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Annual Ground Water Report April 2006 through March 2007 Tuba City, Arizona, Disposal Site

August 2007

U.S. Department of Energy

Office of Legacy Management

Work Performed Under DOE Contract No. DE–AC01–02GJ79491 for the U.S. Department of Energy Office of Legacy Management.
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Work Performed by S.M. Stoller Corporation under DOE Contract No. DE-AC01-02GJ79491
for the U.S. Department of Energy, Grand Junction, Colorado

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1.0 Introduction

1.1 Background Information

This report evaluates the performance of the ground water remediation system at the U.S. Department of Energy (DOE) Legacy Management site near Tuba City, Arizona, for the period April 2006 through March 2007. The site is located in Coconino County, Arizona, within the Navajo Nation and near Hopi Reservation land (Figure 1). Locally, ground water in an underlying sandstone aquifer is contaminated by several inorganic constituents, including nitrate, uranium, and sulfate, the primary site contaminants, as a result of former uranium-ore milling at the site. Surface remedial actions, consisting of encapsulating all solid waste within an on-site engineered disposal cell, occurred between 1988 and 1990. A remnant plume of ground water contamination extends off site to the south and southeast from the former mill area. DOE constructed a pump-and-treat remediation system, operational by mid-2002, to remove the contaminants from the aquifer and thus restore ground water quality. The progress of water quality restoration is evaluated and reported annually.

1.2 Ground Water Remediation System

The ground water remediation system currently comprises 37 extraction wells completed within the contaminated region of the aquifer. The extracted water is conveyed in underground piping to an on-site facility (treatment plant) where it is mechanically distilled following ion exchange pretreatment. An engineered solar evaporation pond receives the waste liquid (brine), and an infiltration trench located upgradient of the contaminant plume returns the treated water (distillate) to the aquifer to promote contaminant flushing. Six injection wells (wells 1003 through 1008) originally intended to create a hydraulic barrier at the downgradient limit of contamination remain unused for that purpose. Of the 37 extraction wells, eight wells (wells 1126 through 1133) were installed in summer 2004 to expand the capture zone of the original 25 wells (wells 1101 through 1125, installed in 1999). Wells 935, 942, 936, and 938, used formerly for monitoring purposes only, were converted to extraction use in summer 2004. Numerous other ground water monitor wells used to track water quality and water level trends are situated within and surrounding the network of extraction wells. The locations of extraction and monitor wells and the primary features of the site are depicted in Figure 2.

1.3 Ground Water Compliance Strategy

The ground water compliance strategy for the Tuba City site, as defined in the *Phase I Ground Water Compliance Action Plan for the Tuba City, Arizona, UMTRA Site* (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 comprise 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).

Ground water contaminants requiring active remediation at the site are molybdenum, nitrate, selenium, sulfate, and uranium (DOE 1999). Restoration standards (see Table 1) for these constituents, except sulfate, correspond to a maximum concentration limit in ground water

established in Table 1 to Subpart A of 40 CFR 192. Sulfate is not regulated by 40 CFR 192. However, a restoration standard was adopted for this constituent because it is present in ground water at the site at concentrations that cause excess potential risk (DOE 1999). The Navajo Nation also requested that the distillate not exceed 20 milligrams per liter (mg/L) of sodium.

Table 1. Ground Water Remediation Goals
(source: DOE 1999)

Constituent/Property	Cleanup Level	Baseline Concentrations in Plume
Nitrate[a]	10 mg/L as N (44 mg/L as NO_3^-)	840–1,500 mg/L
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
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
pCi/L = picocuries per liter

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 on the basis of ground water monitoring conducted in August and February of each year. During these events, samples are collected at monitor 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, plume movement within the aquifer, and concentration trends. The extraction wells are sampled during the August events. The February events also exclude monitoring of several distal wells and lower terrace wells that have no history of contamination.

Other monitoring data are collected during the routine operation of the treatment system to evaluate the efficiency of the treatment process and to measure the extracted mass and volume of contamination. These data include (1) continuous flow metering of each extraction well, (2) continuous flow metering of the bulk influent and all outflow streams, (3) weekly determination of bulk inflow and distillate composition through composite sampling, and (4) approximately monthly analysis of ground water composition at each extraction well.

1.5 Hydrogeologic Setting

The Tuba City site lies on the middle of three alluvial terraces formed during ancestral flow in Moenkopi Wash, located about 1.25 miles southeast of the site. Thin (≤ 20 feet [ft]) surficial deposits of coarse, semi-indurated, Quaternary alluvium and loose dune sand and silt are underlain by the regionally extensive Navajo Sandstone, a massively cross-bedded, friable, fine

to very fine sandstone and siltstone. Escarpments that separate the terraces are formed by cliffs of the Navajo Sandstone. The regional dip of the bedrock is about one 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" is 400 to 450 ft thick. Occasional thin (≤ 2 ft), resistant limestone beds, relicts of former playa lakes, are interspersed throughout both the classic and intertonguing intervals. The Kayenta Formation consists primarily of 100 ft or more of less resistant, fine-bedded, red silt and fine sand, lacking the characteristic cross-beds of the Navajo Sandstone.

Ground water 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 nature of the Kayenta Formation locally, it is not water bearing and so is excluded from the "N" aquifer. Ground water saturation occurs from the ambient water table, about 50 to 60 ft below ground surface on the upper and middle terraces, to the upper contact of the Kayenta Formation, accounting for a saturated thickness on the order of 500 ft. Ground water flow beneath the site is southeast to Moenkopi Wash. There, regional aquifer discharge is expressed as a laterally extensive (miles) spring zone near the exposed base of the intertonguing interval. Local discharge of ground water from higher in the formation occurs in some areas, as evidenced by scattered bands of desert phreatophytes typically near the base of the escarpment between the middle and lower terraces. One such area is noted in Figure 2 as the "greasewood area," where the depth to water is only about 20 ft. Figure A–1 in Appendix A depicts a conceptual model of the site hydrogeology.

1.5.1 Vertical Discretization of the N-Aquifer

In the absence of laterally continuous marker beds in the Navajo Sandstone, for this project the subsurface is discretized into 50-ft intervals, or "horizons," each with a letter designation. These designations are convenient in evaluating the site hydrogeology and depth of contamination. The top 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 include the regions of the intertonguing interval. 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. The steep topography at Moenkopi Wash intersects Horizons E through G. Because contamination of the aquifer is limited in depth, ground water remediation at the site focuses primarily on the upper 250 ft of the bedrock aquifer (Horizons A through E).

The stratigraphic relationships to aquifer horizon are shown in Figure A–1. In Figure 2, color-coding identifies the corresponding horizon in which the mid-point of the screen of each well is located for project extraction wells (round symbols) and monitor 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. Table A–1 includes additional well completion information such as screen length and elevations.

2.0 Treatment & Extraction Systems

2.1 Bulk Treatment Parameters

During the current review period of April 2006 through March 2007, the treatment plant operated for about 342 of 365 total days, for a net on-stream factor of 94 percent. Power failures and scheduled maintenance requiring plant shutdown accounted for most of the downtime. About 44 million gallons of water were treated during this period, resulting in an average operating rate of 89 gallons per minute (gpm) and an effective rate (downtime included) of 84 gpm. The operating capacity of the treatment plant is about 120 gpm. This rate is not attained because of limited formation yield to the extraction system. Total ground water treatment as of April 1, 2007, was approximately 224 million gallons, equivalent to about 19 percent of the total estimated volume of uranium-contaminated ground water prior to remedial action (see Section 4.0 for discussion of contaminant removal rates).

Figure 3 shows the feed rate to the treatment plant and the corresponding concentration of nitrate and sulfate determined from weekly composite samples since the start of remediation. This figure indicates relatively stable concentrations of these constituents entering the treatment system at typical inflows. As seen in Figure 4, uranium concentration in the bulk feed shows a slight downward trend over the same period (concentration trends are discussed in Section 4.0). The masses of nitrate, sulfate, and uranium extracted during the current review period, estimated from the weekly monitoring of bulk inflow to the treatment plant, are respectively, 145,720 pounds (lbs); 366,500 lbs; and 79.3 lbs (Table 2).

Table 2. Treatment System Performance Summary

Contaminant	Typical Feed Concentration (mg/L)	Typical Distillate Concentration (mg/L)	Mass Removed During Review Period (lbs)
Nitrate (as NO_3)	350	7	147,720
Sulfate	1,000	20	366,500
Uranium	0.24	0.0035	79.3

2.2 Distillate Quality

Concentrations of nitrate, sulfate, and uranium in the distillate averaged about 7, 20, and 0.0035 mg/L, respectively, during the review period (Table 2 and Figure 5). Total dissolved solids (TDS) ranged between about 20 and 80 mg/L (40 mg/L average), and chloride concentrations were generally less than 2 mg/L with little variation. These results indicate highly effective contaminant removal and very high quality of water returned to the aquifer.

2.3 Treatment System Water Budget

About 88 percent of the total feed to the treatment system was returned to the aquifer at the infiltration trench over the past year. Treatment system wastewater sent to the evaporation pond comprised about 6 percent of the total inflow as brine and about 6 percent as loss for softener regeneration.

2.4 Extraction Wells

In Figure 2, the extraction wells labeled 1101 to 1125 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 completes the 2-inch annulus to 30 or 40 ft above the screen slots. 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 near the base of Horizon D. Extraction wells 1126 to 1133 are constructed of 4-inch-diameter casing and screen. These wells have a 30-ft to 50-ft screen that is placed across most of Horizon B. These wells became operational in August 2005, as did former monitor wells 935, 936, 938, and 942 (4-inch wells). The extraction well pumps are generally positioned 10 to 15 ft above the bottom of the well. Pumps in wells 935, 936, 938, and 942 are at the bottom of the well because these wells are much shallower and so have much less potential drawdown.

The operational history of each extraction well for the evaluation period is included in Appendix A, Table A–2. Pumping is generally continuous at wells 1101 to 1125. Among these wells, steady pumping rates range between about 1 and 6 gpm, with an average rate of about 3.5 gpm. The contribution from wells 1101 to 1125 is about 96 percent of total production. Continuous pumping is not sustained at wells 1126 to 1133 because of low aquifer yield. The on-stream time for these wells is indicated to be less than 5 percent. During the remaining time, the pumps are off to allow water level recovery. Pumping is discontinuous at wells 935, 936, 938, and 942 primarily because they are shallow wells with short screen lengths.

There is some uncertainty that flow rates for the "new" extraction wells are accurately communicated to the treatment plant monitoring system. Some of these wells may be producing more water than presently registered at the treatment plant. This situation is currently under investigation.

3.0 Ground Water Capture Analysis

3.1 Extent of Ground Water Contamination

Figures 6a through 14a illustrate the concentrations of nitrate, sulfate, and uranium in ground water in the respective aquifer horizons before the start of remediation. Most of the information is from sample collection in March 2002, but data for some locations is from 1999. Figures 6b through 14b show contaminant distribution in August 2006 for the respective contaminant and aquifer horizon. Concentration data for wells 286 to 290 are from May 2007 sampling following their installation in March 2007.

Although each well location sampled for the respective period is shown, a concentration value is posted in Figures 6 through 14 only where the applicable remediation goal or standard was exceeded. In map view, the area of contamination in the various horizons does not appear significantly different from the baseline condition, indicating no lateral spreading of the contaminant plume (see also Section 4.1).

The depth of ground water contamination is generally limited to Horizons A, B, and C beneath the middle terrace. Contamination of Horizon D does not appear widespread or continuous in distribution (see Figures 7b, 10b, and 13b) and is generally of lesser magnitude in concentration. Contamination in Horizon E (see Figures 8b, 11b, and 14b) is limited to a single occurrence of nitrate in well 268 at concentrations of 70 to 80 mg/L as NO_3, which do not greatly exceed the restoration standard of 44 mg/L as NO_3. Contamination was not detected at well 268 prior to the start of remediation, but the nitrate concentration has lately increased to exceed the standard. In response to ground water extraction, the high amount of drawdown produced at this well may be accompanied by the downward movement of some slightly contaminated ground water from upper horizons. Vertical hydraulic gradients analyzed in previous annual site reports identified upward flow potentials from lower horizons to Horizon E in this area.

On the lower terrace, nitrate is present above the restoration standard at three locations, one fewer than the previous year. The maximum concentration of nitrate (89 mg/L as NO_3) among these locations does not greatly exceed the restoration standard of 44 mg/L as NO_3. In the past year, sulfate concentrations have decreased to levels below the restoration goal of 250 mg/L at all lower terrace locations (Figure 10b). Prior to 2005, uranium was present at several lower terrace wells in concentrations that exceeded the restoration standard of 0.044 mg/L. Since 2005, uranium concentrations have decreased to levels less than the restoration standard at all lower terrace locations.

Appendix B provides "plume" maps of the contaminant distributions for August 2006 (Figures B–1, B–2, and B–3). The contours shown in the figures were computer generated using the "natural neighbor" model to interpolate the posted concentration values. This method generates good contours from data sets containing areas of sparse and dense data and does not generate contours in areas beyond the data range. One outcome of this method is that contours do not extend far beneath the disposal cell, where no data are available. Analytical results for each contaminant requiring remediation are tabulated for August 2006, February 2007, and the baseline period in Appendix C.

3.2 Water Table Configuration

Figure 15 shows the estimated water table for the baseline period using water levels in Horizons A and B monitor wells for the middle terrace and Horizon C wells for the lower terrace. On the middle terrace, water levels from 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 for the area of interest. The horizontal direction of ground water flow was predominantly south during the baseline period. A steeper hydraulic gradient corresponds to aquifer thinning at the escarpment (Figure 15).

Figure 16 shows a similarly constructed water table for August 2006. Comparison of Figures 15 and 16 indicates that operation of the extraction wells has significantly depressed the water table, with a significant drawdown cone centered on both the south and east bank of extraction wells. The water table underlying the escarpment and lower terrace appears unaffected by ground water extraction. Additional analysis of ground water flow directions, as influenced by ground water extraction, is provided in Sections 3.4 and 3.5. Also evident in Figure 16 is the development of

an elongate ground water mound and increased hydraulic gradients along the north edge of the disposal cell caused by infiltrating distillate at the trench.

3.2.1 Infiltration Trench

The infiltration trench is constructed into bedrock along the north side of the site (see Figure 2 for trench location). Distillate enters the trench at its mid-point from where it can flow in either direction in perforated pipe embedded in a 3-ft-thick gravel pack. Through mid-2003, non-uniform infiltration caused greater than 20 ft of ground water mounding beneath the southwest section of the trench but only about 1 ft of mounding beneath the northeast section. The ground water mound progressively became more symmetrical after November 2003 when flow valves were installed, and all inflowing water was diverted to the northeast segment of the trench. In April 2005, the valves were again adjusted to redirect some flow back to the southwest section of the trench, which has resulted in comparatively greater mounding in that section. Water levels have risen at well 946 to historical maximums to within about 30 ft of ground surface (water level hydrographs for wells completed in the aquifer in the area of the trench are presented as Figure D–1 in Appendix D). Monitor wells 284 and 285 (see Figure 2 for location), screened across the contact of the terrace deposits and Navajo Sandstone immediately downgradient of the trench, remain dry, indicating that mounding has not over-topped the trench to saturate the alluvium, although the current water level at well 946 is very close to the bedrock/alluvium contact.

3.3 Water Level Drawdown

Figure 17 further illustrates the effect of ground water extraction and infiltration by showing the difference in water levels in Horizons A and B between the baseline period and August 2006. Figures 18 and 19 plot the water level differences between the same period for the deeper horizons. Positive values identify locations where the water level in August 2006 is less than the baseline value. Negative values, such as those at the wells surrounding the infiltration trench (Figure 17), indicate that water levels at the respective locations are presently higher than during the baseline period.

In the area of ground water extraction, the overall pattern of water level drawdown illustrated in Figures 17 through 19 reflects three-dimensional converging flow to the extraction wells. The greatest drawdown (30 to 40 ft) is observed at the Horizon E wells (wells 251 and 268) located within the extraction field. The intakes of these particular monitor wells are nearest to the interval of ground water extraction among all monitor wells for which baseline data are available (extraction wells are screened across Horizons C to E and centered in Horizon D). Drawdown is observed to decrease with vertical and horizontal distance from the extraction zone. Water level drawdown in response to ground water extraction does not imply capture of the water at an extraction well (see Sections 3.4 and 3.5 for capture analysis).

Well hydrographs in Appendix D provide an additional view of water level variation over time at selected monitor wells. The predominantly downward trend in ground water levels indicates an expanding capture zone and that the ground water setting has not attained the condition of steady-state flow since the start of ground water remediation.

3.4 Horizontal Capture

Figure 20 depicts the estimated zone of ground water capture in lateral extent in Horizons A and B, where the bulk of contamination resides. All ground water within the dashed blue line is predicted to ultimately flow to an extraction well. The prediction is based on slope analysis of the water table depicted in Figure 20 using a computerized grid-based contouring application (SURFER). The analysis calculates a vector representing the direction and relative magnitude of the slope for each grid cell. The capture line in Figure 20 is the flow divide that separates vectors that converge on the extraction wells from those that do not. Several conditions were imposed to obtain this result. First, because extraction well water levels are not monitored, the ground water level at each extraction well was assigned a uniform value of 4,990 ft. This value is consistent with the water table elevation observed at several monitor wells located within the extraction field. In addition, to mimic the regional water table gradient, prescribed water table elevations were assigned at several locations in a line upgradient of the site near well 901 and along Moenkopi Wash east and west of well 902.

This analysis indicates that the full width of the contaminant plume along the south edge of the disposal cell is captured, suggesting that flow of contaminated ground water from the site has been eliminated. However, ground water in the area encompassing extraction wells 1126–1129 apparently escapes capture. Evidence of ground water capture in this area may arise in following years with continued operation of these relatively new and lower productivity wells. In this area, contamination is indicated to be limited in vertical extent to Horizons A and B. Concentration values in this part of the plume range from about 150 to 1,370 mg/L nitrate as NO_3; <250 to 3,600 mg/L sulfate; and <0.044 to 0.076 mg/L uranium. Average concentrations are about 450 mg/L nitrate, 750 mg/L sulfate, and 0.065 mg/L uranium. The ranges in concentration for nitrate and sulfate are skewed by relatively high levels at wells 267 and 1126, which are located close together.

3.5 Vertical Capture

Hydrographs included in Appendix D for selected sets of co-located monitor wells illustrate that at a given location, the hydraulic head in the aquifer is a function of well-intake depth. This relationship clearly identifies vertical flow components throughout the entire monitored thickness of the aquifer, both before and since the start of ground water remediation. With few exceptions, the vertical potentials were downward during the baseline period. Since that time, the magnitude of downward flow in Horizons A, B, and C has increased, as exemplified by the greater vertical separation in the hydrographs for the respective locations of well pairs 265/266, 263/264, 908/912, and 909/932 since about mid-2002 (see Appendix D, Figures D–4 through D–7). In the main region of contamination, these increased gradients likely imply capture of ground water from the upper, most contaminated horizons of the aquifer (Horizons A, B, and C).

In the deeper horizons, vertical gradients are now generally upward to the extraction well intakes. For example, the vertical flow potentials have 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 result between Horizons E, I, and possibly M is apparent at the location of wells 251/252/253 (see Figure D–9, the monitoring record is incomplete for well 253, a former Horizon M well that was decommissioned in 2001). A downward flow potential remains between Horizon I and M at wells 254/255 (Figure D–10; well 255 was

decommissioned in August 2005); however, there is an upward gradient at that location between Horizon I (well 254; decommissioned in August 2005) and Horizon D (well 277). This apparent vertical flow divide at this location implies ground water capture possibly to Horizon I but not Horizon M.

Because the observed vertical influence of the extraction wells extends much deeper than the presumed depth of contamination (Horizons A, B, and C, and to a lesser extent Horizon D), it is likely that the remediation system captures the full vertical extent of the contaminant plume and prevents potential downward movement of the contaminants. Although ground water extraction has had no effect on downward flow between Horizons D and G at wells 915 and 916 (Figure D–11), this region of the aquifer is not contaminated. Downward flow potentials in lower terrace ground water also remain unaffected by ground water extraction (Figure D–12), but contamination there is minor and limited to the shallowest horizon. Also, there is no evidence of vertical or lateral spreading of contamination in the lower terrace ground water.

4.0 Remediation Progress

4.1 Contaminant Concentration Trends at Monitor Wells

Appendix E contains time-series graphs of nitrate, sulfate, and uranium concentrations in ground water at selected monitor wells located throughout the project area. In the main region of ground water contamination, obvious upward or downward trending is not apparent at the individual monitor wells (Figures E–1 to E–3). Toward the outer (south) margin of the plume, contaminant concentrations are relatively stable or slightly decreasing (see Figures E–4 through E–6). Horizons A, B, and C wells 271, 683, 684, 914, 921, and 929 are located beyond but near the downgradient or crossgradient extent of contamination. These "sentinel" wells remain uncontaminated, with the exception of minor but decreasing nitrate contamination at well 929, indicating no significant lateral expansion of the contaminant plume.

Breakthrough of clean water from the infiltration trench to the south side of the disposal cell is not yet apparent. Because the water table at well 940 has dropped below the base of the screen, a replacement well was installed 30 ft deeper in April 2007 (well 286). Similarly, a replacement well (well 287) was installed adjacent to well 941 in April 2007, where the water table is only slightly above the base of the screen. Well 942 was converted to an extraction well in 2005 but draws little water and so probably remains suited for monitoring breakthrough of treated water at that location. Porous media flow using Darcy's Law predicts that under the observed water table gradient (Figure 16) and a hydraulic conductivity of 1 ft/day (from DOE 1998), the calculated travel time from the infiltration trench to well 940 is 17 years, which is greater than the cumulative remediation period to date.

Contaminant concentrations remain stable and below remediation standards in Horizons C and D wells 264, 266, 915, and 932 (Figures E–7 through E–8). These results indicate that no southward expansion of the plume is occurring at this depth in the aquifer. In these figures, elevated nitrate and sulfate concentrations at well 912 (Horizon C) are seen to decrease over time, which also indicates that contamination is not spreading in this downgradient direction (southwest).

In ground water beneath the lower terrace, uranium and sulfate concentrations have decreased to levels below the respective restoration objectives at all locations. The current extent of contamination is limited to nitrate at wells 930 (58 mg/L as NO_3), 903 (49 mg/L as NO_3), and co-located wells 691 and 1003 (53 and 89 mg/L as NO_3, respectively). Definitive trending at these locations is not recognized. Migration of this contamination apparently is not significant, as indicated by persistent background levels at nearby wells farther downgradient. Contaminant concentration plots for lower terrace monitor wells are included in Appendix E, Figures E–10 through E–12.

4.2 Contaminant Concentration Trends at Extraction Wells

Figures 21, 22, and 23 illustrate concentration trends at the extraction wells for nitrate, sulfate, and uranium, respectively. For each contaminant, the trend at most wells is of decreasing concentration as contaminant mass is removed from the aquifer. Appendix F contains individual concentration plots for each extraction well based on the monthly on-site sampling and analysis.

On the basis of those figures, Table 3 identifies that the extracted ground water is not below the remediation standard for all three primary contaminants at any extraction well. Although the extraction well samples are likely composites of ground water from several horizons of variable contamination, it is noted that the region of the aquifer east of the evaporation pond and encompassing well 1125 is approaching cleanup goals.

Table 3. Pumping Wells Where a Contaminant Concentration Is Below the Remediation Standard in the Extract, as of February 2007

Nitrate	Sulfate	Uranium
--	1107	--
--	1112	1112
--	1113	1113
--	1116	1116
--	1117	--
--	1123	1123
1125	1125	1125

4.3 Contaminant Inventory and Removal Rates

Table 4 lists the cumulative amounts of nitrate, sulfate, and uranium removed from the aquifer as of April 1, 2007. For comparison, Table 4 also provides the estimated quantities of contamination initially present in the aquifer and the amount of contaminant removed as a percent of the initial quantity. Calculation methods for these estimates are provided in Appendix G as Calculation Set 1.

