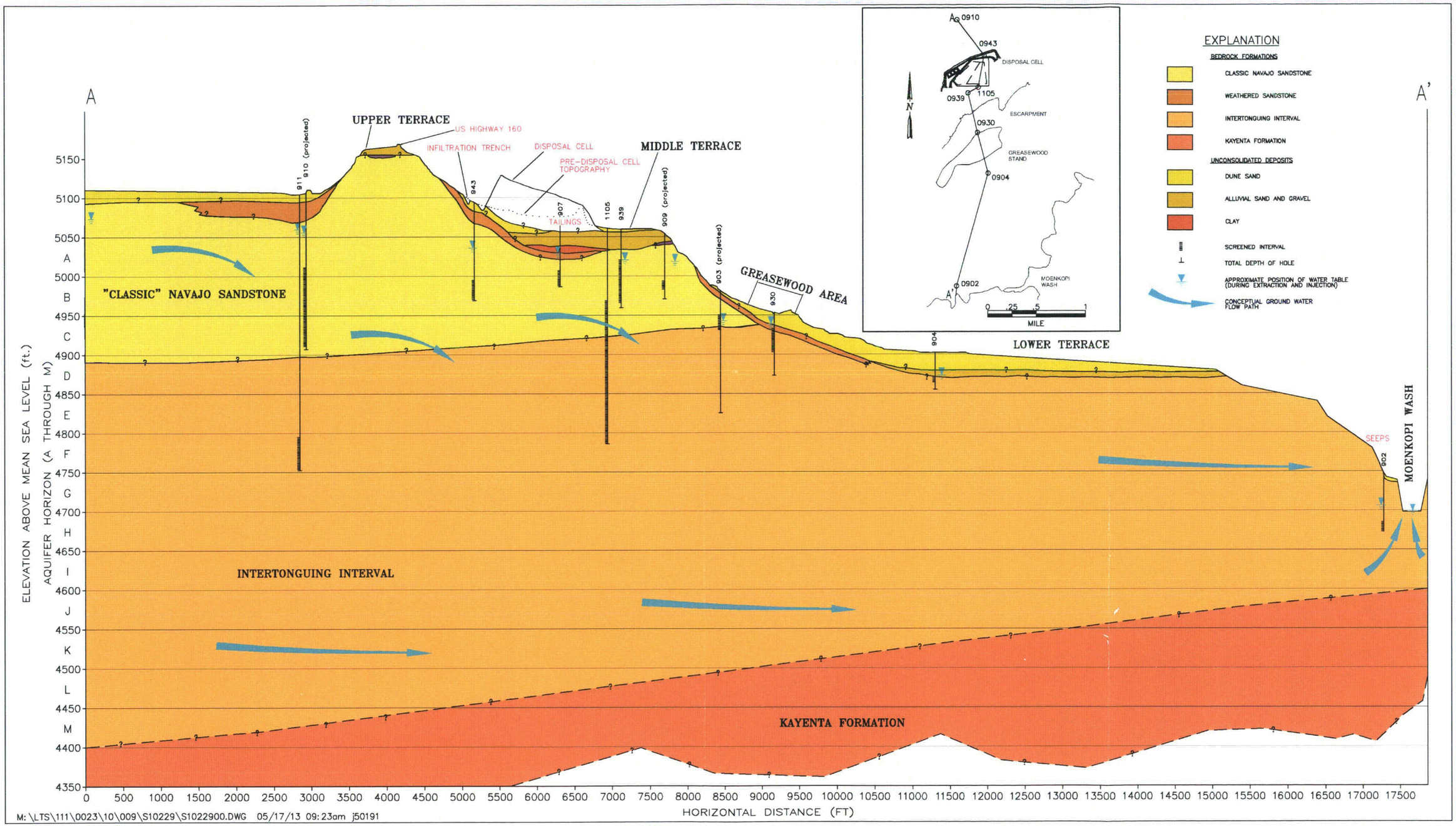

Figure A-1. Conceptual Model of the Site Hydrogeology

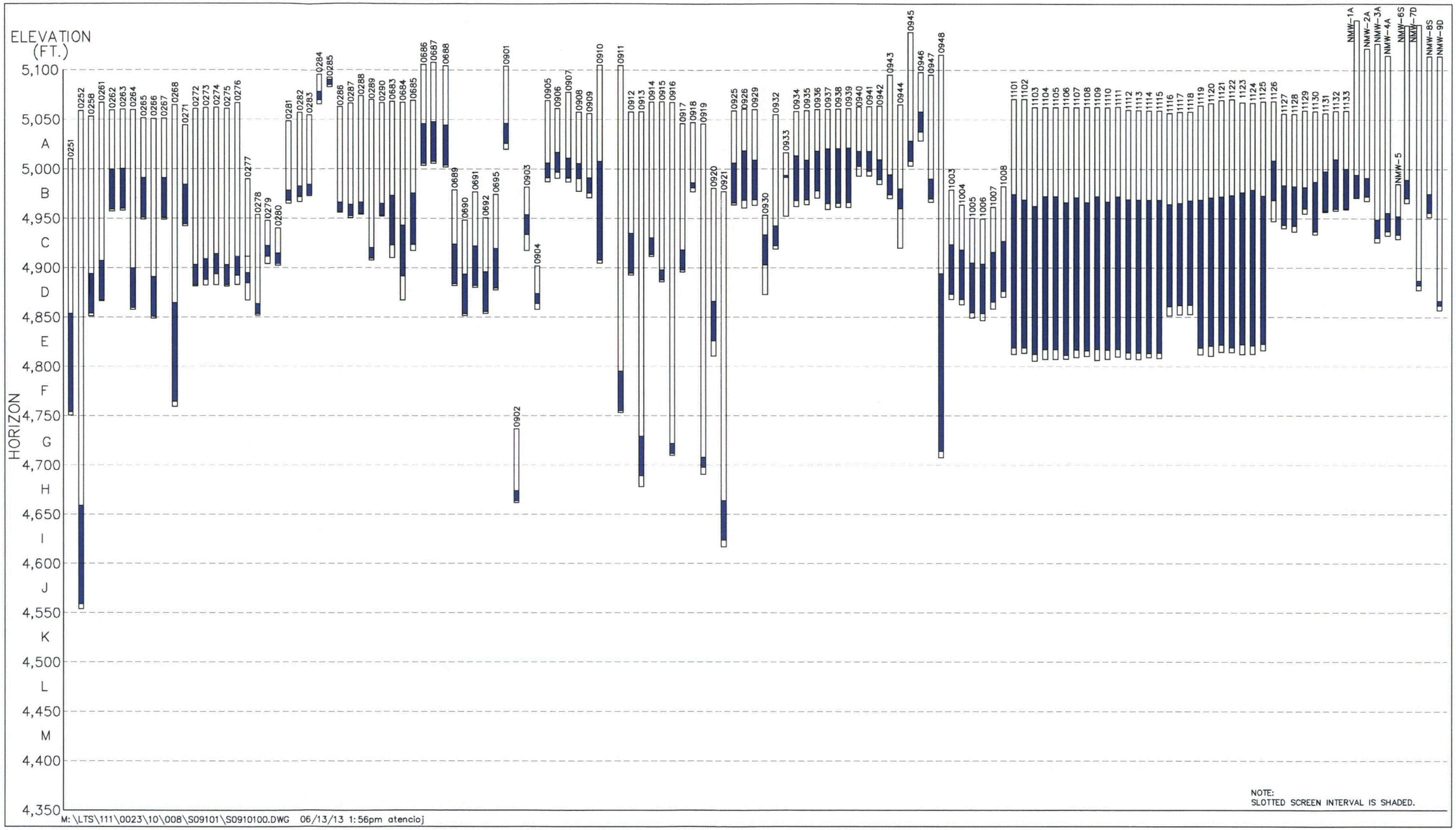

Figure A-2. Well Completions Schematic

Table A-1. Well Completion Information, Sorted on Well ID

Well	Type	Horizon	Sampling Frequency	Top Of Screen Elev.	Mid Screen Elev.	Bottom of Screen Elev.	Top of Screen Depth	Mid Screen Depth	Bottom of Screen Depth	Screen Length	Sump Length	Well Depth	Top of Casing Elev.	Note	Ground Elev.	Note	Well Diameter	Boring Started	Decommission Date	State Plane East	State Plane North
251	MW	E	Semiannual	4858.9	4808.9	4758.9	200	250	300	100	0.3	300.3	5061.25		5058.9		2	28-Apr-00		730215	1871999
252	MW	I	Semiannual	4658.9	4608.9	4558.9	400	450	500	100	0.4	500.4	5061.3		5058.9		4	26-Apr-00		730232	1871993
253	MW	M	DECOM	4458.8	4408.8	4358.8	600	650	700	100	0.4	700.4	5061.11		5058.8		4	18-Apr-00	11-Apr-01	730213	1871974
254	MW	I	DECOM	4662.7	4612.7	4562.7	400	450	500	100	0.4	500.4	5065.38		5062.7		4	3-May-00	13-Aug-05	730951	1872411
255	MW	M	DECOM	4462.3	4412.3	4362.3	600	650	700	100	0.4	700.4	5064.89		5062.3		4	1-May-00	12-Aug-05	730947	1872387
256	MW	I	DECOM	4664	4614	4564	400	450	500	100	0.4	500.4	5066.58		5064		4	13-May-00	14-Aug-05	732277	1872437
257	MW	M	DECOM	4463.4	4413.4	4363.4	600	650	700	100	0.4	700.4	5066.4		5063.4		4	11-May-00	11-Aug-05	732278	1872414
258	MW	D	Semiannual	4894	4874	4854	159	179	199	40	0.3	199.3	5055.56		5053		2	13-Apr-00		732452	1871996
261	MW	D	Annual	4907	4887	4867	160	180	200	40	0.3	200.3	5069.69		5067		2	1-Apr-00		732565	1871578
262	MW	B	Semiannual	4999.2	4979.2	4959.2	60	80	100	40	0.3	100.3	5061.99		5059.2		2	3-Apr-00		731402	1872012
263	MW	B	Semiannual	5000.2	4980.2	4960.2	60	80	100	40	0.3	100.3	5063.1		5060.2		2	4-Apr-00		731565	1871757
264	MW	D	Semiannual	4899.6	4879.6	4859.6	160	180	200	40	0.3	200.3	5062.19		5059.6		2	3-Apr-00		731569	1871746
265	MW	B	Semiannual	4991.1	4971.1	4951.1	60	80	100	40	0.3	100.3	5053.88		5051.1		2	16-Apr-00		730382	1870964
266	MW	D	Semiannual	4890.6	4870.6	4850.6	160	180	200	40	0.3	200.3	5053.32		5050.6		2	15-Apr-00		730380	1870941
267	MW	B	Semiannual	4990.8	4970.8	4950.8	60	80	100	40	0.3	100.3	5053.4		5050.8		2	14-Apr-00		729329	1870707
268	MW	E	Semiannual	4864.5	4814.5	4764.5	200	250	300	100	0.3	300.3	5067.24		5064.5		2	15-May-00		732301	1872430
271*	MW	B	Annual	4984	4964	4944	60	80	100	40	0.3	100.3	5046.72		5044		2	29-Apr-00		728160	1869555
272	MW	D	Semiannual	4902.8	4892.8	4882.8	159.1	169.1	179.1	20	1.5	180.6	5064.24		5061.9		2	28-Aug-04		730112	1872389
273	MW	D	Semiannual	4909.4	4899.4	4889.4	153	163	173	20	1.5	174.5	5064.74		5062.4		2	29-Aug-04		730922	1872397
274	MW	C	Semiannual	4913.6	4903.6	4893.6	149	159	169	20	1.5	170.5	5064.42		5062.6		2	30-Aug-04		731623	1872403
275	MW	D	Semiannual	4903	4893	4883	158.2	168.2	178.2	20	1.5	179.7	5062.64		5061.2		2	1-Sep-04		732092	1872586
276	MW	C	Semiannual	4910	4900	4890	154.5	164.5	174.5	20	1.5	176	5067.55		5064.5		2	1-Sep-04		732081	1873158
277	MW	D	Annual	4884	4879	4874	95.7	100.7	105.7	10	1.5	107.2	4982.35		4979.7		2	12-Aug-04		731290	1870777
278	MW	D	Annual	4862.9	4857.9	4852.9	90.5	95.5	100.5	10	1.5	102	4956.09		4953.4		2	14-Aug-04		731210	1870104
279	MW	C	Annual	4922.1	4917.1	4912.1	26.5	31.5	36.5	10	1.5	38	4951.04		4948.6		2	15-Aug-04		731494	1870132
280	MW	C	Annual	4922.6	4917.6	4912.6	26.5	31.5	36.5	10	1.5	38	4951.52		4949.1		2	15-Aug-04		731794	1870289
281	MW	B	Semiannual	4977.8	4972.8	4967.8	70.5	75.5	80.5	10	1.5	82	5051		5048.3		2	11-Aug-04		729714	1870315
282	MW	B	Semiannual	4983.3	4978.3	4973.3	74.1	79.1	84.1	10	1.5	85.6	5060.04		5057.4		2	10-Aug-04		730062	1871168
283†	MW	B	Semiannual	4984.8	4979.8	4974.8	70.5	75.5	80.5	10	1.5	82	5057.97		5055.3		2	3-Aug-04		730901	1871185
284	MW	A	WL only	5079.8	5074.8	5069.8	16.5	21.5	26.5	10	1.5	28	5098.72		5096.3		2	16-Aug-04		730525	1873562
285	MW	A	WL only	5090.8	5088.3	5085.8	3	5.5	8	5	0.1	8.1	5096.47		5093.8		2	16-Aug-04		731629	1874042
286	MW	B	Semiannual	4968.8	4963.8	4958.8	93.2	98.2	103.2	10	0.4	103.6	5063.99		5062		2	13-Mar-07		730128	1872377
287	MW	B	Semiannual	4962.3	4957.3	4952.3	100.7	105.7	110.7	10	0.4	111.1	5065.65		5063		2	15-Mar-07		730908	1872386
288	MW	B	Semiannual	4965.9	4960.9	4955.9	104	109	114	10	0.5	114.5	5072.54		5069.9		2	18-Mar-07		729995	1872709
289	MW	C	Semiannual	4920.3	4915.3	4910.3	148.3	153.3	158.3	10	0.4	163	5070.82		5068.6		6	28-Mar-07		729965	1872709
290	MW	B	Semiannual	4964.3	4959.3	4954.3	102.7	107.7	112.7	10	0.4	113.1	5068.91		5067		2	17-Mar-07		732633	1872979
683	MW	C	Annual	4973.2	4948.2	4923.2	95	120	145	50	3	148	5070.64		5068.2		6	31-Aug-99		732661	1872574
684	MW	C	Annual	4943.1	4917.4	4891.8	124.2	149.9	175.5	51.3	2.5	178	5070.05		5067.3		6	20-Aug-99		732642	1873521
685	MW	C	Annual	4975.6	4949.7	4923.8	93.7	119.6	145.5	51.8	2.5	148	5072.44		5069.3		6	19-Aug-99		732295	1873760
686	MW	A	Annual	5045.5	5025.5	5005.5	60	80	100	40	0.3	100.3	5107.97		5105.5		2	28-Mar-00		729978	1873416
687	MW	A	Annual	5047.6	5027.6	5007.6	60	80	100	40	0.3	100.3	5109.82		5107.6		2	29-Mar-00		731152	1874024
688	MW	A	Annual	5044.1	5024.1	5004.1	60	80	100	40	0.3	100.3	5106.98		5104.1		2	29-Mar-00		731961	1874385

Table A-1 (continued). Well Completion Information, Sorted on Well ID

Well	Type	Horizon	Sampling Frequency	Top Of Screen Elev.	Mid Screen Elev.	Bottom of Screen Elev.	Top of Screen Depth	Mid Screen Depth	Bottom of Screen Depth	Screen Length	Sump Length	Well Depth	Top of Casing Elev.	Note	Ground Elev.	Note	Well Diameter	Boring Started	Decommission Date	State Plane East	State Plane North
689*	MW	C	Annual	4923.9	4903.9	4883.9	55	75	95	40	0.3	95.3	4981.63		4978.9		2	31-Mar-00		730439	1869893
690	MW	D	Annual	4893.3	4873.3	4853.3	55	75	95	40	0.3	95.3	4950.87		4948.3		2	30-Mar-00		731521	1870140
691	MW	C	Semiannual	4921.9	4901.9	4881.9	55	75	95	40	0.3	95.3	4979.41		4976.9		2	30-Mar-00		732124	1870872
692*	MW	D	Annual	4895.6	4875.6	4855.6	55	75	95	40	0.3	95.3	4953.31		4950.6		2	5-Apr-00		731821	1870303
695	MW	D	Annual	4919.3	4899.3	4879.3	55	75	95	40	0.3	95.3	4976.83		4974.3		2	6-Apr-00		732566	1870896
901	MW	A	Annual	5045.8	5035.8	5025.8	58	68	78	20	2	80	5105.46		5103.8		2	16-Oct-84		730185	1875918
902	MW	H	WL only	4673.7	4668.7	4663.7	63	68	73	10	2	75	4737.42		4736.7		2	2-Dec-84		730179	1862292
903	MW	C	Annual	4953.5	4943.5	4933.5	28	38	48	20	2	50	4983.33		4981.5		2	30-Oct-84		731314	1870829
904	MW	D	Annual	4873.8	4868.8	4863.8	28	33	38	10	2	40	4904.11		4901.8		2	7-Nov-84		731808	1868036
905	MW	B	DECOM	5006	4998.5	4991	63	70.5	78	15	2	80	5072.8		5069		2	14-Nov-84	24-May-00	732933	1873200
906	MW	A	Semiannual	5016.9	5006.9	4996.9	44	54	64	20	2	66	5062.1		5060.9		2	19-Nov-84		730838	1872181
907	MW	A	DECOM	5010.7	5000.7	4990.7	66.5	76.5	86.5	20			5079.17		5077.2		2	30-Nov-84	19-Apr-88	731252	1872920
908	MW	B	Semiannual	5005.3	4997.8	4990.3	52	59.5	67	15	2	69	5058.14		5057.3		2	17-Nov-84		729366	1871999
909	MW	B	Semiannual	4990.8	4983.3	4975.8	65	72.5	80	15	2	82	5057.17		5055.8		2	18-Nov-84		730927	1871393
910	MW	B	Annual	5007.6	4957.6	4907.6	97	147	197	100	1	198	5106.7		5104.6		4	26-Jul-85		730219	1875840
911	MW	F	Annual	4795.2	4775.2	4755.2	309.4	329.4	349.4	40	2	351.4	5106.96		5104.6		4	18-Jul-85		730265	1875920
912	MW	C	Annual	4934.7	4914.7	4894.7	123	143	163	40	2	165	5059.97		5057.7		4	12-Aug-85		729324	1871942
913	MW	G	Annual	4729.2	4709.2	4689.2	328.7	348.7	368.7	40	2	370.7	5060.16		5057.9		4	2-Aug-85		729327	1871871
914*	MW	C	Annual	4930.3	4921.8	4913.3	137.2	145.7	154.2	17	2	156.2	5070.1		5067.5		4	16-Aug-85		732723	1872119
915	MW	D	Annual	4897.8	4892.8	4887.8	170	175	180	10	2	182	5070.84		5067.8		4	24-Aug-85		732740	1872209
916	MW	G	Annual	4721.7	4716.7	4711.7	345.7	350.7	355.7	10	2	357.7	5070		5067.4		4	22-Aug-85		732811	1872146
917	MW	C	WL only	4917.8	4907.8	4897.8	128	138	148	20	2	150	5048.02		5045.8		4	14-Aug-85		727255	1868642
918	MW	B	WL only	4986.2	4983.7	4981.2	61	63.5	66	5	2	68	5049.63		5047.2		4	15-Aug-85		727294	1868724
919	MW	G	WL only	4707.9	4702.9	4697.9	337.7	342.7	347.7	10	2	349.7	5048.56		5045.6		4	26-Aug-85		727353	1868654
920	MW	E	Annual	4866	4846	4826	114.4	134.4	154.4	40	2	156.4	4982.97		4980.4		4	30-Jul-85		731262	1870737
921	MW	I	Annual	4663.7	4643.7	4623.7	313.2	333.2	353.2	40	2	355.2	4979.08		4976.9		4	22-Jul-85		731379	1870742
925	EXT	B	DECOM	5005.8	4985.8	4965.8	53	73	93	40	0.5	93.5	5060.87		5058.8		6	21-Oct-95	24-May-00	729452	1872006
926	EXT	B	DECOM	5018.3	4993.3	4968.3	42.2	67.2	92.2	50	3	95.2	5062.85		5060.5		6	25-Oct-95	17-May-00	730790	1872126
928	MW	A	DECOM	5022.1	5009.6	4997.1	30	42.5	55	25	3	58	5053.99		5052.1		4	20-Oct-95	24-May-00	729401	1870814
929*	MW	A	Semiannual	5010.4	4990.4	4970.4	48.2	68.2	88.2	40			5060.82		5058.6		4			728780	1871453
930	MW	C	Semiannual	4933	4918	4903	20	35	50	30	3	53	4954.96		4953		4	23-Oct-95		731257	1870099
932	MW	C	Semiannual	4942.3	4932.3	4922.3	112.5	122.5	132.5	20	2.7	135.2	5057.32		5054.8		4	29-Oct-95		730900	1871401
933	MW	B	DECOM	4993.3	4992.3	4991.3	23	24	25	2			5018.03		5016.3		4	18-Oct-95	24-May-00	731727	1871341
934	MW	B	Semiannual	5013	4990.5	4968	45	67.5	90	45	3	93	5059.73		5058		4	2-Nov-95		730018	1871649
935	MW/EXT	B	Semiannual	5008.8	4988.8	4968.8	50	70	90	40	3	93	5061.5		5058.8		4	28-Oct-95		729461	1871978
936	MW/EXT	B	Semiannual	5017.9	4997.9	4977.9	42	62	82	40	3	85	5062.3		5059.9		6	26-Oct-95		730055	1872121
937	MW	B	DECOM	5020.2	4992.7	4965.2	40	67.5	95	55	3	98	5062.8		5060.2		4	9-Nov-95	24-May-00	730790	1872116
938	MW/EXT	B	Semiannual	5020.4	4992.9	4965.4	40	67.5	95	55	3	98	5063.64		5060.4		4	26-Oct-95		730769	1872124
939	EXT	B	DECOM	5021.1	4993.6	4966.1	40	67.5	95	55	3	98	5063.23		5061.1		6	23-Oct-95	16-May-00	731403	1872132
940	MW	A	Semiannual	5017.9	5010.4	5002.9	45	52.5	60	15	3	68	5064.77		5062.9		4	1-Nov-95		730130	1872391
941	MW	A	Semiannual	5018	5008	4998	45	55	65	20	3	68	5065.97		5063		4	10-Nov-95		730908	1872398
942	MW/EXT	B	Semiannual	5009.5	4999.5	4989.5	54	64	74	20	3	77	5066.45		5063.5		4	3-Nov-95		731642	1872409
943	MW	B	Annual	4994.1	4984.1	4974.1	101	111	121	20	3	124	5098.05		5095.1		4	13-Oct-95		731596	1874034

Table A-1 (continued). Well Completion Information, Sorted on Well ID

Well	Type	Horizon	Sampling Frequency	Top Of Screen Elev.	Mid Screen Elev.	Bottom of Screen Elev.	Top of Screen Depth	Mid Screen Depth	Bottom of Screen Depth	Screen Length	Sump Length	Well Depth	Top of Casing Elev.	Note	Ground Elev.	Note	Well Diameter	Boring Started	Decommission Date	State Plane East	State Plane North
944	MW	B	DECOM	4979.9	4969.9	4959.9	85	95	105	20	2	107	5067		5064.9		4	4-Nov-95	28-Jul-99	732199	1873007
945	MW	A	Annual	5028.1	5018.1	5008.1	110	120	130	20	3	133	5140.49		5138.1		4	11-Oct-95		730019	1873857
946	MW	A	Annual	5057.6	5047.6	5037.6	40	50	60	20	3.3	63.3	5100.5		5097.6		4	2-Nov-95		730547	1873582
947	MW	B	Annual	4990	4980	4970	105	115	125	20	3.3	128.3	5097.01		5095		4	3-Nov-95		732786	1874642
948	EXDS	E	WL only	4893.9	4803.9	4713.9	221.5	311.5	401.5	180	5	406.5	5117.8		5115.4		4	17-Oct-95		733915	1875516
1003	INJ-MW	D	Annual	4923.4	4898.4	4873.4	55.5	80.5	105.5	50	2.5	108	4976.58		4978.9		6	26-Jul-99		732101	1870898
1004	INJ-MW	D	Annual	4918.1	4893.1	4868.1	45.5	70.5	95.5	50	2.5	98	4961.55		4963.6		6	27-Jul-99		731892	1870544
1005	INJ-MW	D	WL only	4904.7	4879.7	4854.7	45.5	70.5	95.5	50	2.5	98	4947.83		4950.2		6	25-Jul-99		731496	1870168
1006	INJ-MW	D	Annual	4903.7	4878.7	4853.7	45.7	70.7	95.7	50	2.5	98.2	4947.08		4949.5		6	24-Jul-99		731233	1869918
1007	INJ-MW	D	Annual	4915.6	4890.5	4865.4	45.8	70.9	96	50.2	2.5	98.5	4958.56		4961.4		6	23-Jul-99		730770	1869861
1008	INJ-MW	C	WL only	4926.8	4901.6	4876.4	55.6	80.8	106	50.4	2.5	108.5	4980.52		4982.3		6	23-Jul-99		730410	1869916
1101	EXT	D	Annual	4974.2	4896.5	4818.9	96.1	173.8	251.5	155.4	2.5	254	5067.29		5070.4		6	24-Aug-99		732223	1872970
1102	EXT	D	Annual	4968.8	4893.8	4818.8	101.5	176.5	251.5	150	2.5	254	5066.76		5070.3		6	24-Aug-99		732225	1872670
1103	EXT	D	Annual	4962.3	4887.3	4812.3	100	175	250	150	2.5	252.5	5059.56		5062.3		6	30-Jul-99		731896	1872407
1104	EXT	D	Annual	4972.3	4894.8	4817.3	90	167.5	245	155	3	248	5059.57		5062.3		6	1-Aug-99		731527	1872404
1105	EXT	D	Annual	4972.1	4894.6	4817.1	90	167.5	245	155	3	248	5059.33		5062.1		6	2-Aug-99		731304	1872401
1106	EXT	D	Annual	4966	4888.7	4811.4	96.5	173.8	251.1	154.6	2.9	254	5059.73		5062.5		6	3-Aug-99		731081	1872400
1107	EXT	D	Annual	4971.2	4894	4816.8	91.1	168.3	245.5	154.4	2.5	248	5059.51		5062.3		6	3-Aug-99		730858	1872398
1108	EXT	D	Annual	4966.1	4891.1	4816.1	96.3	171.3	246.3	150	2.5	248.8	5059.62		5062.4		6	3-Aug-99		730634	1872396
1109	EXT	D	Annual	4972.1	4894.7	4817.3	90.3	167.7	245.1	154.8	2.9	248	5059.64		5062.4		6	4-Aug-99		730410	1872394
1110	EXT	D	Annual	4966.8	4891.8	4816.8	95.5	170.5	245.5	150	2.5	248	5059.47		5062.3		6	7-Aug-99		730187	1872392
1111	EXT	D	Annual	4971.9	4894.7	4817.5	90.7	167.9	245.1	154.4	2.5	247.6	5059.87		5062.6		6	6-Aug-99		729993	1872392
1112	EXT	D	Annual	4969.1	4891.6	4814.1	90.5	168	245.5	155	2.5	248	5057.08		5059.6		6	17-Aug-99		730494	1872064
1113	EXT	D	Annual	4968.7	4891.2	4813.7	90.5	168	245.5	155	2.5	248	5058.54		5059.2		6	17-Aug-99		730196	1872061
1114	EXT	D	Annual	4968.5	4891	4813.6	90.6	168	245.5	154.9	2.5	248	5056.25		5059.1		6	11-Aug-99		729896	1872057
1115	EXT	D	Annual	4968.6	4891.2	4813.7	90.5	168	245.5	155	2.5	248	5056.36		5059.2		6	7-Aug-99		729596	1872055
1116	EXT	C	Annual	4964.1	4912.5	4861	92.4	143.9	195.5	103.1	2.5	198	5053.74		5056.5		6	8-Aug-99		730350	1871702
1117	EXT	C	Annual	4965.3	4913.7	4862.1	92.3	143.9	195.5	103.2	2.5	198	5054.95		5057.6		6	11-Aug-99		729981	1871688
1118	EXT	C	Annual	4967.9	4915.1	4862.3	89.9	142.7	195.5	105.6	2.5	198	5055.11		5057.8		6	12-Aug-99		729756	1871695
1119	EXT	D	Annual	4968.7	4893.7	4818.7	95.3	170.3	245.3	150	2.5	247.8	5061.19		5064		6	31-Jul-99		731894	1872667
1120	EXT	D	Annual	4971	4896	4821	95.5	170.5	245.5	150	2.5	248	5063.6		5066.5		6	28-Jul-99		731891	1872967
1121	EXT	D	Annual	4972	4897	4822	97.5	172.5	247.5	150	2.5	250	5066.61		5069.5		6	28-Jul-99		731889	1873267
1122	EXT	D	Annual	4973.4	4896.3	4819.2	96.9	174	251.1	154.2	2.9	254	5067.31		5070.3		6	26-Aug-99		732221	1873269
1123	EXT	D	Annual	4976.2	4899.2	4822.2	91	168	245	154	3	248	5064.54		5067.2		6	2-Sep-99		732508	1873222
1124	EXT	D	Annual	4978.7	4899.9	4821.1	87.9	166.7	245.5	157.6	2.5	248	5063.86		5066.6		6	23-Aug-99		732512	1872972
1125	EXT	D	Annual	4972.8	4897.8	4822.8	95.5	170.5	245.5	150	2.5	248	5065.47		5068.3		6	25-Aug-99		732515	1872671
1126	EXT	B	Annual	4991.9	4971.9	4951.9	60	80	100	40	3.3	103.3	5051.9	**	5051.9	**	4	9-Sep-04		729517	1870728
1127	EXT	B	Annual	4984.2	4964.2	4944.2	72.7	92.7	112.7	40	3.3	116	5056.9	**	5056.9	**	4	11-Sep-04		730044	1871022
1128	EXT	B	Annual	4982.3	4962.3	4942.3	72.7	92.7	112.7	40	3.3	116	5055	**	5055	**	4	12-Sep-04		730679	1871294
1129	EXT	B	Annual	4990.9	4975.9	4960.9	68.2	83.2	98.2	30	3.3	101.5	5059.1	**	5059.1	**	4	30-Aug-04		731237	1871690
1130	EXT	B	Annual	4987.3	4962.3	4937.3	71.7	96.7	121.7	50	3.3	125	5059	**	5059	**	4	29-Jul-04		731699	1871907
1131	EXT	B	Annual	4998.1	4978.1	4958.1	59.7	79.7	99.7	40	3.3	103	5057.8	**	5057.8	**	4	8-Sep-04		732011	1872106
1132	EXT	B	Annual	5009.1	4984.1	4959.1	49.7	74.7	99.7	50	3.3	103	5058.8	**	5058.8	**	4	31-Aug-04		731310	1872015

Table A-1 (continued). Well Completion Information, Sorted on Well ID

Well	Type	Horizon	Sampling Frequency	Top Of Screen Elev.	Mid Screen Elev.	Bottom of Screen Elev.	Top of Screen Depth	Mid Screen Depth	Bottom of Screen Depth	Screen Length	Sump Length	Well Depth	Top of Casing Elev.	Note	Ground Elev.	Note	Well Diameter	Boring Started	Decommission Date	State Plane East	State Plane North
1133	EXT	B	Annual	4999.4	4979.4	4959.4	59.7	79.7	99.7	40	3.3	103	5059.1	**	5059.1	**	4	2-Sep-04		730850	1871827
NMW-1A*	MW	B	Semiannual	4980.7	4970	4960.7	167.5	177.5	187.5	20	5	192.5	5150.95		5148.2		4	25-Sep-10		728130	1872744
NMW-2A	MW	B	Annual	4978.7	4968	4958.7	140.5	150.5	160.5	20	5	165.46	5121.69		5119.15		4	27-Sep-10		728826	1874729
NMW-3A	MW	B	Semiannual	4975.1	4965	4955.1	190.6	200.6	210.6	20	5	215.62	5168.51		5165.73		4	10-Oct-10		730559	1874974
NMW-4A	MW	B	Semiannual	4964.2	4954	4944.2	170.5	180.5	190.5	20	5	195.46	5137.44		5134.68		4	7-Oct-10		727368	1874332
NMW-5	MW	C	Semiannual	4948.2	4938	4928.2	35	45	55	20	5	59.95	4985.85		4983.1		4	8-Oct-10		715095	1867920
NMW-6S	MW	B	Semiannual	4975.1	4965	4955.1	167.6	177.6	187.6	20	5	192.62	5145.93		5142.74		4	23-Sep-10		729015	1873349
NMW-7D	MW	D	Semiannual	4865.7	4863	4860.7	278.2	280.7	283.2	5	5	288.19	5147.13		5143.92		4	21-Sep-10		729017	1873387
NMW-8S	MW	B	Semiannual	4962.4	4952	4942.4	149.4	159.4	169.4	20	5	174.43	5114.87		5112.3		4	6-Oct-10		727588	1871585
NMW-9D	MW	E	Semiannual	4847.6	4845	4842.6	265.5	268	270.5	5	5	275.52	5115.92		5113.14		4	4-Oct-10		727573	1871587

All dimensions in feet except well diameter in inches; all depths are relative to ground surface.

* Sentinel well, to monitor plume boundary. For this annual report, the sentinel well subset was revised to include NMW-1A and lower terrace wells 0689 and 0692. Wells 683 and 684, located east of the disposal cell and identified as sentinel wells in previous annual reports, are no longer considered sentinel wells.

** Approximate (elevation).

DECOM Decommissioned well.

EXDS Extraction well domestic supply, completed in Navajo Sandstone. EXDS well 0948 (single sampling in 1995), located about 1,500 ft east of the site, is used to supply the Tuba City site treatment facility with domestic non-potable water.

EXT Groundwater remediation extraction well.

INJ-MW Groundwater remediation injection well, used as monitoring well. Although the injection infrastructure remains intact, to date these lower terrace wells (1003–1008) have only been used for water quality and/or water level monitoring purposes.

MW Monitoring well.

MW/EXT Extraction well converted to monitoring well in August 2005.

NMW Wells owned by Navajo Nation Environmental Protection Agency (NNEPA).

WL Water Levels—Semiannual.

Sampling Frequencies: Annual–August only; Semiannual–February and August.

†Monitoring well 283 has been dry since February 2007.

Table A-2. Well Completion Information, Sorted on Horizon, Well ID

Well	Type	Horizon	Sampling Frequency	Top Of Screen Elev.	Mid Screen Elev.	Bottom of Screen Elev.	Top of Screen Depth	Mid Screen Depth	Bottom of Screen Depth	Screen Length	Sump Length	Well Depth	Top of Casing Elev.	Note	Ground Elev.	Note	Well Diameter	Boring Started	Decommission Date	State Plane East	State Plane North
929*	MW	A	Semiannual	5010.4	4990.4	4970.4	48.2	68.2	88.2	40			5060.82		5058.6		4			728780	1871453
284	MW	A	WL only	5079.8	5074.8	5069.8	16.5	21.5	26.5	10	1.5	28	5098.72		5096.3		2	16-Aug-04		730525	1873562
285	MW	A	WL only	5090.8	5088.3	5085.8	3	5.5	8	5	0.1	8.1	5096.47		5093.8		2	16-Aug-04		731629	1874042
686	MW	A	Annual	5045.5	5025.5	5005.5	60	80	100	40	0.3	100.3	5107.97		5105.5		2	28-Mar-00		729978	1873416
687	MW	A	Annual	5047.6	5027.6	5007.6	60	80	100	40	0.3	100.3	5109.82		5107.6		2	29-Mar-00		731152	1874024
688	MW	A	Annual	5044.1	5024.1	5004.1	60	80	100	40	0.3	100.3	5106.98		5104.1		2	29-Mar-00		731961	1874385
901	MW	A	Annual	5045.8	5035.8	5025.8	58	68	78	20	2	80	5105.46		5103.8		2	16-Oct-84		730185	1875918
906	MW	A	Semiannual	5016.9	5006.9	4996.9	44	54	64	20	2	66	5062.1		5060.9		2	19-Nov-84		730838	1872181
907	MW	A	DECOM	5010.7	5000.7	4990.7	66.5	76.5	86.5	20			5079.17		5077.2		2	30-Nov-84	19-Apr-88	731252	1872920
928	MW	A	DECOM	5022.1	5009.6	4997.1	30	42.5	55	25	3	58	5053.99		5052.1		4	20-Oct-95	24-May-00	729401	1870814
940	MW	A	Semiannual	5017.9	5010.4	5002.9	45	52.5	60	15	3	68	5064.77		5062.9		4	1-Nov-95		730130	1872391
941	MW	A	Semiannual	5018	5008	4998	45	55	65	20	3	68	5065.97		5063		4	10-Nov-95		730908	1872398
945	MW	A	Annual	5028.1	5018.1	5008.1	110	120	130	20	3	133	5140.49		5138.1		4	11-Oct-95		730019	1873857
946	MW	A	Annual	5057.6	5047.6	5037.6	40	50	60	20	3.3	63.3	5100.5		5097.6		4	2-Nov-95		730547	1873582
271*	MW	B	Annual	4984	4964	4944	60	80	100	40	0.3	100.3	5046.72		5044		2	29-Apr-00		728160	1869555
NMW-1A*	MW	B	Semiannual	4980.7	4970	4960.7	167.5	177.5	187.5	20	5	192.5	5150.95		5148.2		4	25-Sep-10		728130	1872744
NMW-8S	MW	B	Semiannual	4962.4	4952	4942.4	149.4	159.4	169.4	20	5	174.43	5114.87		5112.3		4	6-Oct-10		727588	1871585
NMW-6S	MW	B	Semiannual	4975.1	4965	4955.1	167.6	177.6	187.6	20	5	192.62	5145.93		5142.74		4	23-Sep-10		729015	1873349
NMW-4A	MW	B	Semiannual	4964.2	4954	4944.2	170.5	180.5	190.5	20	5	195.46	5137.44		5134.68		4	7-Oct-10		727368	1874332
NMW-3A	MW	B	Semiannual	4975.1	4965	4955.1	190.6	200.6	210.6	20	5	215.62	5168.51		5165.73		4	10-Oct-10		730559	1874974
NMW-2A	MW	B	Annual	4978.7	4968	4958.7	140.5	150.5	160.5	20	5	165.46	5121.69		5119.15		4	27-Sep-10		728826	1874729
262	MW	B	Semiannual	4999.2	4979.2	4959.2	60	80	100	40	0.3	100.3	5061.99		5059.2		2	3-Apr-00		731402	1872012
263	MW	B	Semiannual	5000.2	4980.2	4960.2	60	80	100	40	0.3	100.3	5063.1		5060.2		2	4-Apr-00		731565	1871757
265	MW	B	Semiannual	4991.1	4971.1	4951.1	60	80	100	40	0.3	100.3	5053.88		5051.1		2	16-Apr-00		730382	1870964
267	MW	B	Semiannual	4990.8	4970.8	4950.8	60	80	100	40	0.3	100.3	5053.4		5050.8		2	14-Apr-00		729329	1870707
281	MW	B	Semiannual	4977.8	4972.8	4967.8	70.5	75.5	80.5	10	1.5	82	5051		5048.3		2	11-Aug-04		729714	1870315
282	MW	B	Semiannual	4983.3	4978.3	4973.3	74.1	79.1	84.1	10	1.5	85.6	5060.04		5057.4		2	10-Aug-04		730062	1871168
283†	MW	B	Semiannual	4984.8	4979.8	4974.8	70.5	75.5	80.5	10	1.5	82	5057.97		5055.3		2	3-Aug-04		730901	1871185
286	MW	B	Semiannual	4968.8	4963.8	4958.8	93.2	98.2	103.2	10	0.4	103.6	5063.99		5062		2	13-Mar-07		730128	1872377
287	MW	B	Semiannual	4962.3	4957.3	4952.3	100.7	105.7	110.7	10	0.4	111.1	5065.65		5063		2	15-Mar-07		730908	1872386
288	MW	B	Semiannual	4965.9	4960.9	4955.9	104	109	114	10	0.5	114.5	5072.54		5069.9		2	18-Mar-07		729995	1872709
290	MW	B	Semiannual	4964.3	4959.3	4954.3	102.7	107.7	112.7	10	0.4	113.1	5068.91		5067		2	17-Mar-07		732633	1872979
905	MW	B	DECOM	5006	4998.5	4991	63	70.5	78	15	2	80	5072.8		5069		2	14-Nov-84	24-May-00	732933	1873200
908	MW	B	Semiannual	5005.3	4997.8	4990.3	52	59.5	67	15	2	69	5058.14		5057.3		2	17-Nov-84		729366	1871999
909	MW	B	Semiannual	4990.8	4983.3	4975.8	65	72.5	80	15	2	82	5057.17		5055.8		2	18-Nov-84		730927	1871393
910	MW	B	Annual	5007.6	4957.6	4907.6	97	147	197	100	1	198	5106.7		5104.6		4	26-Jul-85		730219	1875840
918	MW	B	WL only	4986.2	4983.7	4981.2	61	63.5	66	5	2	68	5049.63		5047.2		4	15-Aug-85		727294	1868724
925	EXT	B	DECOM	5005.8	4985.8	4965.8	53	73	93	40	0.5	93.5	5060.87		5058.8		6	21-Oct-95	24-May-00	729452	1872006
926	EXT	B	DECOM	5018.3	4993.3	4968.3	42.2	67.2	92.2	50	3	95.2	5062.85		5060.5		6	25-Oct-95	17-May-00	730790	1872126
933	MW	B	DECOM	4993.3	4992.3	4991.3	23	24	25	2			5018.03		5016.3		4	18-Oct-95	24-May-00	731727	1871341
934	MW	B	Semiannual	5013	4990.5	4968	45	67.5	90	45	3	93	5059.73		5058		4	2-Nov-95		730018	1871649
935	MW/EXT	B	Semiannual	5008.8	4988.8	4968.8	50	70	90	40	3	93	5061.5		5058.8		4	28-Oct-95		729461	1871978

Table A-2 (continued). Well Completion Information, Sorted on Horizon, Well ID

Well	Type	Horizon	Sampling Frequency	Top Of Screen Elev.	Mid Screen Elev.	Bottom of Screen Elev.	Top of Screen Depth	Mid Screen Depth	Bottom of Screen Depth	Screen Length	Sump Length	Well Depth	Top of Casing Elev.	Note	Ground Elev.	Note	Well Diameter	Boring Started	Decommission Date	State Plane East	State Plane North
936	MW/EXT	B	Semiannual	5017.9	4997.9	4977.9	42	62	82	40	3	85	5062.3		5059.9		6	26-Oct-95		730055	1872121
937	MW	B	DECOM	5020.2	4992.7	4965.2	40	67.5	95	55	3	98	5062.8		5060.2		4	9-Nov-95	24-May-00	730790	1872116
938	MW/EXT	B	Semiannual	5020.4	4992.9	4965.4	40	67.5	95	55	3	98	5063.64		5060.4		4	26-Oct-95		730769	1872124
939	EXT	B	DECOM	5021.1	4993.6	4966.1	40	67.5	95	55	3	98	5063.23		5061.1		6	23-Oct-95	16-May-00	731403	1872132
942	MW/EXT	B	Semiannual	5009.5	4999.5	4989.5	54	64	74	20	3	77	5066.45		5063.5		4	3-Nov-95		731642	1872409
943	MW	B	Annual	4994.1	4984.1	4974.1	101	111	121	20	3	124	5098.05		5095.1		4	13-Oct-95		731596	1874034
944	MW	B	DECOM	4979.9	4969.9	4959.9	85	95	105	20	2	107	5067		5064.9		4	4-Nov-95	28-Jul-99	732199	1873007
947	MW	B	Annual	4990	4980	4970	105	115	125	20	3.3	128.3	5097.01		5095		4	3-Nov-95		732786	1874642
1126	EXT	B	Annual	4991.9	4971.9	4951.9	60	80	100	40	3.3	103.3	5051.9	**	5051.9	**	4	9-Sep-04		729517	1870728
1127	EXT	B	Annual	4984.2	4964.2	4944.2	72.7	92.7	112.7	40	3.3	116	5056.9	**	5056.9	**	4	11-Sep-04		730044	1871022
1128	EXT	B	Annual	4982.3	4962.3	4942.3	72.7	92.7	112.7	40	3.3	116	5055	**	5055	**	4	12-Sep-04		730679	1871294
1129	EXT	B	Annual	4990.9	4975.9	4960.9	68.2	83.2	98.2	30	3.3	101.5	5059.1	**	5059.1	**	4	30-Aug-04		731237	1871690
1130	EXT	B	Annual	4987.3	4962.3	4937.3	71.7	96.7	121.7	50	3.3	125	5059	**	5059	**	4	29-Jul-04		731699	1871907
1131	EXT	B	Annual	4998.1	4978.1	4958.1	59.7	79.7	99.7	40	3.3	103	5057.8	**	5057.8	**	4	8-Sep-04		732011	1872106
1132	EXT	B	Annual	5009.1	4984.1	4959.1	49.7	74.7	99.7	50	3.3	103	5058.8	**	5058.8	**	4	31-Aug-04		731310	1872015
1133	EXT	B	Annual	4999.4	4979.4	4959.4	59.7	79.7	99.7	40	3.3	103	5059.1	**	5059.1	**	4	2-Sep-04		730850	1871827
689*	MW	C	Annual	4923.9	4903.9	4883.9	55	75	95	40	0.3	95.3	4981.63		4978.9		2	31-Mar-00		730439	1869893
914*	MW	C	Annual	4930.3	4921.8	4913.3	137.2	145.7	154.2	17	2	156.2	5070.1		5067.5		4	16-Aug-85		732723	1872119
NMW-5	MW	C	Semiannual	4948.2	4938	4928.2	35	45	55	20	5	59.95	4985.85		4983.1		4	8-Oct-10		715095	1867920
274	MW	C	Semiannual	4913.6	4903.6	4893.6	149	159	169	20	1.5	170.5	5064.42		5062.6		2	30-Aug-04		731623	1872403
276	MW	C	Semiannual	4910	4900	4890	154.5	164.5	174.5	20	1.5	176	5067.55		5064.5		2	1-Sep-04		732081	1873158
279	MW	C	Annual	4922.1	4917.1	4912.1	26.5	31.5	36.5	10	1.5	38	4951.04		4948.6		2	15-Aug-04		731494	1870132
280	MW	C	Annual	4922.6	4917.6	4912.6	26.5	31.5	36.5	10	1.5	38	4951.52		4949.1		2	15-Aug-04		731794	1870289
289	MW	C	Semiannual	4920.3	4915.3	4910.3	148.3	153.3	158.3	10	0.4	163	5070.82		5068.6		6	28-Mar-07		729965	1872709
683	MW	C	Annual	4973.2	4948.2	4923.2	95	120	145	50	3	148	5070.64		5068.2		6	31-Aug-99		732661	1872574
684	MW	C	Annual	4943.1	4917.4	4891.8	124.2	149.9	175.5	51.3	2.5	178	5070.05		5067.3		6	20-Aug-99		732642	1873521
685	MW	C	Annual	4975.6	4949.7	4923.8	93.7	119.6	145.5	51.8	2.5	148	5072.44		5069.3		6	19-Aug-99		732295	1873760
691	MW	C	Semiannual	4921.9	4901.9	4881.9	55	75	95	40	0.3	95.3	4979.41		4976.9		2	30-Mar-00		732124	1870872
903	MW	C	Annual	4953.5	4943.5	4933.5	28	38	48	20	2	50	4983.33		4981.5		2	30-Oct-84		731314	1870829
912	MW	C	Annual	4934.7	4914.7	4894.7	123	143	163	40	2	165	5059.97		5057.7		4	12-Aug-85		729324	1871942
917	MW	C	WL only	4917.8	4907.8	4897.8	128	138	148	20	2	150	5048.02		5045.8		4	14-Aug-85		727255	1868642
930	MW	C	Semiannual	4933	4918	4903	20	35	50	30	3	53	4954.96		4953		4	23-Oct-95		731257	1870099
932	MW	C	Semiannual	4942.3	4932.3	4922.3	112.5	122.5	132.5	20	2.7	135.2	5057.32		5054.8		4	29-Oct-95		730900	1871401
1008	INJ-MW	C	WL only	4926.8	4901.6	4876.4	55.6	80.8	106	50.4	2.5	108.5	4980.52		4982.3		6	23-Jul-99		730410	1869916
1116	EXT	C	Annual	4964.1	4912.5	4861	92.4	143.9	195.5	103.1	2.5	198	5053.74		5056.5		6	8-Aug-99		730350	1871702
1117	EXT	C	Annual	4965.3	4913.7	4862.1	92.3	143.9	195.5	103.2	2.5	198	5054.95		5057.6		6	11-Aug-99		729981	1871688
1118	EXT	C	Annual	4967.9	4915.1	4862.3	89.9	142.7	195.5	105.6	2.5	198	5055.11		5057.8		6	12-Aug-99		729756	1871695
692*	MW	D	Annual	4895.6	4875.6	4855.6	55	75	95	40	0.3	95.3	4953.31		4950.6		2	5-Apr-00		731821	1870303
NMW-7D	MW	D	Semiannual	4865.7	4863	4860.7	278.2	280.7	283.2	5	5	288.19	5147.13		5143.92		4	21-Sep-10		729017	1873387
258	MW	D	Semiannual	4894	4874	4854	159	179	199	40	0.3	199.3	5055.56		5053		2	13-Apr-00		732452	1871996
261	MW	D	Annual	4907	4887	4867	160	180	200	40	0.3	200.3	5069.69		5067		2	1-Apr-00		732565	1871578
264	MW	D	Semiannual	4899.6	4879.6	4859.6	160	180	200	40	0.3	200.3	5062.19		5059.6		2	3-Apr-00		731569	1871746
266	MW	D	Semiannual	4890.6	4870.6	4850.6	160	180	200	40	0.3	200.3	5053.32		5050.6		2	15-Apr-00		730380	1870941

Table A-2 (continued). Well Completion Information, Sorted on Horizon, Well ID

Well	Type	Horizon	Sampling Frequency	Top Of Screen Elev.	Mid Screen Elev.	Bottom of Screen Elev.	Top of Screen Depth	Mid Screen Depth	Bottom of Screen Depth	Screen Length	Sump Length	Well Depth	Top of Casing Elev.	Note	Ground Elev.	Note	Well Diameter	Boring Started	Decommission Date	State Plane East	State Plane North
272	MW	D	Semiannual	4902.8	4892.8	4882.8	159.1	169.1	179.1	20	1.5	180.6	5064.24		5061.9		2	28-Aug-04		730112	1872389
273	MW	D	Semiannual	4909.4	4899.4	4889.4	153	163	173	20	1.5	174.5	5064.74		5062.4		2	29-Aug-04		730922	1872397
275	MW	D	Semiannual	4903	4893	4883	158.2	168.2	178.2	20	1.5	179.7	5062.64		5061.2		2	1-Sep-04		732092	1872586
277	MW	D	Annual	4884	4879	4874	95.7	100.7	105.7	10	1.5	107.2	4982.35		4979.7		2	12-Aug-04		731290	1870777
278	MW	D	Annual	4862.9	4857.9	4852.9	90.5	95.5	100.5	10	1.5	102	4956.09		4953.4		2	14-Aug-04		731210	1870104
690	MW	D	Annual	4893.3	4873.3	4853.3	55	75	95	40	0.3	95.3	4950.87		4948.3		2	30-Mar-00		731521	1870140
695	MW	D	Annual	4919.3	4899.3	4879.3	55	75	95	40	0.3	95.3	4976.83		4974.3		2	6-Apr-00		732566	1870896
904	MW	D	Annual	4873.8	4868.8	4863.8	28	33	38	10	2	40	4904.11		4901.8		2	7-Nov-84		731808	1868036
915	MW	D	Annual	4897.8	4892.8	4887.8	170	175	180	10	2	182	5070.84		5067.8		4	24-Aug-85		732740	1872209
1003	INJ-MW	D	Annual	4923.4	4898.4	4873.4	55.5	80.5	105.5	50	2.5	108	4976.58		4978.9		6	26-Jul-99		732101	1870898
1004	INJ-MW	D	Annual	4918.1	4893.1	4868.1	45.5	70.5	95.5	50	2.5	98	4961.55		4963.6		6	27-Jul-99		731892	1870544
1005	INJ-MW	D	WL only	4904.7	4879.7	4854.7	45.5	70.5	95.5	50	2.5	98	4947.83		4950.2		6	25-Jul-99		731496	1870168
1006	INJ-MW	D	Annual	4903.7	4878.7	4853.7	45.7	70.7	95.7	50	2.5	98.2	4947.08		4949.5		6	24-Jul-99		731233	1869918
1007	INJ-MW	D	Annual	4915.6	4890.5	4865.4	45.8	70.9	96	50.2	2.5	98.5	4958.56		4961.4		6	23-Jul-99		730770	1869861
1101	EXT	D	Annual	4974.2	4896.5	4818.9	96.1	173.8	251.5	155.4	2.5	254	5067.29		5070.4		6	24-Aug-99		732223	1872970
1102	EXT	D	Annual	4968.8	4893.8	4818.8	101.5	176.5	251.5	150	2.5	254	5066.76		5070.3		6	24-Aug-99		732225	1872670
1103	EXT	D	Annual	4962.3	4887.3	4812.3	100	175	250	150	2.5	252.5	5059.56		5062.3		6	30-Jul-99		731896	1872407
1104	EXT	D	Annual	4972.3	4894.8	4817.3	90	167.5	245	155	3	248	5059.57		5062.3		6	1-Aug-99		731527	1872404
1105	EXT	D	Annual	4972.1	4894.6	4817.1	90	167.5	245	155	3	248	5059.33		5062.1		6	2-Aug-99		731304	1872401
1106	EXT	D	Annual	4966	4888.7	4811.4	96.5	173.8	251.1	154.6	2.9	254	5059.73		5062.5		6	3-Aug-99		731081	1872400
1107	EXT	D	Annual	4971.2	4894	4816.8	91.1	168.3	245.5	154.4	2.5	248	5059.51		5062.3		6	3-Aug-99		730858	1872398
1108	EXT	D	Annual	4966.1	4891.1	4816.1	96.3	171.3	246.3	150	2.5	248.8	5059.62		5062.4		6	3-Aug-99		730634	1872396
1109	EXT	D	Annual	4972.1	4894.7	4817.3	90.3	167.7	245.1	154.8	2.9	248	5059.64		5062.4		6	4-Aug-99		730410	1872394
1110	EXT	D	Annual	4966.8	4891.8	4816.8	95.5	170.5	245.5	150	2.5	248	5059.47		5062.3		6	7-Aug-99		730187	1872392
1111	EXT	D	Annual	4971.9	4894.7	4817.5	90.7	167.9	245.1	154.4	2.5	247.6	5059.87		5062.6		6	6-Aug-99		729993	1872392
1112	EXT	D	Annual	4969.1	4891.6	4814.1	90.5	168	245.5	155	2.5	248	5057.08		5059.6		6	17-Aug-99		730494	1872064
1113	EXT	D	Annual	4968.7	4891.2	4813.7	90.5	168	245.5	155	2.5	248	5058.54		5059.2		6	17-Aug-99		730196	1872061
1114	EXT	D	Annual	4968.5	4891	4813.6	90.6	168	245.5	154.9	2.5	248	5056.25		5059.1		6	11-Aug-99		729896	1872057
1115	EXT	D	Annual	4968.6	4891.2	4813.7	90.5	168	245.5	155	2.5	248	5056.36		5059.2		6	7-Aug-99		729596	1872055
1119	EXT	D	Annual	4968.7	4893.7	4818.7	95.3	170.3	245.3	150	2.5	247.8	5061.19		5064		6	31-Jul-99		731894	1872667
1120	EXT	D	Annual	4971	4896	4821	95.5	170.5	245.5	150	2.5	248	5063.6		5066.5		6	28-Jul-99		731891	1872967
1121	EXT	D	Annual	4972	4897	4822	97.5	172.5	247.5	150	2.5	250	5066.61		5069.5		6	28-Jul-99		731889	1873267
1122	EXT	D	Annual	4973.4	4896.3	4819.2	96.9	174	251.1	154.2	2.9	254	5067.31		5070.3		6	26-Aug-99		732221	1873269
1123	EXT	D	Annual	4976.2	4899.2	4822.2	91	168	245	154	3	248	5064.54		5067.2		6	2-Sep-99		732508	1873222
1124	EXT	D	Annual	4978.7	4899.9	4821.1	87.9	166.7	245.5	157.6	2.5	248	5063.86		5066.6		6	23-Aug-99		732512	1872972
1125	EXT	D	Annual	4972.8	4897.8	4822.8	95.5	170.5	245.5	150	2.5	248	5065.47		5068.3		6	25-Aug-99		732515	1872671
NMW-9D	MW	E	Semiannual	4847.6	4845	4842.6	265.5	268	270.5	5	5	275.52	5115.92		5113.14		4	4-Oct-10		727573	1871587
251	MW	E	Semiannual	4858.9	4808.9	4758.9	200	250	300	100	0.3	300.3	5061.25		5058.9		2	28-Apr-00		730215	1871999
268	MW	E	Semiannual	4864.5	4814.5	4764.5	200	250	300	100	0.3	300.3	5067.24		5064.5		2	15-May-00		732301	1872430
920	MW	E	Annual	4866	4846	4826	114.4	134.4	154.4	40	2	156.4	4982.97		4980.4		4	30-Jul-85		731262	1870737
948	EXDS	E	WL only	4893.9	4803.9	4713.9	221.5	311.5	401.5	180	5	406.5	5117.8		5115.4		4	17-Oct-95		733915	1875516
911	MW	F	Annual	4795.2	4775.2	4755.2	309.4	329.4	349.4	40	2	351.4	5106.96		5104.6		4	18-Jul-85		730265	1875920
913	MW	G	Annual	4729.2	4709.2	4689.2	328.7	348.7	368.7	40	2	370.7	5060.16		5057.9		4	2-Aug-85		729327	1871871

Table A-2 (continued). Well Completion Information, Sorted on Horizon, Well ID

Well	Type	Horizon	Sampling Frequency	Top Of Screen Elev.	Mid Screen Elev.	Bottom of Screen Elev.	Top of Screen Depth	Mid Screen Depth	Bottom of Screen Depth	Screen Length	Sump Length	Well Depth	Top of Casing Elev.	Note	Ground Elev.	Note	Well Diameter	Boring Started	Decommission Date	State Plane East	State Plane North
916	MW	G	Annual	4721.7	4716.7	4711.7	345.7	350.7	355.7	10	2	357.7	5070		5067.4		4	22-Aug-85		732811	1872146
919	MW	G	WL only	4707.9	4702.9	4697.9	337.7	342.7	347.7	10	2	349.7	5048.56		5045.6		4	26-Aug-85		727353	1868654
902	MW	H	WL only	4673.7	4668.7	4663.7	63	68	73	10	2	75	4737.42		4736.7		2	2-Dec-84		730179	1862292
252	MW	I	Semiannual	4658.9	4608.9	4558.9	400	450	500	100	0.4	500.4	5061.3		5058.9		4	26-Apr-00		730232	1871993
254	MW	I	DECOM	4662.7	4612.7	4562.7	400	450	500	100	0.4	500.4	5065.38		5062.7		4	3-May-00	13-Aug-05	730951	1872411
256	MW	I	DECOM	4664	4614	4564	400	450	500	100	0.4	500.4	5066.58		5064		4	13-May-00	14-Aug-05	732277	1872437
921	MW	I	Annual	4663.7	4643.7	4623.7	313.2	333.2	353.2	40	2	355.2	4979.08		4976.9		4	22-Jul-85		731379	1870742
253	MW	M	DECOM	4458.8	4408.8	4358.8	600	650	700	100	0.4	700.4	5061.11		5058.8		4	18-Apr-00	11-Apr-01	730213	1871974
255	MW	M	DECOM	4462.3	4412.3	4362.3	600	650	700	100	0.4	700.4	5064.89		5062.3		4	1-May-00	12-Aug-05	730947	1872387
257	MW	M	DECOM	4463.4	4413.4	4363.4	600	650	700	100	0.4	700.4	5066.4		5063.4		4	11-May-00	11-Aug-05	732278	1872414

All dimensions in feet except well diameter in inches; all depths are relative to ground surface.