By these estimates, at current mass recovery rates of between 1.6 to 4.3 percent per year, ground water restoration will require about 23 to 63 years to complete since the inception of active remediation in mid-2002 (see also Figures 24 and 25, which project current removal rates to future years), assuming total plume capture. The corresponding volume of ground water extracted at 23 years, assuming constant withdrawal of 85 gpm, is 1 billion gallons, or approximately one estimated pore volume of the contaminant plume.

Table 4. Summary of Cumulative Mass and Volume Recovery as of April 1, 2006

Contaminant	Initial Mass (lbs)[a]	Cumulative Mass Removed (lbs)	Cumulative Percent Mass Reduction	Initial Volume (gal)[a]	Volume Treated (gal)	Percent Plume Volume Reduction
Nitrate	9,500,000	757,445	8.0	1.2E+09	224,000,000	19
Sulfate	20,150,000	1,862,880	9.3	1.2E+09	224,000,000	19
Uranium	2,300	493	21.4	1.2E+09	224,000,000	19

[a]Source: see Appendix G

4.3.1 Aquifer Restoration Index

The restoration period is also estimated by an approach that is independent of mass and volume calculations. By this approach, an average concentration of a contaminant is computed for each sampling event from a selected group of monitor wells. The composition of the ground water plume is thus represented as a single concentration value for a given contaminant at a given time. A graph of the averages over time can then provide a measure of restoration progress. Figures 26 and 27 illustrate respectively how the geometric mean of the sulfate and uranium concentration for the individual sampling events varies since the baseline period. The selected monitor wells for this analysis are those located throughout the contaminant plume and sampled most regularly. Appendix G provides calculation information for this performance metric as Calculation Sets 3 and 4.

Despite the small increment of change and the relatively brief period of observation, the results presented in Figures 26 and 27 suggest a developing trend showing the effects of remediation in reducing the bulk concentration of uranium and sulfate (nitrate results not yet analyzed by this method). Linear projection of these data predicts a restoration time of 25 to 30 years since the inception of active remediation in mid-2002. This compares to an estimated 27 years to remove one pore volume of the initial contaminant plume (Table 4) at the current cumulative extraction rate of about 3.7 percent per year by volume.

5.0 Year in Review Summary

- On-stream extraction and treatment flow rates meet design objectives.
- Distillate quality meets or exceeds design objectives.
- Return flow to the aquifer as a percentage of extracted water meets design objectives.
- The current configuration and operation of the extraction system effectively captures the region of maximum ground water contamination.
- The current configuration and operation of the extraction system likely captures the full vertical extent of ground water contamination.
- Plume expansion is not significant on either the middle or lower terrace.
- Uranium and sulfate concentrations have decreased to levels less than the restoration standard at all lower terrace monitoring locations. Only minor nitrate contamination remains on the lower terrace.

- Bulk concentration trends indicate measurable progress in water quality restoration.
- Projected cleanup times range between about 25 and 60 years since mid-2002. These projections assume total plume capture, which currently is not achieved. Also, the projections do not forecast the potential flushing effects of trench water arriving to the extraction zone.
- Production from the extraction wells installed in 2004 is much less than expected, probably due to the low permeability of the formation; however, field observations indicate that production from these wells may be greater than is registered at the treatment plant.
- Sampling and analysis for gross alpha and gross beta activity, strontium, and isotopic uranium was discontinued with concurrence of all stakeholders.
- Five new monitor wells were installed. Two wells (wells 286 and 287) replace wells 940 and 941, which have gone dry or will do so soon; nested wells 288 and 290 are to monitor the arrival of treated water from the trench; and well 290 closes the plume boundary east of the eastern extraction wells.

6.0 Recommendations

- Reduce ground water monitoring (except that conducted for treatment plant operations) to one annual comprehensive event, possibly in March.
- Divert more flow of distillate to the northwest section of the infiltration trench.
- Consider implementing injection of distillate at the existing but unused injection wells if current trends of rising water levels at the infiltration trench continue.
- Use ground water modeling to predict the restoration time as the system is currently configured and operated and under assumed conditions of expanded ground water capture using additional extraction wells.

7.0 References

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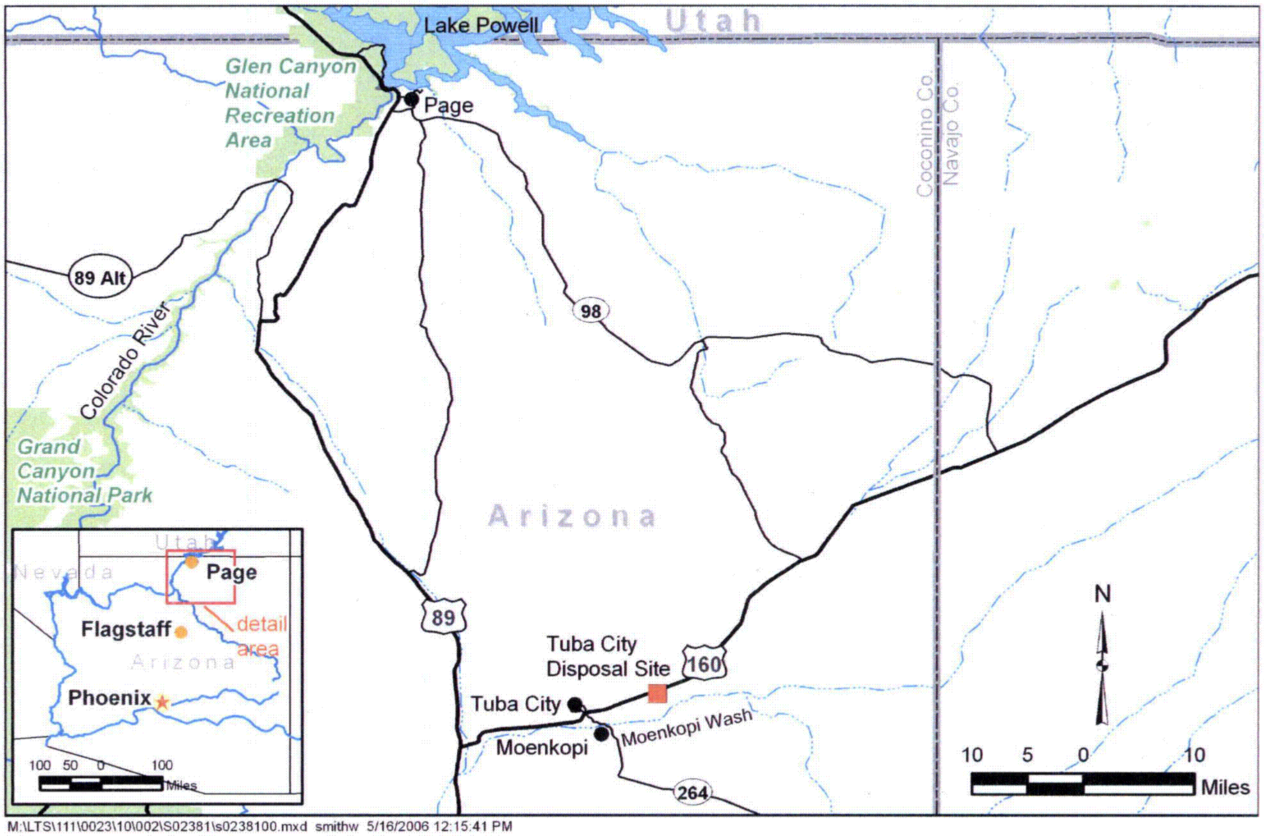

Figure 1. Tuba City Site Location

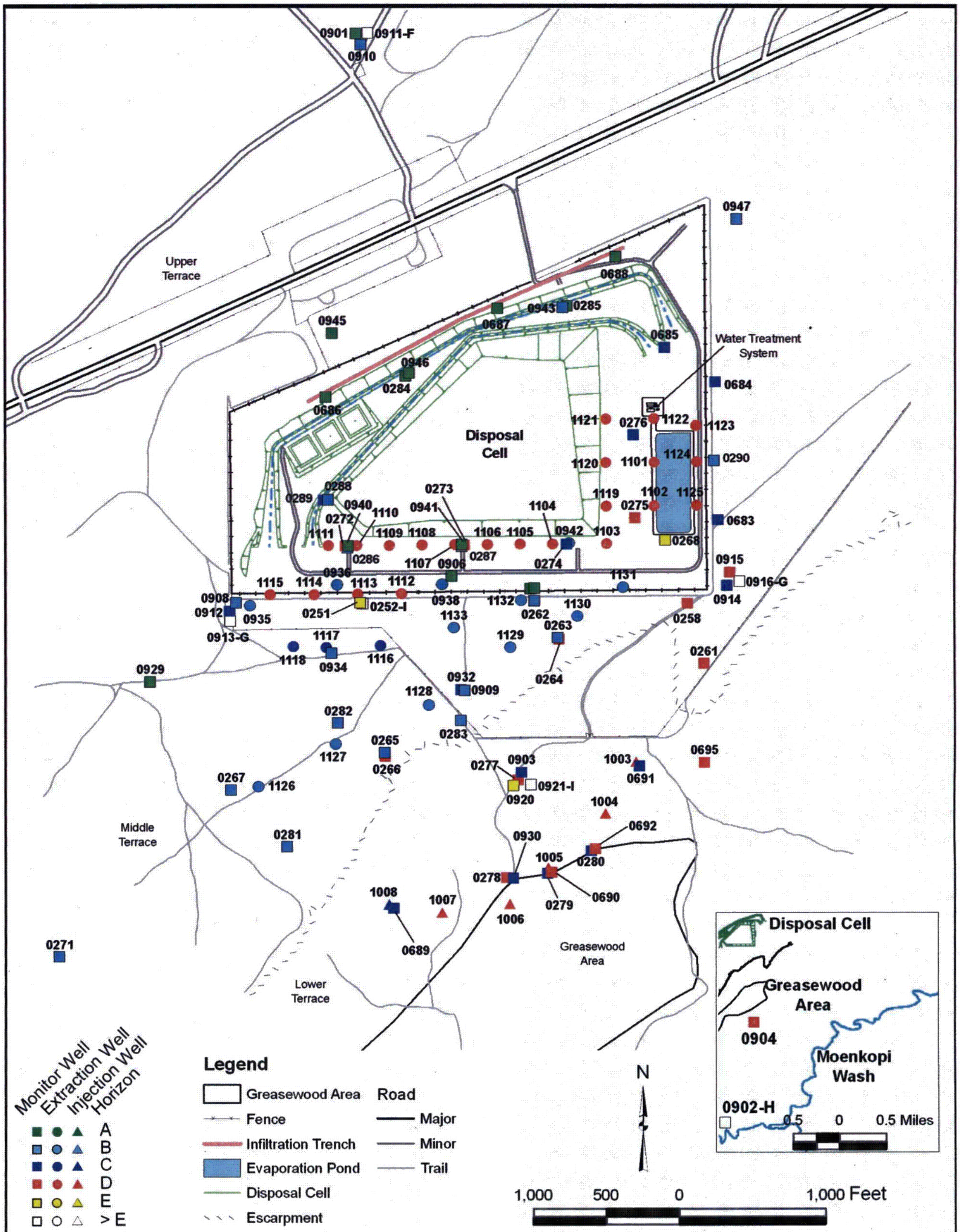

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Figure 2. Tuba City Site Features and Well Locations

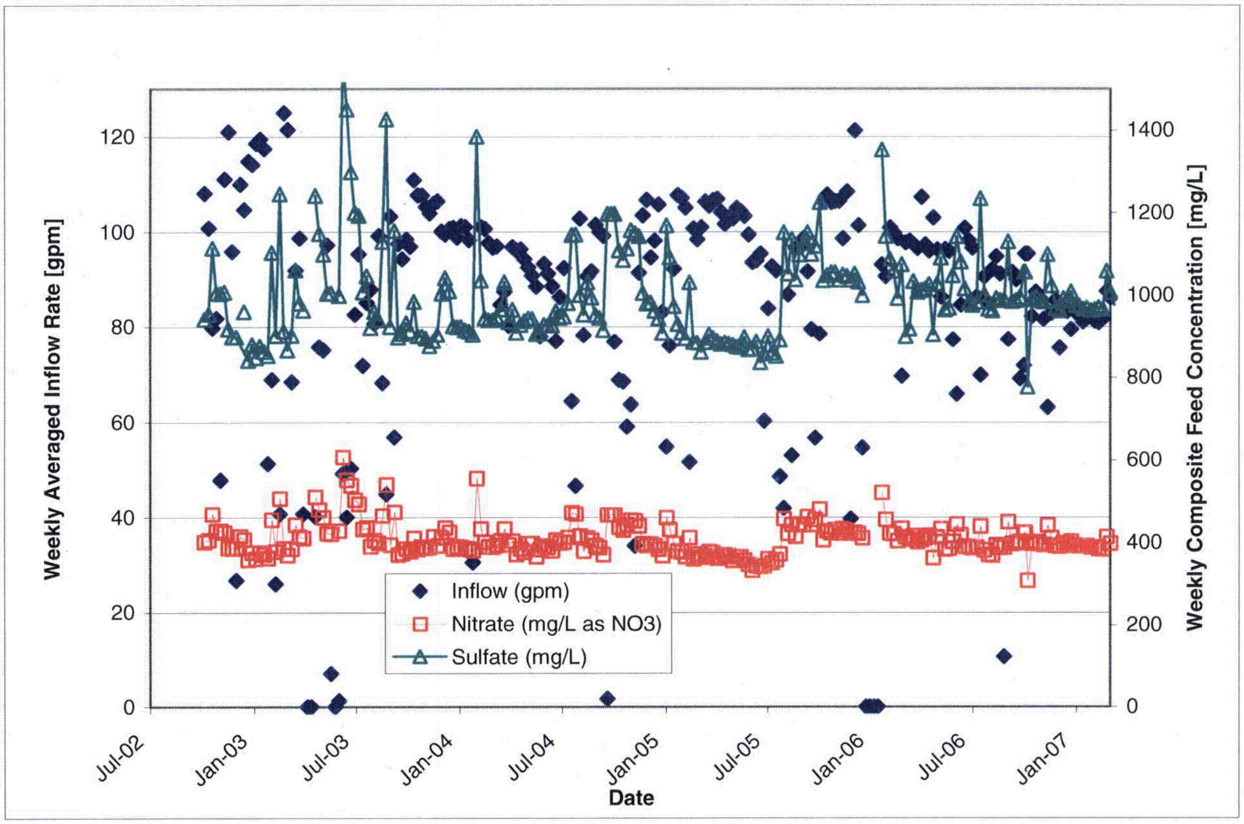

Figure 3. Treatment Plant Inflow Rate and Nitrate and Sulfate Concentration

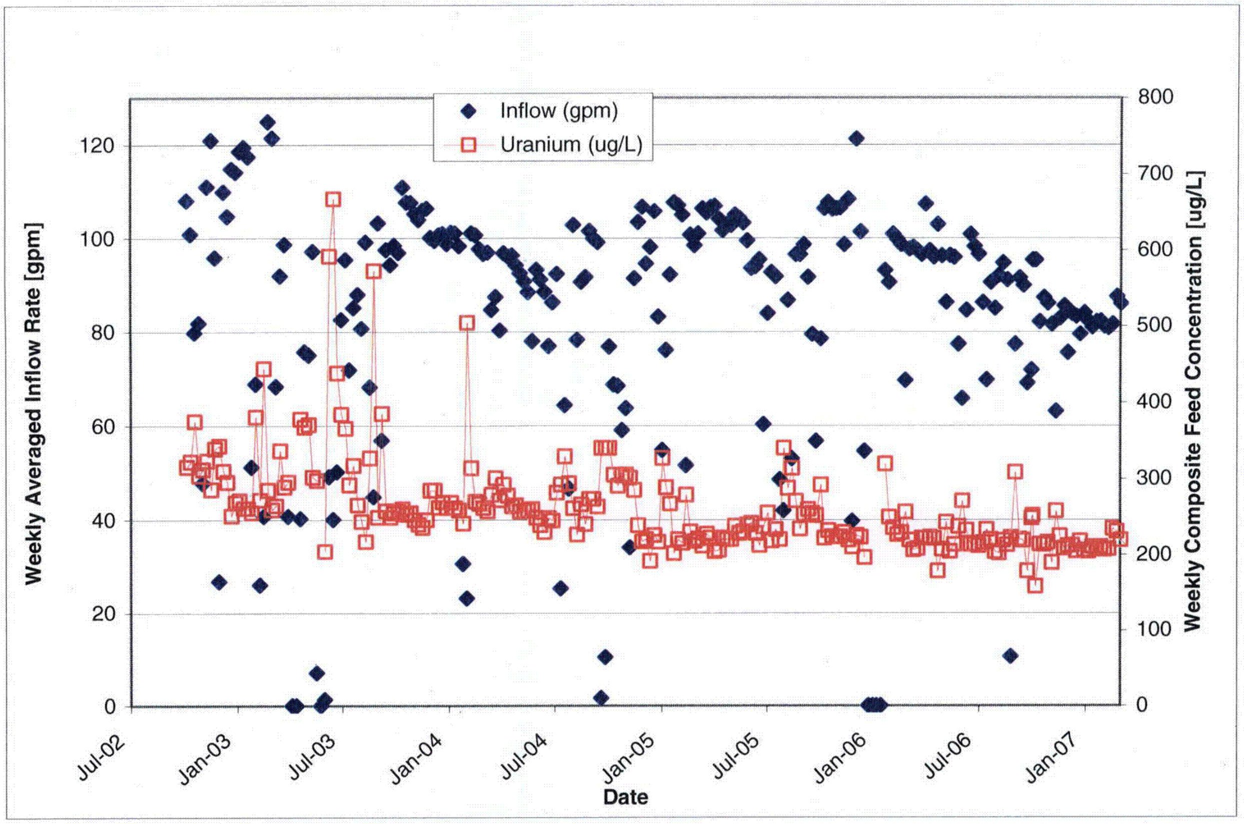

Figure 4. Treatment Plant Inflow Rate and Uranium Concentration

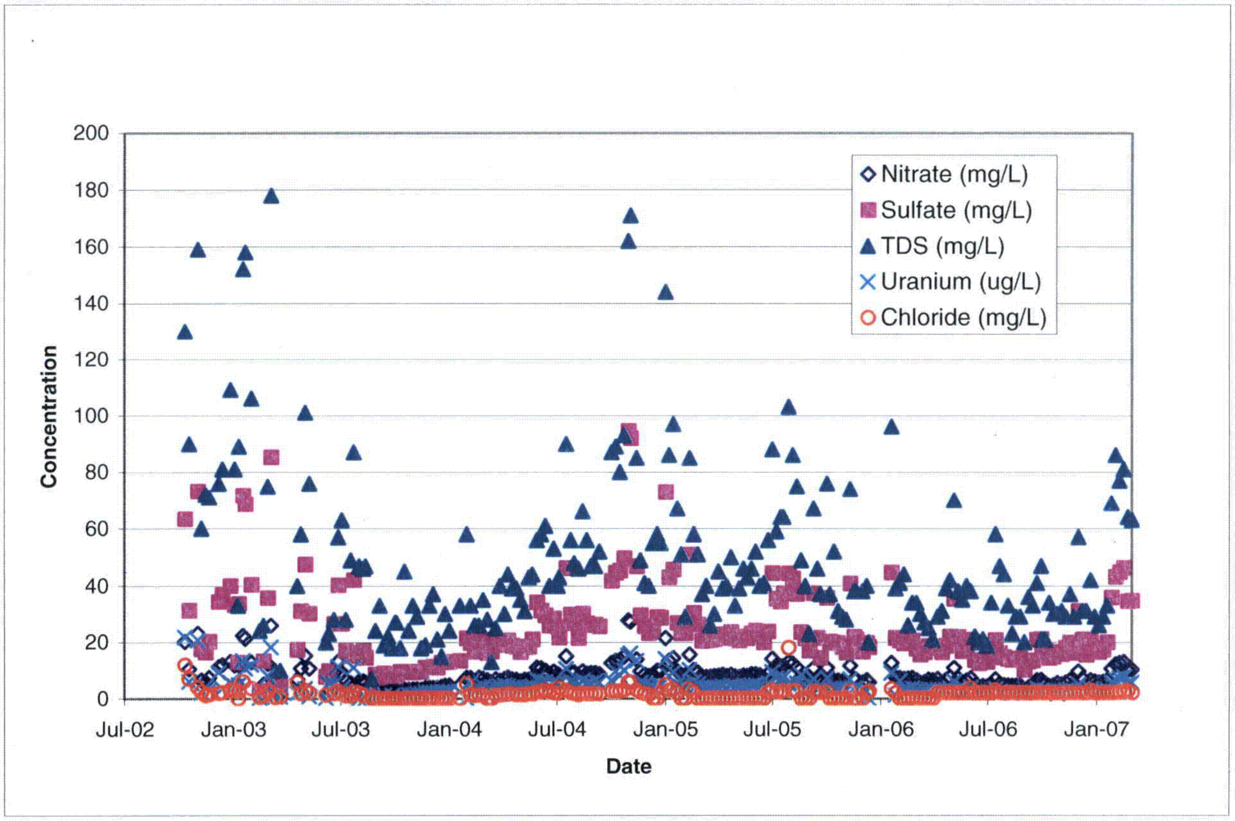

Figure 5. Treatment Plant Distillate Quality

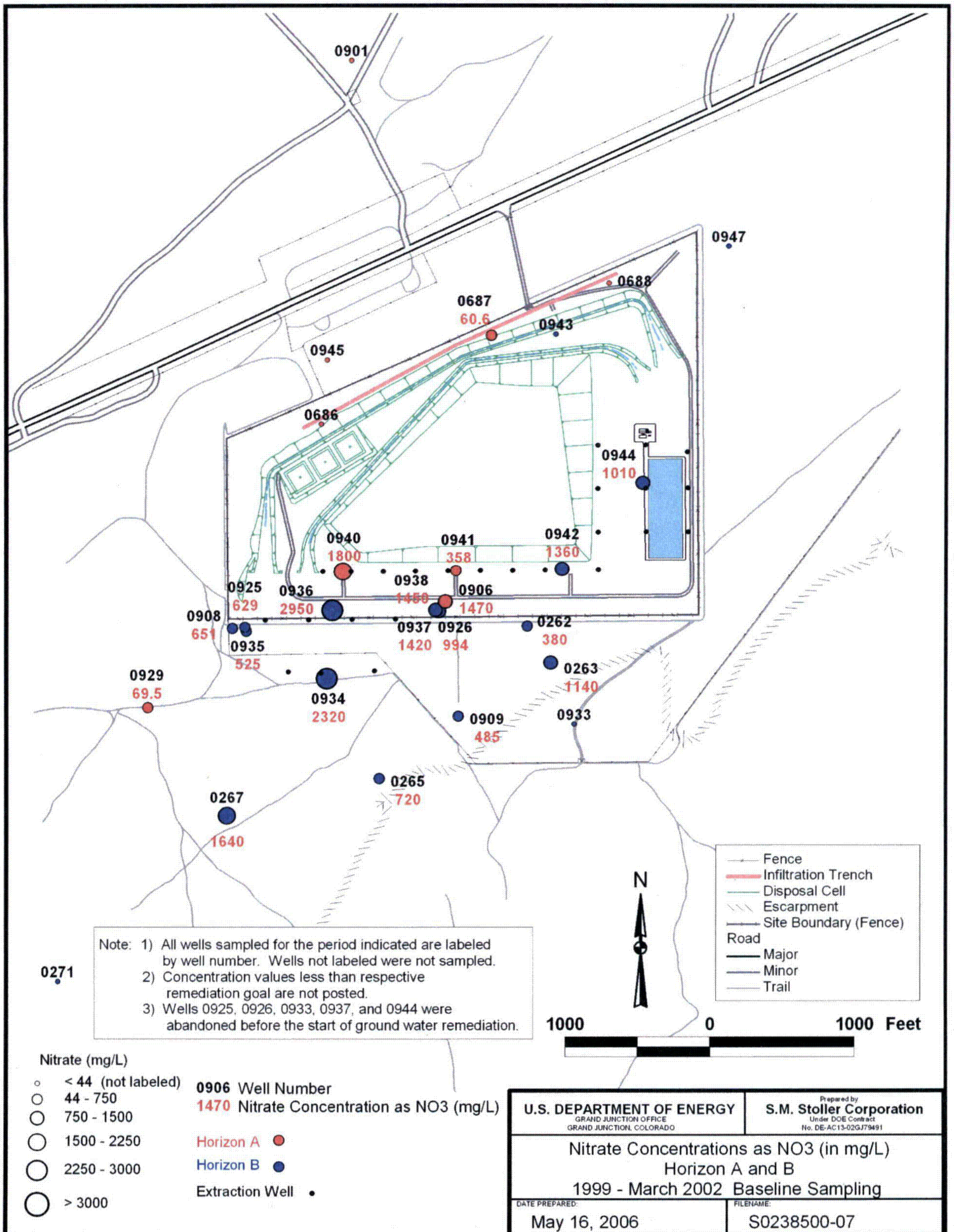

Figure 6a. Nitrate Concentrations in Ground Water, Horizons A and B, Baseline Period