* Sentinel well, to monitor plume boundary. For this annual report, the sentinel well subset was revised to include NMW-1A and lower terrace wells 0689 and 0692. Wells 683 and 684, located east of the disposal cell and identified as sentinel wells in previous annual reports, are no longer considered sentinel wells.

** Approximate (elevation).

DECOM Decommissioned well.

EXDS Extraction well domestic supply, completed in Navajo Sandstone. EXDS well 0948 (single sampling in 1995), located about 1,500 ft east of the site, is used to supply the Tuba City site treatment facility with domestic non-potable water.

EXT Groundwater remediation extraction well.

INJ-MW Groundwater remediation injection well, used as monitoring well. Although the injection infrastructure remains intact, to date these lower terrace wells (1003–1008) have only been used for water quality and/or water level monitoring purposes.

MW Monitoring well.

MW/EXT Extraction well converted to monitoring well in August 2005.

NMW Wells owned by Navajo Nation Environmental Protection Agency (NNEPA).

WL Water Levels—Semiannual.

Sampling Frequencies: Annual–August only; Semiannual–February and August.

† Monitoring well 283 has been dry since February 2007.

Appendix B

Groundwater Sample Results for Contaminants of Concern: August 2012, February 2013, and the Baseline Period

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Contents

Tables

Note:

Based on the trip reports provided in the Data Validation Packages (DVPs; DOE 2012, DOE 2013), the following locations were not sampled during this 2012–2013 reporting period.

August 2012: 15 locations were not sampled.

- Monitoring wells 0283 and 0909 did not have enough water to sample (this has been the case historically, or the wells have been dry).
- The pumps at 13 extraction wells—0936, 0938, 0942, 1102, 1109, 1115, 1121, 1122, 1126, 1127, 1128, 1130, and 1131—were not functioning.

February 2013: 3 locations were not sampled.

- Monitoring well 0283 was dry, and well 0909 did not have enough water to sample.
- The pump at extraction well 0936 was not functioning.

Wells 0917 and 1008, although sampled during the baseline period, are not listed in these tables because they are now sampled for water levels only (see Appendix A, Table A-1).

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Table B-1a. Baseline, August 2012, and February 2013 Molybdenum Concentrations, Sorted on Well ID

Well Number	Horizon	Baseline Molybdenum Concentration (mg/L)	Year Sampled, Baseline	August 2012 Molybdenum Concentration (mg/L)	February 2013 Molybdenum Concentration (mg/L)
0251	E	0.0015U	2002	0.00022	0.00023
0252	I	0.0015U	2002	0.00014	0.00016
0258	D	0.0026	2001	0.00043	0.00054
0261	D	0.0031	2001	0.00047	
0262	B	0.432	2001	0.61	0.94
0263	B	0.192	2001	0.034	0.048
0264	D	0.00058	2001	0.00033	0.00042
0265	B	0.00046	2001	0.00016U	0.000086B
0266	D			0.00018	0.00026
0267	B	0.0015U	2002	0.00032U	0.000093B
0268	E	0.0015U	2002	0.00033	0.00031
0271	B	0.0015U	2002	0.00031	
0272	D			0.00023	0.00024
0273	D			0.019	0.023
0274	C			0.00037	0.0004
0275	D			0.00032U	0.00028
0276	C			0.00039	0.00047
0277	D			0.00043	
0278	D	0.0015U	2002	0.00033	
0279	C			0.00075	
0280	C			0.00048	
0281	B			0.00075	0.00076
0282	B			0.00031	0.00031
0286	B			0.0013	0.0006
0287	B			0.13	0.14
0288	B			0.00011	0.00015
0289	C			0.0004	0.00049
0290	B			0.00011	0.00019
0683	C	0.0015U	2002	0.00046	
0684	C	0.0015U	2002	0.00047	
0685	C	0.0015U	2002	0.00039	
0686	A	0.0015U	2002	0.0017	
0687	A	0.0113	2002	0.0081	
0688	A	0.0015U	2002	0.0011	
0689	C	0.0015U	2002	0.00031	
0690	D	0.0015U	2002	0.00025	
0691	C	0.0015U	2002	0.00016U	0.0004
0692	D	0.0015U	2002	0.00026	
0695	D	0.00077	2001	0.00052	
0901	A	0.00078	2001	0.00056	
0903	C	0.0015U	2002	0.00022	
0904	D	0.00054	2001	0.0008	
0906	A	0.0137	2002	0.0018	0.0017
0908	B	0.0015U	2002	0.00032U	0.00014
0909	B	0.0015U	2002	NS	NS
0910	B			0.00049	
0911	F			0.00018	
0912	C	0.0003U	2001	0.000086B	
0913	G	0.0003U	2001	0.00011	
0914	C	0.00081	2001	0.00084	

Table B-1a (continued.). Baseline, August 2012, and February 2013 Molybdenum Concentrations, Sorted on Well ID

Well Number	Horizon	Baseline Molybdenum Concentration (mg/L)	Year Sampled, Baseline	August 2012 Molybdenum Concentration (mg/L)	February 2013 Molybdenum Concentration (mg/L)
0915	D	0.0004U	2000	0.00056	
0916	G	0.00096	2001	0.00099	
0920	E	0.0003U	2001	0.00024	
0921	I	0.0003U	2001	0.00018	
0929	A	0.0015U	2002	0.00028	0.00029
0930	C	0.0015U	2002	0.00016	0.00016
0932	C	0.0018U	2002	0.00037	0.00051
0934	B	0.0015U	2002	0.00052B	0.00054
0935	B	0.0015U	2002	0.0011	0.00062
0936	B	0.0015U	2002	NS	NS
0938	B	0.001U	1999	NS	0.0031
0940	A	0.0015U	2002	0.0012	0.00057
0941	A	0.0284	2002	0.032	0.027
0942	B	0.021	2002	NS	0.0046
0943	B	0.0015U	2002	0.00046	
0945	A	0.0015U	2002	0.0006	
0946	A			0.0013	
0947	B	0.0015U	2002	0.00045	
1003	D	0.0004U	2000	0.00013	
1004	D	0.0004U	2000	0.00034	
1005	D	0.0004U	2000	0.00028	
1006	D	0.0015U	2002	0.00025	
1007	D	0.0015U	2002	0.00025	
1101	D	0.0015U	2002	0.0024	
1102	D	0.0916	2002	NS	
1103	D	2.96	2002	0.0057	
1104	D	1.26	2002	0.038	
1105	D	0.16	2002	0.51	
1106	D	0.0015U	2002	0.11	
1107	D	0.0015U	2002	0.089	
1108	D	0.0015U	2002	0.00043B	
1109	D	0.0015U	2002	NS	
1110	D	0.0015U	2002	0.00016U	
1111	D	0.0015U	2002	0.00032U	
1112	D	0.0027	2002	0.00022B	
1113	D	0.0015U	2002	0.0043	
1114	D	0.0053	2002	0.0038	
1115	D	0.0815	2002	NS	
1116	C	0.0015U	2002	0.00022	
1117	C	0.0015U	2002	0.000095B	
1118	C	0.00063	2000	0.00033	
1119	D	0.105	2002	0.0047	
1120	D	0.0003U	2001	0.037	
1121	D	0.00081	2001	NS	
1122	D	0.0015U	2002	NS	
1123	D	0.0015U	2002	0.00032U	
1124	D	0.0015U	2002	0.00032U	
1125	D	0.0015U	2002	0.00033	
1129	B			0.49	
1130	B			NS	

Table B-1a (continued). Baseline, August 2012, and February 2013 Molybdenum Concentrations, Sorted on Well ID

Well Number	Horizon	Baseline Molybdenum Concentration (mg/L)	Year Sampled, Baseline	August 2012 Molybdenum Concentration (mg/L)	February 2013 Molybdenum Concentration (mg/L)
1132	B			1.4	
1133	B			0.01	
NMW-1A	B			0.00039	0.00039
NMW-2A	B			0.00048	
NMW-3A	B			0.00038	
NMW-4A	B			0.00029	
NMW-5	C			0.0011	
NMW-6S	B			0.00043	
NMW-7D	D			0.00031	0.00024
NMW-8S	B			0.00027	0.00035
NMW-9D	E			0.00024	0.00021

B Result between instrument detection limit and contract required detection limit.
NS Not Sampled (see Note on page B-i)
U Analytical result below detection limit.

Values in red equal or exceed the corresponding groundwater remediation target for molybdenum, 0.1 mg/L (see Table 1 of main report). Well numbers with groundwater concentrations greater than the remediation target during this reporting period are also listed in red.

Table B-1b. Baseline, August 2012, and February 2013 Molybdenum Concentrations, Sorted on Horizon

Well Number	Horizon	Baseline Molybdenum Concentration (mg/L)	Year Sampled, Baseline	August 2012 Molybdenum Concentration (mg/L)	February 2013 Molybdenum Concentration (mg/L)
0686	A	0.0015U	2002	0.0017	
0687	A	0.0113	2002	0.0081	
0688	A	0.0015U	2002	0.0011	
0901	A	0.00078	2001	0.00056	
0906	A	0.0137	2002	0.0018	0.0017
0929	A	0.0015U	2002	0.00028	0.00029
0940	A	0.0015U	2002	0.0012	0.00057
0941	A	0.0284	2002	0.032	0.027
0945	A	0.0015U	2002	0.0006	
0946	A			0.0013	
0262	B	0.432	2001	0.61	0.94
0263	B	0.192	2001	0.034	0.048
0265	B	0.00046	2001	0.00016U	0.000086B
0267	B	0.0015U	2002	0.00032U	0.000093B
0271	B	0.0015U	2002	0.00031	
0281	B			0.00075	0.00076
0282	B			0.00031	0.00031
0286	B			0.0013	0.0006
0287	B			0.13	0.14
0288	B			0.00011	0.00015
0290	B			0.00011	0.00019
0908	B	0.0015U	2002	0.00032U	0.00014
0909	B	0.0015U	2002	NS	NS
0910	B			0.00049	
0934	B	0.0015U	2002	0.00052B	0.00054
0935	B	0.0015U	2002	0.0011	0.00062
0936	B	0.0015U	2002	NS	NS
0938	B	0.001U	1999	NS	0.0031
0942	B	0.021	2002	NS	0.0046
0943	B	0.0015U	2002	0.00046	
0947	B	0.0015U	2002	0.00045	
1129	B			0.49	
1130	B			NS	
1132	B			1.4	
1133	B			0.01	
NMW-1A	B			0.00039	0.00039
NMW-2A	B			0.00048	
NMW-3A	B			0.00038	
NMW-4A	B			0.00029	
NMW-6S	B			0.00043	
NMW-8S	B			0.00027	0.00035
0274	C			0.00037	0.0004
0276	C			0.00039	0.00047
0279	C			0.00075	
0280	C			0.00048	
0289	C			0.0004	0.00049
0683	C	0.0015U	2002	0.00046	
0684	C	0.0015U	2002	0.00047	
0685	C	0.0015U	2002	0.00039	
0689	C	0.0015U	2002	0.00031	

Table B-1b (continued). Baseline, August 2012, and February 2013 Molybdenum Concentrations, Sorted on Horizon

Well Number	Horizon	Baseline Molybdenum Concentration (mg/L)	Year Sampled, Baseline	August 2012 Molybdenum Concentration (mg/L)	February 2013 Molybdenum Concentration (mg/L)
0691	C	0.0015U	2002	0.00016U	0.0004
0903	C	0.0015U	2002	0.00022	
0912	C	0.0003U	2001	0.000086B	
0914	C	0.00081	2001	0.00084	
0930	C	0.0015U	2002	0.00016	0.00016
0932	C	0.0018U	2002	0.00037	0.00051
1116	C	0.0015U	2002	0.00022	
1117	C	0.0015U	2002	0.000095B	
1118	C	0.00063	2000	0.00033	
NMW-5	C			0.0011	
0258	D	0.0026	2001	0.00043	0.00054
0261	D	0.0031	2001	0.00047	
0264	D	0.00058	2001	0.00033	0.00042
0266	D			0.00018	0.00026
0272	D			0.00023	0.00024
0273	D			0.019	0.023
0275	D			0.00032U	0.00028
0277	D			0.00043	
0278	D	0.0015U	2002	0.00033	
0690	D	0.0015U	2002	0.00025	
0692	D	0.0015U	2002	0.00026	
0695	D	0.00077	2001	0.00052	
0904	D	0.00054	2001	0.0008	
0915	D	0.0004U	2000	0.00056	
1003	D	0.0004U	2000	0.00013	
1004	D	0.0004U	2000	0.00034	
1005	D	0.0004U	2000	0.00028	
1006	D	0.0015U	2002	0.00025	
1007	D	0.0015U	2002	0.00025	
1101	D	0.0015U	2002	0.0024	
1102	D	0.0916	2002	NS	
1103	D	2.96	2002	0.0057	
1104	D	1.26	2002	0.038	
1105	D	0.16	2002	0.51	
1106	D	0.0015U	2002	0.11	
1107	D	0.0015U	2002	0.089	
1108	D	0.0015U	2002	0.00043B	
1109	D	0.0015U	2002	NS	
1110	D	0.0015U	2002	0.00016U	
1111	D	0.0015U	2002	0.00032U	
1112	D	0.0027	2002	0.00022B	
1113	D	0.0015U	2002	0.0043	
1114	D	0.0053	2002	0.0038	
1115	D	0.0815	2002	NS	
1119	D	0.105	2002	0.0047	
1120	D	0.0003U	2001	0.037	
1121	D	0.00081	2001	NS	
1122	D	0.0015U	2002	NS	
1123	D	0.0015U	2002	0.00032U	
1124	D	0.0015U	2002	0.00032U	

Table B−1b (continued). Baseline, August 2012, and February 2013 Molybdenum Concentrations, Sorted on Horizon

Well Number	Horizon	Baseline Molybdenum Concentration (mg/L)	Year Sampled, Baseline	August 2012 Molybdenum Concentration (mg/L)	February 2013 Molybdenum Concentration (mg/L)
1125	D	0.0015U	2002	0.00033	
NMW-7D	D			0.00031	0.00024
0251	E	0.0015U	2002	0.00022	0.00023
0268	E	0.0015U	2002	0.00033	0.00031
0920	E	0.0003U	2001	0.00024	
NMW-9D	E			0.00024	0.00021
0911	F			0.00018	
0913	G	0.0003U	2001	0.00011	
0916	G	0.00096	2001	0.00099	
0252	I	0.0015U	2002	0.00014	0.00016
0921	I	0.0003U	2001	0.00018	

B Result between instrument detection limit and contract required detection limit.
NS Not Sampled (see Note on page B-i)
U Analytical result below detection limit.

Values in red equal or exceed the corresponding groundwater remediation target for molybdenum, 0.1 mg/L (see Table 1 of main report). Identifiers Well numbers with groundwater concentrations ≥ the remediation target during this reporting period are also listed in red.

Table B-2a. Baseline, August 2012, and February 2013 Nitrate Concentrations (as NO_3), Sorted on Well ID

Well Number	Horizon	Baseline Nitrate Concentration (mg/L)	Year Sampled, Baseline	August 2012 Nitrate Concentration (mg/L)	February 2013 Nitrate Concentration (mg/L)
0251	E	426	2002	15.9	15.5
0252	I	15.3	2002	11.5	10.6
0258	D	15	2000	15.9	15.1
0261	D	14	2001	15.5	
0262	B	380	2001	1,018	797
0263	B	1140	2001	1062	1018
0264	D	24.3	2001	53.1	48.7
0265	B	720	2001	752.6	841.1
0266	D	14	2001	15.9	15.1
0267	B	1640	2002	1,505	1328
0268	E	15.4	2002	110.7	177.1
0271	B	15.6	2002	17.3	
0272	D			18.1	17.3
0273	D			194.8	190.4
0274	C			16.4	15.5
0275	D			1151	1062
0276	C			15.5	14.6
0277	D			13.7	
0278	D			14.6	
0279	C			35.4	
0280	C			12.8	
0281	B			132.8	106.2
0282	B			212.5	208.1
0286	B			1417	973.9
0287	B			1284	1151
0288	B			252.3	239
0289	C			185.9	119.5
0290	B			354.1	309.9
0683	C	14.1	2002	15.5	
0684	C	13.9	2002	15.1	
0685	C	14.3	2002	15.5	
0686	A	32.2	2002	15.5	
0687	A	60.6	2002	28.3	
0688	A	35.1	2002	32.3	
0689	C	14.3	2002	15.1	
0690	D	12.5	2002	15.1	
0691	C	298	2002	332	323.2
0692	D	12.5	2002	14.6	
0695	D	25.4	2002	23.9	
0901	A	13	2001	14.2	NS
0903	C	54.8	2002	75.3	
0904	D	5.13	2001	7.5	
0906	A	1470	2002	2346	2036
0908	B	651	2002	885.4	841.1
0909	B	485	2002	NS	NS
0910	B			13.3	13.9
0911	F			13.7	
0912	C	403	2001	318.7	
0913	G	12.4	2001	14.2	

Table B−2a (continued). Baseline, August 2012, and February 2013 Nitrate Concentrations (as NO_3), Sorted on Well ID

Well Number	Horizon	Baseline Nitrate Concentration (mg/L)	Year Sampled, Baseline	August 2012 Nitrate Concentration (mg/L)	February 2013 Nitrate Concentration (mg/L)
0914	C	13	2001	12.8	
0915	D	14.1	2001	15.1	
0916	G	11.6	2001	8.9	
0920	E	14.8	2001	16.4	
0921	I	11	2001	12.8	
0929	A	69.5	2002	66.4	62.0
0930	C	50.9	2002	101.8	110.7
0932	C	25.3	2002	31.9	28.8
0934	B	2320	2002	1726	1549
0935	B	525	2002	796.8	841.1
0936	B	2950	2002	NS	NS
0938	B	1450	1999	NS	1417
0940	A	1800	2002	1859	1505
0941	A	358	2002	1240	1195
0942	B	1360	2002	NS	841.1
0943	B	22.1	2002	10.2	
0945	A	12.7	2002	23.5	
0946	A			11.5	
0947	B	12.5	2002	15.5	
1003	D	176	2000	305.4	
1004	D	49.1	2000	30.1	
1005	D	14.5	2000		
1006	D	14.1	2000	14.2	
1007	D	15.3	2000	15.5	
1101	D	438	2002	327.6	
1102	D	650	2002	NS	
1103	D	1120	2002	796.8	
1104	D	993	2002	752.6	
1105	D	648	2002	619.8	
1106	D	614	2002	486.9	
1107	D	1060	2002	752.6	
1108	D	1410	2002	575.5	
1109	D	798	2002	NS	
1110	D	227	2002	354.1	
1111	D	421	2002	486.9	
1112	D	617	2002	243.5	
1113	D	143	2002	575.5	
1114	D	228	2002	318.7	
1115	D	766	2002	NS	
1116	C	106	2002	18.6	
1117	C	225	2002	486.9	
1118	C	164	2002	619.8	
1119	D	468	2002	367.4	
1120	D	493	2002	128.4	
1121	D	573	2002	NS	
1122	D	954	2002	NS	
1123	D	643	2002	70.8	
1124	D	781	2002	402.8	
1125	D	104	2002	66.4	
1129	B			486.9	

Table B-2a (continued). Baseline, August 2012, and February 2013 Nitrate Concentrations (as NO_3), Sorted on Well ID

Well Number	Horizon	Baseline Nitrate Concentration (mg/L)	Year Sampled, Baseline	August 2012 Nitrate Concentration (mg/L)	February 2013 Nitrate Concentration (mg/L)
1130	B			NS	
1132	B			752.6	
1133	B			212.5	
NMW-1A	B			14.6	15.5
NMW-2A	B				15.1
NMW-3A	B				14.6
NMW-4A	B				16.4
NMW-5	C				12.0
NMW-6S	B			15.1	16.4
NMW-7D	D			13.7	14.6
NMW-8S	B			15.1	16.4
NMW-9D	E			8.0	8.0

NS Not Sampled (see Note on page B-i)

Values in red exceed the corresponding groundwater remediation target for nitrate (as NO_3), 44 mg/L (see Table 1 of main report). Well numbers with groundwater concentrations greater than the remediation target during this reporting period are also listed in red.

Table B-2b. Baseline, August 2012, and February 2013 Nitrate Concentrations (as NO_3), Sorted on Horizon

Well Number	Horizon	Baseline Nitrate Concentration (mg/L)	Year Sampled, Baseline	August 2012 Nitrate Concentration (mg/L)	February 2013 Nitrate Concentration (mg/L)
0686	A	32.2	2002	15.5	
0687	A	60.6	2002	28.3	
0688	A	35.1	2002	32.3	
0901	A	13	2001	14.2	NS
0906	A	1470	2002	2346	2036
0929	A	69.5	2002	66.4	62.0
0940	A	1800	2002	1859	1505
0941	A	358	2002	1240	1195
0945	A	12.7	2002	23.5	
0946	A			11.5	
NMW-8S	B			15.1	16.4
NMW-6S	B			15.1	16.4
NMW-4A	B				16.4
NMW-3A	B				14.6
NMW-2A	B				15.1
NMW-1A	B			14.6	15.5
0262	B	380	2001	1,018	797
0263	B	1140	2001	1062	1018
0265	B	720	2001	752.6	841.1
0267	B	1640	2002	1,505	1328
0271	B	15.6	2002	17.3	
0281	B			132.8	106.2
0282	B			212.5	208.1
0286	B			1417	973.9
0287	B			1284	1151
0288	B			252.3	239
0290	B			354.1	309.9
0908	B	651	2002	885.4	841.1
0909	B	485	2002	NS	NS
0910	B			13.3	13.9
0934	B	2320	2002	1726	1549
0935	B	525	2002	796.8	841.1
0936	B	2950	2002	NS	NS
0938	B	1450	1999	NS	1417
0942	B	1360	2002	NS	841.1
0943	B	22.1	2002	10.2	
0947	B	12.5	2002	15.5	
1129	B			486.9	
1130	B			NS	
1132	B			752.6	
1133	B			212.5	
NMW-5	C				12.0
0274	C			16.4	15.5
0276	C			15.5	14.6
0279	C			35.4	
0280	C			12.8	
0289	C			185.9	119.5
0683	C	14.1	2002	15.5	
0684	C	13.9	2002	15.1	

Table B-2b (continued). Baseline, August 2012, and February 2013 Nitrate Concentrations (as NO_3), Sorted on Horizon

Well Number	Horizon	Baseline Nitrate Concentration (mg/L)	Year Sampled, Baseline	August 2012 Nitrate Concentration (mg/L)	February 2013 Nitrate Concentration (mg/L)
0685	C	14.3	2002	15.5	
0689	C	14.3	2002	15.1	
0691	C	298	2002	332	323.2
0903	C	54.8	2002	75.3	
0912	C	403	2001	318.7	
0914	C	13	2001	12.8	
0930	C	50.9	2002	101.8	110.7
0932	C	25.3	2002	31.9	28.8
1116	C	106	2002	18.6	
1117	C	225	2002	486.9	
1118	C	164	2002	619.8	
NMW-7D	D			13.7	14.6
0258	D	15	2000	15.9	15.1
0261	D	14	2001	15.5	
0264	D	24.3	2001	53.1	48.7
0266	D	14	2001	15.9	15.1
0272	D			18.1	17.3
0273	D			194.8	190.4
0275	D			1151	1062
0277	D			13.7	
0278	D			14.6	
0690	D	12.5	2002	15.1	
0692	D	12.5	2002	14.6	
0695	D	25.4	2002	23.9	
0904	D	5.13	2001	7.5	
0915	D	14.1	2001	15.1	
1003	D	176	2000	305.4	
1004	D	49.1	2000	30.1	
1005	D	14.5	2000		
1006	D	14.1	2000	14.2	
1007	D	15.3	2000	15.5	
1101	D	438	2002	327.6	
1102	D	650	2002	NS	
1103	D	1120	2002	796.8	
1104	D	993	2002	752.6	
1105	D	648	2002	619.8	
1106	D	614	2002	486.9	
1107	D	1060	2002	752.6	
1108	D	1410	2002	575.5	
1109	D	798	2002	NS	
1110	D	227	2002	354.1	
1111	D	421	2002	486.9	
1112	D	617	2002	243.5	
1113	D	143	2002	575.5	
1114	D	228	2002	318.7	
1115	D	766	2002	NS	
1119	D	468	2002	367.4	
1120	D	493	2002	128.4	
1121	D	573	2002	NS	
1122	D	954	2002	NS	

Table B−2b (continued). Baseline, August 2012, and February 2013 Nitrate Concentrations (as NO_3), Sorted on Horizon

Well Number	Horizon	Baseline Nitrate Concentration (mg/L)	Year Sampled, Baseline	August 2012 Nitrate Concentration (mg/L)	February 2013 Nitrate Concentration (mg/L)
1123	D	643	2002	70.8	
1124	D	781	2002	402.8	
1125	D	104	2002	66.4	
NMW-9D	E			8.0	8.0
0251	E	426	2002	15.9	15.5
0268	E	15.4	2002	110.7	177.1
0920	E	14.8	2001	16.4	
0911	F			13.7	
0913	G	12.4	2001	14.2	
0916	G	11.6	2001	8.9	
0252	I	15.3	2002	11.5	10.6
0921	I	11	2001	12.8	

NS Not Sampled (see Note on page B-i)

Values in red exceed the corresponding groundwater remediation target for nitrate (as NO_3), 44 mg/L (see Table 1 of main report). Well numbers with groundwater concentrations greater than the remediation target during this reporting period are also listed in red.

Table B-3a. Baseline, August 2012, and February 2013 Selenium Concentration, Sorted on Well ID

Well Number	Horizon	Baseline Selenium Concentration (mg/L)	Year Sampled, Baseline	August 2012 Selenium Concentration (mg/L)	February 2013 Selenium Concentration (mg/L)
0251	E	0.0035	2002	0.001	0.00092
0252	I	0.00092	2002	0.0008	0.00072
0258	D	0.0018	2000	0.0017	0.0016
0261	D	0.0021	2001	0.0017	
0262	B	0.0621	2001	0.066	0.11
0263	B	0.0632	2001	0.039	0.048
0264	D	0.0018	2001	0.0019	0.0022
0265	B	0.0071	2001	0.0064	0.0075
0266	D	0.0013	2001	0.0011	0.001
0267	B	0.0532	2002	0.046	0.054
0268	E	0.0018	2002	0.0024	0.0028
0271	B	0.0016	2002	0.0015	
0272	D			0.0011	0.0011
0273	D			0.016	0.017
0274	C			0.0015	0.0014
0275	D			0.032	0.036
0276	C			0.0017	0.0017
0277	D			0.0012	
0278	D			0.0013	
0279	C			0.0022	
0280	C			0.0021	
0281	B			0.002	0.0018
0282	B			0.0017	0.0017
0286	B			0.045	0.039
0287	B			0.091	0.098
0288	B			0.0026	0.0024
0289	C			0.0019	0.0019
0290	B			0.011	0.01
0683	C	0.0022	2002	0.0017	
0684	C	0.0019	2002	0.0015	
0685	C	0.0017	2002	0.0017	
0686	A	0.0088	2002	0.0077	
0687	A	0.0145	2002	0.0022	
0688	A	0.0033	2002	0.008	
0689	C	0.0014	2002	0.0013	
0690	D	0.0014	2002	0.0013	
0691	C	0.0046	2002	0.0046	0.0044
0692	D	0.0022	2002	0.0014	
0695	D	0.0019	2002	0.0017	
0901	A	0.0024	2001	0.0025	
0903	C	0.0023	2002	0.0021	
0904	D	0.0131	2001	0.013	
0906	A	0.0335	2002	0.032	0.034
0908	B	0.0163	2002	0.02	0.022
0909	B	0.0224	2002	NS	NS
0910	B			0.0013	
0911	F			0.00011	
0912	C	0.0137	2001	0.007	
0913	G	0.00063	2001	0.00086	
0914	C	0.0016	2001	0.0012	
0915	D	0.0019	2001	0.0018	

Table B-3a (continued). Baseline, August 2012, and February 2013 Selenium Concentration, Sorted on Well ID

Well Number	Horizon	Baseline Selenium Concentration (mg/L)	Year Sampled, Baseline	August 2012 Selenium Concentration (mg/L)	February 2013 Selenium Concentration (mg/L)
0916	G	0.001	2001	0.00079	
0920	E	0.0014	2001	0.0012	
0921	I	0.00091	2001	0.00096	
0929	A	0.0028	2002	0.0022	0.0023
0930	C	0.002	2002	0.0022	0.0023
0932	C	0.0019	2002	0.0015	0.0015
0934	B	0.0116	2002	0.01	0.0097
0935	B	0.0195	2002	0.0075	0.012
0936	B	0.0869	2002	NS	NS
0938	B	0.0432	1999	NS	0.083
0940	A	0.105	2002	0.07	0.076
0941	A	0.0348	2002	0.098	0.11
0942	B	0.0348	2002	NS	0.055
0943	B	0.0021	2002	0.0003	
0945	A	0.0035	2002	0.0036	
0946	A			0.001	
0947	B	0.0019	2002	0.0017	
1003	D	0.003	2000	0.0037	
1004	D	0.0021	2000	0.0016	
1005	D	0.0014	2000		
1006	D	0.0013	2000	0.0012	
1007	D	0.0013	2000	0.0012	
1101	D	0.0188	2002	.0092	
1102	D	0.0121	2002	NS	
1103	D	0.0613	2002	0.032	
1104	D	0.0344	2002	0.045	
1105	D	0.0871	2002	0.045	
1106	D	0.0925	2002	0.043	
1107	D	0.0903	2002	0.052	
1108	D	0.0704	2002	0.032	
1109	D	0.0372	2002	NS	
1110	D	0.0081	2002	0.01	
1111	D	0.0172	2002	0.013	
1112	D	0.0154	2002	0.0071	
1113	D	0.0025	2002	0.015	
1114	D	0.0035	2002	.0094	
1115	D	0.0362	2002	NS	
1116	C	0.0018	2002	0.0013	
1117	C	0.0028	2002	0.012	
1118	C	0.0028	2002	0.017	
1119	D	0.029	2002	0.017	
1120	D	0.0563	2002	0.0098	
1121	D	0.0455	2002	NS	
1122	D	0.0558	2002	NS	
1123	D	0.0449	2002	0.0093	
1124	D	0.0186	2002	0.029	
1125	D	0.0025	2002	0.0024	
1129	B			0.05	
1130	B			NS	
1132	B			0.084	

Table B-3a (continued). Baseline, August 2012, and February 2013 Selenium Concentration, Sorted on Well ID

Well Number	Horizon	Baseline Selenium Concentration (mg/L)	Year Sampled, Baseline	August 2012 Selenium Concentration (mg/L)	February 2013 Selenium Concentration (mg/L)
1133	B			0.018	
NMW-1A	B			0.0011	0.0013
NMW-2A	B				0.0012
NMW-3A	B				0.0011
NMW-4A	B				0.0012
NMW-5	C				0.0027
NMW-6S	B			0.0015	0.0015
NMW-7D	D			0.00095	0.0012
NMW-8S	B			0.0012	0.0013
NMW-9D	E			0.0009	0.00088

NS Not Sampled (see Note on page B-i)

Values in red equal or exceed the corresponding groundwater remediation target for selenium, 0.01 mg/L (see Table 1 of main report). Well numbers with groundwater concentrations greater than the remediation target during this reporting period are also listed in red.

Table B-3b. Baseline, August 2012, and February 2013 Selenium Concentration, Sorted on Horizon

Well Number	Horizon	Baseline Selenium Concentration (mg/L)	Year Sampled, Baseline	August 2012 Selenium Concentration (mg/L)	February 2013 Selenium Concentration (mg/L)
0686	A	0.0088	2002	0.0077	
0687	A	0.0145	2002	0.0022	
0688	A	0.0033	2002	0.008	
0901	A	0.0024	2001	0.0025	
0906	A	0.0335	2002	0.032	0.034
0929	A	0.0028	2002	0.0022	0.0023
0940	A	0.105	2002	0.07	0.076
0941	A	0.0348	2002	0.098	0.11
0945	A	0.0035	2002	0.0036	
0946	A			0.001	
0262	B	0.0621	2001	0.066	0.11
0263	B	0.0632	2001	0.039	0.048
0265	B	0.0071	2001	0.0064	0.0075
0267	B	0.0532	2002	0.046	0.054
0271	B	0.0016	2002	0.0015	
0281	B			0.002	0.0018
0282	B			0.0017	0.0017
0286	B			0.045	0.039
0287	B			0.091	0.098
0288	B			0.0026	0.0024
0290	B			0.011	0.01
0908	B	0.0163	2002	0.02	0.022
0909	B	0.0224	2002	NS	NS
0910	B			0.0013	
0934	B	0.0116	2002	0.01	0.0097
0935	B	0.0195	2002	0.0075	0.012
0936	B	0.0869	2002	NS	NS
0938	B	0.0432	1999	NS	0.083
0942	B	0.0348	2002	NS	0.055
0943	B	0.0021	2002	0.0003	
0947	B	0.0019	2002	0.0017	
1129	B			0.05	
1130	B			NS	
1132	B			0.084	
1133	B			0.018	
NMW-1A	B			0.0011	0.0013
NMW-2A	B				0.0012
NMW-3A	B				0.0011
NMW-4A	B				0.0012
NMW-6S	B			0.0015	0.0015
NMW-8S	B			0.0012	0.0013
0274	C			0.0015	0.0014
0276	C			0.0017	0.0017
0279	C			0.0022	
0280	C			0.0021	
0289	C			0.0019	0.0019
0683	C	0.0022	2002	0.0017	
0684	C	0.0019	2002	0.0015	
0685	C	0.0017	2002	0.0017	
0689	C	0.0014	2002	0.0013	
0691	C	0.0046	2002	0.0046	0.0044

Table B-3b (continued). Baseline, August 2012, and February 2013 Selenium Concentrations, Sorted on Horizon

Well Number	Horizon	Baseline Selenium Concentration (mg/L)	Year Sampled, Baseline	August 2012 Selenium Concentration (mg/L)	February 2013 Selenium Concentration (mg/L)
0903	C	0.0023	2002	0.0021	
0912	C	0.0137	2001	0.007	
0914	C	0.0016	2001	0.0012	
0930	C	0.002	2002	0.0022	0.0023
0932	C	0.0019	2002	0.0015	0.0015
1116	C	0.0018	2002	0.0013	
1117	C	0.0028	2002	0.012	
1118	C	0.0028	2002	0.017	
NMW-5	C				0.0027
0258	D	0.0018	2000	0.0017	0.0016
0261	D	0.0021	2001	0.0017	
0264	D	0.0018	2001	0.0019	0.0022
0266	D	0.0013	2001	0.0011	0.001
0272	D			0.0011	0.0011
0273	D			0.016	0.017
0275	D			0.032	0.036
0277	D			0.0012	
0278	D			0.0013	
0690	D	0.0014	2002	0.0013	
0692	D	0.0022	2002	0.0014	
0695	D	0.0019	2002	0.0017	
0904	D	0.0131	2001	0.013	
0915	D	0.0019	2001	0.0018	
1003	D	0.003	2000	0.0037	
1004	D	0.0021	2000	0.0016	
1005	D	0.0014	2000		
1006	D	0.0013	2000	0.0012	
1007	D	0.0013	2000	0.0012	
1101	D	0.0188	2002	.0092	
1102	D	0.0121	2002	NS	
1103	D	0.0613	2002	0.032	
1104	D	0.0344	2002	0.045	
1105	D	0.0871	2002	0.045	
1106	D	0.0925	2002	0.043	
1107	D	0.0903	2002	0.052	
1108	D	0.0704	2002	0.032	
1109	D	0.0372	2002	NS	
1110	D	0.0081	2002	0.01	
1111	D	0.0172	2002	0.013	
1112	D	0.0154	2002	0.0071	
1113	D	0.0025	2002	0.015	
1114	D	0.0035	2002	.0094	
1115	D	0.0362	2002	NS	
1119	D	0.029	2002	0.017	
1120	D	0.0563	2002	0.0098	
1121	D	0.0455	2002	NS	
1122	D	0.0558	2002	NS	
1123	D	0.0449	2002	0.0093	
1124	D	0.0186	2002	0.029	
1125	D	0.0025	2002	0.0024	
NMW-7D	D			0.00095	0.0012

Table B-3b (continued). Baseline, August 2012, and February 2013 Selenium Concentrations, Sorted on Horizon

Well Number	Horizon	Baseline Selenium Concentration (mg/L)	Year Sampled, Baseline	August 2012 Selenium Concentration (mg/L)	February 2013 Selenium Concentration (mg/L)
0251	E	0.0035	2002	0.001	0.00092
0268	E	0.0018	2002	0.0024	0.0028
0920	E	0.0014	2001	0.0012	
NMW-9D	E			0.0009	0.00088
0911	F			0.00011	
0913	G	0.00063	2001	0.00086	
0916	G	0.001	2001	0.00079	
0252	I	0.00092	2002	0.0008	0.00072
0921	I	0.00091	2001	0.00096	

NS Not Sampled (see Note on page B-i)

Values in red equal or exceed the corresponding groundwater remediation target for selenium, 0.01 mg/L (see Table 1 of main report). Well numbers with groundwater concentrations greater than the remediation target during this reporting period are also listed in red.

Table B-4a. Baseline, August 2012, and February 2013 Sulfate Concentrations, Sorted on Well ID

Well Number	Horizon	Baseline Sulfate Concentration (mg/L)	Year Sampled, Baseline	August 2012 Sulfate Concentration (mg/L)	February 2013 Sulfate Concentration (mg/L)
0251	E	617	2002	11	13
0252	I	19.2	2002	6.5	7.1
0258	D	17.4	2000	18	19
0261	D	18.2	2001	19	
0262	B	931	2001	2200	2200
0263	B	1990	2001	2700	2900
0264	D	37.7	2001	81	96
0265	B	1520	2001	1200	1200
0266	D	10.9	2001	11	12
0267	B	3680	2002	3200	3500
0268	E	17.4	2002	200	360
0271	B	16.4	2002	15	
0272	D			12	13
0273	D			190	190
0274	C			16	17
0275	D			2300	2400
0276	C			17	19
0277	D			16	
0278	D			13	
0279	C			48	
0280	C			2`	
0281	B			100	99
0282	B			110	150
0286	B			3700	3100
0287	B			1800	1900
0288	B			260	250
0289	C			200	140
0290	B			550	580
0683	C	21.6	2002	18	
0684	C	18	2002	15	
0685	C	26.2	2002	18	
0686	A	98.6	2002	130	
0687	A	329	2002	80	
0688	A	40	2002	130	
0689	C	13.7	2002	14	
0690	D	13.8	2002	13	
0691	C	587	2002	550	640
0692	D	20.8	2002	15	
0695	D	50.4	2002	39	
0901	A	26.2	2001	28	26.1
0903	C	76.5	2002	85	
0904	D	96.5	2001	79	
0906	A	1660	2002	2100	2100
0908	B	2430	2002	2800	3000
0909	B	666	2002	NS	NS
0910	B			14	
0911	F			9.3	
0912	C	846	2001	540	
0913	G	8.43	2001	7.6	
0914	C	15.6	2001	13	

Table B-4a (continued). Baseline, August 2012, and February 2013 Sulfate Concentrations, Sorted on Well ID

Well Number	Horizon	Baseline Sulfate Concentration (mg/L)	Year Sampled, Baseline	August 2012 Sulfate Concentration (mg/L)	February 2013 Sulfate Concentration (mg/L)
0915	D	17.8	2001	17	
0916	G	13.5	2001	8.6	
0920	E	12.7	2001	13	
0921	I	8.52	2001	8.3	
0929	A	28.1	2002	23	27
0930	C	59.8	2002	110	140
0932	C	30.2	2002	29	34
0934	B	7360	2002	2600	3000
0935	B	2690	2002	2500	2600
0936	B	4360	2002	NS	NS
0938	B	2120	1999	NS	3100
0940	A	7550	2002	7000	6700
0941	A	745	2002	1600	1700
0942	B	3030	2002	NS	3600
0943	B	29	2002	22	
0945	A	32.1	2002	40	
0946	A			40	
0947	B	18.7	2002	17	
1003	D	302	2000	530	
1004	D	66.2	2000	39	
1005	D	12.7	2000		
1006	D	12.2	2000	12	
1007	D	11.7	2000	12	
1101	D	960	2002		
1102	D	1320	2002	NS	
1103	D	2570	2002	2000	
1104	D	1870	2002	2400	
1105	D	1590	2002	2400	
1106	D	1050	2002	1100	
1107	D	1200	2002	1200	
1108	D	3400	2002	1500	
1109	D	3280	2002	NS	
1110	D	512	2002		
1111	D	988	2002	1200	
1112	D	1140	2002	300	
1113	D	136	2002	100	
1114	D	328	2002	650	
1115	D	1930	2002	NS	
1116	C	176	2002	18	
1117	C	255	2002	810	
1118	C	163	2002	1400	
1119	D	1560	2002	1400	
1120	D	2330	2002	2300	
1121	D	2590	2002	NS	
1122	D	2960	2002	NS	
1123	D	1240	2002	2100	
1124	D	1170	2002	2200	
1125	D	165	2002	89	
1129	B			910	
1130	B			NS	

Table B-4a (continued). Baseline, August 2012, and February 2013 Sulfate Concentrations, Sorted on Well ID

Well Number	Horizon	Baseline Sulfate Concentration (mg/L)	Year Sampled, Baseline	August 2012 Sulfate Concentration (mg/L)	February 2013 Sulfate Concentration (mg/L)
1132	B			1700	
1133	B			220	
NMW-1A	B			13	14
NMW-2A	B				14
NMW-3A	B				13
NMW-4A	B				14
NMW-5	C				63
NMW-6S	B			15	17
NMW-7D	D			9.2	10.0
NMW-8S	B			13	15
NMW-9D	E			28	32

NS Not Sampled (see Note on page B-i)

Values in red exceed the corresponding groundwater remediation target for sulfate, 250 mg/L (see Table 1 of main report). Well numbers with groundwater concentrations greater than the remediation target during this reporting period are also listed in red.

Table B-4b. Baseline, August 2012, and February 2013 Sulfate Concentrations, Sorted on Horizon

Well Number	Horizon	Baseline Sulfate Concentration (mg/L)	Year Sampled, Baseline	August 2012 Sulfate Concentration (mg/L)	February 2013 Sulfate Concentration (mg/L)
0686	A	98.6	2002	130	
0687	A	329	2002	80	
0688	A	40	2002	130	
0901	A	26.2	2001	28	26.1
0906	A	1660	2002	2100	2100
0929	A	28.1	2002	23	27
0940	A	7550	2002	7000	6700
0941	A	745	2002	1600	1700
0945	A	32.1	2002	40	
0946	A			40	
0262	B	931	2001	2200	2200
0263	B	1990	2001	2700	2900
0265	B	1520	2001	1200	1200
0267	B	3680	2002	3200	3500
0271	B	16.4	2002	15	
0281	B			100	99
0282	B			110	150
0286	B			3700	3100
0287	B			1800	1900
0288	B			260	250
0290	B			550	580
0908	B	2430	2002	2800	3000
0909	B	666	2002	NS	NS
0910	B			14	
0934	B	7360	2002	2600	3000
0935	B	2690	2002	2500	2600
0936	B	4360	2002	NS	NS
0938	B	2120	1999	NS	3100
0942	B	3030	2002	NS	3600
0943	B	29	2002	22	
0947	B	18.7	2002	17	
1129	B			910	
1130	B			NS	
1132	B			1700	
1133	B			220	
NMW-1A	B			13	14
NMW-2A	B				14
NMW-3A	B				13
NMW-4A	B				14
NMW-6S	B			15	17
NMW-8S	B			13	15
0274	C			16	17
0276	C			17	19
0279	C			48	
0280	C			2`	
0289	C			200	140
0683	C	21.6	2002	18	
0684	C	18	2002	15	
0685	C	26.2	2002	18	
0689	C	13.7	2002	14	
0691	C	587	2002	550	640

Table B-4b (continued). Baseline, August 2012, and February 2013 Sulfate Concentrations, Sorted on Horizon

Well Number	Horizon	Baseline Sulfate Concentration (mg/L)	Year Sampled, Baseline	August 2012 Sulfate Concentration (mg/L)	February 2013 Sulfate Concentration (mg/L)
0903	C	76.5	2002	85	
0912	C	846	2001	540	
0914	C	15.6	2001	13	
0930	C	59.8	2002	110	140
0932	C	30.2	2002	29	34
1116	C	176	2002	18	
1117	C	255	2002	810	
1118	C	163	2002	1400	
NMW-5	C				63
0258	D	17.4	2000	18	19
0261	D	18.2	2001	19	
0264	D	37.7	2001	81	96
0266	D	10.9	2001	11	12
0272	D			12	13
0273	D			190	190
0275	D			2300	2400
0277	D			16	
0278	D			13	
0690	D	13.8	2002	13	
0692	D	20.8	2002	15	
0695	D	50.4	2002	39	
0904	D	96.5	2001	79	
0915	D	17.8	2001	17	
1003	D	302	2000	530	
1004	D	66.2	2000	39	
1005	D	12.7	2000		
1006	D	12.2	2000	12	
1007	D	11.7	2000	12	
1101	D	960	2002		
1102	D	1320	2002	NS	
1103	D	2570	2002	2000	
1104	D	1870	2002	2400	
1105	D	1590	2002	2400	
1106	D	1050	2002	1100	
1107	D	1200	2002	1200	
1108	D	3400	2002	1500	
1109	D	3280	2002	NS	
1110	D	512	2002		
1111	D	988	2002	1200	
1112	D	1140	2002	300	
1113	D	136	2002	100	
1114	D	328	2002	650	
1115	D	1930	2002	NS	
1119	D	1560	2002	1400	
1120	D	2330	2002	2300	
1121	D	2590	2002	NS	
1122	D	2960	2002	NS	
1123	D	1240	2002	2100	
1124	D	1170	2002	2200	
1125	D	165	2002	89	

Table B-4b (continued). Baseline, August 2012, and February 2013 Sulfate Concentrations, Sorted on Horizon

Well Number	Horizon	Baseline Sulfate Concentration (mg/L)	Year Sampled, Baseline	August 2012 Sulfate Concentration (mg/L)	February 2013 Sulfate Concentration (mg/L)
NMW-7D	D			9.2	10.0
0251	E	617	2002	11	13
0268	E	17.4	2002	200	360
0920	E	12.7	2001	13	
NMW-9D	E			28	32
0911	F			9.3	
0913	G	8.43	2001	7.6	
0916	G	13.5	2001	8.6	
0252	I	19.2	2002	6.5	7.1
0921	I	8.52	2001	8.3	

NS Not Sampled (see Note on page B-i)

Values in red exceed the corresponding groundwater remediation target for sulfate, 250 mg/L (see Table 1 of main report). Well numbers with groundwater concentrations greater than the remediation target during this reporting.

Table B-5a. Baseline, August 2012, and February 2013 Uranium Concentrations, Sorted on Well ID

Well Number	Horizon	Baseline Uranium Concentration (mg/L)	Year Sampled, Baseline	August 2012 Uranium Concentration (mg/L)	February 2013 Uranium Concentration (mg/L)
0251	E	0.0481	2002	0.0015	0.0016
0252	I	0.0024	2002	0.0018	0.0020
0258	D	0.0018	2000	0.0018	0.0020
0261	D	0.0018	2001	0.0012	
0262	B	0.379	2001	0.66	0.88
0263	B	0.485	2001	0.18	0.26
0264	D	0.0033	2001	0.0035	0.0043
0265	B	0.0897	2001	0.054	0.062
0266	D	0.0019	2001	0.0014	0.0017
0267	B	0.0731	2002	0.057	0.071
0268	E	0.0014	2002	0.035	0.082
0271	B	0.0014	2002	0.0013	
0272	D			0.0013	0.0015
0273	D			0.032	0.044
0274	C			0.0015	0.0017
0275	D			0.39	0.42
0276	C			0.0014	0.0017
0277	D			0.0023	
0278	D			0.0012	
0279	C			0.0018	
0280	C			0.0013	
0281	B			0.0062	0.0054
0282	B			0.0059	0.0080
0286	B			0.35	0.4
0287	B			0.24	0.27
0288	B			0.011	0.011
0289	C			0.013	0.013
0290	B			0.05	0.055
0683	C	0.0012	2002	0.0012	
0684	C	0.0019	2002	0.0013	
0685	C	0.0012	2002	0.0012	
0686	A	0.0021	2002	0.0023	
0687	A	0.0208	2002	0.0028	
0688	A	0.002	2002	0.0021	
0689	C	0.0011	2002	0.0012	
0690	D	0.0018	2002	0.0015	
0691	C	0.0657	2002	0.056	0.077
0692	D	0.0015	2002	0.0016	
0695	D	0.002	2002	0.0019	
0901	A	0.0026	2001	0.002	0.00353
0903	C	0.0022	2002	0.0023	
0904	D	0.0044	2001	0.0043	
0906	A	0.951	2002	0.43	0.46
0908	B	0.122	2002	0.072	0.087
0909	B	0.0389	2002	NS	NS
0910	B			0.001	0.00155
0911	F			0.0012	
0912	C	0.0342	2001	0.024	
0913	G	0.0016	2001	0.0012	
0914	C	0.0013	2001	0.000009B	

Table B-5a (continued). Baseline, August 2012, and February 2013 Uranium Concentrations, Sorted on Well ID

Well Number	Horizon	Baseline Uranium Concentration (mg/L)	Year Sampled, Baseline	August 2012 Uranium Concentration (mg/L)	February 2013 Uranium Concentration (mg/L)
0915	D	0.0017	2001	0.000004B	
0916	G	0.0014	2001	0.00002	
0920	E	0.0017	2001	0.0013	
0921	I	0.0047	2001	0.0043	
0929	A	0.0012	2002	0.0014	0.0017
0930	C	0.0023	2002	0.0042	0.0054
0932	C	0.0016	2002	0.002	0.0018
0934	B	0.312	2002	0.13	0.15
0935	B	0.0868	2002	0.12	0.14
0936	B	0.267	2002	NS	NS
0938	B	0.21	1999	NS	0.31
0940	A	0.546	2002	0.49	0.56
0941	A	0.0886	2002	0.21	0.25
0942	B	0.246	2002	NS	0.54
0943	B	0.0049	2002	0.0053	
0945	A	0.0031	2002	0.0013	
0946	A			0.0002	
0947	B	0.0024	2002	0.0011	
1003	D	0.0205	2000	0.037	
1004	D	0.0053	2000	0.004	
1005	D	0.0013	2000		
1006	D	0.0014	2000	0.0013	
1007	D	0.0012	2000	0.0013	
1101	D	0.245	2002	0.27	
1102	D	0.533	2002	NS	
1103	D	0.355	2002	0.39	
1104	D	0.194	2002	1.1	
1105	D	2.1	2002	1.1	
1106	D	2.1	2002	1.8	
1107	D	0.118	2002	0.36	
1108	D	0.646	2002	0.75	
1109	D	0.565	2002	NS	
1110	D	0.0528	2002	0.12	
1111	D	0.161	2002	0.16	
1112	D	0.13	2002	0.071	
1113	D	0.0149	2002	0.075	
1114	D	0.0277	2002	0.063	
1115	D	0.41	2002	NS	
1116	C	0.0081	2002	0.0018	
1117	C	0.0151	2002	0.034	
1118	C	0.0098	2002	0.068	
1119	D	0.555	2002	0.19	
1120	D	1.3	2002	0.11	
1121	D	0.857	2002	NS	
1122	D	0.878	2002	NS	
1123	D	0.261	2002	0.16	
1124	D	0.171	2002	0.28	
1125	D	0.0176	2002	0.012	
1129	B			0.5	
1130	B			NS	

Table B-5a (continued). Baseline, August 2012, and February 2013 Uranium Concentrations, Sorted on Well ID

Well Number	Horizon	Baseline Uranium Concentration (mg/L)	Year Sampled, Baseline	August 2012 Uranium Concentration (mg/L)	February 2013 Uranium Concentration (mg/L)
1132	B			1.1	
1133	B			0.074	
NMW-1A	B			0.0014	0.0016
NMW-2A	B				0.0014
NMW-3A	B				0.0012
NMW-4A	B				0.0013
NMW-5	C				0.0049
NMW-6S	B			0.0011	0.0013
NMW-7D	D			0.0008	0.0009
NMW-8S	B			0.0012	0.0014
NMW-9D	E			0.0013	0.0014

B = Result between instrument detection limit and contract required detection limit.
NS Not Sampled (see Note on page B-i)

Values in red exceed the corresponding groundwater remediation target for uranium, 0.044 mg/L (see Table 1 of main report). Well numbers with groundwater concentrations greater than the remediation target during this reporting period are also listed in red.