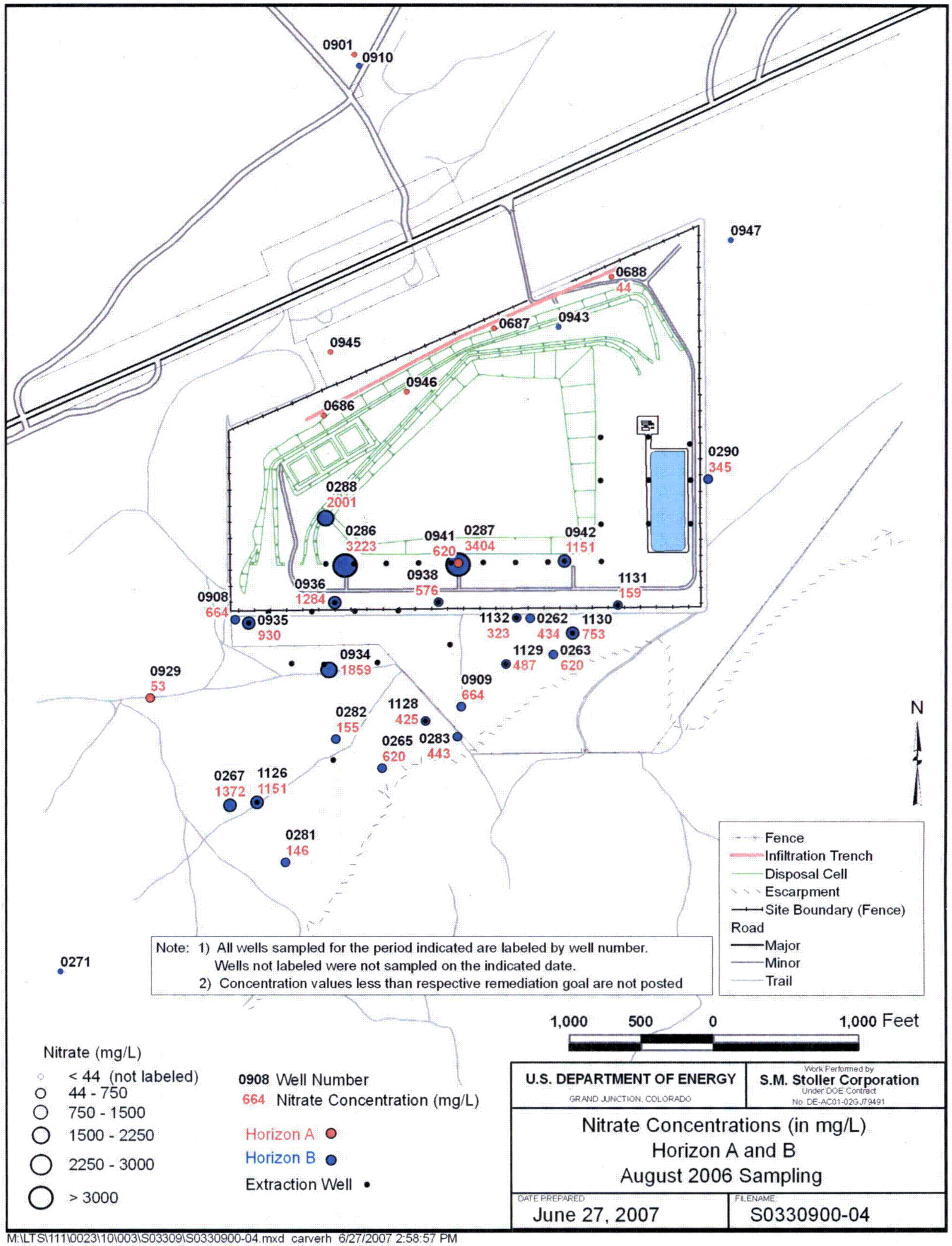

Figure 6b. Nitrate Concentrations in Ground Water, Horizons A and B, August 2006

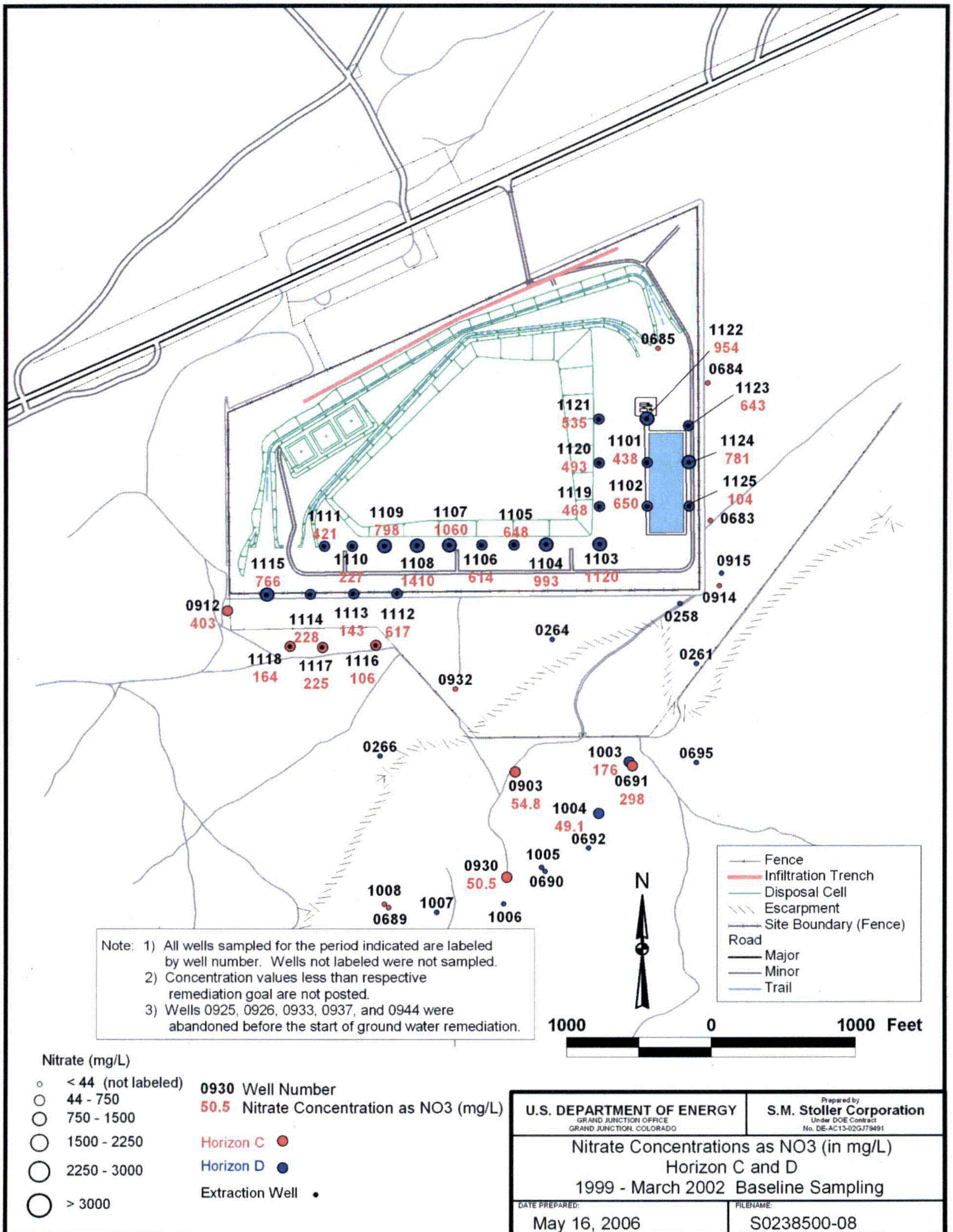

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Figure 7a. Nitrate Concentrations in Ground Water, Horizons C and D, Baseline Period

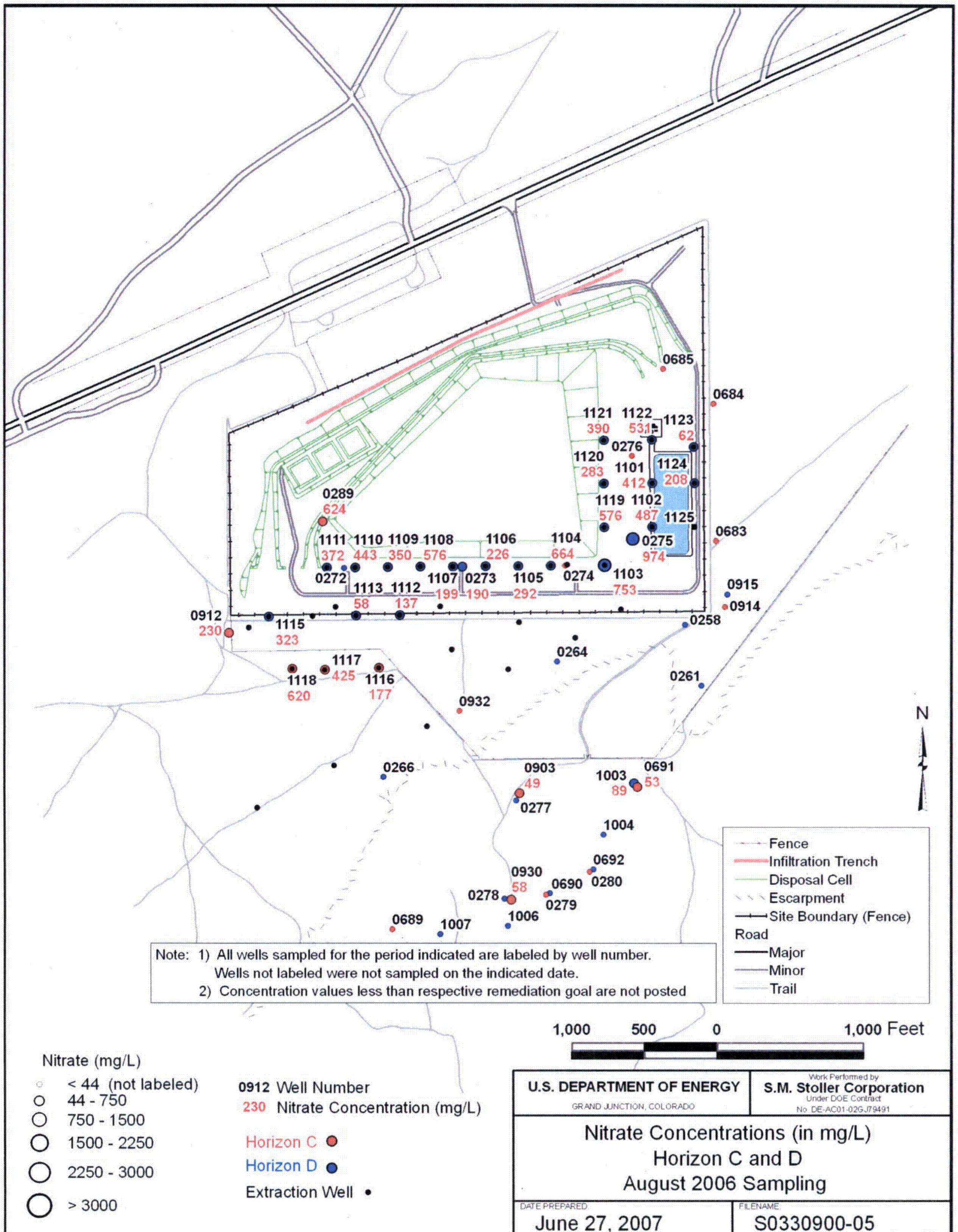

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Figure 7b. Nitrate Concentrations in Ground Water, Horizons C and D, August 2006

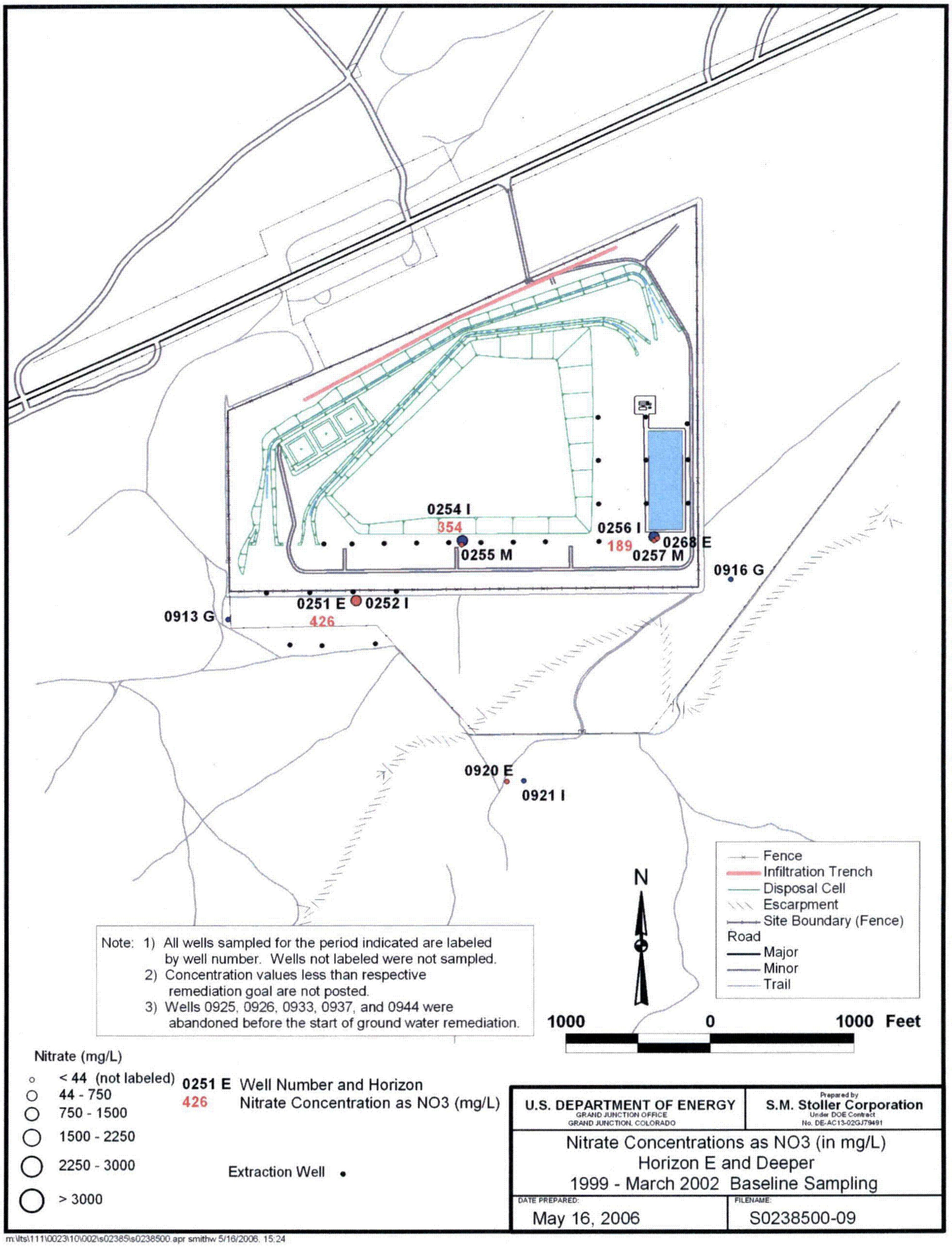

Figure 8a. Nitrate Concentrations in Ground Water, Horizons E and Deeper, Baseline Period

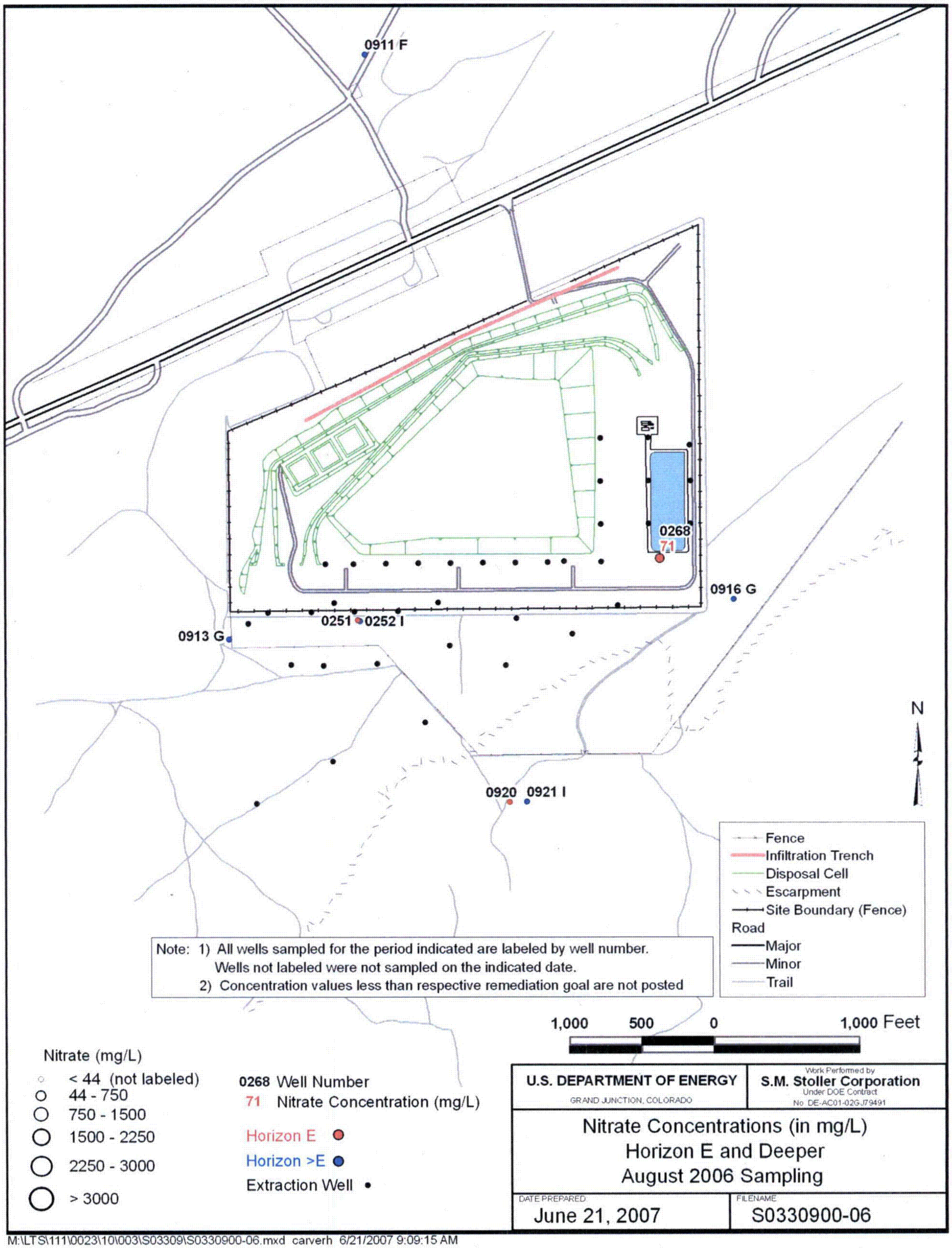

Figure 8b. Nitrate Concentrations in Ground Water, Horizons E and Deeper, August 2006

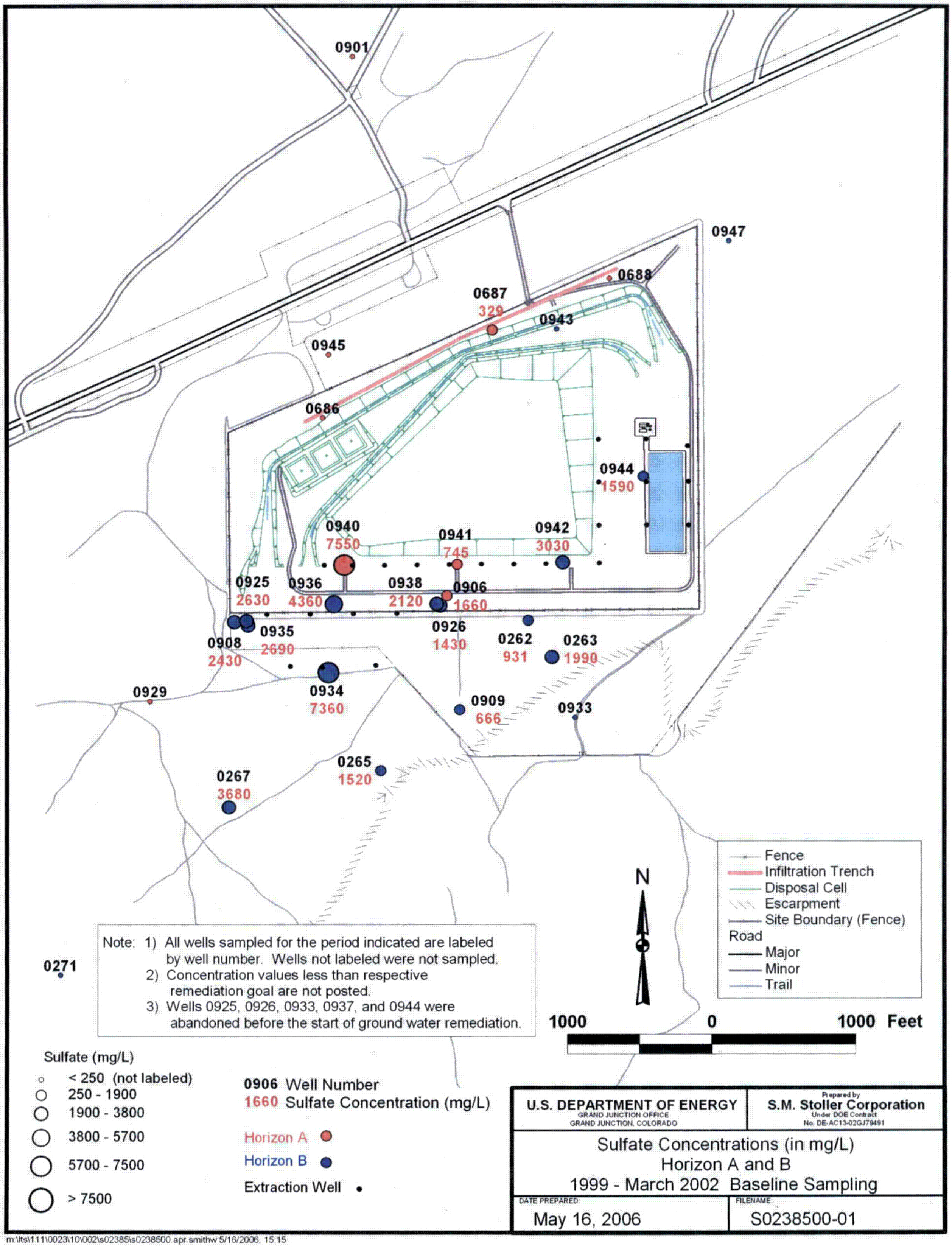

Figure 9a. Sulfate Concentrations in Ground Water, Horizons A and B, Baseline Period

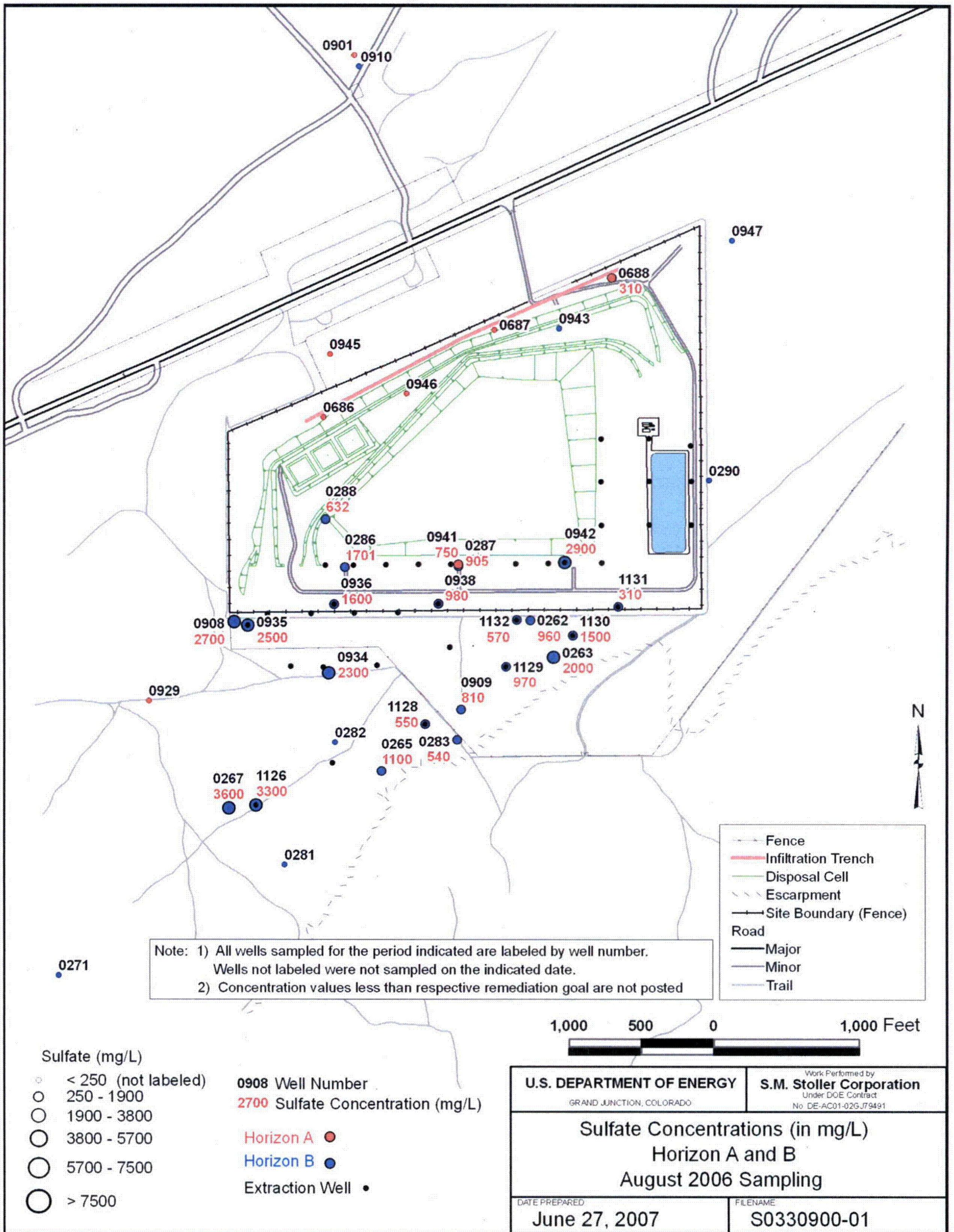

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Figure 9b. Sulfate Concentrations in Ground Water, Horizons A and B, August 2006

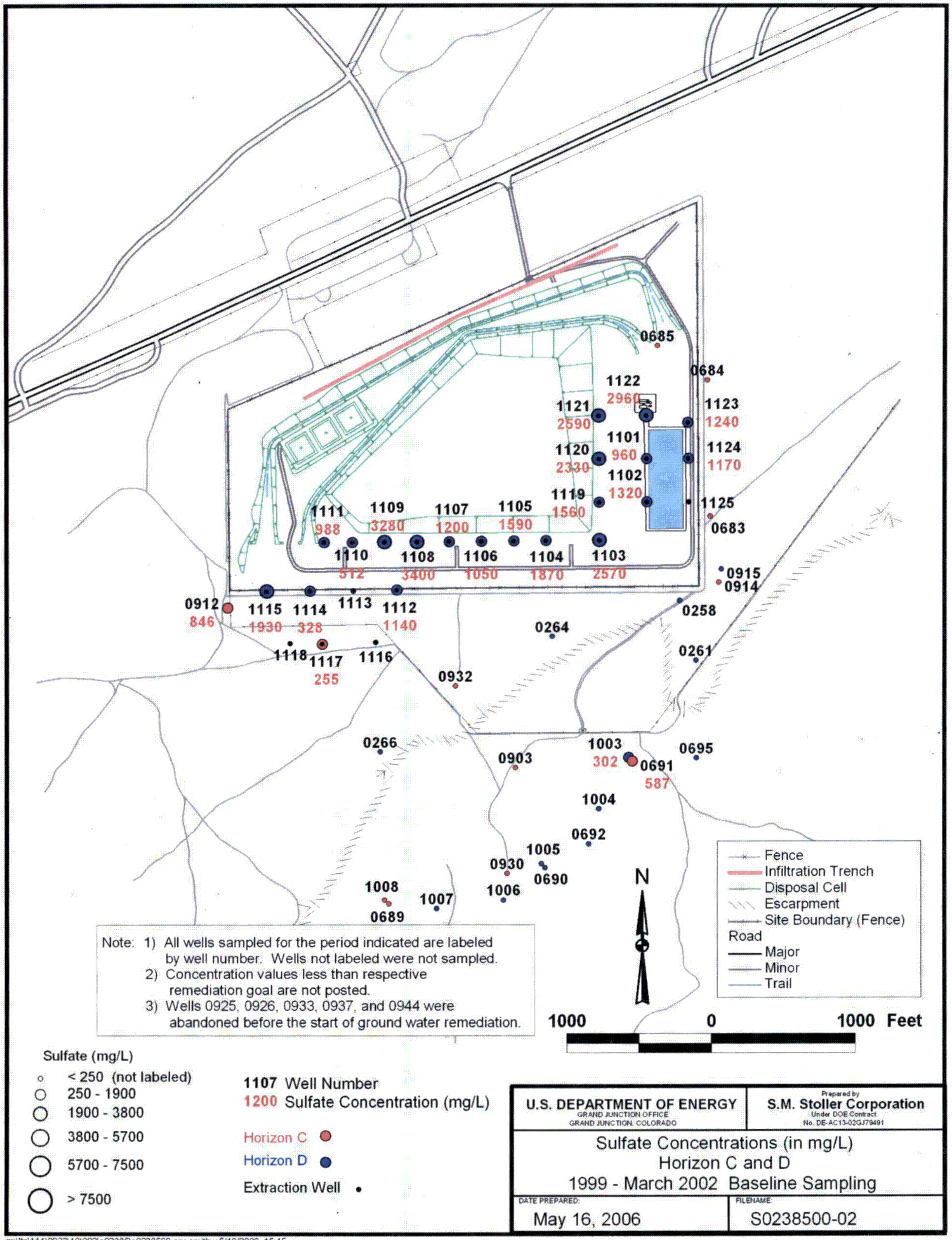

Figure 10a. Sulfate Concentrations in Ground Water, Horizons C and D, Baseline Period

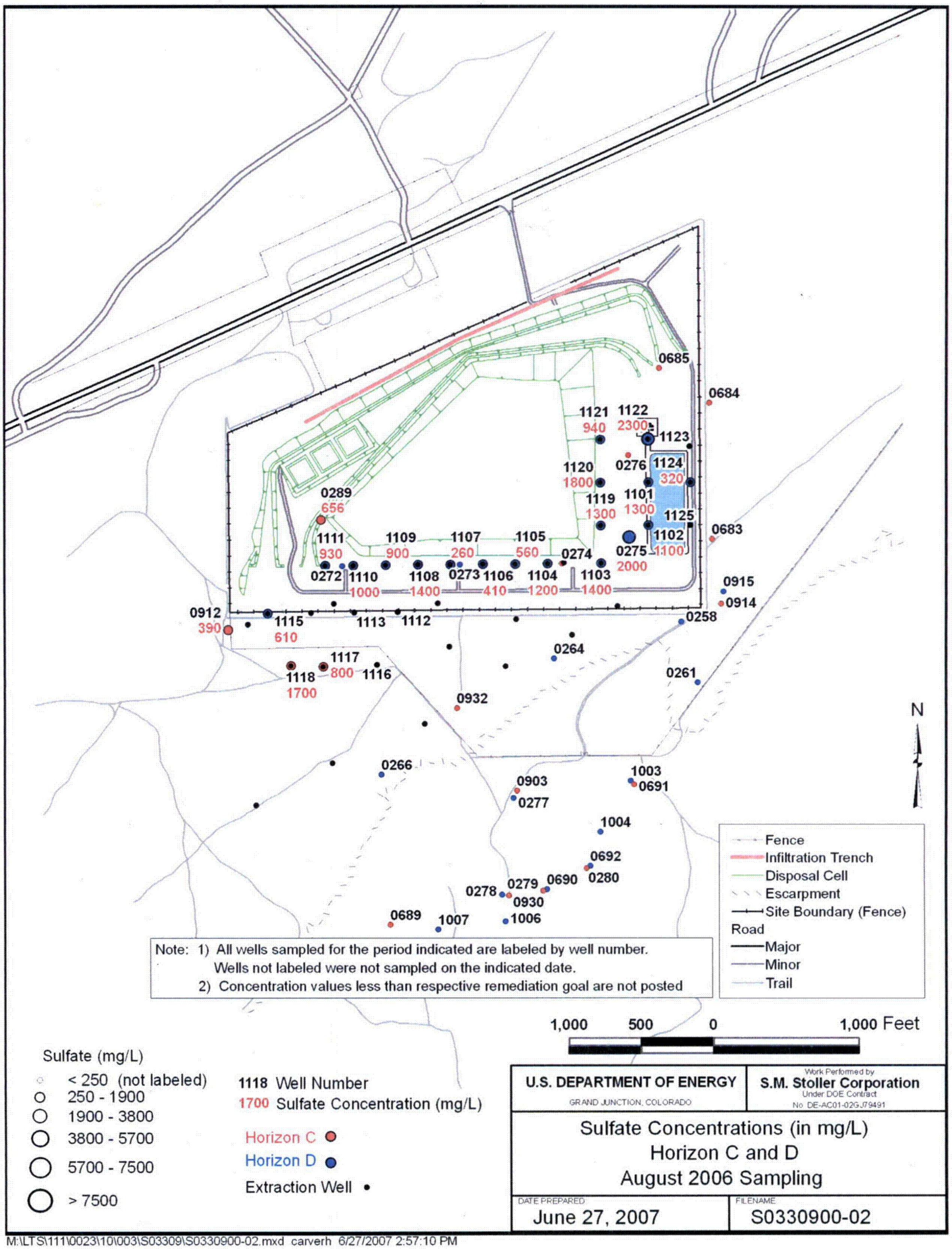

Figure 10b. Sulfate Concentrations in Ground Water, Horizons C and D, August 2006

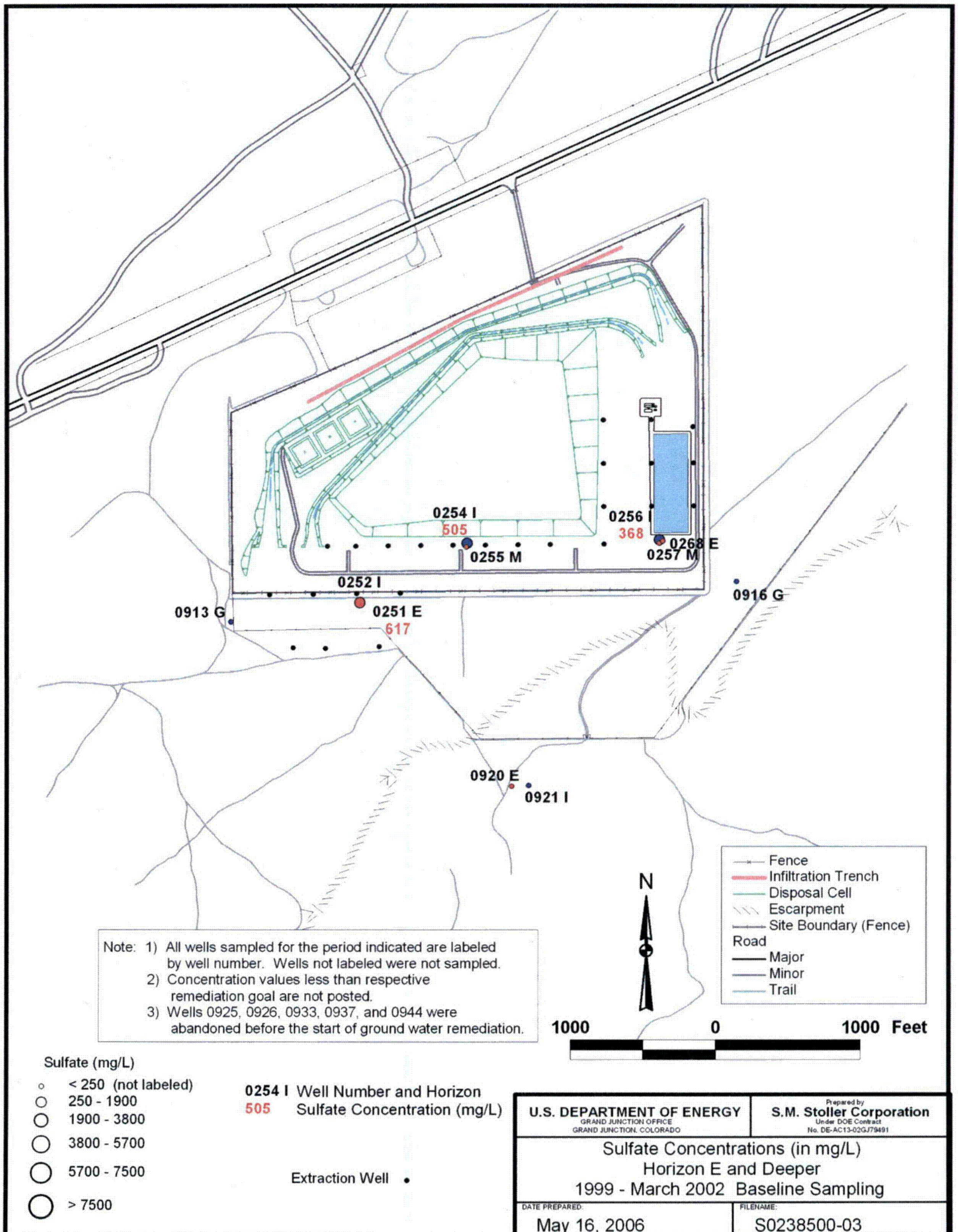

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Figure 11a. Sulfate Concentrations in Ground Water, Horizons E and Deeper, Baseline Period

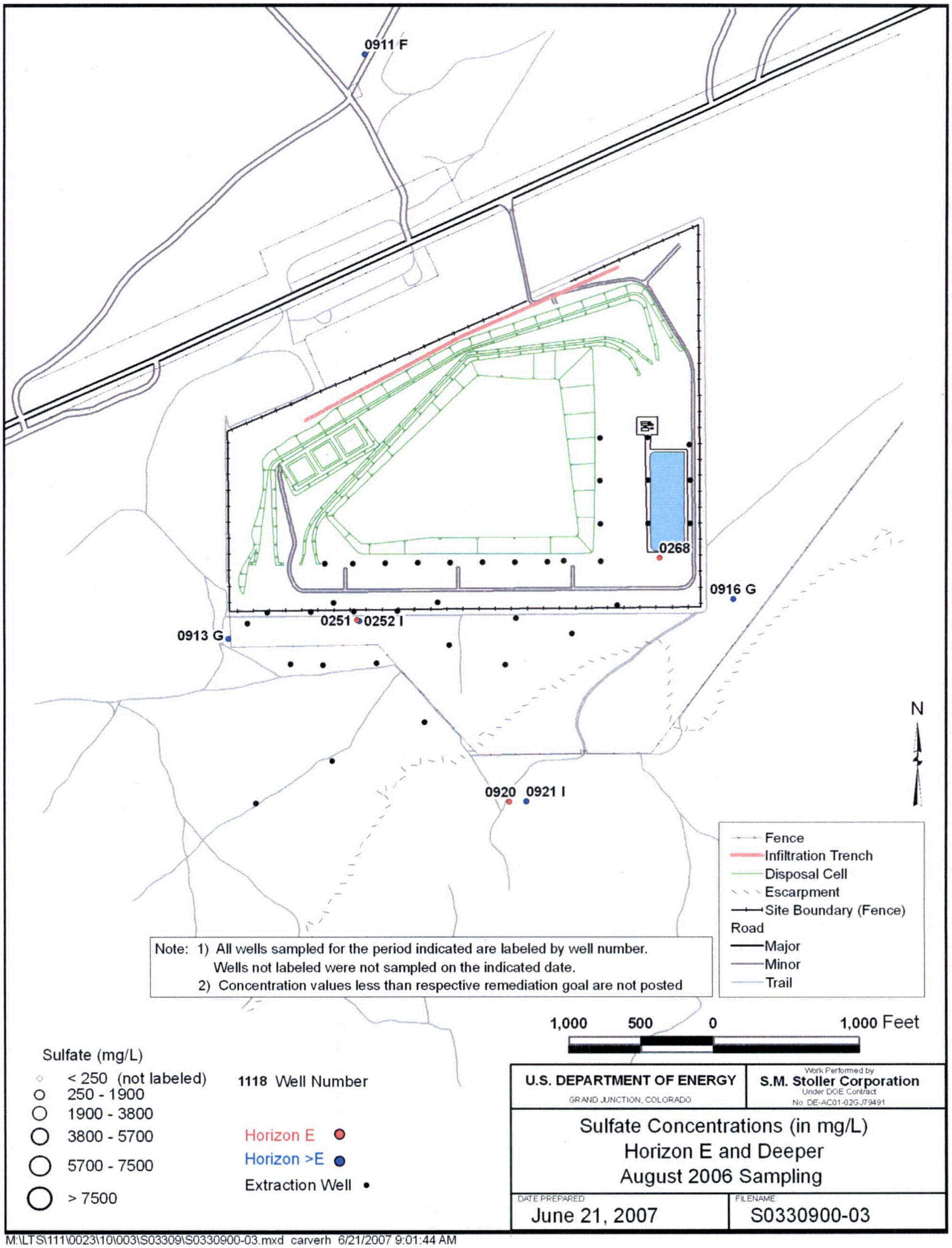

Figure 11b. Sulfate Concentrations in Ground Water, Horizons E and Deeper, August 2006

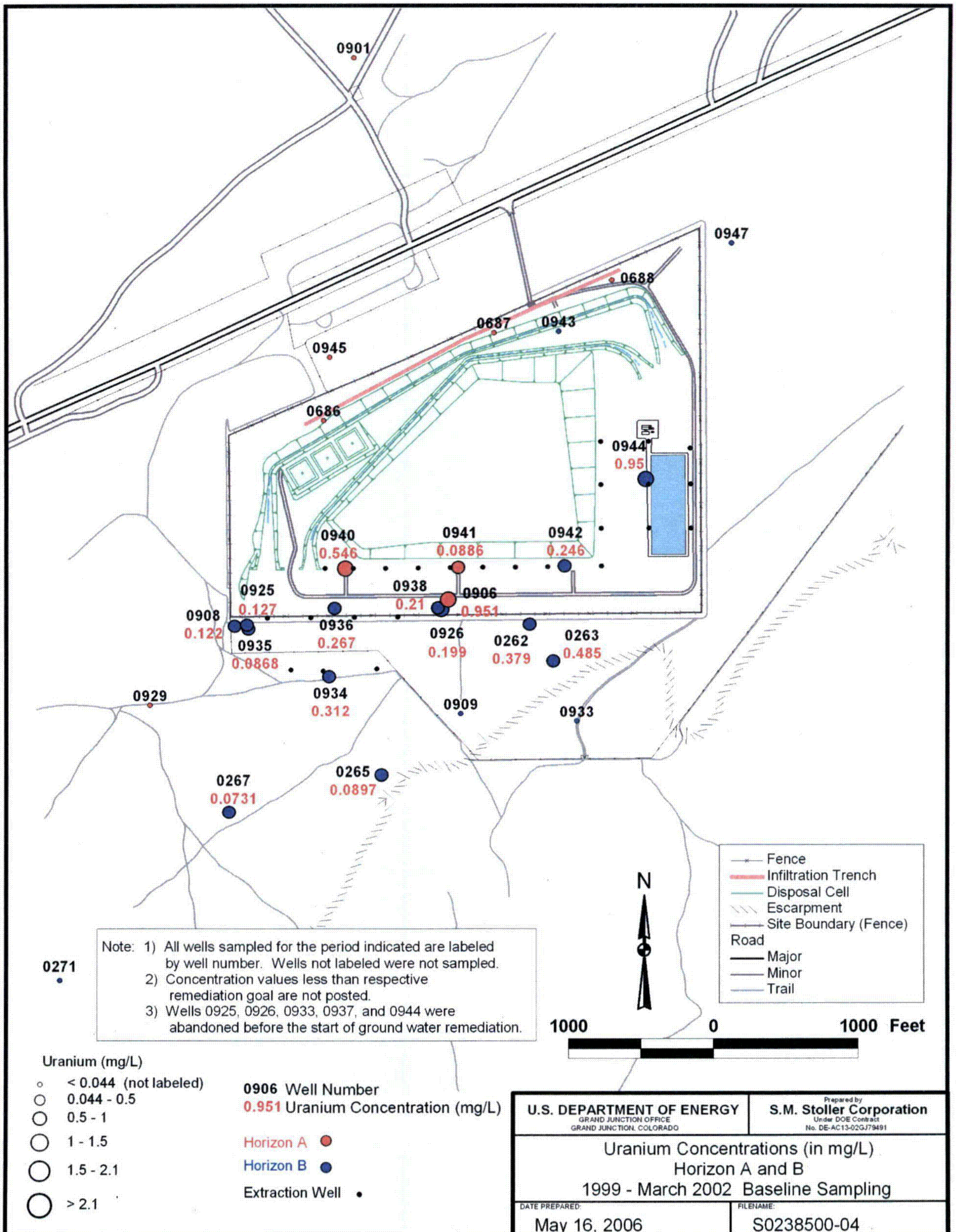

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Figure 12a. Uranium Concentrations in Ground Water, Horizons A and B, Baseline Period