Table B-5b. Baseline, August 2012, and February 2013 Uranium Concentrations, Sorted on Horizon

Well Number	Horizon	Baseline Uranium Concentration (mg/L)	Year Sampled, Baseline	August 2012 Uranium Concentration (mg/L)	February 2013 Uranium Concentration (mg/L)
0686	A	0.0021	2002	0.0023	
0687	A	0.0208	2002	0.0028	
0688	A	0.002	2002	0.0021	
0901	A	0.0026	2001	0.002	0.00353
0906	A	0.951	2002	0.43	0.46
0929	A	0.0012	2002	0.0014	0.0017
0940	A	0.546	2002	0.49	0.56
0941	A	0.0886	2002	0.21	0.25
0945	A	0.0031	2002	0.0013	
0946	A			0.0002	
0262	B	0.379	2001	0.66	0.88
0263	B	0.485	2001	0.18	0.26
0265	B	0.0897	2001	0.054	0.062
0267	B	0.0731	2002	0.057	0.071
0271	B	0.0014	2002	0.0013	
0281	B			0.0062	0.0054
0282	B			0.0059	0.0080
0286	B			0.35	0.4
0287	B			0.24	0.27
0288	B			0.011	0.011
0290	B			0.05	0.055
0908	B	0.122	2002	0.072	0.087
0909	B	0.0389	2002	NS	NS
0910	B			0.001	0.00155
0934	B	0.312	2002	0.13	0.15
0935	B	0.0868	2002	0.12	0.14
0936	B	0.267	2002	NS	NS
0938	B	0.21	1999	NS	0.31
0942	B	0.246	2002	NS	0.54
0943	B	0.0049	2002	0.0053	
0947	B	0.0024	2002	0.0011	
1129	B			0.5	
1130	B			NS	
1132	B			1.1	
1133	B			0.074	
NMW-1A	B			0.0014	0.0016
NMW-2A	B				0.0014
NMW-3A	B				0.0012
NMW-4A	B				0.0013
NMW-6S	B			0.0011	0.0013
NMW-8S	B			0.0012	0.0014
0274	C			0.0015	0.0017
0276	C			0.0014	0.0017
0279	C			0.0018	
0280	C			0.0013	
0289	C			0.013	0.013
0683	C	0.0012	2002	0.0012	
0684	C	0.0019	2002	0.0013	
0685	C	0.0012	2002	0.0012	
0689	C	0.0011	2002	0.0012	

Table B-5b (continued). Baseline, August 2012, and February 2013 Uranium Concentrations, Sorted on Horizon

Well Number	Horizon	Baseline Uranium Concentration (mg/L)	Year Sampled, Baseline	August 2012 Uranium Concentration (mg/L)	February 2013 Uranium Concentration (mg/L)
0691	C	0.0657	2002	0.056	0.077
0903	C	0.0022	2002	0.0023	
0912	C	0.0342	2001	0.024	
0914	C	0.0013	2001	0.000009B	
0930	C	0.0023	2002	0.0042	0.0054
0932	C	0.0016	2002	0.002	0.0018
1116	C	0.0081	2002	0.0018	
1117	C	0.0151	2002	0.034	
1118	C	0.0098	2002	0.068	
NMW-5	C				0.0049
0258	D	0.0018	2000	0.0018	0.0020
0261	D	0.0018	2001	0.0012	
0264	D	0.0033	2001	0.0035	0.0043
0266	D	0.0019	2001	0.0014	0.0017
0272	D			0.0013	0.0015
0273	D			0.032	0.044
0275	D			0.39	0.42
0277	D			0.0023	
0278	D			0.0012	
0690	D	0.0018	2002	0.0015	
0692	D	0.0015	2002	0.0016	
0695	D	0.002	2002	0.0019	
0904	D	0.0044	2001	0.0043	
0915	D	0.0017	2001	0.000004B	
1003	D	0.0205	2000	0.037	
1004	D	0.0053	2000	0.004	
1005	D	0.0013	2000		
1006	D	0.0014	2000	0.0013	
1007	D	0.0012	2000	0.0013	
1101	D	0.245	2002	0.27	
1102	D	0.533	2002	NS	
1103	D	0.355	2002	0.39	
1104	D	0.194	2002	1.1	
1105	D	2.1	2002	1.1	
1106	D	2.1	2002	1.8	
1107	D	0.118	2002	0.36	
1108	D	0.646	2002	0.75	
1109	D	0.565	2002	NS	
1110	D	0.0528	2002	0.12	
1111	D	0.161	2002	0.16	
1112	D	0.13	2002	0.071	
1113	D	0.0149	2002	0.075	
1114	D	0.0277	2002	0.063	
1115	D	0.41	2002	NS	
1119	D	0.555	2002	0.19	
1120	D	1.3	2002	0.11	
1121	D	0.857	2002	NS	
1122	D	0.878	2002	NS	
1123	D	0.261	2002	0.16	
1124	D	0.171	2002	0.28	

Table B−5b (continued). Baseline, August 2012, and February 2013 Uranium Concentrations, Sorted on Horizon

Well Number	Horizon	Baseline Uranium Concentration (mg/L)	Year Sampled, Baseline	August 2012 Uranium Concentration (mg/L)	February 2013 Uranium Concentration (mg/L)
1125	D	0.0176	2002	0.012	
NMW-7D	D			0.0008	0.0009
0251	E	0.0481	2002	0.0015	0.0016
0268	E	0.0014	2002	0.035	0.082
0920	E	0.0017	2001	0.0013	
NMW-9D	E			0.0013	0.0014
0911	F			0.0012	
0913	G	0.0016	2001	0.0012	
0916	G	0.0014	2001	0.00002	
0252	I	0.0024	2002	0.0018	0.0020
0921	I	0.0047	2001	0.0043	

B = Result between instrument detection limit and contract required detection limit.
NS Not Sampled (see Note on page B-i)

Values in red exceed the corresponding groundwater remediation target for uranium, 0.044 mg/L (see Table 1 of main report). Well numbers with groundwater concentrations greater than the remediation target during this reporting period are also listed in red.

Appendix C

Nitrate, Sulfate, and Uranium Plume Maps

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Figures

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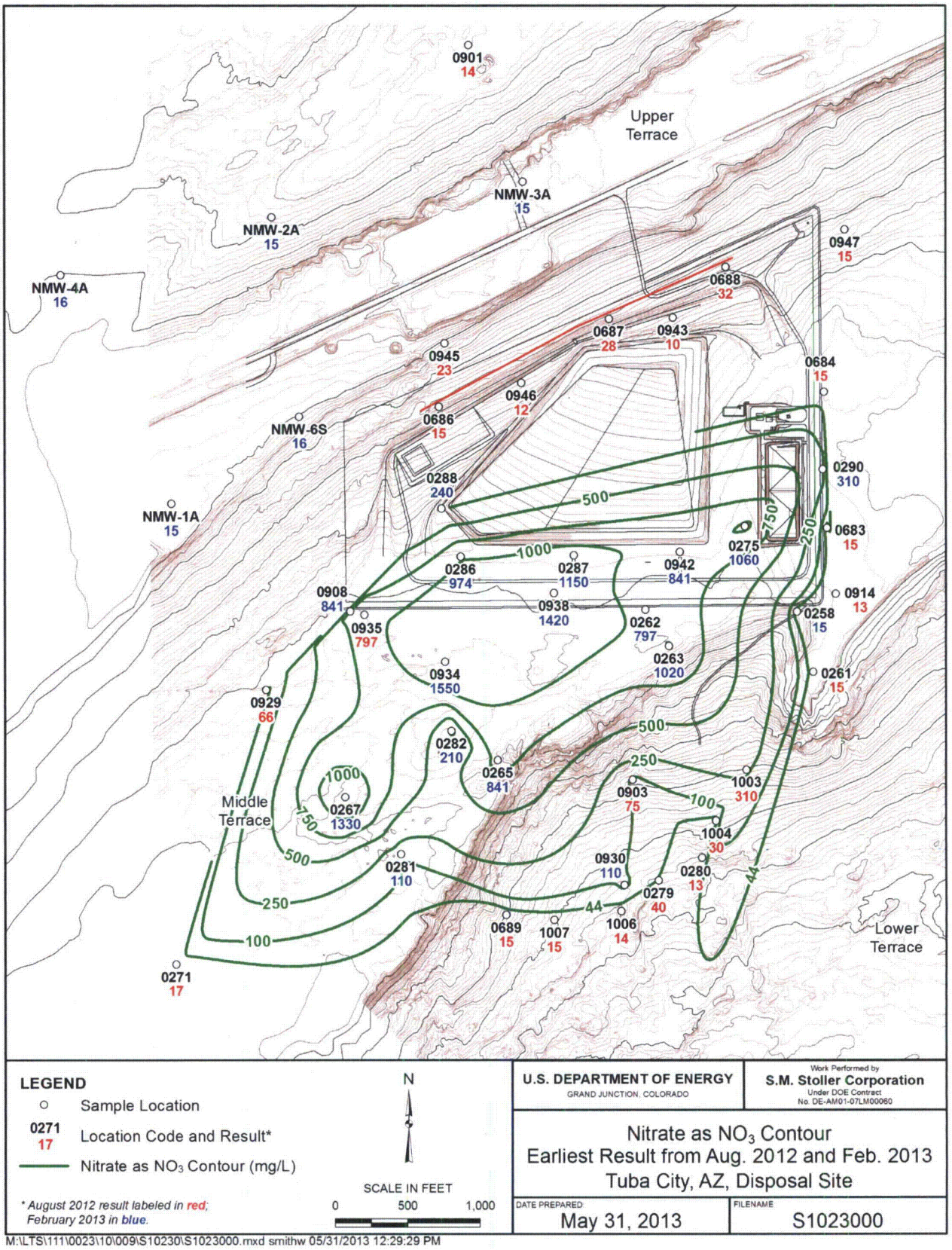

Figure C-1. Nitrate (mg/L as NO_3) Plume Map: August 2012–February 2013

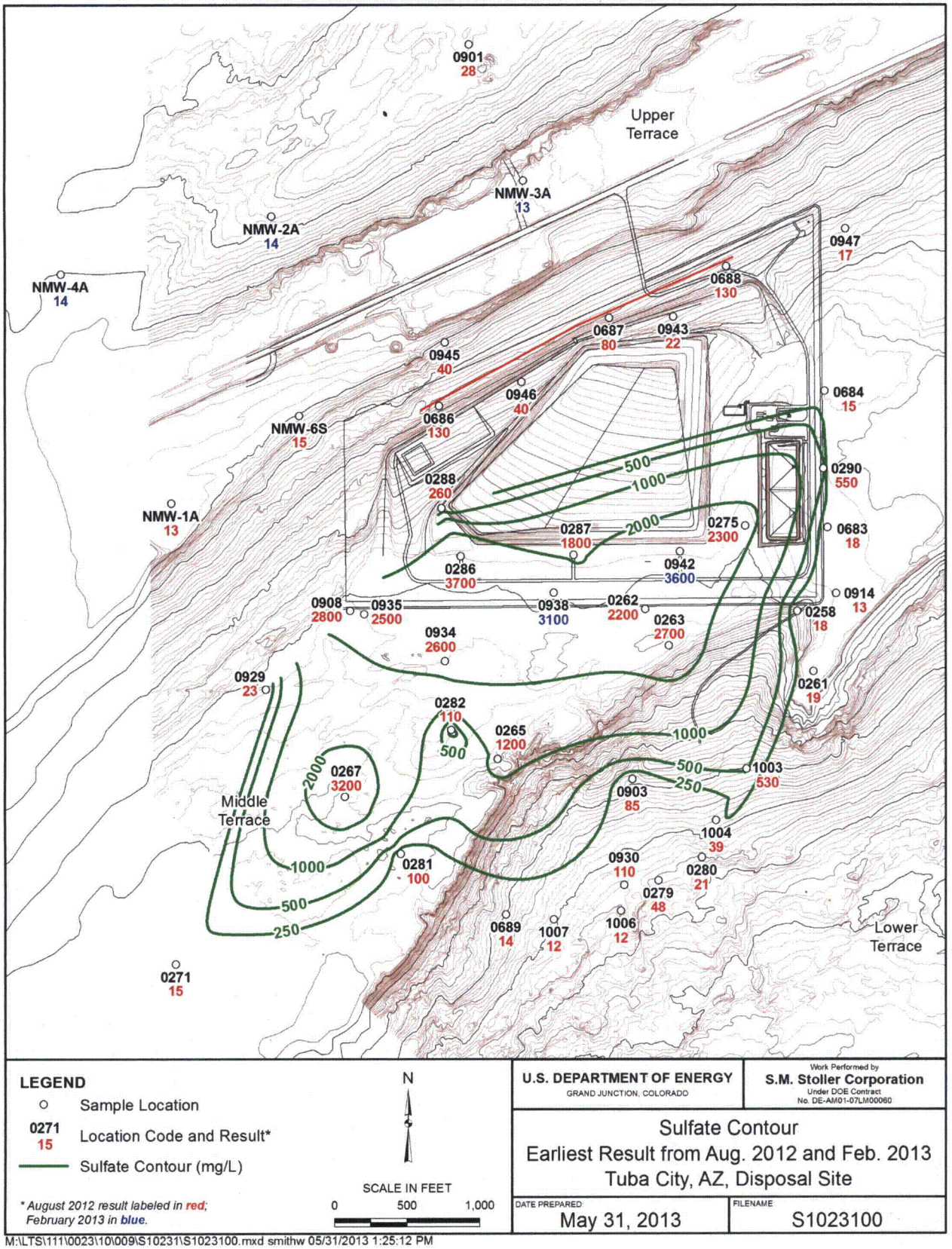

Figure C-2. Sulfate (mg/L) Plume Map: August 2012–February 2013

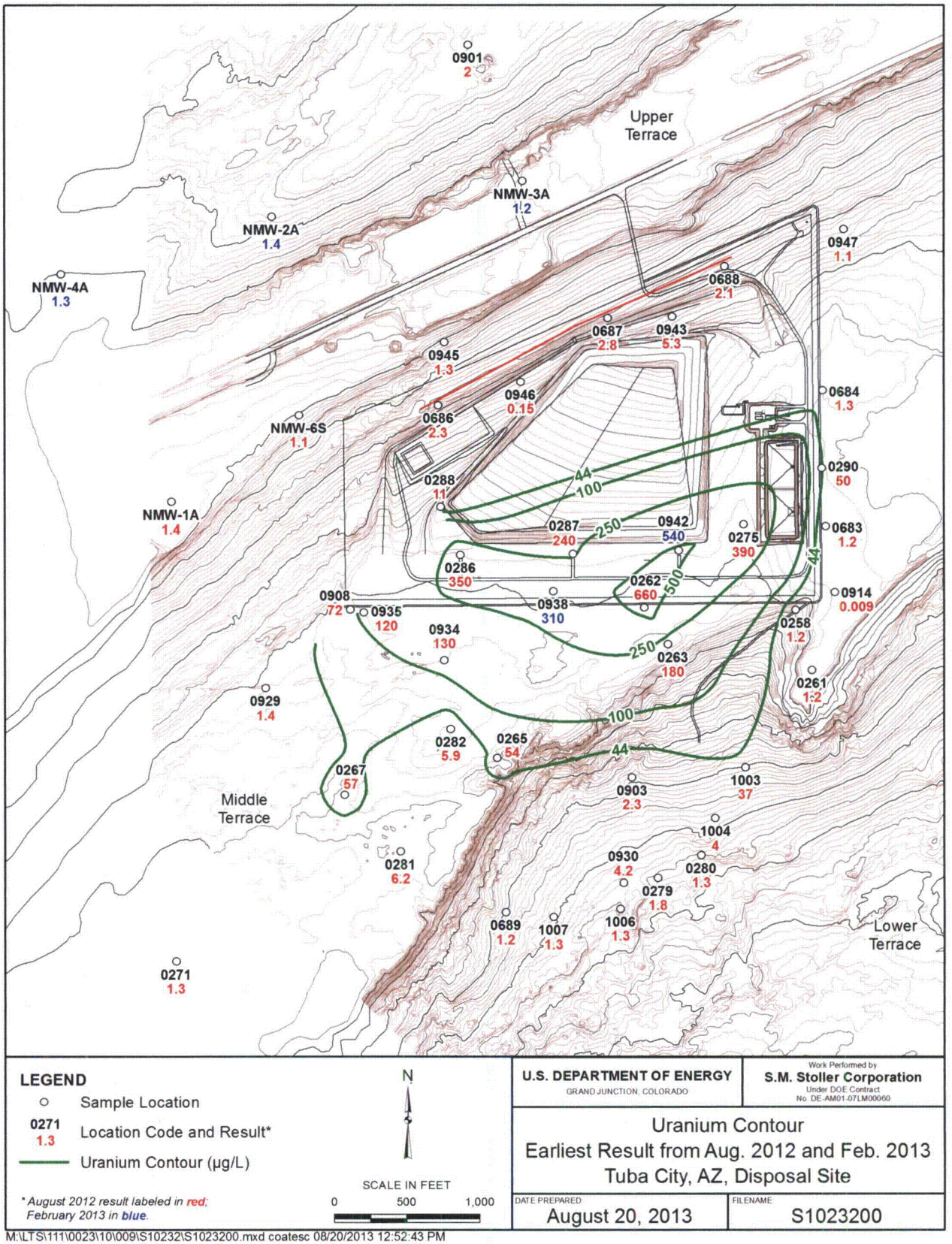

Figure C-3. Uranium (µg/L) Plume Map: August 2012–February 2013

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Appendix D

Monitoring Well Water Level Hydrographs

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Figures

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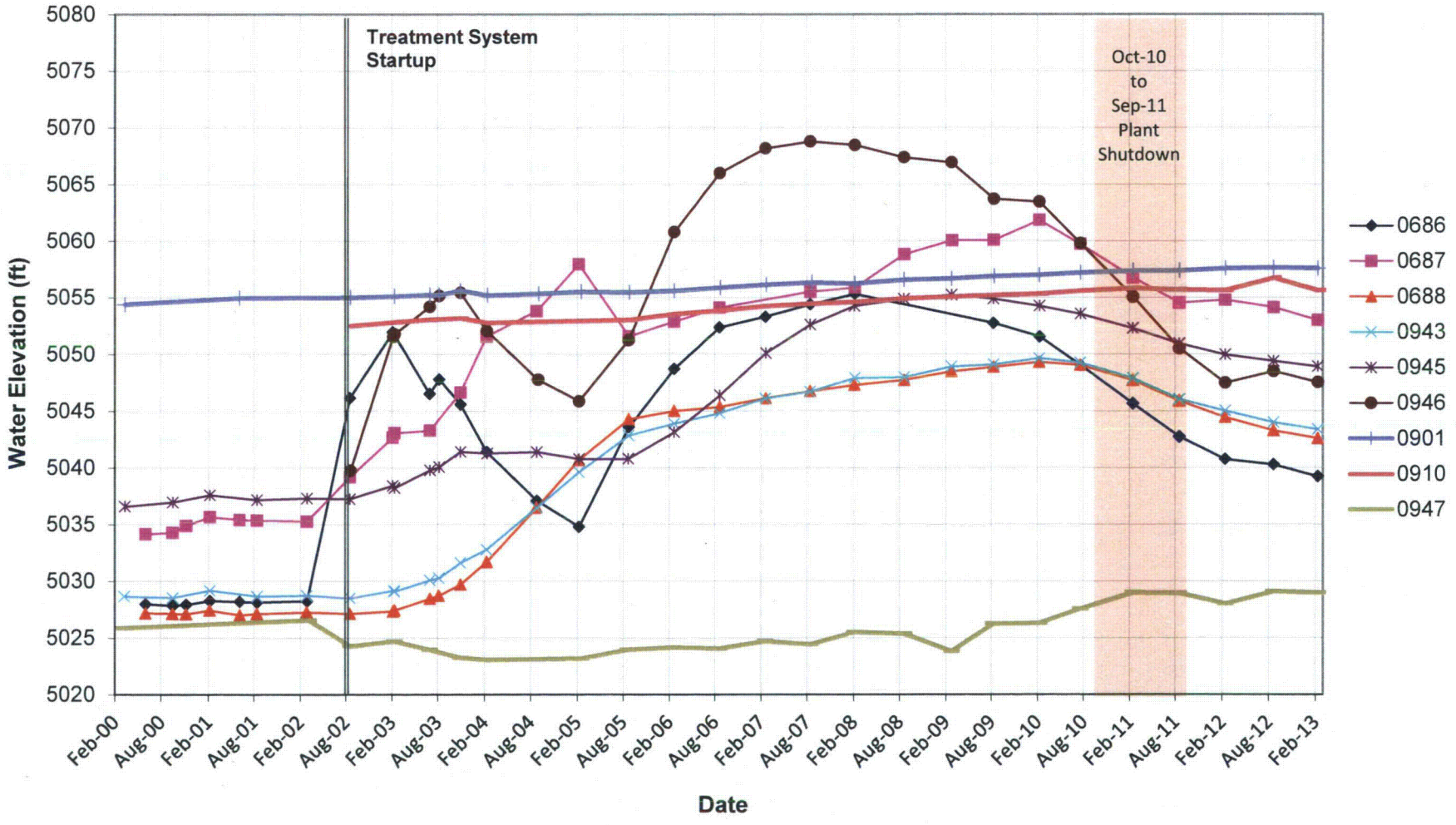

Figure D-1. Monitoring Wells at Infiltration Trench (686–688, 943, 945, 946) and Background Wells 901, 910, and 947