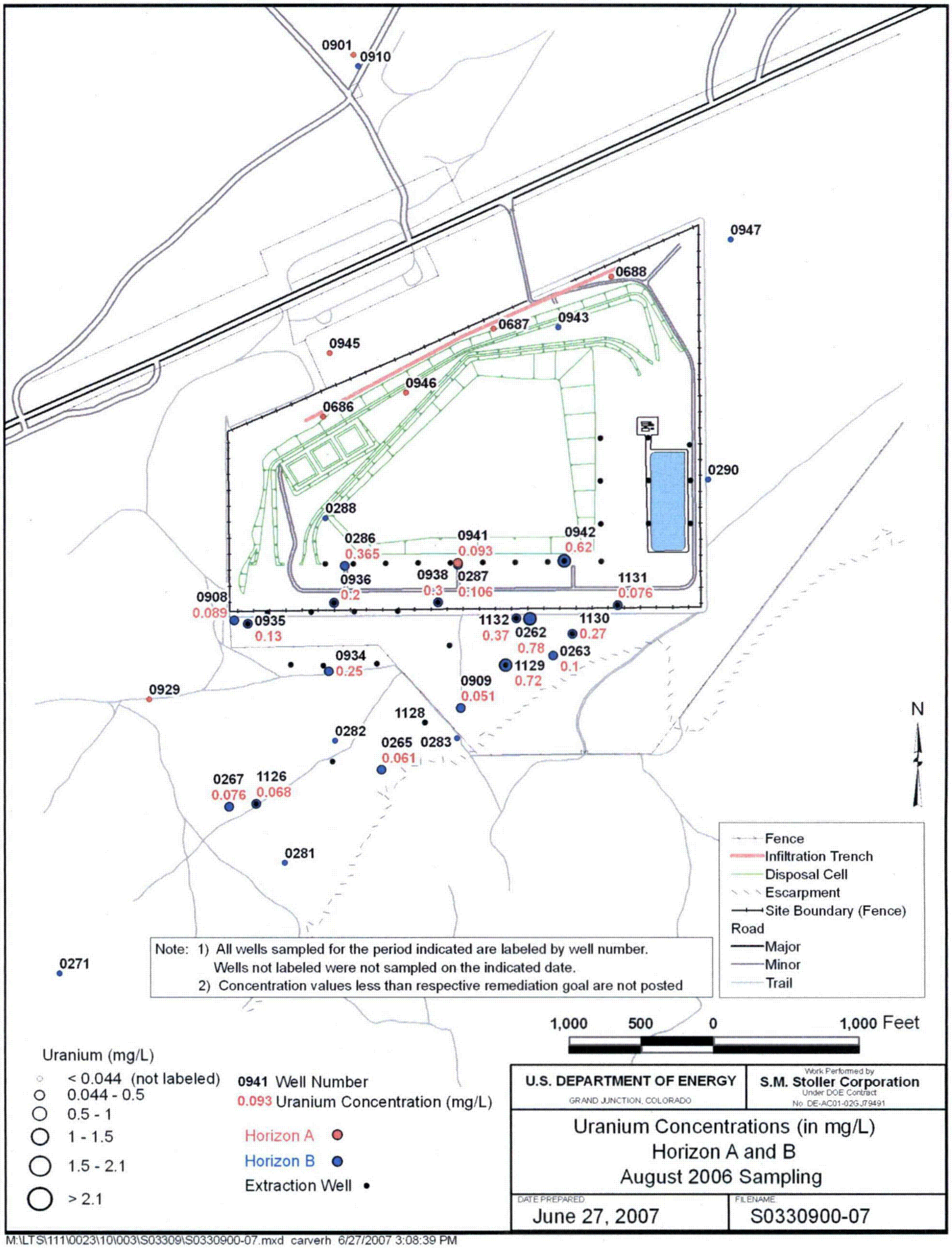

Figure 12b. Uranium Concentrations in Ground Water, Horizons A and B, August 2006

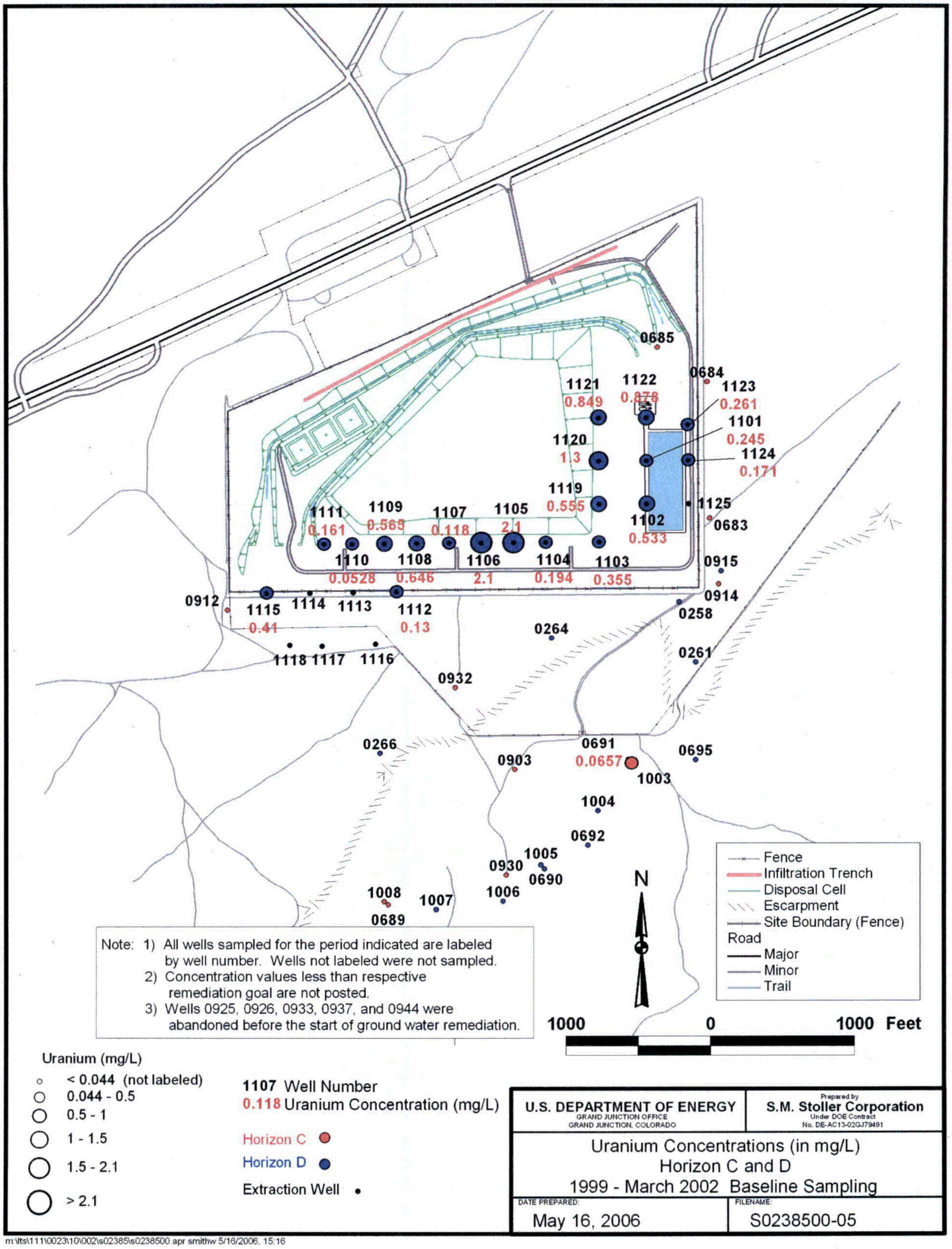

Figure 13a. Uranium Concentrations in Ground Water, Horizons C and D, Baseline

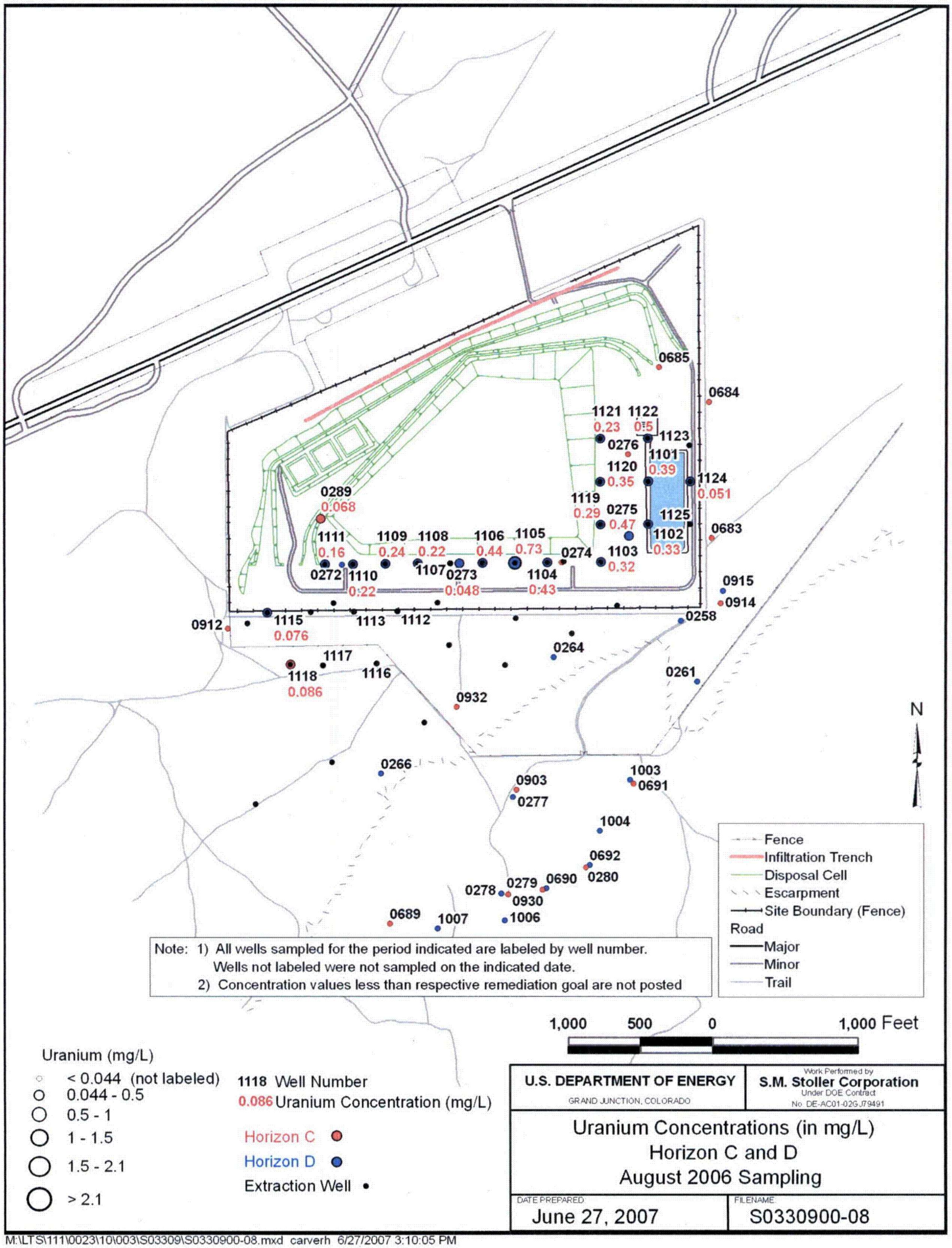

Figure 13b. Uranium Concentrations in Ground Water, Horizons C and D, August 2006

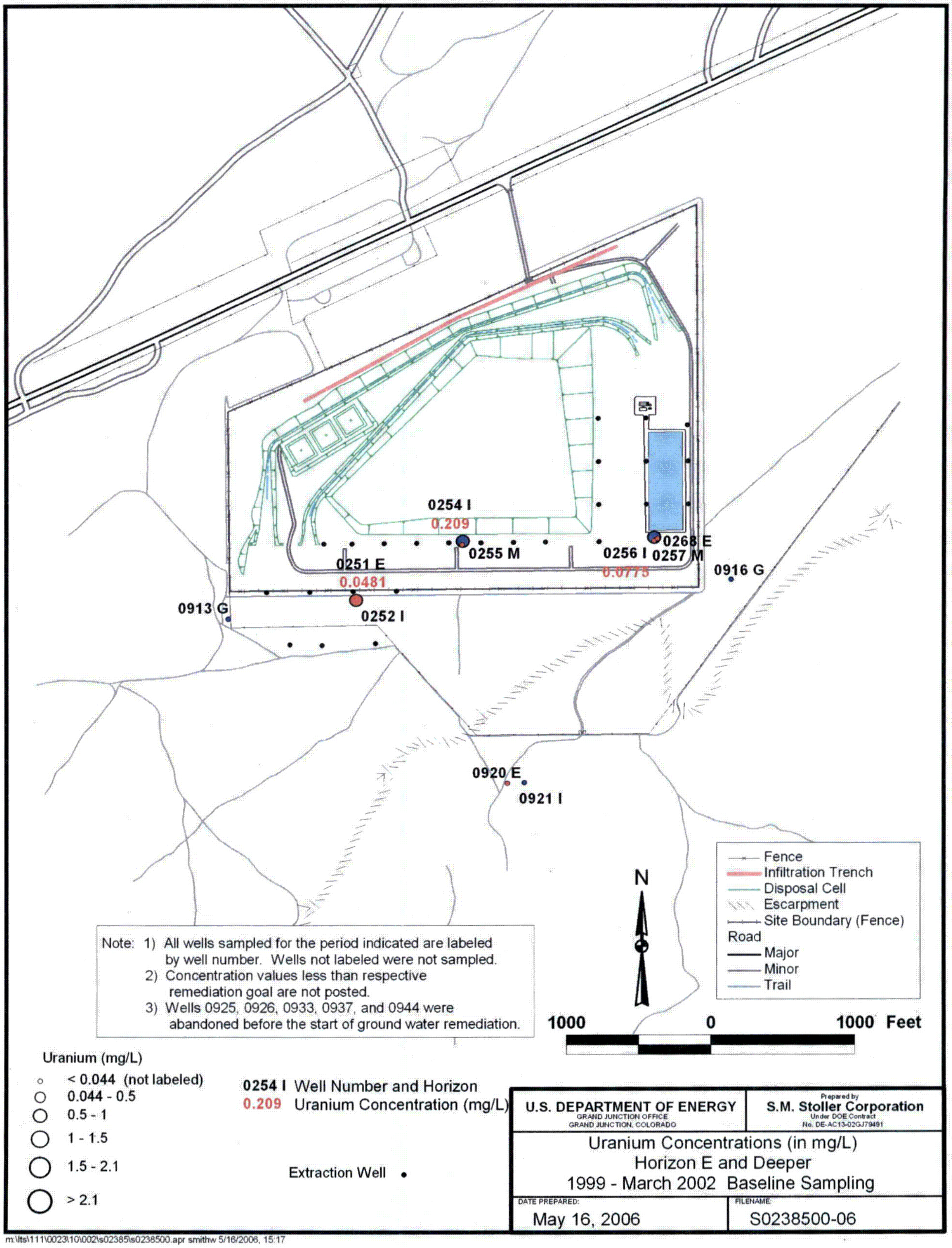

Figure 14a. Uranium Concentrations in Ground Water, Horizons E and Deeper, Baseline Period

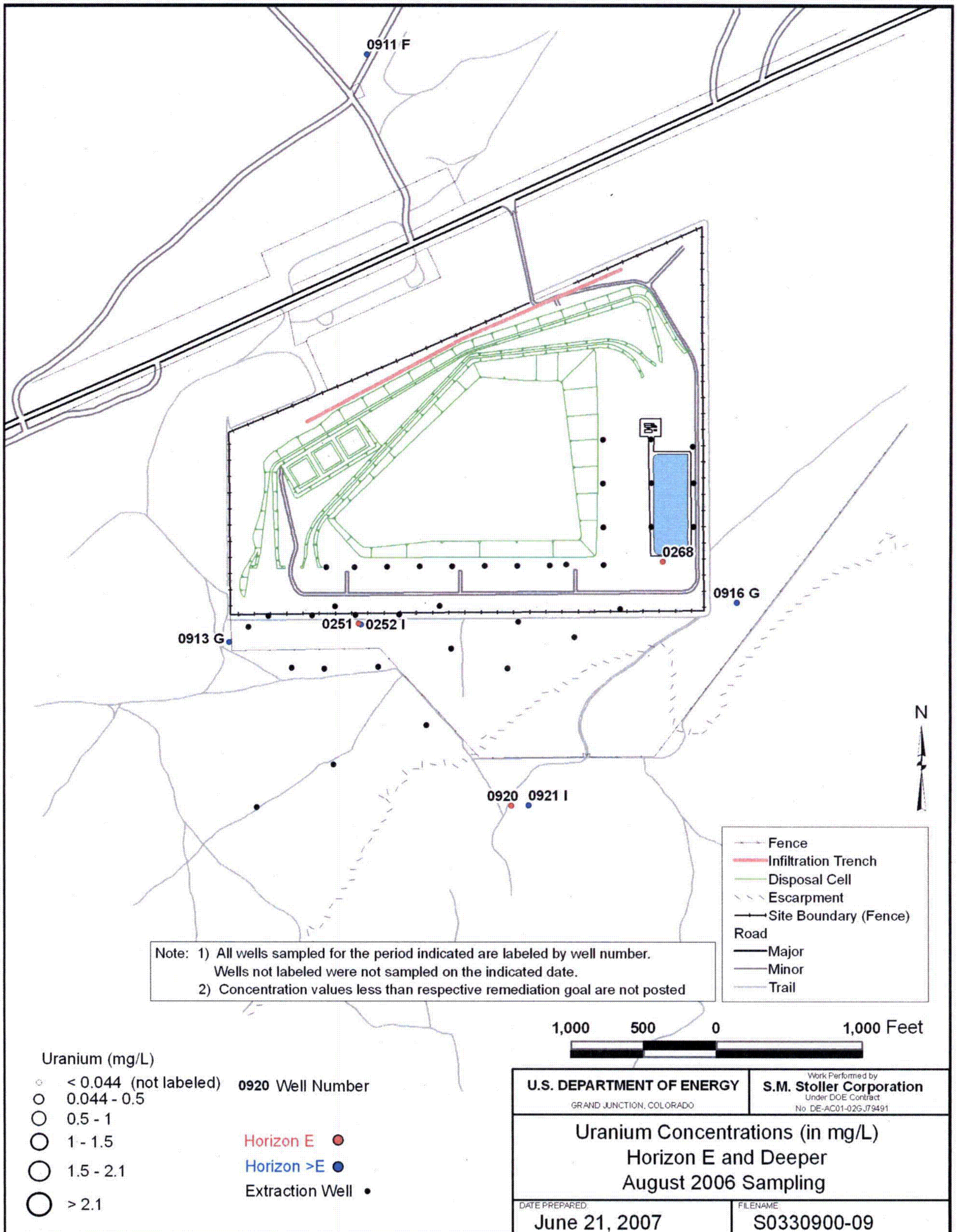

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Figure 14b. Uranium Concentrations in Ground Water, Horizons E and Deeper, August 2006

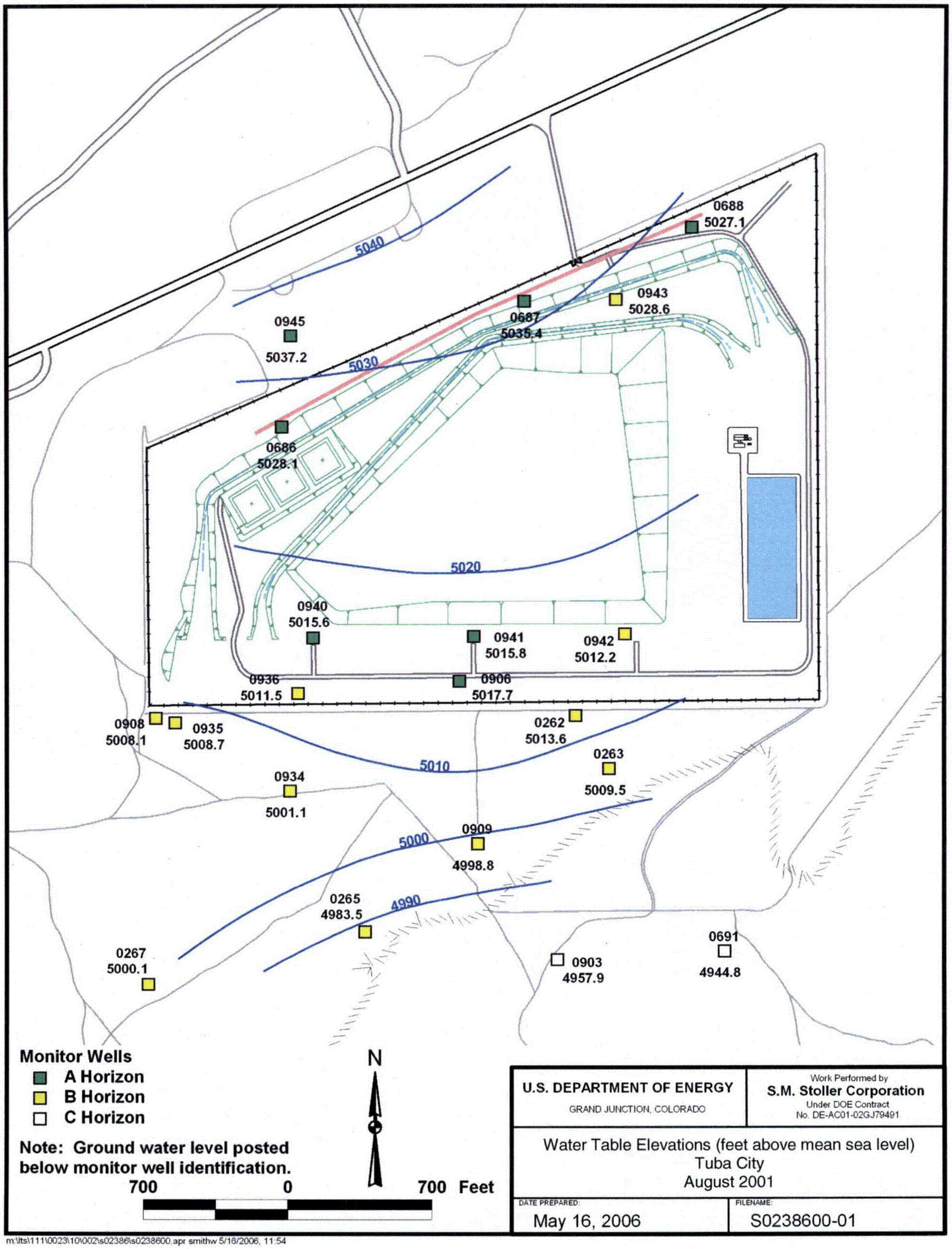

Figure 15. Water Table Elevations (feet above mean sea level), Tuba City Site, August 2001

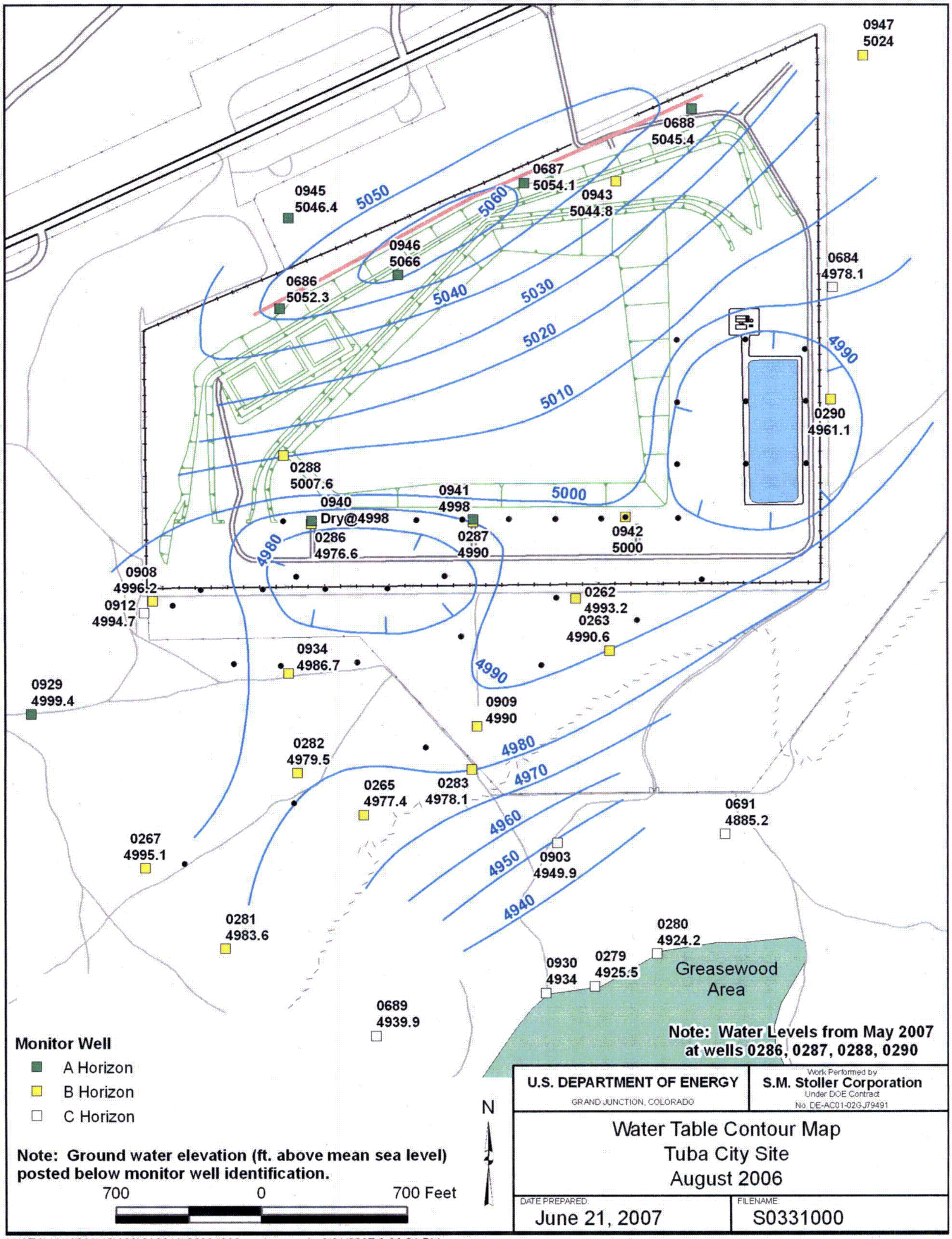

Figure 16. Water Table Contour Map, Tuba City Site, August 2006

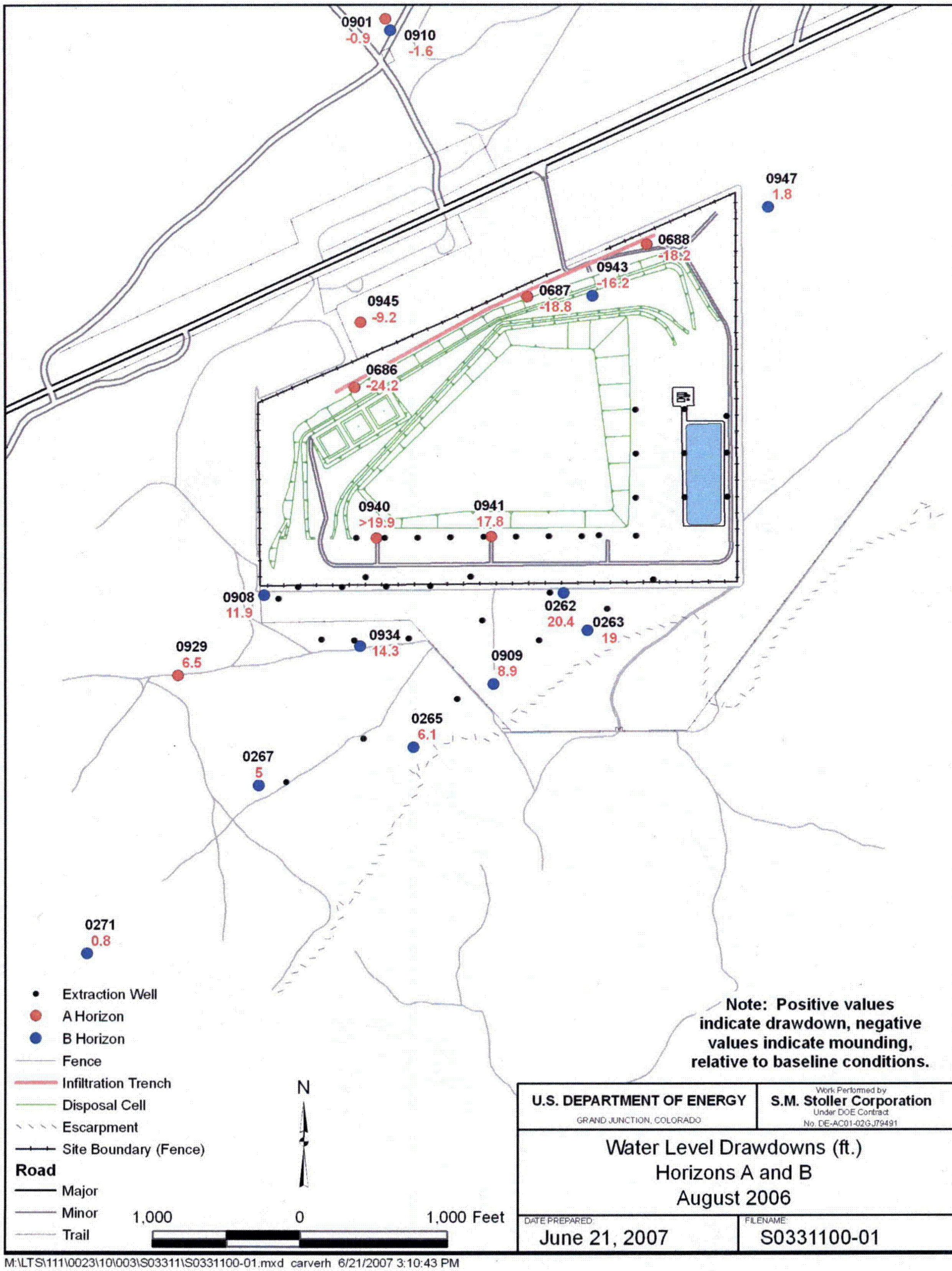

Figure 17. Water Level Drawdowns (feet), Horizons A and B, August 2005

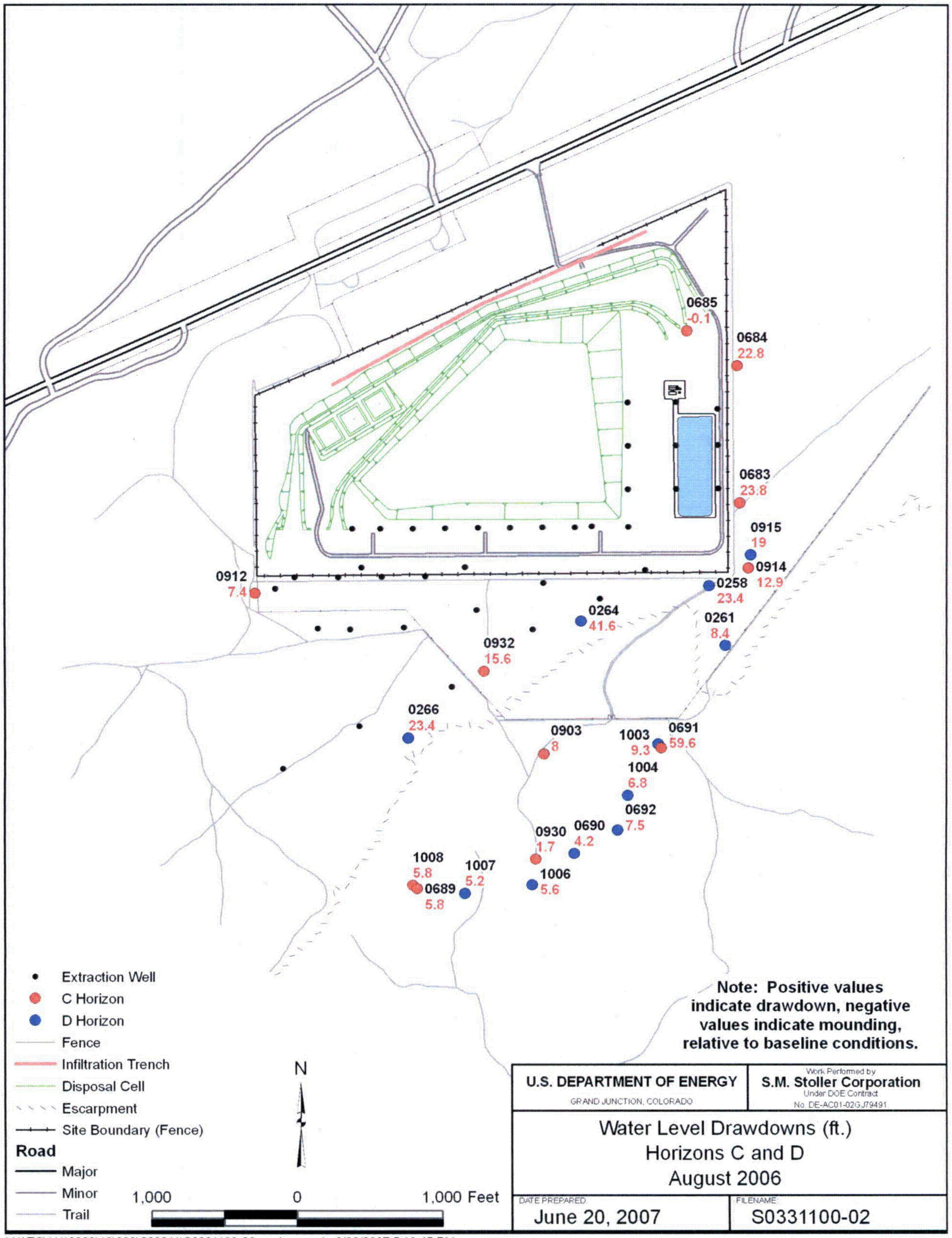

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Figure 18. Water Level Drawdowns (feet), Horizons C and D, August 2006

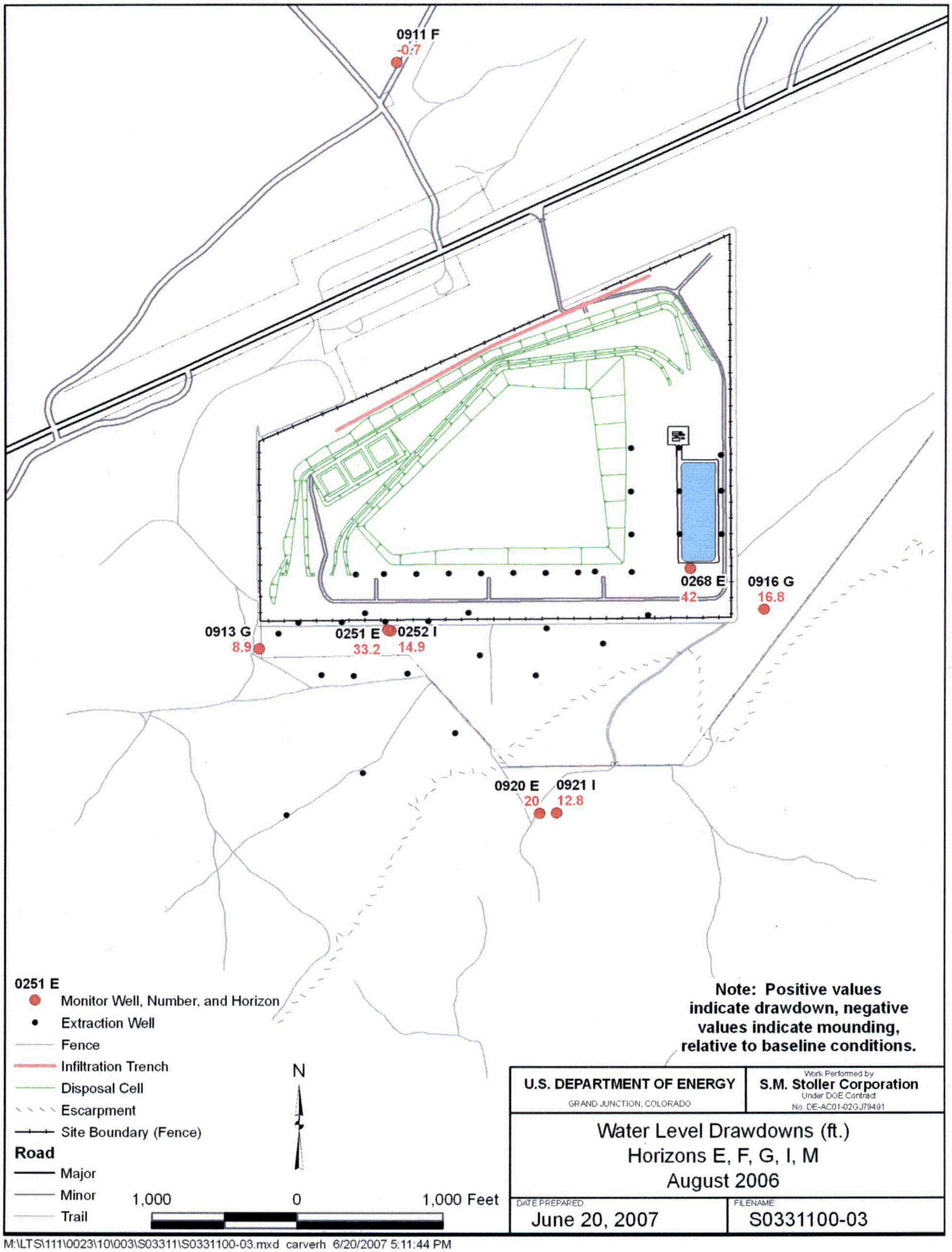

Figure 19. Water Level Drawdowns (feet), Horizons E, F, G, I, and M, August 2006

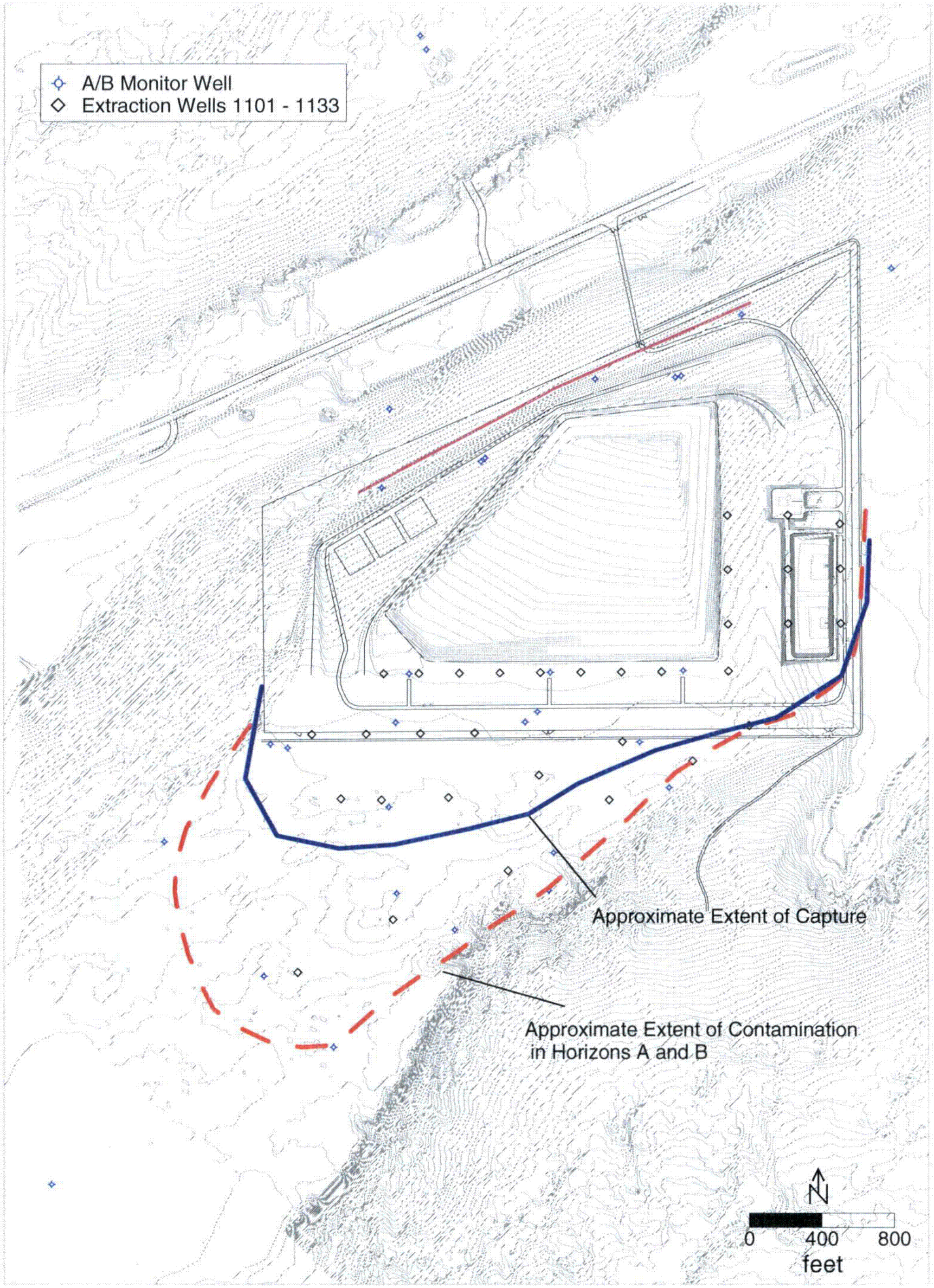

Figure 20. Extent of Ground Water Contamination and Extraction System Capture Zone: Horizons A and B