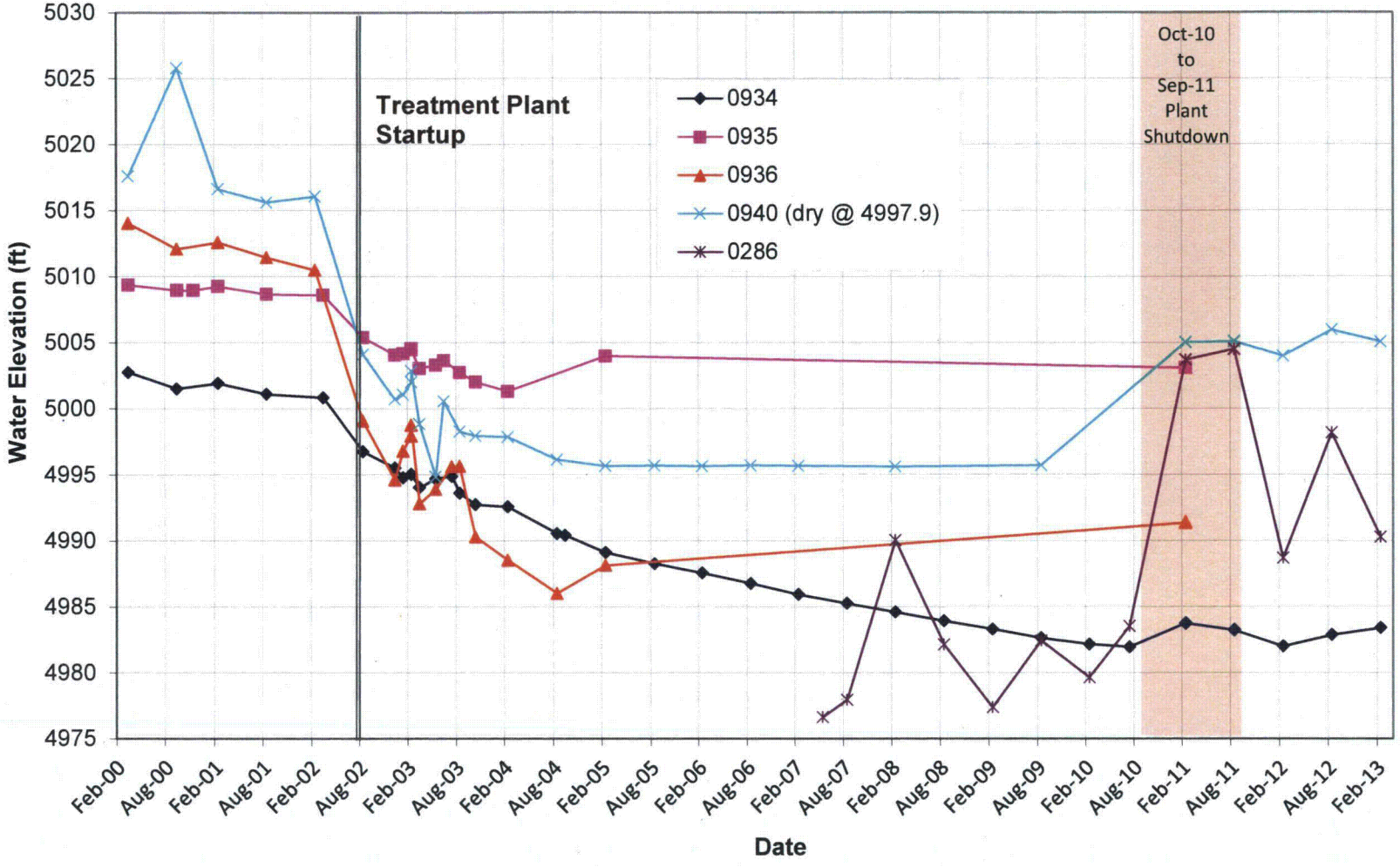

Figure D-2. Horizon A and B Monitoring Wells 286, 934–936, 940

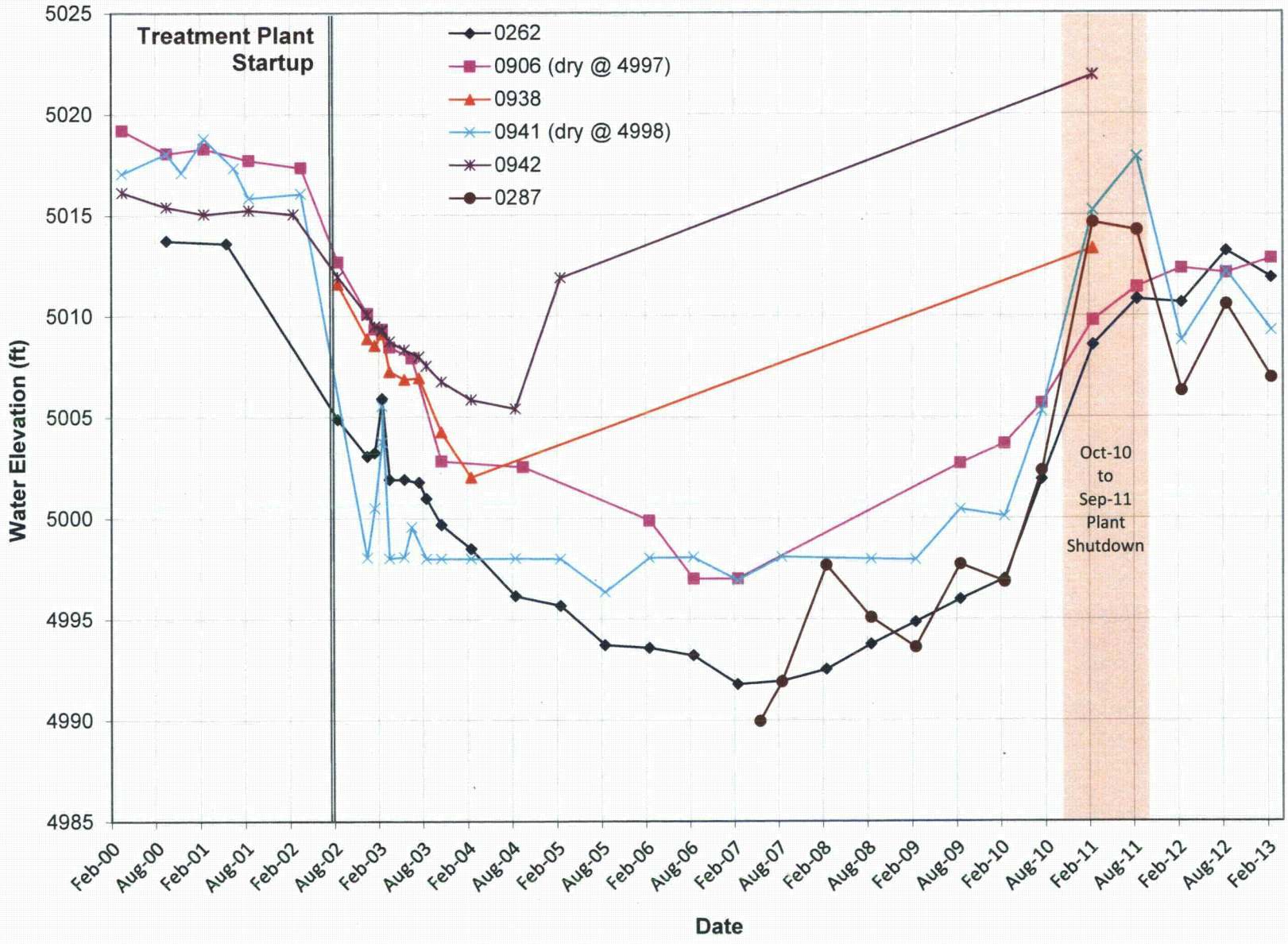

Figure D-3. Horizon A and B Monitoring Wells 262, 287, 906, 938, 941, 942

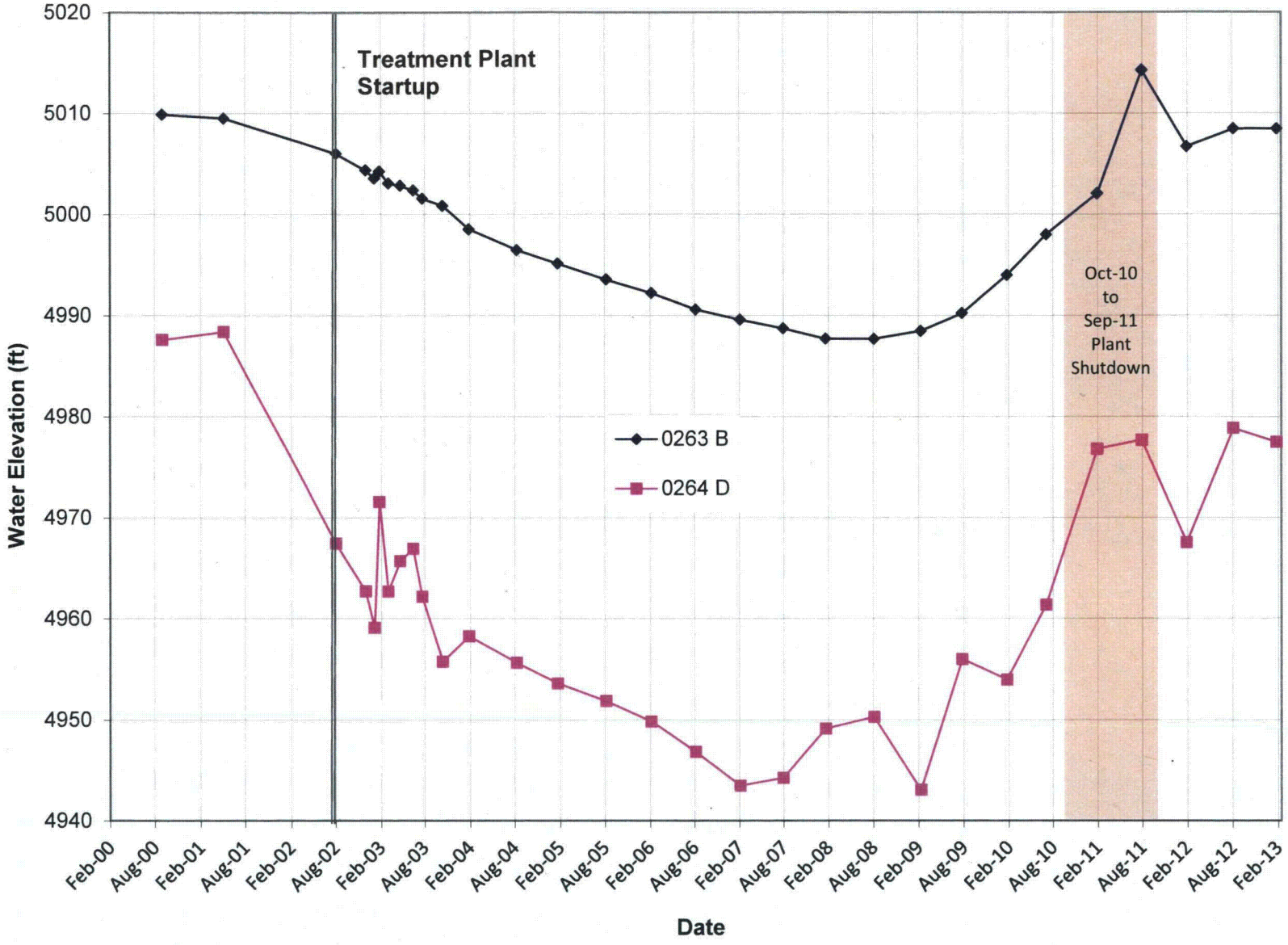

Figure D-4. Middle Terrace Well Pair 263 and 264

Figure D-5. Middle Terrace Well Pair 265 and 266

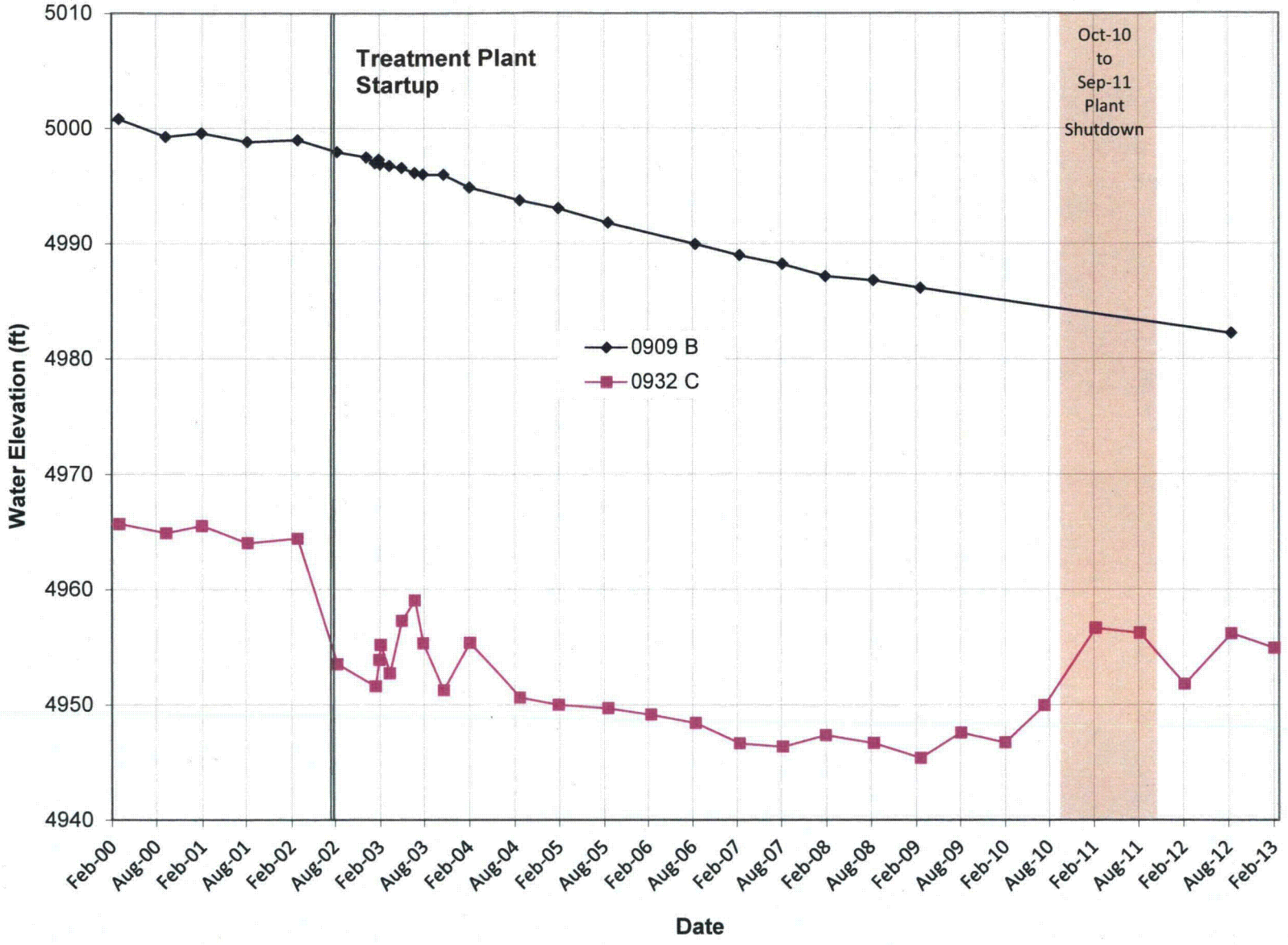

Figure D-6. Middle Terrace Well Pair 909 and 932

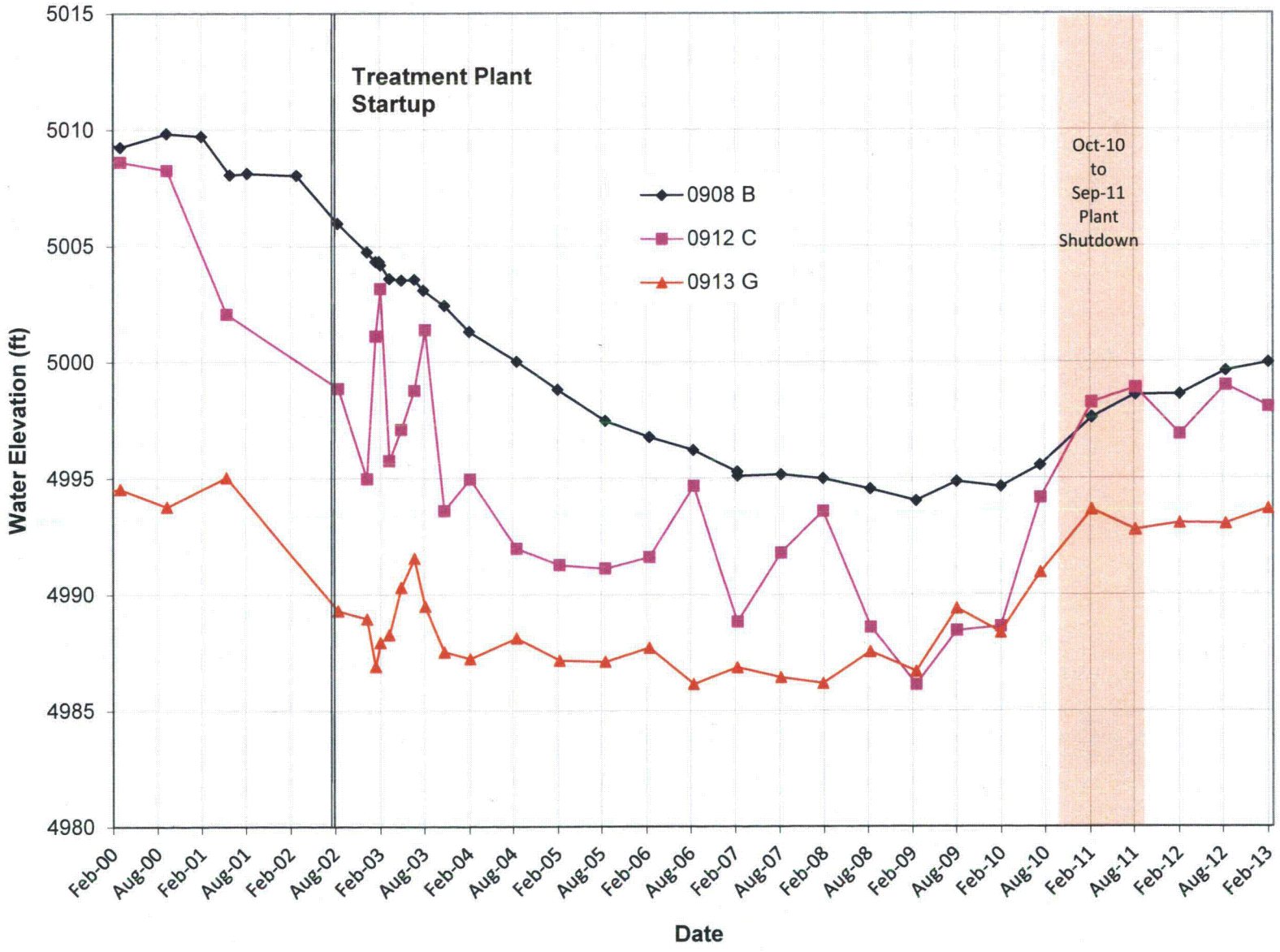

Figure D-7. Middle Terrace Well Cluster 908, 912, and 913

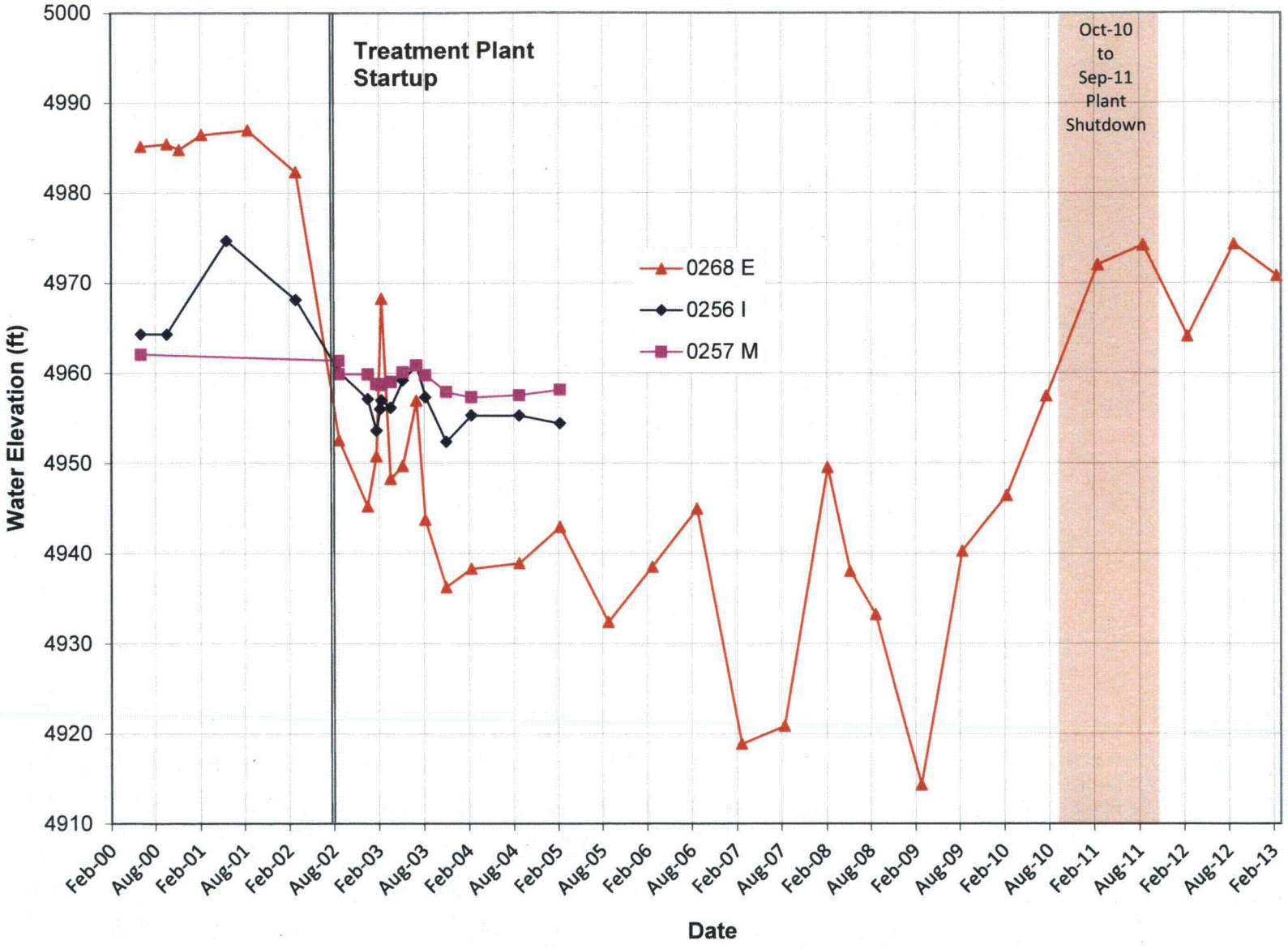

Figure D-8. Middle Terrace Well Cluster 256, 257, and 268

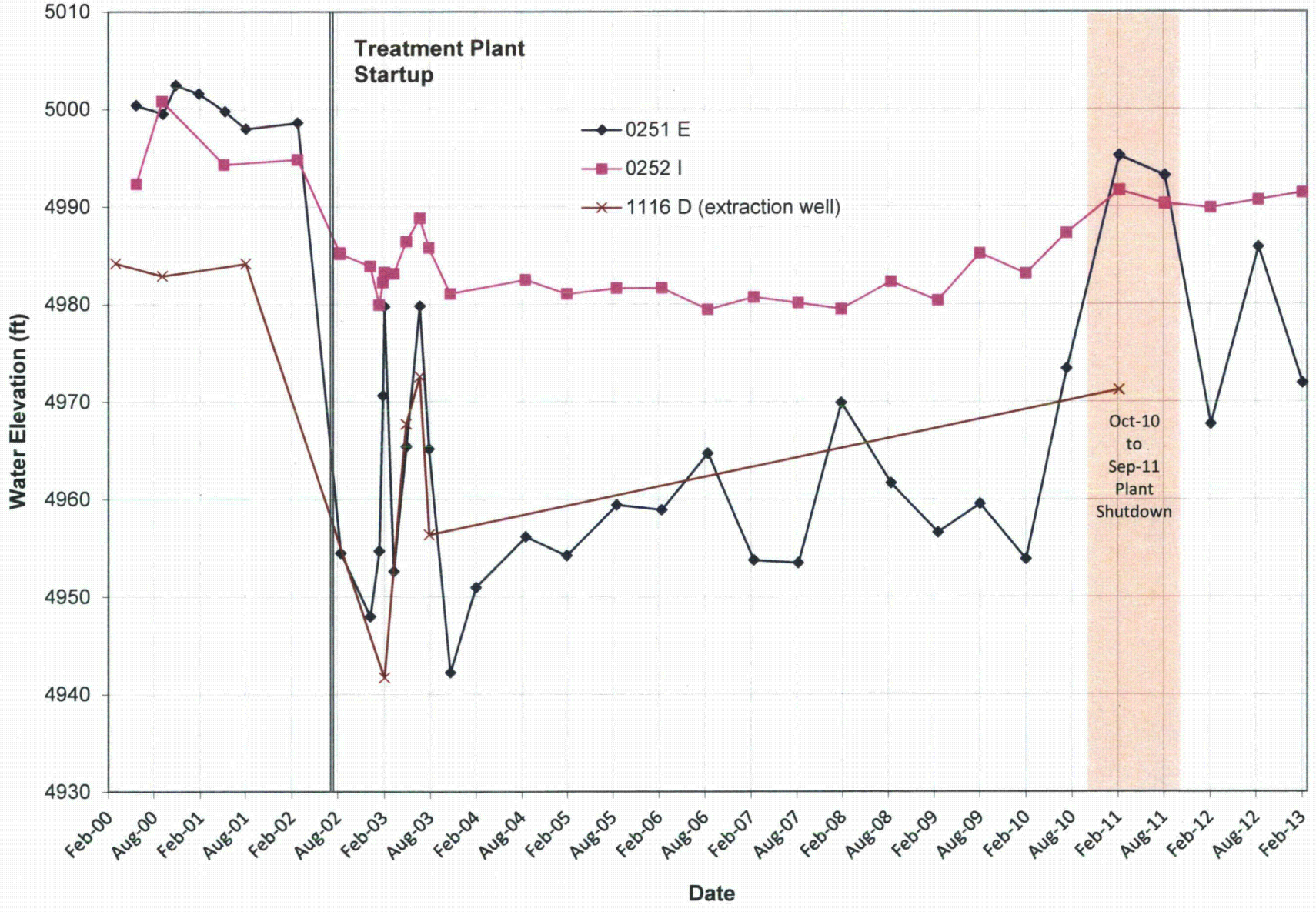

Figure D-9. Middle Terrace Well Cluster 251, 252, and 1116

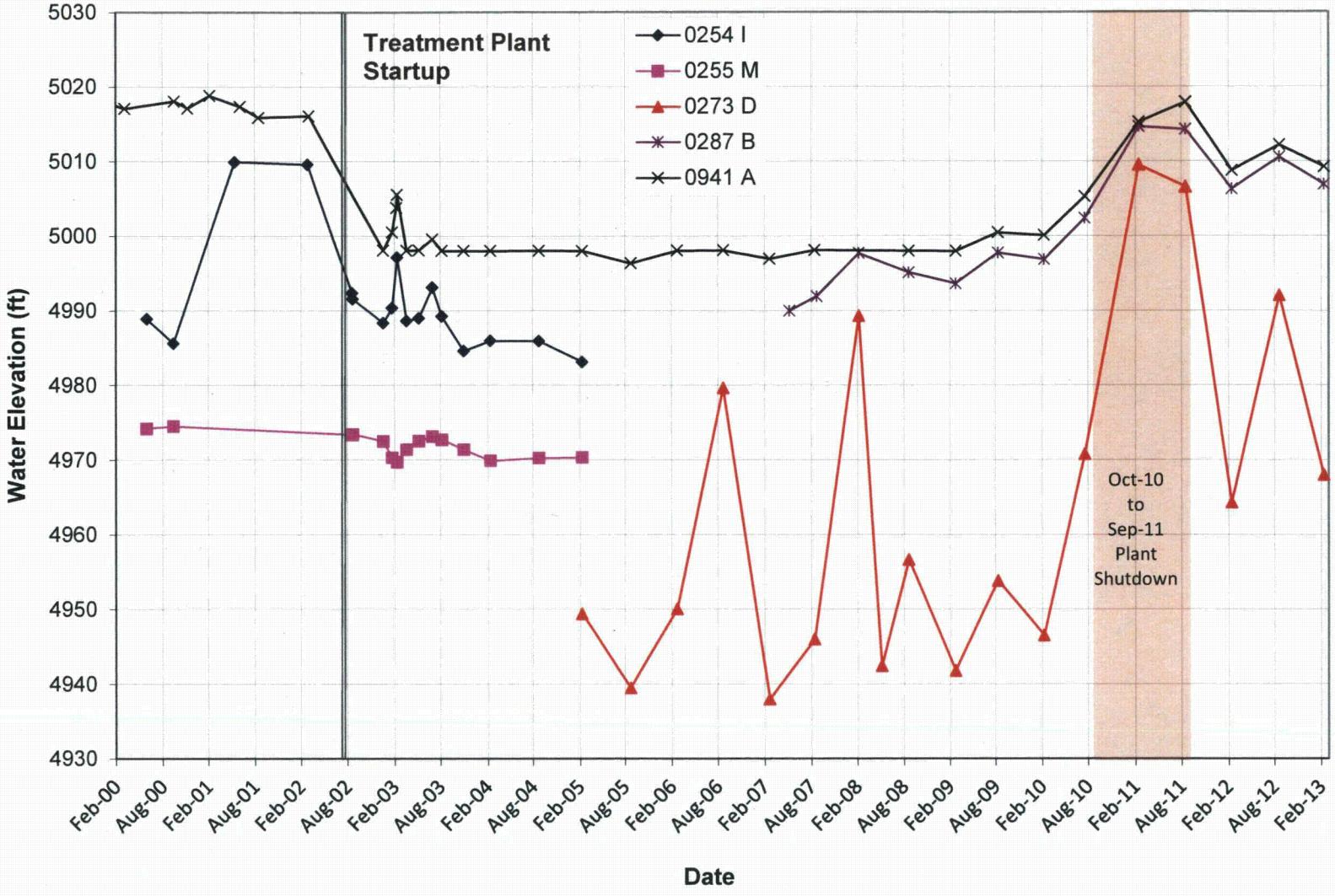

Figure D-10. Middle Terrace Well Cluster 254, 255, 273, 287, and 941

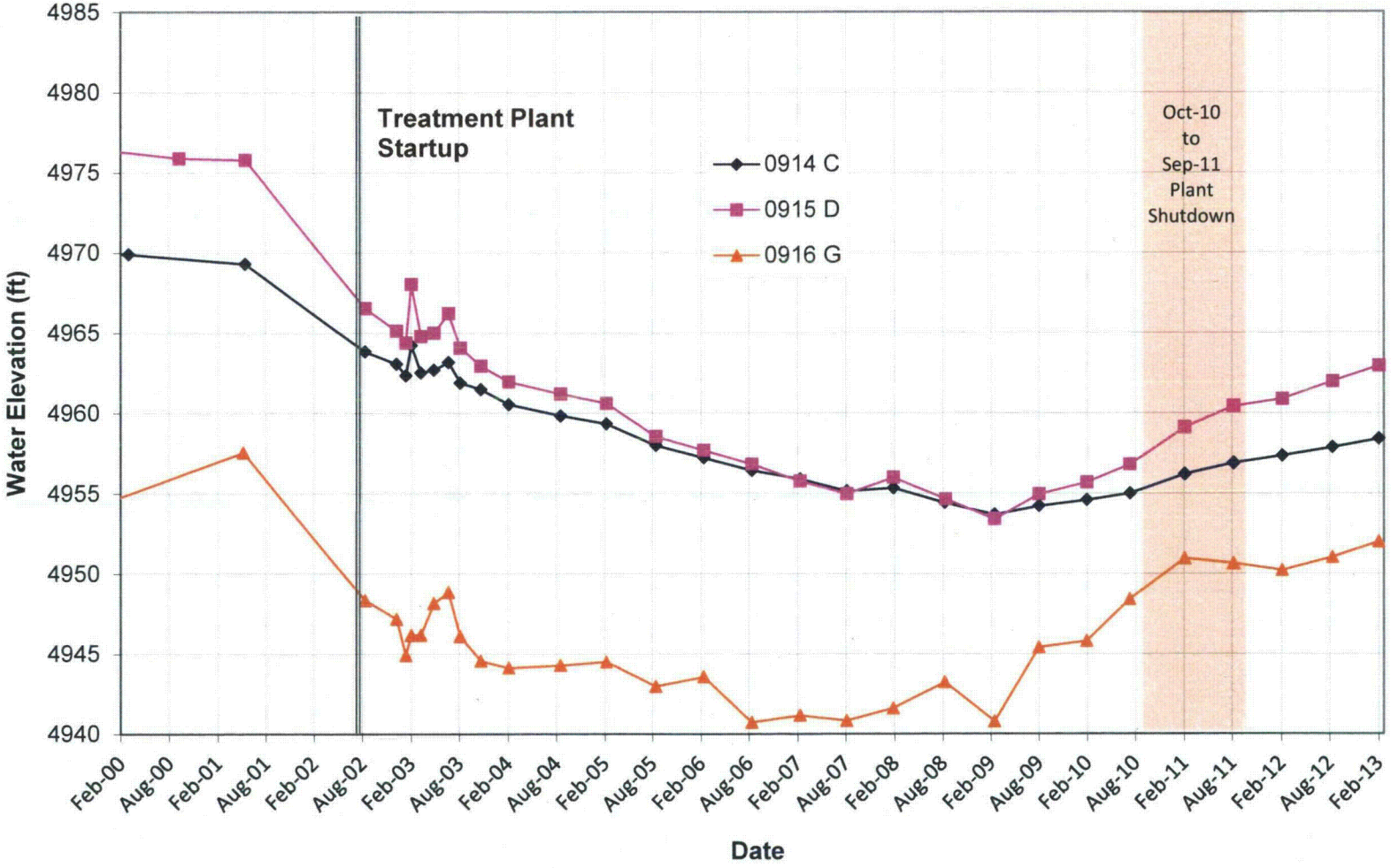

Figure D-11. Middle Terrace Well Cluster 914, 915, and 916

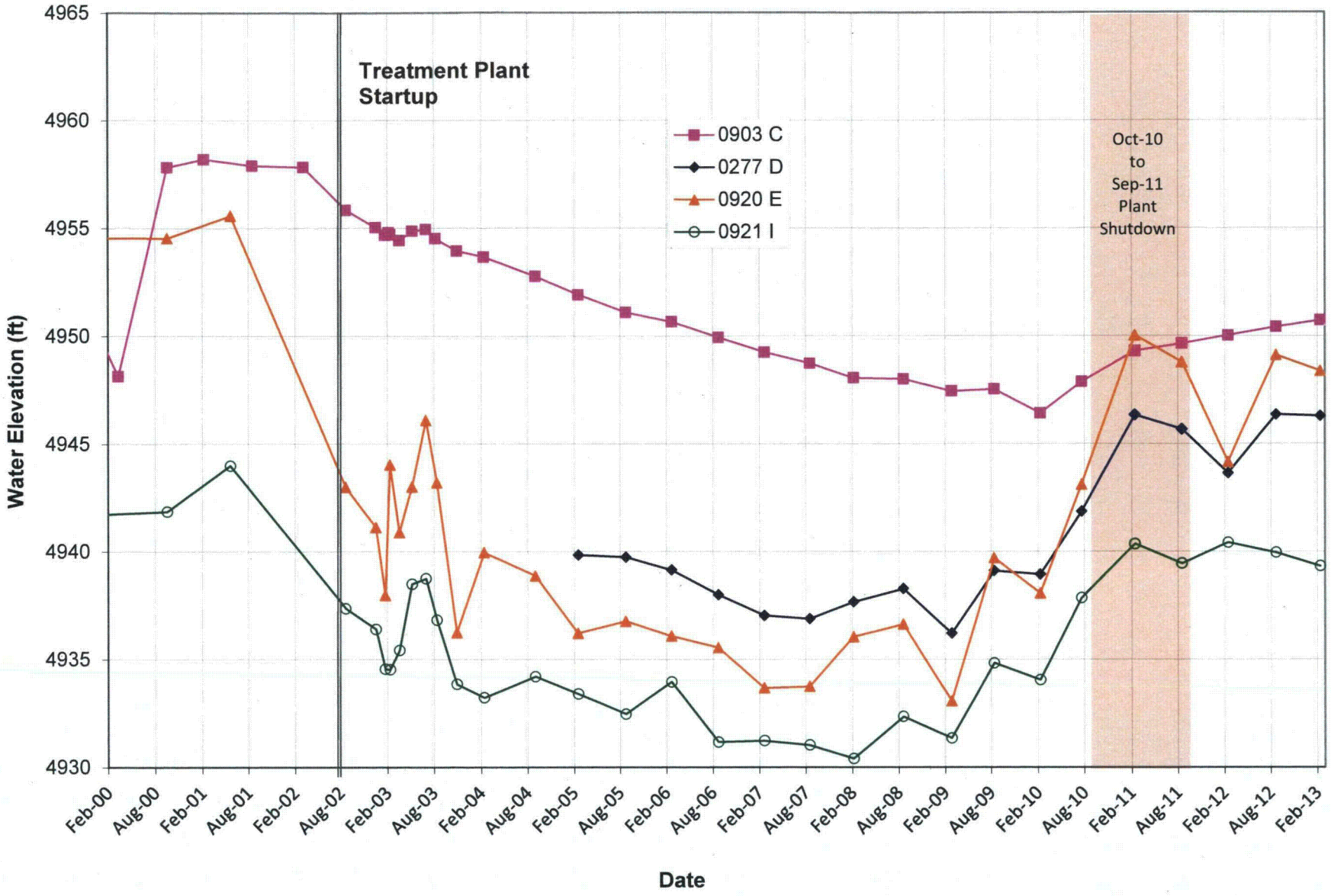

Figure D-12. Lower Terrace Well Cluster 277, 903, 920, and 921

Appendix E

Contaminant Concentration Trends at Monitoring Wells

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Figures

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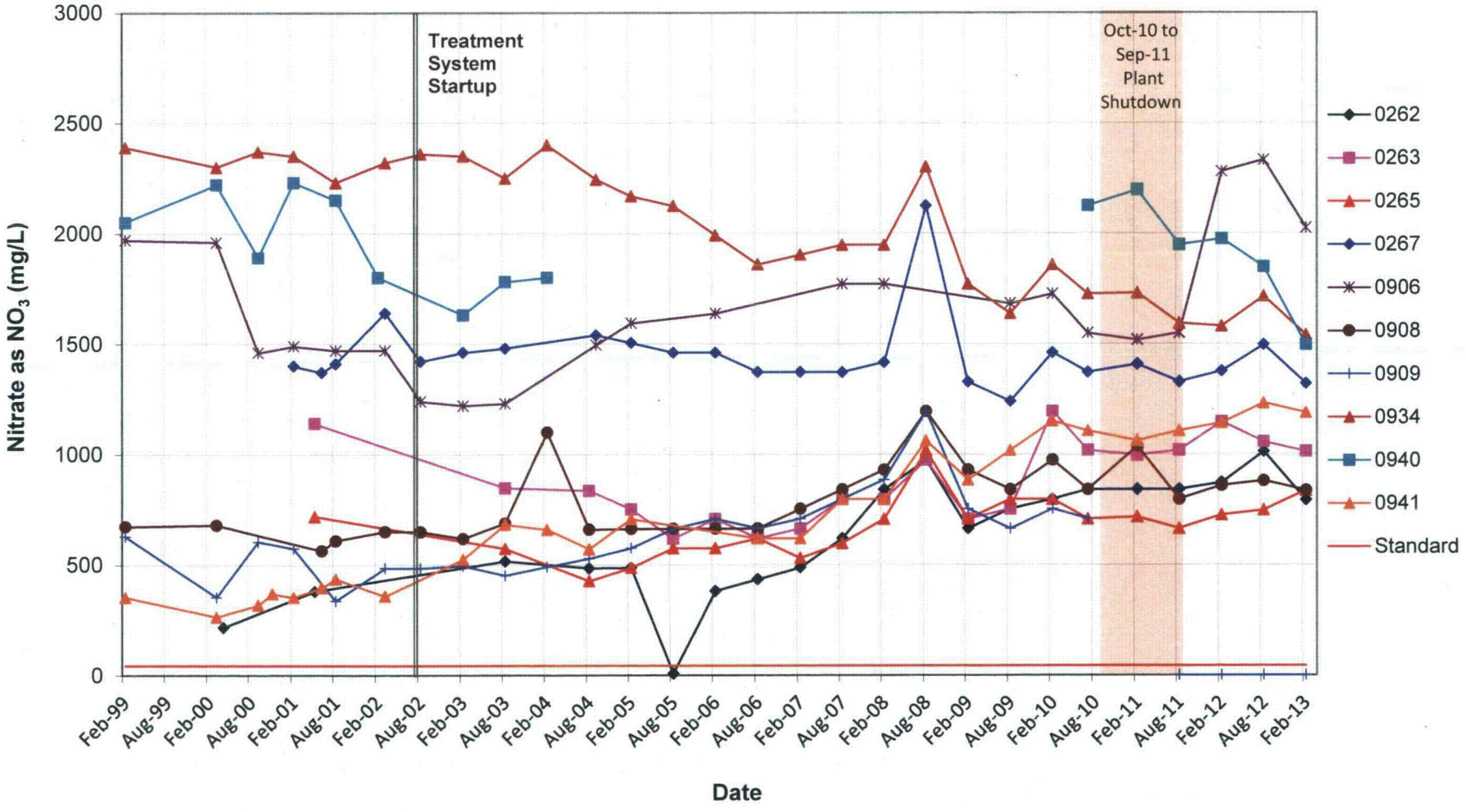

Figure E-1. Nitrate as NO_3 Concentrations in Horizons A and B Monitoring Wells

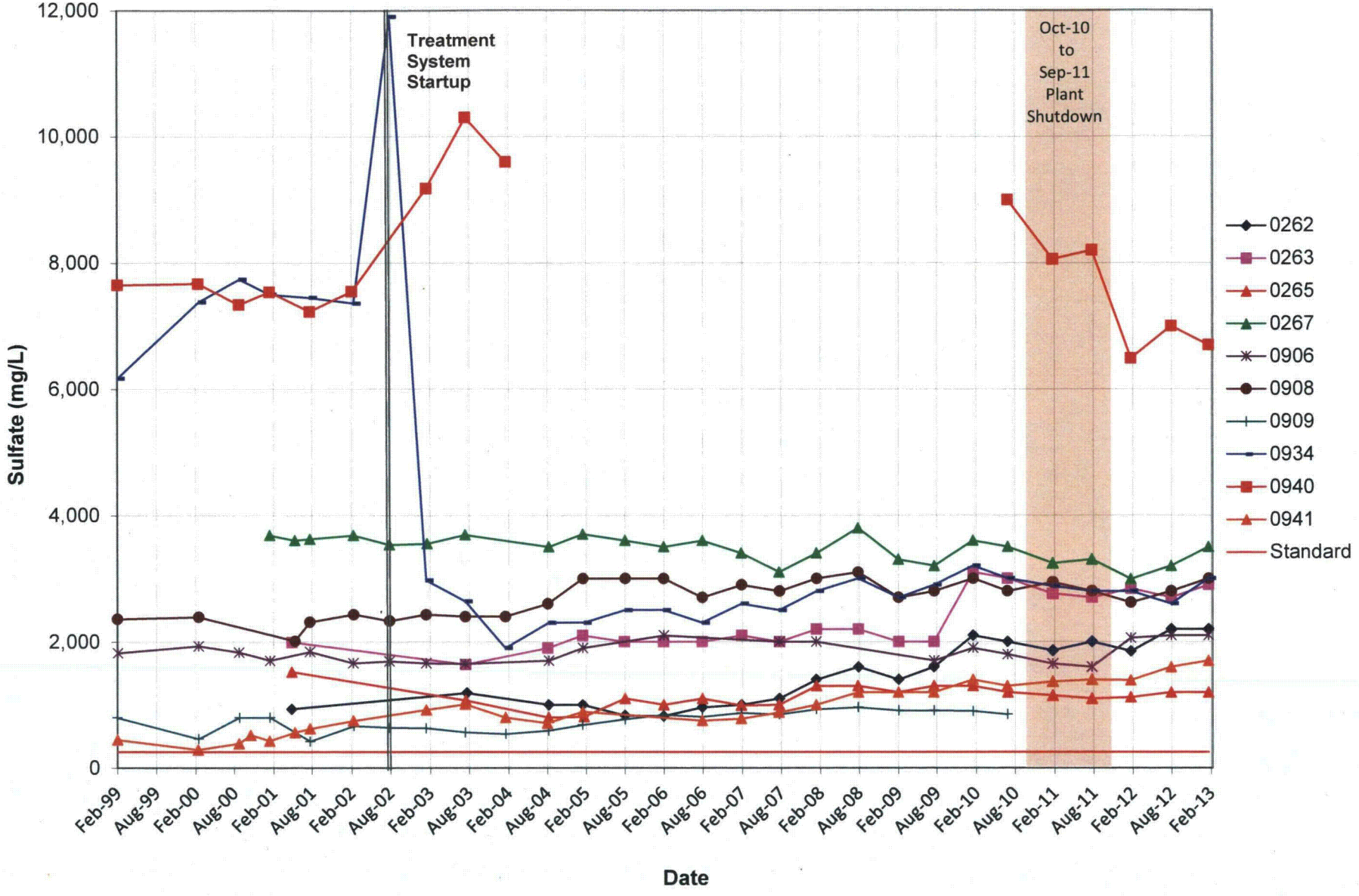

Figure E-2. Sulfate Concentrations in Horizons A and B Monitoring Wells

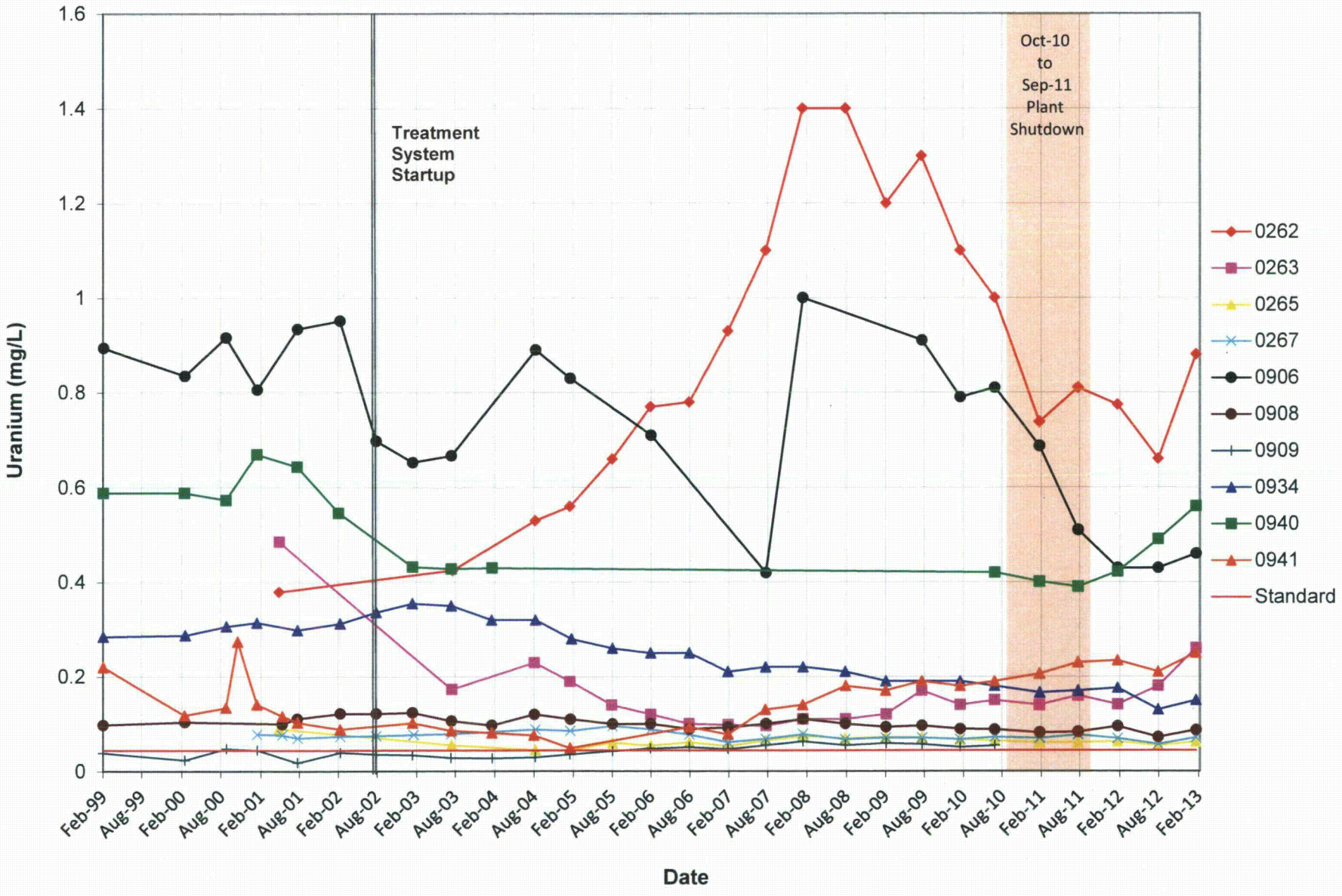

Figure E-3. Uranium Concentrations in Horizons A and B Monitoring Wells

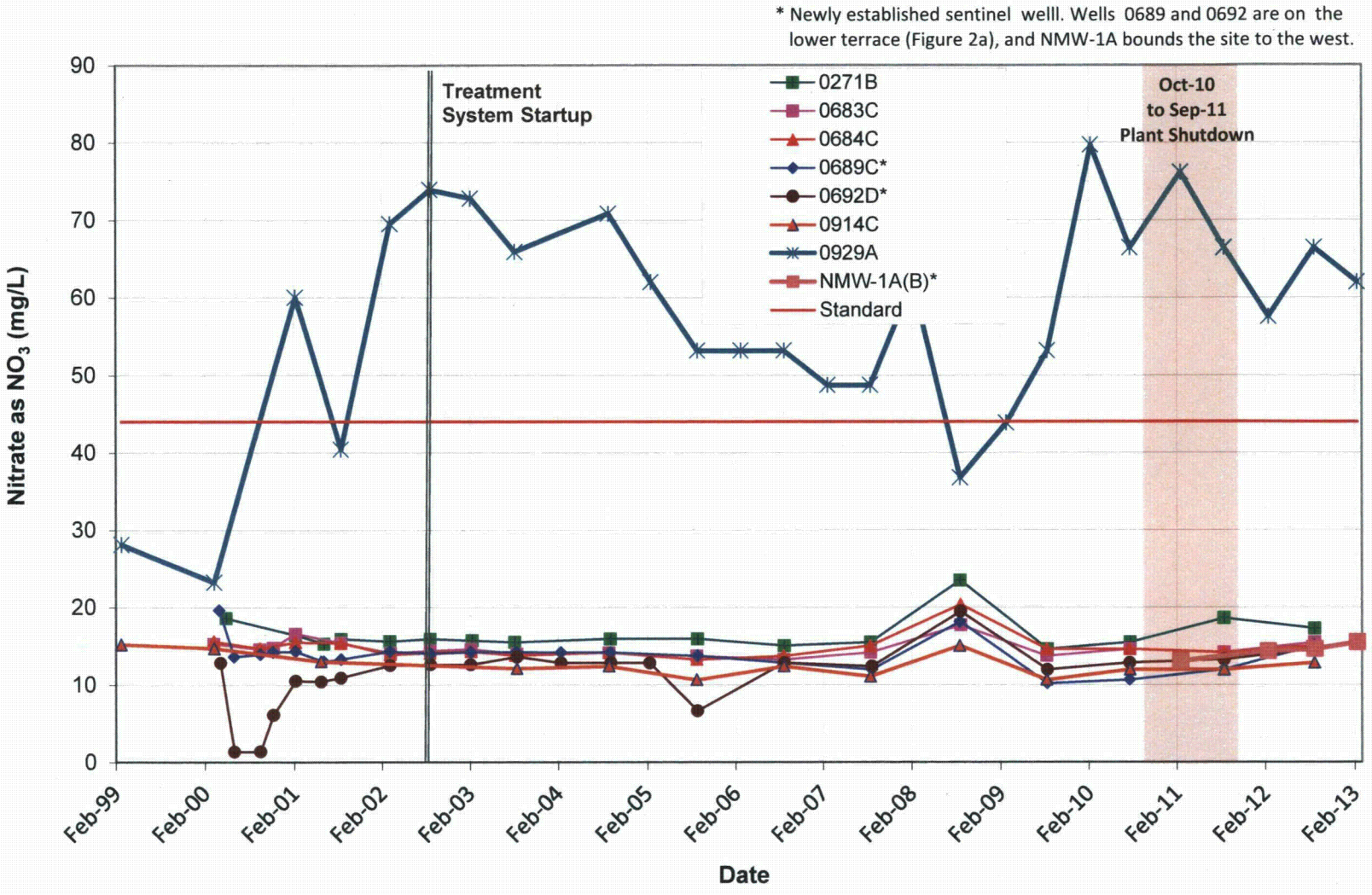

Figure E-4. Nitrate as NO_3 Concentrations in Horizons A–D Sentinel Wells

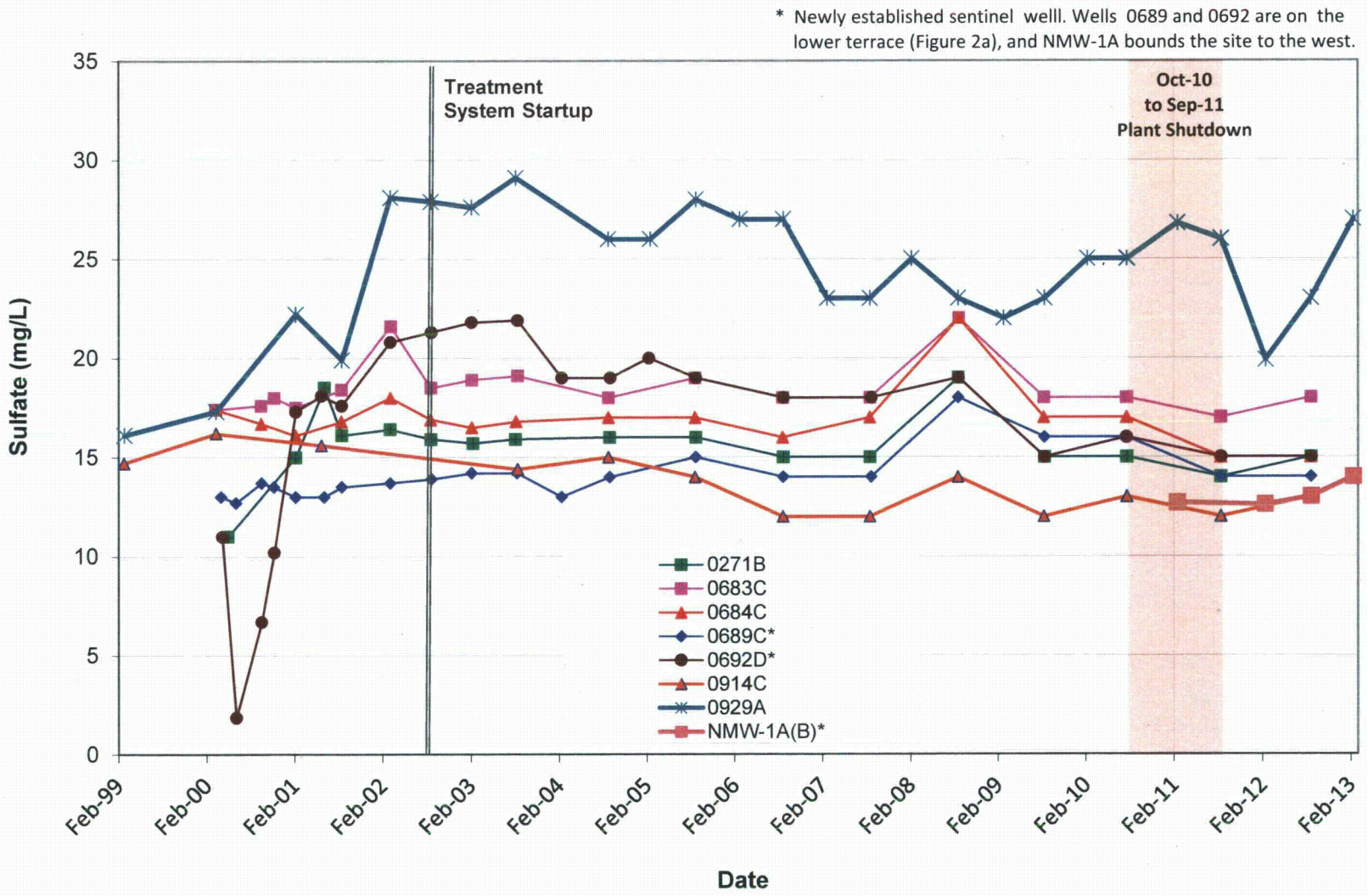

Figure E-5. Sulfate Concentrations in Horizons A–D Sentinel Wells

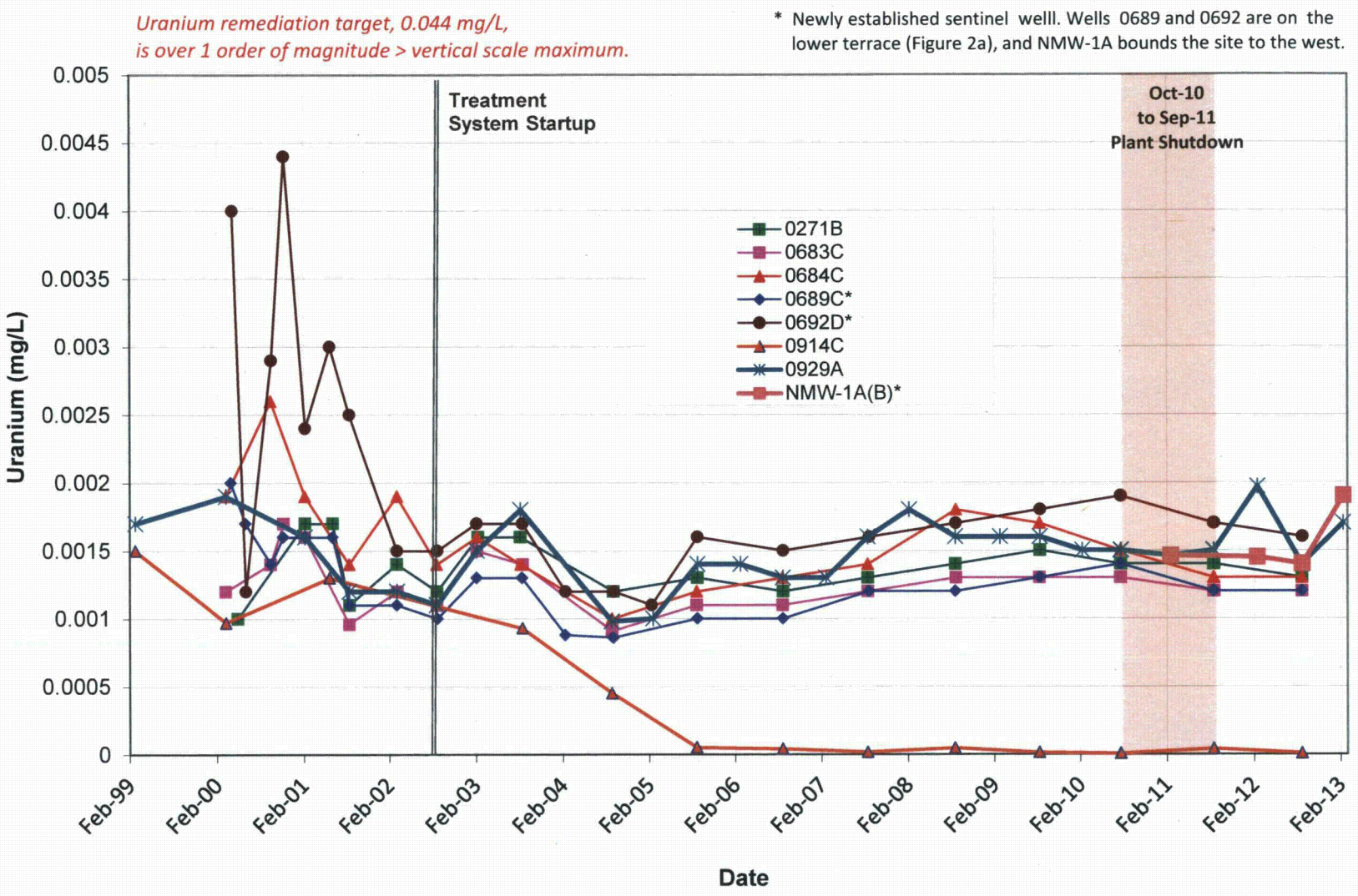

Figure E-6. Uranium Concentrations in Horizons A–D Sentinel Wells

Note: Horizon C well 0914 is also a sentinel well (see Figure E–4).

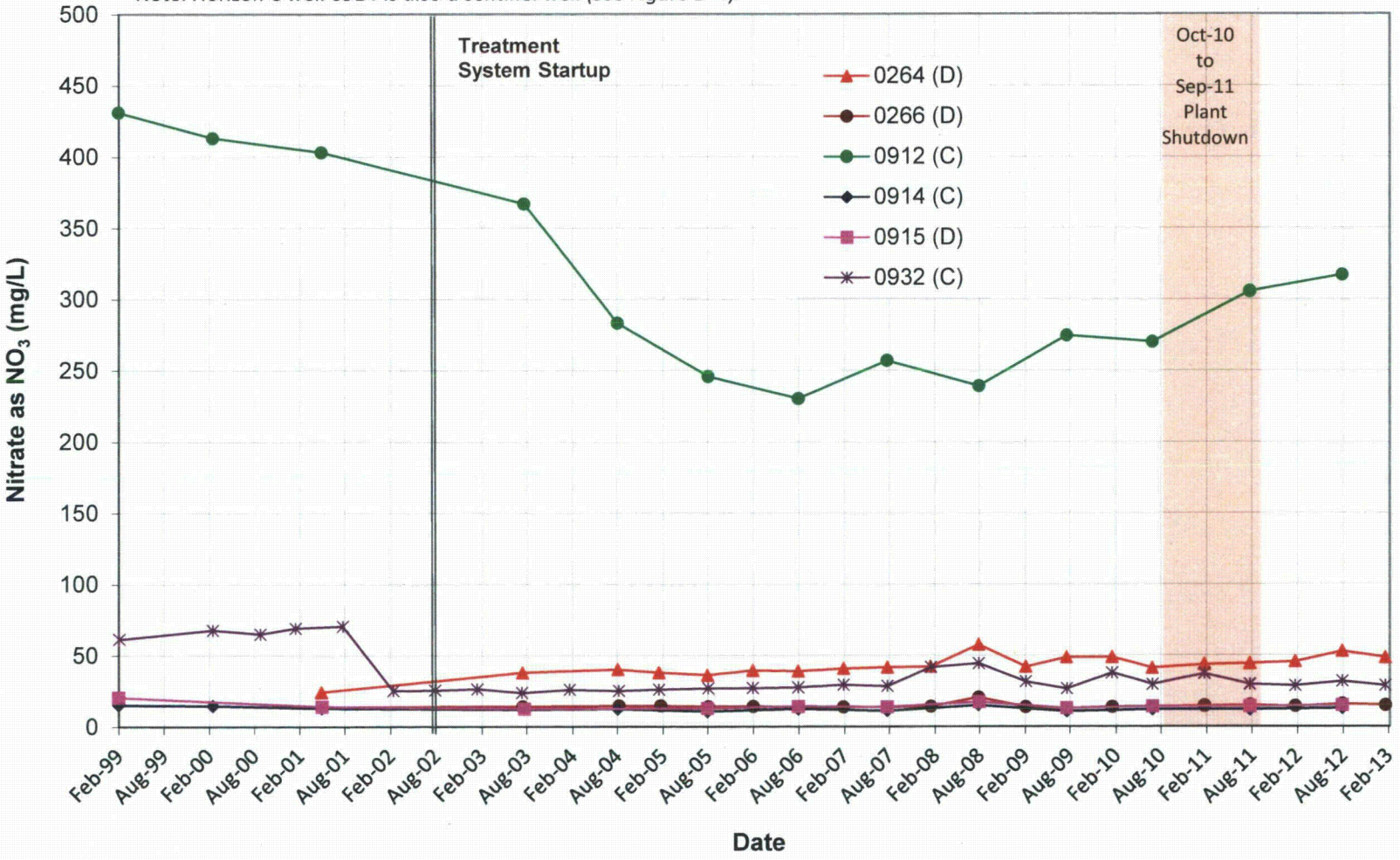

Figure E-7. Nitrate as NO_3 Concentrations in Horizons C–D Middle Terrace Monitoring Wells

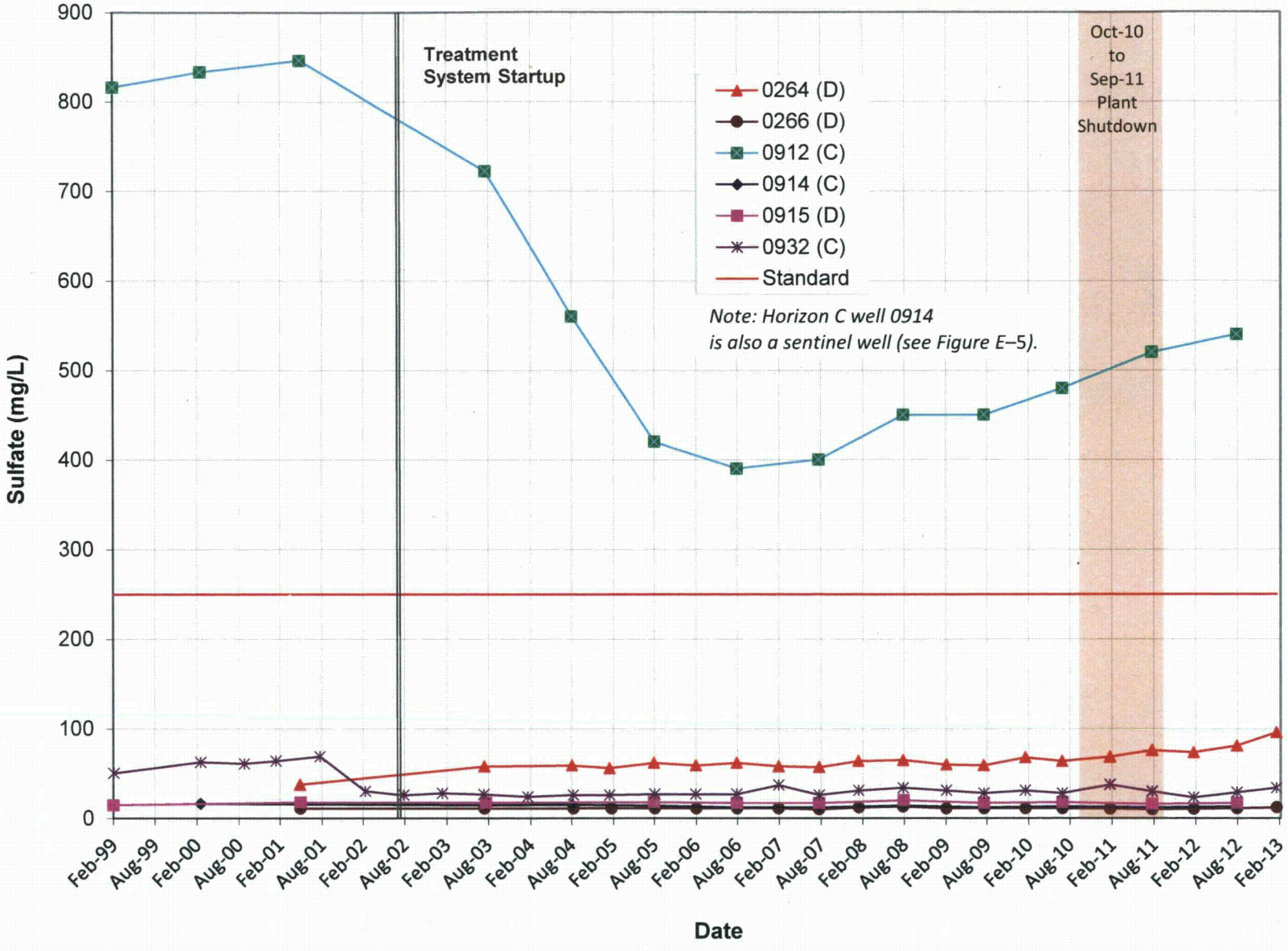

Figure E-8. Sulfate Concentrations in Horizons C–D Middle Terrace Monitoring Wells