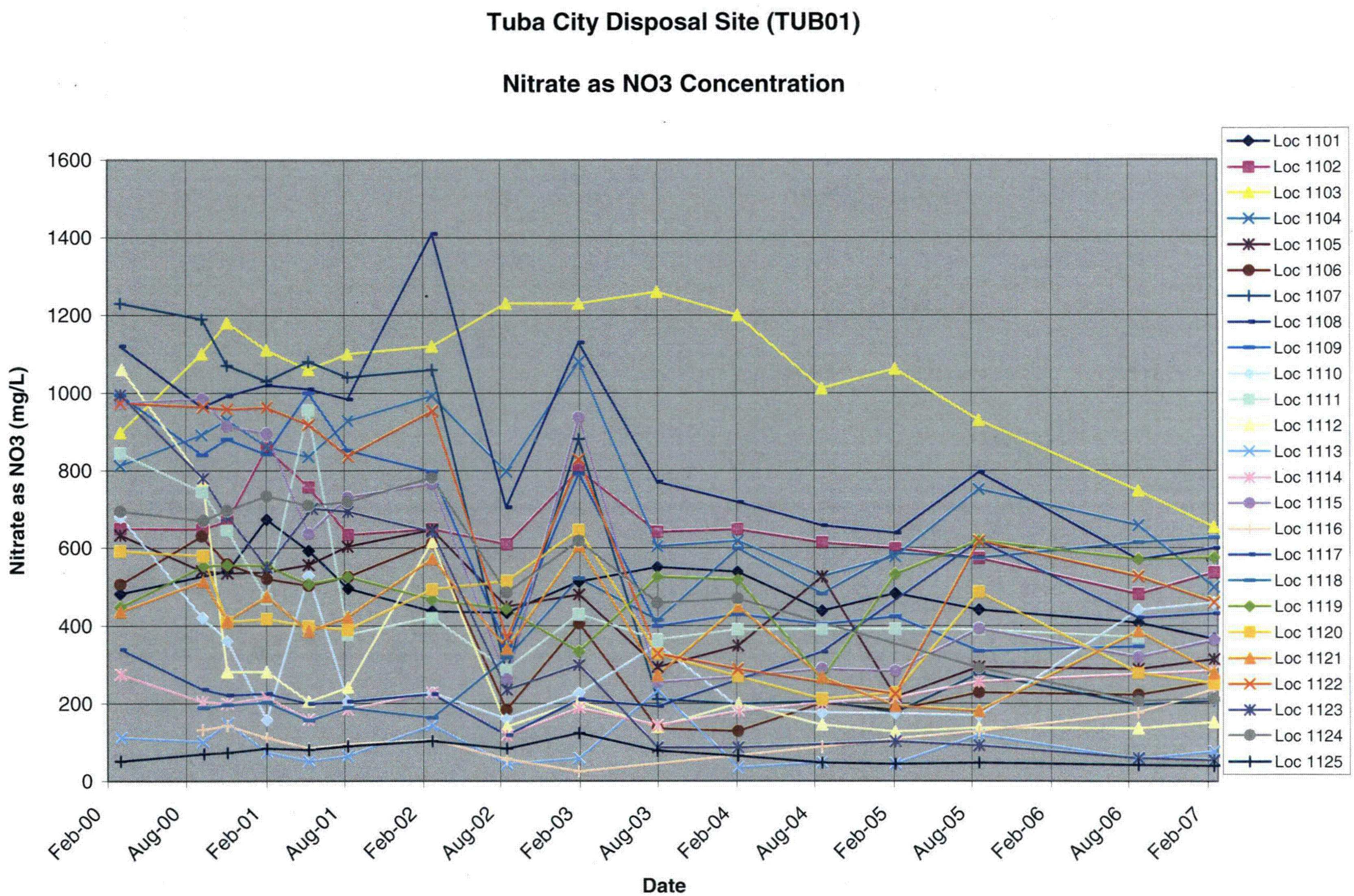

Figure 21. Nitrate Concentration Trends at Extraction Wells

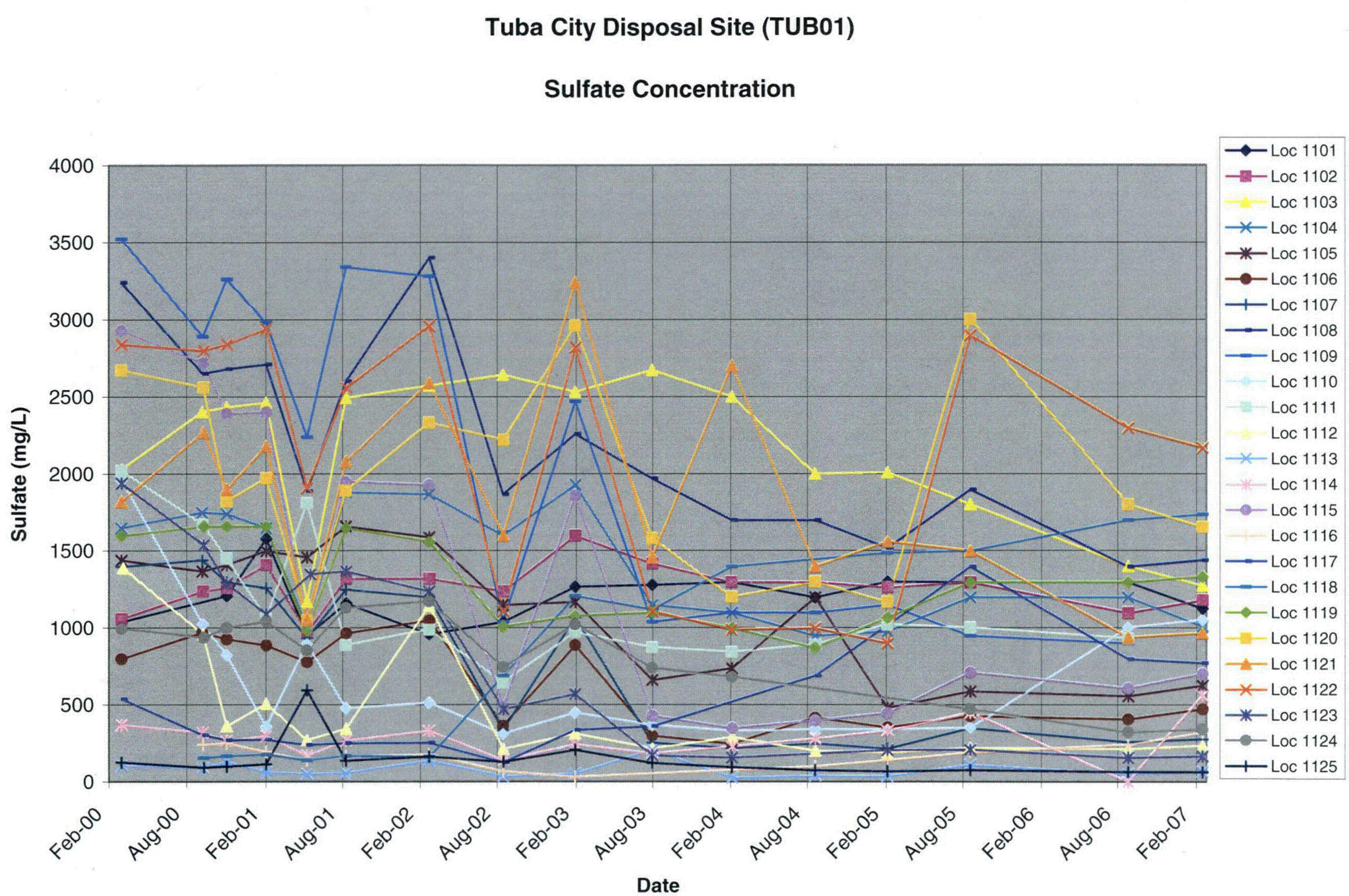

Figure 22. Sulfate Concentration Trends at Extraction Wells

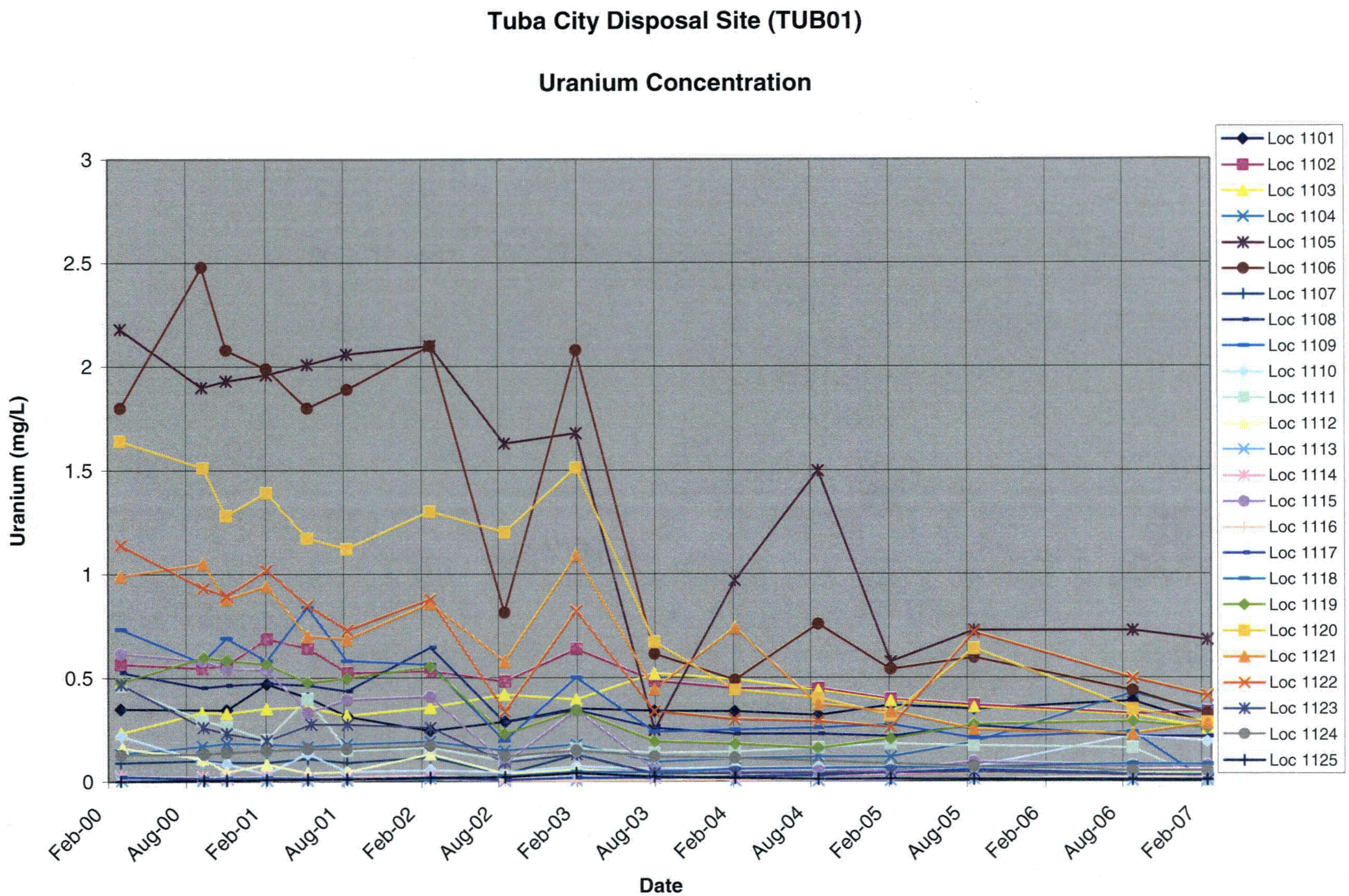

Figure 23. Uranium Concentration Trends at Extraction Wells

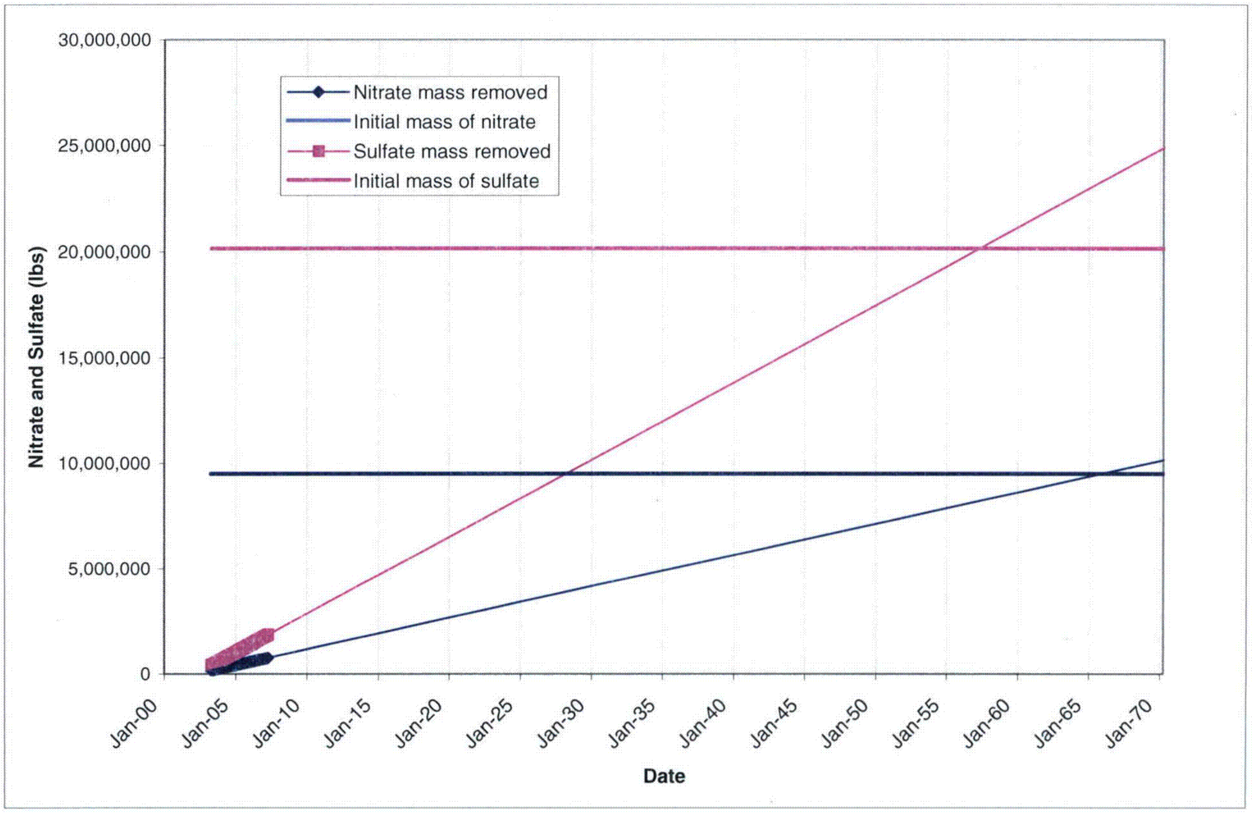

Figure 24. Nitrate and Sulfate Mass Removal Rate Projections

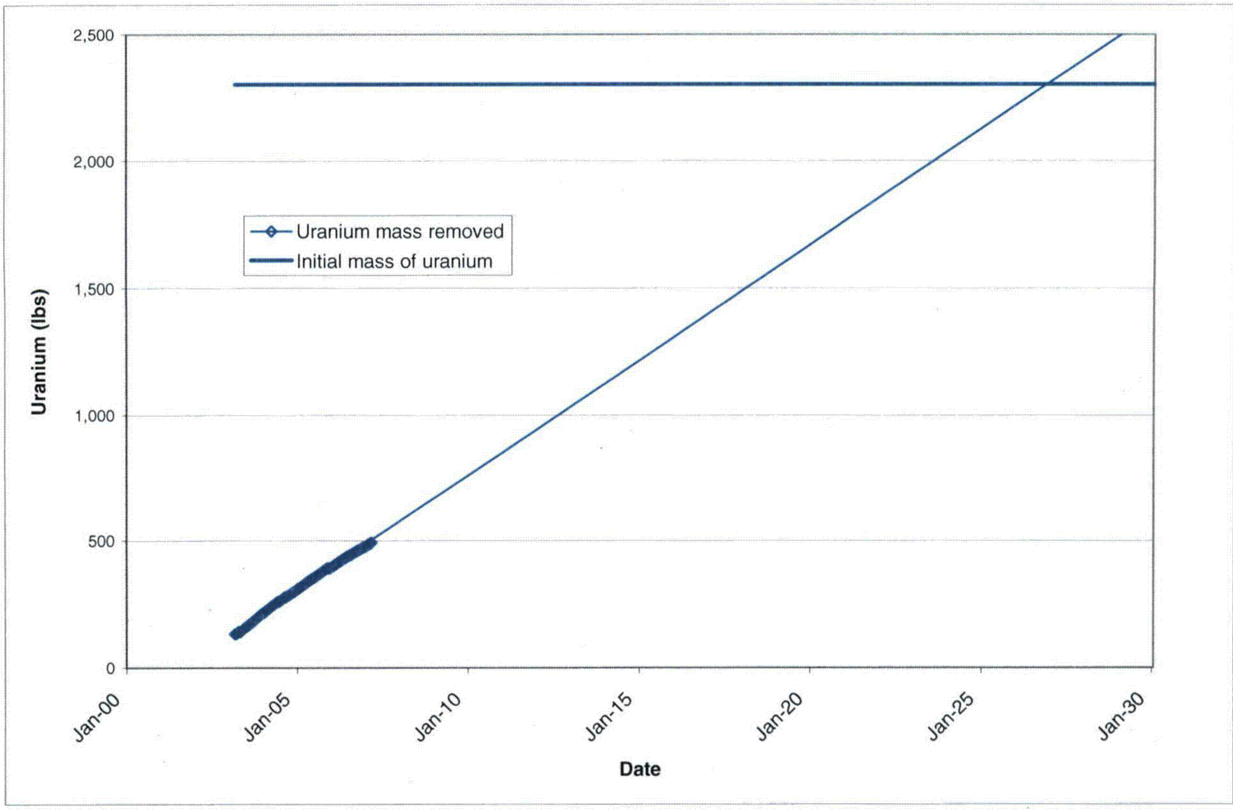

Figure 25. Uranium Mass Removal Rate Projection

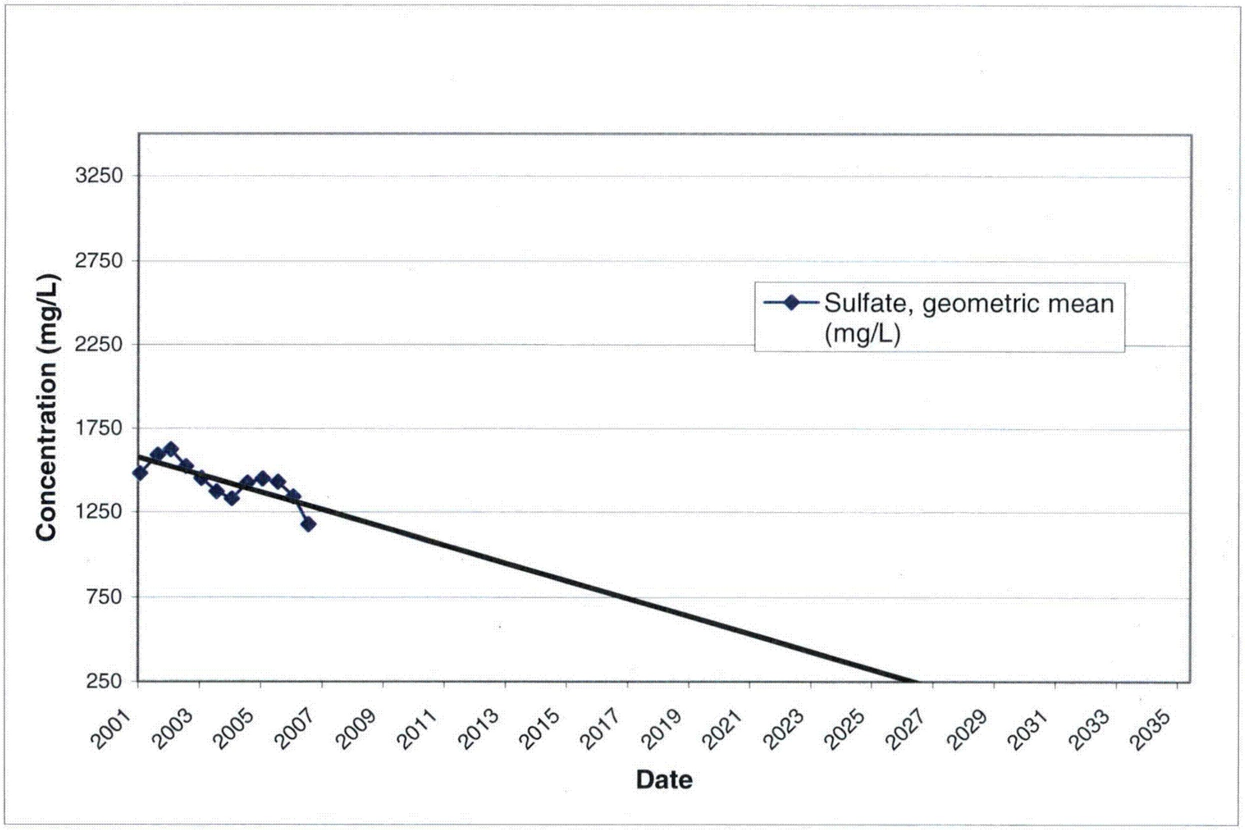

Figure 26. Bulk Restoration Trend for Sulfate

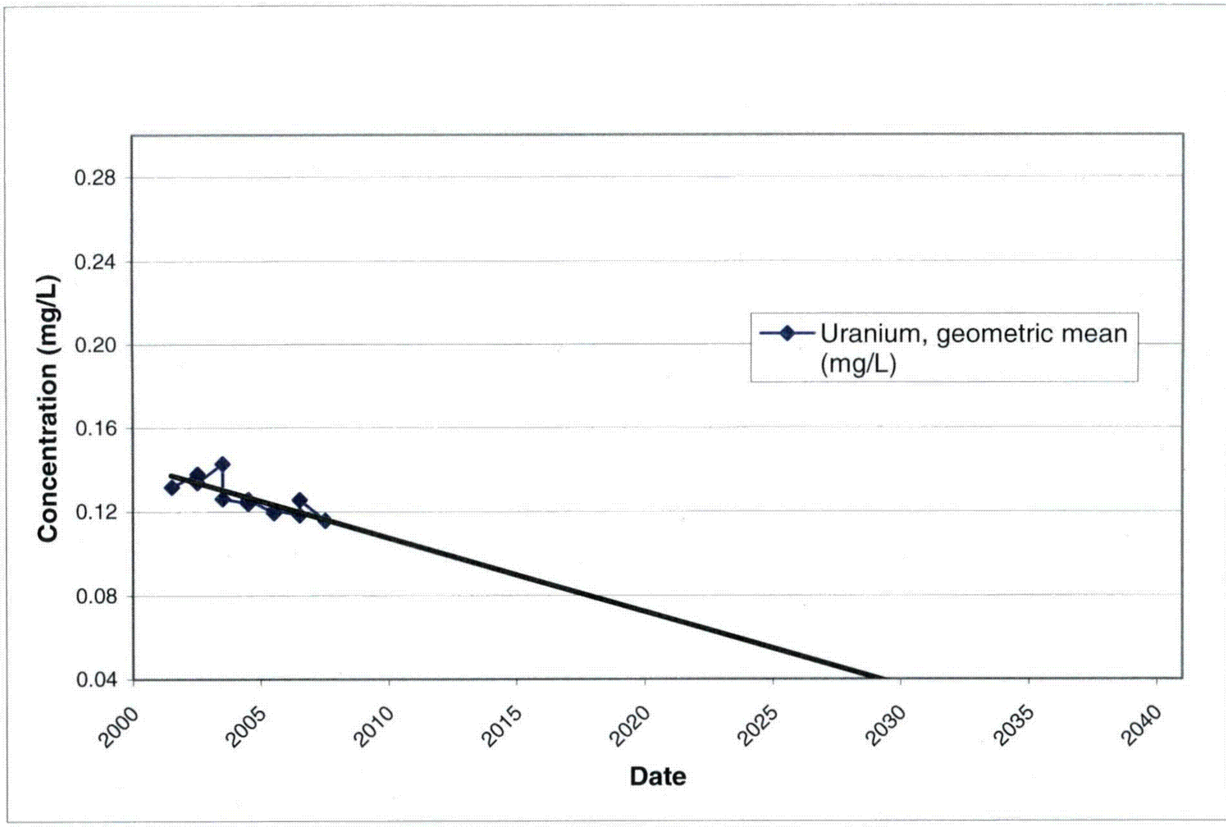

Figure 27. Bulk Restoration Trend for Uranium

Appendix A

Well Completion Information, Conceptual Site Model, and Extraction Well Operation Summary