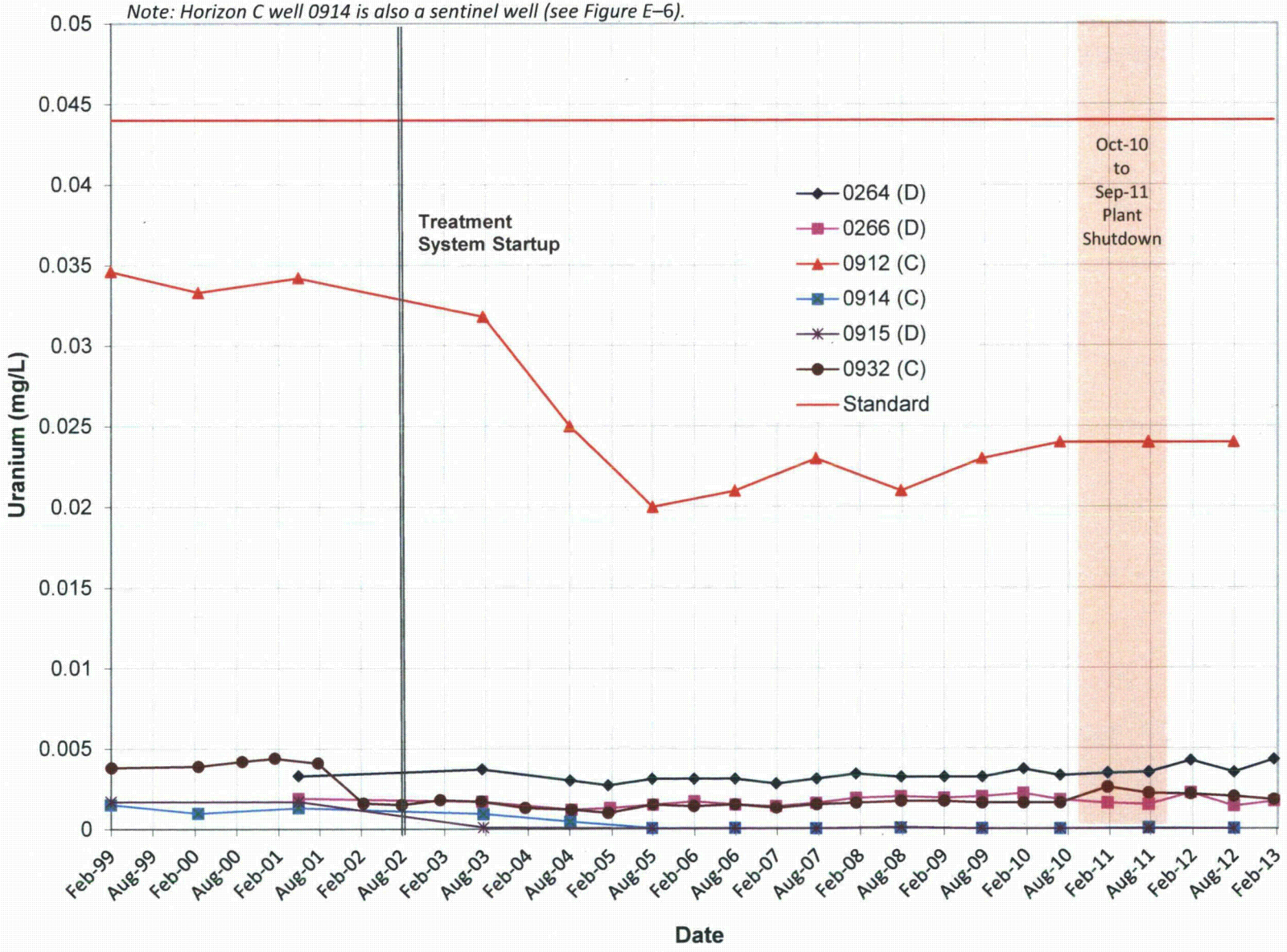

Figure E-9. Uranium Concentrations in Horizons C–D Middle Terrace Monitoring Wells

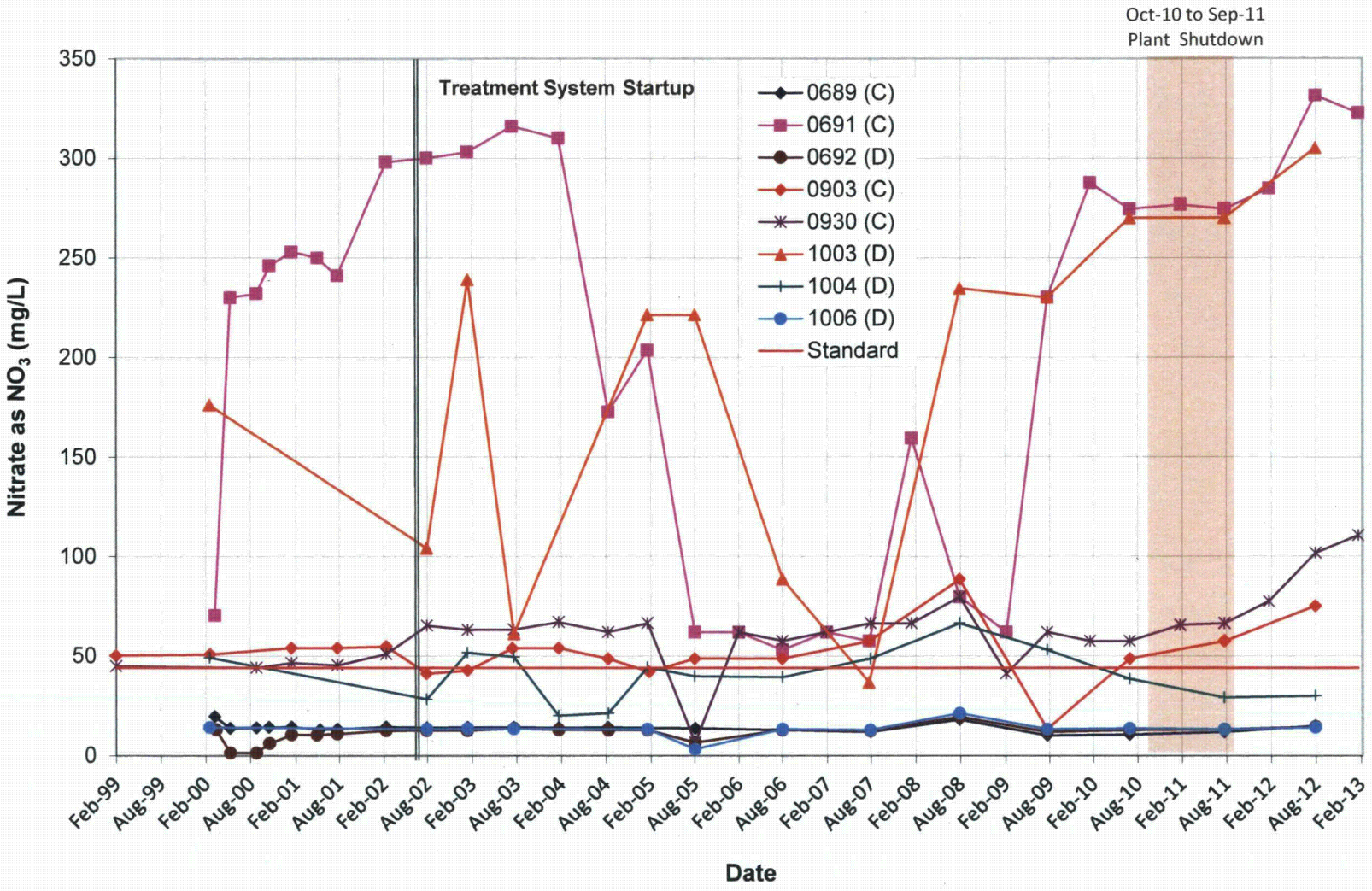

Figure E-10. Nitrate as NO_3 Concentrations in Horizons C–D Lower Terrace Monitoring Wells

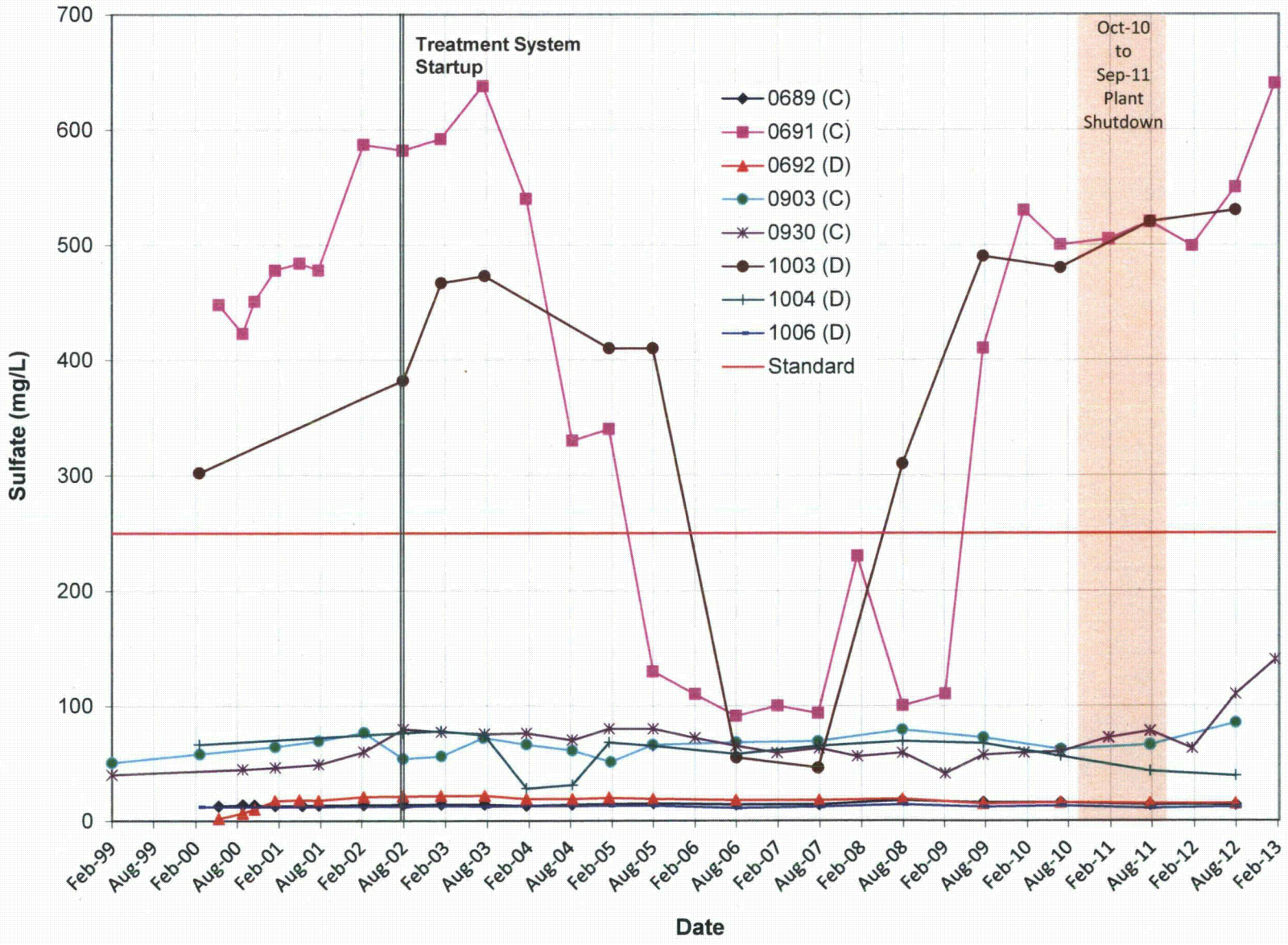

Figure E-11. Sulfate Concentrations in Horizons C–D Lower Terrace Monitoring Wells

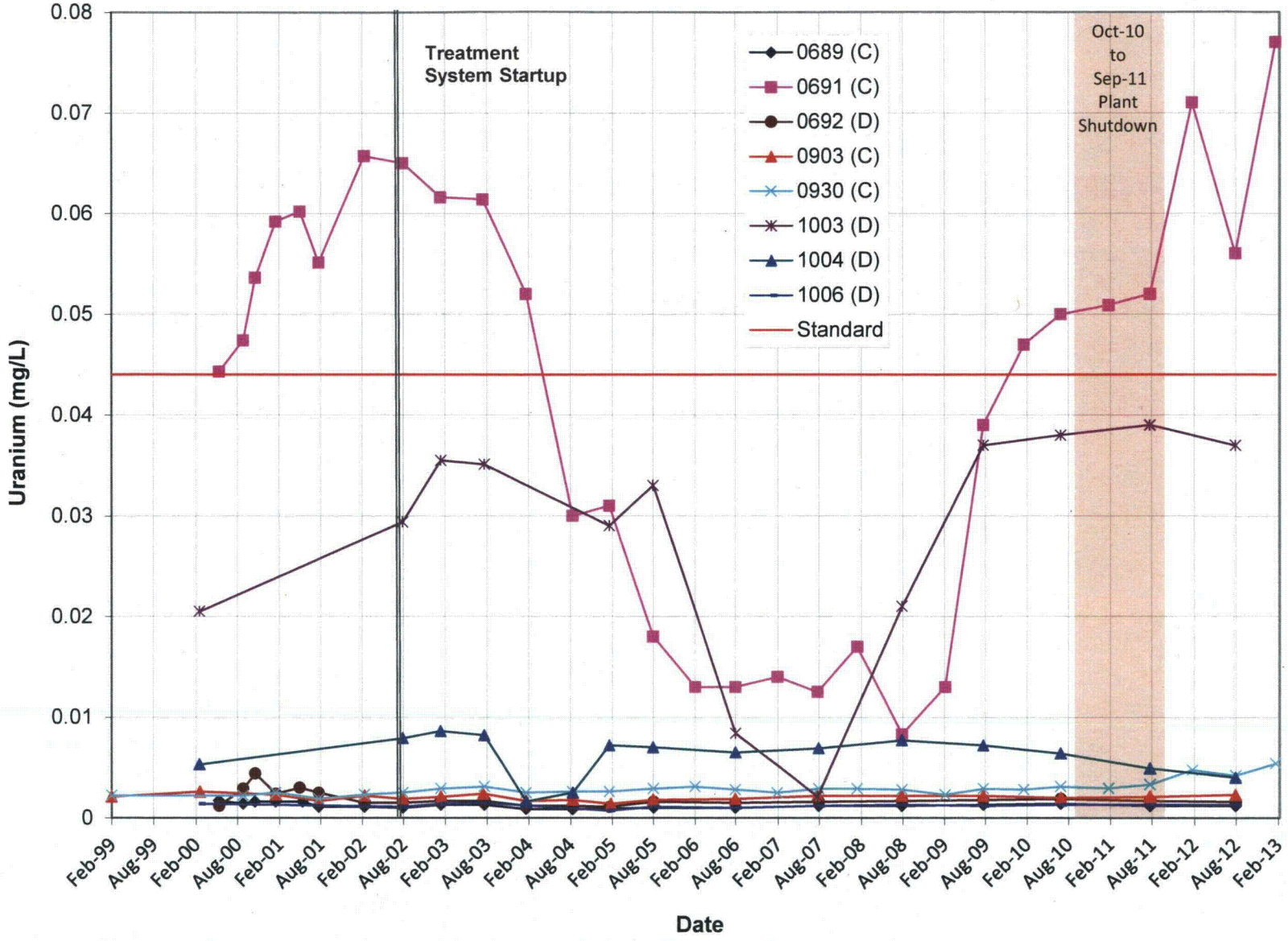

Figure E-12. Uranium Concentrations in Horizons C–D Lower Terrace Monitoring Wells

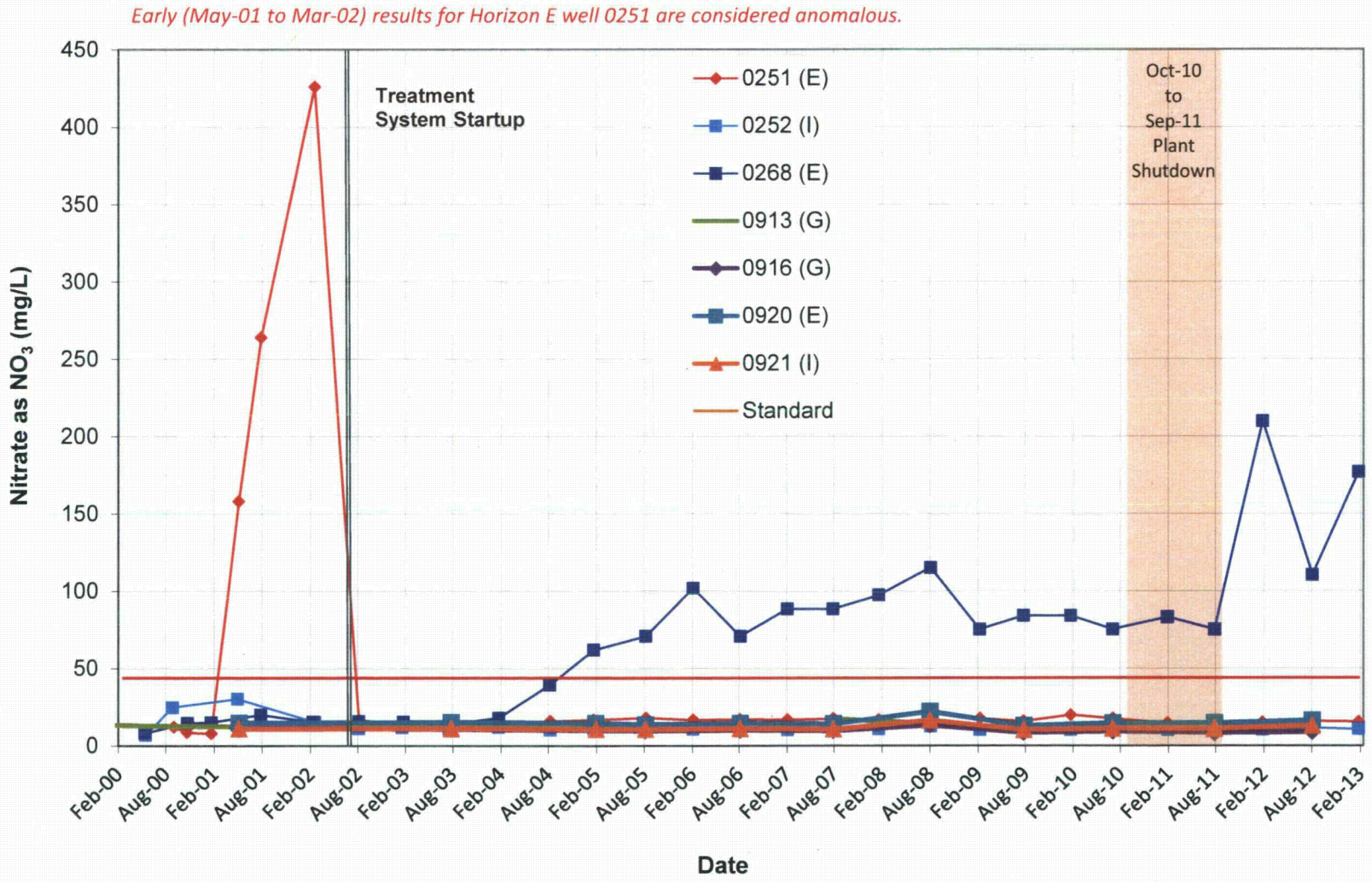

Figure E-13. Nitrate as NO_3 Concentrations in Deep Monitoring Wells

Early (May-01 to Mar-02) results for Horizon E well 0251 are considered anomalous.

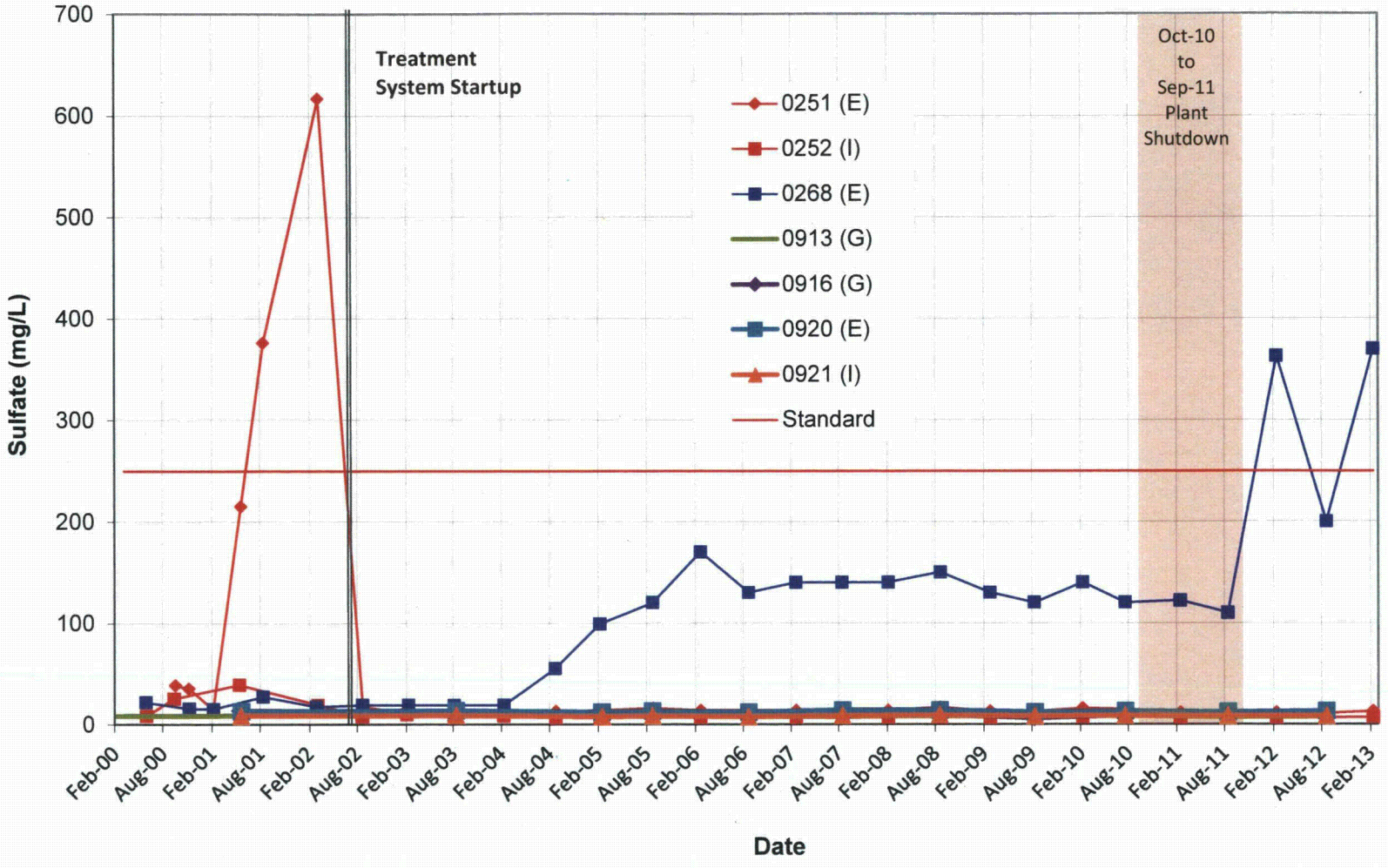

Figure E-14. Sulfate Concentrations in Deep Monitoring Wells

Early (May-01 to Mar-02) results for Horizon E well 0251 are considered anomalous.

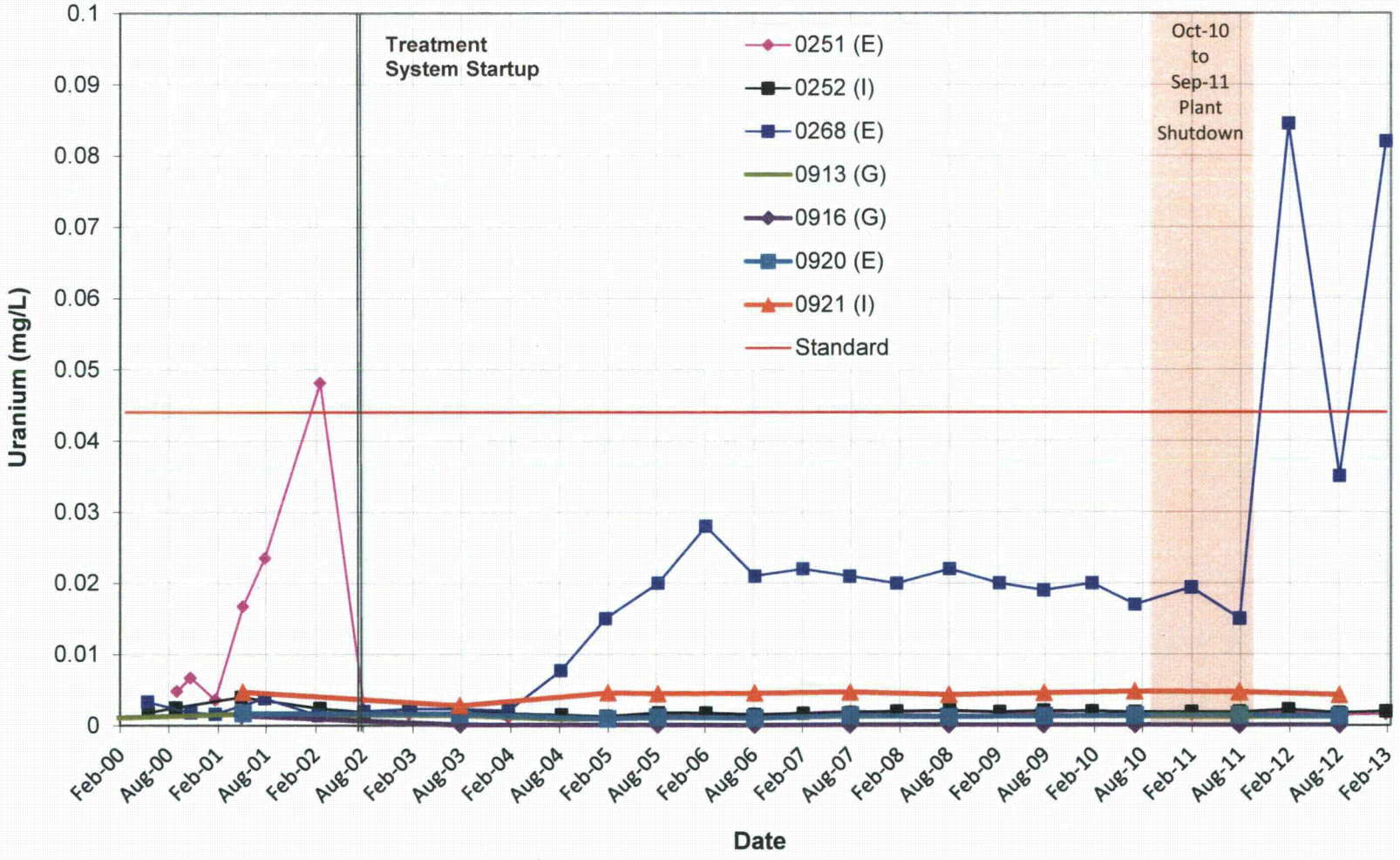

Figure E-15. Uranium Concentrations in Deep Monitoring Wells

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