Table A–1. Well Completion Information

WELL	TYPE	Horizon	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
0284	MW	A	5079.8	5074.8	5069.8	16.5	21.5	26.5	10.0	1.5	28.0
0285	MW	A	5090.8	5088.3	5085.8	3.0	5.5	8.0	5.0	0.1	8.1
0686	MW	A	5045.5	5025.5	5005.5	60.0	80.0	100.0	40.0	0.3	100.3
0687	MW	A	5047.6	5027.6	5007.6	60.0	80.0	100.0	40.0	0.3	100.3
0688	MW	A	5044.1	5024.1	5004.1	60.0	80.0	100.0	40.0	0.3	100.3
0901	MW	A	5045.8	5035.8	5025.8	58.0	68.0	78.0	20.0	2.0	80.0
0906	MW	A	5016.9	5006.9	4996.9	44.0	54.0	64.0	20.0	2.0	66.0
0907	MW	A	5010.7	5000.7	4990.7	66.5	76.5	86.5	20.0		
0928	MW	A	5022.1	5009.6	4997.1	30.0	42.5	55.0	25.0	3.0	58.0
0929	MW	A	5010.4	4990.4	4970.4	48.2	68.2	88.2	40.0		
0940	MW	A	5017.9	5010.4	5002.9	45.0	52.5	60.0	15.0	3.0	68.0
0941	MW	A	5018.0	5008.0	4998.0	45.0	55.0	65.0	20.0	3.0	68.0
0945	MW	A	5028.1	5018.1	5008.1	110.0	120.0	130.0	20.0	3.0	133.0
0946	MW	A	5057.6	5047.6	5037.6	40.0	50.0	60.0	20.0	3.3	63.3
0262	MW	B	4999.2	4979.2	4959.2	60.0	80.0	100.0	40.0	0.3	100.3
0263	MW	B	5000.2	4980.2	4960.2	60.0	80.0	100.0	40.0	0.3	100.3
0265	MW	B	4991.1	4971.1	4951.1	60.0	80.0	100.0	40.0	0.3	100.3
0267	MW	B	4990.8	4970.8	4950.8	60.0	80.0	100.0	40.0	0.3	100.3
0271	MW	B	4984.0	4964.0	4944.0	60.0	80.0	100.0	40.0	0.3	100.3
0281	MW	B	4977.8	4972.8	4967.8	70.5	75.5	80.5	10.0	1.5	82.0
0282	MW	B	4983.3	4978.3	4973.3	74.1	79.1	84.1	10.0	1.5	85.6
0283	MW	B	4984.8	4979.8	4974.8	70.5	75.5	80.5	10.0	1.5	82.0
0286	MW	B	4968.84	4963.8	4958.84	93.2	98.2	103.2	10.0	0.4	103.6
0287	MW	B	4962.29	4957.3	4952.29	100.7	105.7	110.7	10.0	0.4	111.1
0288	MW	B	4965.86	4960.9	4955.86	104.0	109.0	114.0	10.0	0.5	114.5
0290	MW	B	4964.33	4959.3	4954.33	102.7	107.7	112.7	10.0	0.4	113.1
0905	MW	B	5006.0	4998.5	4991.0	63.0	70.5	78.0	15.0	2.0	80.0
0908	MW	B	5005.3	4997.8	4990.3	52.0	59.5	67.0	15.0	2.0	69.0
0909	MW	B	4990.8	4983.3	4975.8	65.0	72.5	80.0	15.0	2.0	82.0
0910	MW	B	5007.6	4957.6	4907.6	97.0	147.0	197.0	100.0	1.0	198.0
0918	MW	B	4986.2	4983.7	4981.2	61.0	63.5	66.0	5.0	2.0	68.0
0925	EXT	B	5005.8	4985.8	4965.8	53.0	73.0	93.0	40.0	0.5	93.5
0926	EXT	B	5018.3	4993.3	4968.3	42.2	67.2	92.2	50.0	3.0	95.2
0933	MW	B	4993.3	4992.3	4991.3	23.0	24.0	25.0	2.0		
0934	MW	B	5013.0	4990.5	4968.0	45.0	67.5	90.0	45.0	3.0	93.0
0935	MW	B	5008.8	4988.8	4968.8	50.0	70.0	90.0	40.0	3.0	93.0
0936	MW	B	5017.9	4997.9	4977.9	42.0	62.0	82.0	40.0	3.0	85.0
0937	MW	B	5020.2	4992.7	4965.2	40.0	67.5	95.0	55.0	3.0	98.0
0938	MW	B	5020.4	4992.9	4965.4	40.0	67.5	95.0	55.0	3.0	98.0
0939	EXT	B	5021.1	4993.6	4966.1	40.0	67.5	95.0	55.0	3.0	98.0
0942	MW	B	5009.5	4999.5	4989.5	54.0	64.0	74.0	20.0	3.0	77.0
0943	MW	B	4994.1	4984.1	4974.1	101.0	111.0	121.0	20.0	3.0	124.0
0944	MW	B	4979.9	4969.9	4959.9	85.0	95.0	105.0	20.0	2.0	107.0
0947	MW	B	4990.0	4980.0	4970.0	105.0	115.0	125.0	20.0	3.3	128.3
1126	EXT	B	4991.9	4971.9	4951.9	60.0	80.0	100.0	40.0	3.3	103.3
1127	EXT	B	4984.2	4964.2	4944.2	72.7	92.7	112.7	40.0	3.3	116.0
1128	EXT	B	4982.3	4962.3	4942.3	72.7	92.7	112.7	40.0	3.3	116.0
1129	EXT	B	4990.9	4975.9	4960.9	68.2	83.2	98.2	30.0	3.3	101.5
1130	EXT	B	4987.3	4962.3	4937.3	71.7	96.7	121.7	50.0	3.3	125.0
1131	EXT	B	4998.1	4978.1	4958.1	59.7	79.7	99.7	40.0	3.3	103.0
1132	EXT	B	5009.1	4984.1	4959.1	49.7	74.7	99.7	50.0	3.3	103.0
1133	EXT	B	4999.4	4979.4	4959.4	59.7	79.7	99.7	40.0	3.3	103.0
0274	MW	C	4913.6	4903.6	4893.6	149.0	159.0	169.0	20.0	1.5	170.5
0276	MW	C	4910.0	4900.0	4890.0	154.5	164.5	174.5	20.0	1.5	176.0
0279	MW	C	4922.1	4917.1	4912.1	26.5	31.5	36.5	10.0	1.5	38.0
0280	MW	C	4922.6	4917.6	4912.6	26.5	31.5	36.5	10.0	1.5	38.0
0683	MW	C	4973.2	4948.2	4923.2	95.0	120.0	145.0	50.0	3.0	148.0
0684	MW	C	4943.1	4917.4	4891.8	124.2	149.9	175.5	51.3	2.5	178.0
0685	MW	C	4975.6	4949.7	4923.8	93.7	119.6	145.5	51.8	2.5	148.0
0689	MW	C	4923.9	4903.9	4883.9	55.0	75.0	95.0	40.0	0.3	95.3
0691	MW	C	4921.9	4901.9	4881.9	55.0	75.0	95.0	40.0	0.3	95.3
0903	MW	C	4953.5	4943.5	4933.5	28.0	38.0	48.0	20.0	2.0	50.0
0912	MW	C	4934.7	4914.7	4894.7	123.0	143.0	163.0	40.0	2.0	165.0
0914	MW	C	4930.3	4921.8	4913.3	137.2	145.7	154.2	17.0	2.0	156.2
0917	MW	C	4917.8	4907.8	4897.8	128.0	138.0	148.0	20.0	2.0	150.0
0930	MW	C	4933.0	4918.0	4903.0	20.0	35.0	50.0	30.0	3.0	53.0
0932	MW	C	4942.3	4932.3	4922.3	112.5	122.5	132.5	20.0	2.7	135.2
1008	INJ	C	4926.8	4901.6	4876.4	55.6	80.8	106.0	50.4	2.5	108.5
1116	EXT	C	4964.1	4912.5	4861.0	92.4	143.9	195.5	103.1	2.5	198.0
1117	EXT	C	4965.3	4913.7	4862.1	92.3	143.9	195.5	103.2	2.5	198.0

Table A-1 (continued). Well Completion Information

WELL	TYPE	Horizon	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
1118	EXT	C	4967.9	4915.1	4862.3	89.9	142.7	195.5	105.6	2.5	198.0
0258	MW	D	4894.0	4874.0	4854.0	159.0	179.0	199.0	40.0	0.3	199.3
0261	MW	D	4907.0	4887.0	4867.0	160.0	180.0	200.0	40.0	0.3	200.3
0264	MW	D	4899.6	4879.6	4859.6	160.0	180.0	200.0	40.0	0.3	200.3
0266	MW	D	4890.6	4870.6	4850.6	160.0	180.0	200.0	40.0	0.3	200.3
0272	MW	D	4902.8	4892.8	4882.8	159.1	169.1	179.1	20.0	1.5	180.6
0273	MW	D	4909.4	4899.4	4889.4	153.0	163.0	173.0	20.0	1.5	174.5
0275	MW	D	4903.0	4893.0	4883.0	158.2	168.2	178.2	20.0	1.5	179.7
0277	MW	D	4884.0	4879.0	4874.0	95.7	100.7	105.7	10.0	1.5	107.2
0278	MW	D	4862.9	4857.9	4852.9	90.5	95.5	100.5	10.0	1.5	102.0
0690	MW	D	4893.3	4873.3	4853.3	55.0	75.0	95.0	40.0	0.3	95.3
0692	MW	D	4895.6	4875.6	4855.6	55.0	75.0	95.0	40.0	0.3	95.3
0695	MW	D	4919.3	4899.3	4879.3	55.0	75.0	95.0	40.0	0.3	95.3
0904	MW	D	4873.8	4868.8	4863.8	28.0	33.0	38.0	10.0	2.0	40.0
0915	MW	D	4897.8	4892.8	4887.8	170.0	175.0	180.0	10.0	2.0	182.0
1003	INJ	D	4923.4	4898.4	4873.4	55.5	80.5	105.5	50.0	2.5	108.0
1004	INJ	D	4918.1	4893.1	4868.1	45.5	70.5	95.5	50.0	2.5	98.0
1005	INJ	D	4904.7	4879.7	4854.7	45.5	70.5	95.5	50.0	2.5	98.0
1006	INJ	D	4903.7	4878.7	4853.7	45.7	70.7	95.7	50.0	2.5	98.2
1007	INJ	D	4915.6	4890.5	4865.4	45.8	70.9	96.0	50.2	2.5	98.5
1101	EXT	D	4974.2	4896.5	4818.9	96.1	173.8	251.5	155.4	2.5	254.0
1102	EXT	D	4968.8	4893.8	4818.8	101.5	176.5	251.5	150.0	2.5	254.0
1103	EXT	D	4962.3	4887.3	4812.3	100.0	175.0	250.0	150.0	2.5	252.5
1104	EXT	D	4972.3	4894.8	4817.3	90.0	167.5	245.0	155.0	3.0	248.0
1105	EXT	D	4972.1	4894.6	4817.1	90.0	167.5	245.0	155.0	3.0	248.0
1106	EXT	D	4966.0	4888.7	4811.4	96.5	173.8	251.1	154.6	2.9	254.0
1107	EXT	D	4971.2	4894.0	4816.8	91.1	168.3	245.5	154.4	2.5	248.0
1108	EXT	D	4966.1	4891.1	4816.1	96.3	171.3	246.3	150.0	2.5	248.8
1109	EXT	D	4972.1	4894.7	4817.3	90.3	167.7	245.1	154.8	2.9	248.0
1110	EXT	D	4966.8	4891.8	4816.8	95.5	170.5	245.5	150.0	2.5	248.0
1111	EXT	D	4971.9	4894.7	4817.5	90.7	167.9	245.1	154.4	2.5	247.6
1112	EXT	D	4969.1	4891.6	4814.1	90.5	168.0	245.5	155.0	2.5	248.0
1113	EXT	D	4968.7	4891.2	4813.7	90.5	168.0	245.5	155.0	2.5	248.0
1114	EXT	D	4968.5	4891.0	4813.6	90.6	168.0	245.5	154.9	2.5	248.0
1115	EXT	D	4968.6	4891.2	4813.7	90.5	168.0	245.5	155.0	2.5	248.0
1119	EXT	D	4968.7	4893.7	4818.7	95.3	170.3	245.3	150.0	2.5	247.8
1120	EXT	D	4971.0	4896.0	4821.0	95.5	170.5	245.5	150.0	2.5	248.0
1121	EXT	D	4972.0	4897.0	4822.0	97.5	172.5	247.5	150.0	2.5	250.0
1122	EXT	D	4973.4	4896.3	4819.2	96.9	174.0	251.1	154.2	2.9	254.0
1123	EXT	D	4976.2	4899.2	4822.2	91.0	168.0	245.0	154.0	3.0	248.0
1124	EXT	D	4978.7	4899.9	4821.1	87.9	166.7	245.5	157.6	2.5	248.0
1125	EXT	D	4972.8	4897.8	4822.8	95.5	170.5	245.5	150.0	2.5	248.0
0251	MW	E	4858.9	4808.9	4758.9	200.0	250.0	300.0	100.0	0.3	300.3
0268	MW	E	4864.5	4814.5	4764.5	200.0	250.0	300.0	100.0	0.3	300.3
0920	MW	E	4866.0	4846.0	4826.0	114.4	134.4	154.4	40.0	2.0	156.4
0948	EXDS	E	4893.9	4803.9	4713.9	221.5	311.5	401.5	180.0	5.0	406.5
0911	MW	F	4795.2	4775.2	4755.2	309.4	329.4	349.4	40.0	2.0	351.4
0913	MW	G	4729.2	4709.2	4689.2	328.7	348.7	368.7	40.0	2.0	370.7
0916	MW	G	4721.7	4716.7	4711.7	345.7	350.7	355.7	10.0	2.0	357.7
0919	MW	G	4707.9	4702.9	4697.9	337.7	342.7	347.7	10.0	2.0	349.7
0902	MW	H	4673.7	4668.7	4663.7	63.0	68.0	73.0	10.0	2.0	75.0
0252	MW	I	4658.9	4608.9	4558.9	400.0	450.0	500.0	100.0	0.4	500.4
0254	MW	I	4662.7	4612.7	4562.7	400.0	450.0	500.0	100.0	0.4	500.4
0256	MW	I	4664.0	4614.0	4564.0	400.0	450.0	500.0	100.0	0.4	500.4
0921	MW	I	4663.7	4643.7	4623.7	313.2	333.2	353.2	40.0	2.0	355.2
0253	MW	M	4458.8	4408.8	4358.8	600.0	650.0	700.0	100.0	0.4	700.4
0255	MW	M	4462.3	4412.3	4362.3	600.0	650.0	700.0	100.0	0.4	700.4
0257	MW	M	4463.4	4413.4	4363.4	600.0	650.0	700.0	100.0	0.4	700.4
0968	EXDS		5000.4	4699.9	4399.4	106.0	406.5	707.0	601.0	0.0	707.0
0970	EXDS		5007.7	4705.2	4402.7	100.0	402.5	705.0	605.0	0.0	705.0
0971	EXDS		4985.3	4693.8	4402.3	117.0	408.5	700.0	583.0	0.0	700.0
0972	EXDS		5039.7	4724.7	4409.7	100.0	415.0	730.0	630.0	0.0	730.0

Table A-1 (continued). Well Completion Information

WELL	TYPE	Horizon	TOP OF CASING ELEV	GROUND ELEV	WELL DIAMETER	BORING STARTED	DECOMMISSION DATE	STATE PLANE EAST	STATE PLANE NORTH
0284	MW	A	5098.72	5096.3	2	16-Aug-04		730525	1873562
0285	MW	A	5096.47	5093.8	2	16-Aug-04		731629	1874042
0686	MW	A	5107.97	5105.5	2	28-Mar-00		729978	1873416
0687	MW	A	5109.82	5107.6	2	29-Mar-00		731152	1874024
0688	MW	A	5106.98	5104.1	2	29-Mar-00		731961	1874385
0901	MW	A	5105.46	5103.8	2	16-Oct-84		730185	1875918
0906	MW	A	5062.10	5060.9	2	19-Nov-84		730838	1872181
0907	MW	A	5079.17	5077.2	2	30-Nov-84	19-Apr-88	731252	1872920
0928	MW	A	5053.99	5052.1	4	20-Oct-95	24-May-00	729401	1870814
0929	MW	A	5060.82	5058.6	4			728780	1871453
0940	MW	A	5064.77	5062.9	4	01-Nov-95		730130	1872391
0941	MW	A	5065.97	5063.0	4	10-Nov-95		730908	1872398
0945	MW	A	5140.49	5138.1	4	11-Oct-95		730019	1873857
0946	MW	A	5100.50	5097.6	4	02-Nov-95		730547	1873582
0262	MW	B	5061.99	5059.2	2	03-Apr-00		731402	1872012
0263	MW	B	5063.10	5060.2	2	04-Apr-00		731565	1871757
0265	MW	B	5053.88	5051.1	2	16-Apr-00		730382	1870964
0267	MW	B	5053.40	5050.8	2	14-Apr-00		729329	1870707
0271	MW	B	5046.72	5044.0	2	29-Apr-00		728160	1869555
0281	MW	B	5051.00	5048.3	2	11-Aug-04		729714	1870315
0282	MW	B	5060.04	5057.4	2	10-Aug-04		730062	1871168
0283	MW	B	5057.97	5055.3	2	03-Aug-04		730901	1871185
0286	MW	B	5063.99	5062.0	2	13-Mar-07		730128	1872377
0287	MW	B	5065.65	5063.0	2	15-Mar-07		730908	1872386
0288	MW	B	5072.54	5069.9	2	18-Mar-07		729995	1872709
0290	MW	B	5068.91	5067.0	2	17-Mar-07		732633	1872979
0905	MW	B	5072.80	5069.0	2	14-Nov-84	24-May-00	732933	1873200
0908	MW	B	5058.14	5057.3	2	17-Nov-84		729366	1871999
0909	MW	B	5057.17	5055.8	2	18-Nov-84		730927	1871393
0910	MW	B	5106.70	5104.6	4	26-Jul-85		730219	1875840
0918	MW	B	5049.63	5047.2	4	15-Aug-85		727294	1868724
0925	EXT	B	5060.87	5058.8	6	21-Oct-95	24-May-00	729452	1872006
0926	EXT	B	5062.85	5060.5	6	25-Oct-95	17-May-00	730790	1872126
0933	MW	B	5018.03	5016.3	4	18-Oct-95	24-May-00	731727	1871341
0934	MW	B	5059.73	5058.0	4	02-Nov-95		730018	1871649
0935	MW	B	5061.50	5058.8	4	28-Oct-95	*	729461	1871978
0936	MW	B	5062.30	5059.9	6	26-Oct-95	*	730055	1872121
0937	MW	B	5062.80	5060.2	4	09-Nov-95	24-May-00	730790	1872116
0938	MW	B	5063.64	5060.4	4	26-Oct-95	*	730769	1872124
0939	EXT	B	5063.23	5061.1	6	23-Oct-95	16-May-00	731403	1872132
0942	MW	B	5066.45	5063.5	4	03-Nov-95	*	731642	1872409
0943	MW	B	5098.05	5095.1	4	13-Oct-95		731596	1874034
0944	MW	B	5067.00	5064.9	4	04-Nov-95	28-Jul-99	732199	1873007
0947	MW	B	5097.01	5095.0	4	03-Nov-95		732786	1874642
1126	EXT	B	*5051.9* **	*5051.9* **	4	09-Sep-04		729517	1870728
1127	EXT	B	*5056.9* **	*5056.9* **	4	11-Sep-04		730044	1871022
1128	EXT	B	*5055.0* **	*5055.0* **	4	12-Sep-04		730679	1871294
1129	EXT	B	*5059.1* **	*5059.1* **	4	30-Aug-04		731237	1871690
1130	EXT	B	*5059.0* **	*5059.0* **	4	29-Jul-04		731699	1871907
1131	EXT	B	*5057.8* **	*5057.8* **	4	08-Sep-04		732011	1872106
1132	EXT	B	*5058.8* **	*5058.8* **	4	31-Aug-04		731310	1872015
1133	EXT	B	*5059.1* **	*5059.1* **	4	02-Sep-04		730850	1871827
0274	MW	C	5064.42	5062.6	2	30-Aug-04		731623	1872403
0276	MW	C	5067.55	5064.5	2	01-Sep-04		732081	1873158
0279	MW	C	4951.04	4948.6	2	15-Aug-04		731494	1870132
0280	MW	C	4951.52	4949.1	2	15-Aug-04		731794	1870289
0683	MW	C	5070.64	5068.2	6	31-Aug-99		732661	1872574
0684	MW	C	5070.05	5067.3	6	20-Aug-99		732642	1873521
0685	MW	C	5072.44	5069.3	6	19-Aug-99		732295	1873760
0689	MW	C	4981.63	4978.9	2	31-Mar-00		730439	1869893
0691	MW	C	4979.41	4976.9	2	30-Mar-00		732124	1870872
0903	MW	C	4983.33	4981.5	2	30-Oct-84		731314	1870829
0912	MW	C	5059.97	5057.7	4	12-Aug-85		729324	1871942
0914	MW	C	5070.10	5067.5	4	16-Aug-85		732723	1872119
0917	MW	C	5048.02	5045.8	4	14-Aug-85		727255	1868642
0930	MW	C	4954.96	4953.0	4	23-Oct-95		731257	1870099
0932	MW	C	5057.32	5054.8	4	29-Oct-95		730900	1871401
1008	INJ	C	4980.52	4982.3	6	23-Jul-99		730410	1869916
1116	EXT	C	5053.74	5056.5	6	08-Aug-99		730350	1871702
1117	EXT	C	5054.95	5057.6	6	11-Aug-99		729981	1871688

Table A–1 (continued). Well Completion Information

WELL	TYPE	Horizon	TOP OF CASING ELEV	GROUND ELEV	WELL DIAMETER	BORING STARTED	DECOMMISSION DATE	STATE PLANE EAST	STATE PLANE NORTH
1118	EXT	C	5055.11	5057.8	6	12-Aug-99		729756	1871695
0258	MW	D	5055.56	5053.0	2	13-Apr-00		732452	1871996
0261	MW	D	5069.69	5067.0	2	01-Apr-00		732565	1871578
0264	MW	D	5062.19	5059.6	2	03-Apr-00		731569	1871746
0266	MW	D	5053.32	5050.6	2	15-Apr-00		730380	1870941
0272	MW	D	5064.24	5061.9	2	28-Aug-04		730112	1872389
0273	MW	D	5064.74	5062.4	2	29-Aug-04		730922	1872397
0275	MW	D	5062.64	5061.2	2	01-Sep-04		732092	1872586
0277	MW	D	4982.35	4979.7	2	12-Aug-04		731290	1870777
0278	MW	D	4956.09	4953.4	2	14-Aug-04		731210	1870104
0690	MW	D	4950.87	4948.3	2	30-Mar-00		731521	1870140
0692	MW	D	4953.31	4950.6	2	05-Apr-00		731821	1870303
0695	MW	D	4976.83	4974.3	2	06-Apr-00		732566	1870896
0904	MW	D	4904.11	4901.8	2	07-Nov-84		731808	1868036
0915	MW	D	5070.84	5067.8	4	24-Aug-85		732740	1872209
1003	INJ	D	4976.58	4978.9	6	26-Jul-99		732101	1870898
1004	INJ	D	4961.55	4963.6	6	27-Jul-99		731892	1870544
1005	INJ	D	4947.83	4950.2	6	25-Jul-99		731496	1870168
1006	INJ	D	4947.08	4949.5	6	24-Jul-99		731233	1869918
1007	INJ	D	4958.56	4961.4	6	23-Jul-99		730770	1869861
1101	EXT	D	5067.29	5070.4	6	24-Aug-99		732223	1872970
1102	EXT	D	5066.76	5070.3	6	24-Aug-99		732225	1872670
1103	EXT	D	5059.56	5062.3	6	30-Jul-99		731896	1872407
1104	EXT	D	5059.57	5062.3	6	01-Aug-99		731527	1872404
1105	EXT	D	5059.33	5062.1	6	02-Aug-99		731304	1872401
1106	EXT	D	5059.73	5062.5	6	03-Aug-99		731081	1872400
1107	EXT	D	5059.51	5062.3	6	03-Aug-99		730858	1872398
1108	EXT	D	5059.62	5062.4	6	03-Aug-99		730634	1872396
1109	EXT	D	5059.64	5062.4	6	04-Aug-99		730410	1872394
1110	EXT	D	5059.47	5062.3	6	07-Aug-99		730187	1872392
1111	EXT	D	5059.87	5062.6	6	06-Aug-99		729993	1872392
1112	EXT	D	5057.08	5059.6	6	17-Aug-99		730494	1872064
1113	EXT	D	5058.54	5059.2	6	17-Aug-99		730196	1872061
1114	EXT	D	5056.25	5059.1	6	11-Aug-99		729896	1872057
1115	EXT	D	5056.36	5059.2	6	07-Aug-99		729596	1872055
1119	EXT	D	5061.19	5064.0	6	31-Jul-99		731894	1872667
1120	EXT	D	5063.60	5066.5	6	28-Jul-99		731891	1872967
1121	EXT	D	5066.61	5069.5	6	28-Jul-99		731889	1873267
1122	EXT	D	5067.31	5070.3	6	26-Aug-99		732221	1873269
1123	EXT	D	5064.54	5067.2	6	02-Sep-99		732508	1873222
1124	EXT	D	5063.86	5066.6	6	23-Aug-99		732512	1872972
1125	EXT	D	5065.47	5068.3	6	25-Aug-99		732515	1872671
0251	MW	E	5061.25	5058.9	2	28-Apr-00		730215	1871999
0268	MW	E	5067.24	5064.5	2	15-May-00		732301	1872430
0920	MW	E	4982.97	4980.4	4	30-Jul-85		731262	1870737
0948	EXDS	E	5117.80	5115.4	4	17-Oct-95		733915	1875516
0911	MW	F	5106.96	5104.6	4	18-Jul-85		730265	1875920
0913	MW	G	5060.16	5057.9	4	02-Aug-85		729327	1871871
0916	MW	G	5070.00	5067.4	4	22-Aug-85		732811	1872146
0919	MW	G	5048.56	5045.6	4	26-Aug-85		727353	1868654
0902	MW	H	4737.42	4736.7	2	02-Dec-84		730179	1862292
0252	MW	I	5061.30	5058.9	4	26-Apr-00		730232	1871993
0254	MW	I	5065.38	5062.7	4	03-May-00		730951	1872411
0256	MW	I	5066.58	5064.0	4	13-May-00		732277	1872437
0921	MW	I	4979.08	4976.9	4	22-Jul-85		731379	1870742
0253	MW	M	5061.11	5058.8	4	18-Apr-00	11-Apr-01	730213	1871974
0255	MW	M	5064.89	5062.3	4	01-May-00		730947	1872387
0257	MW	M	5066.40	5063.4	4	11-May-00		732278	1872414
0968	EXDS		5107.00	5106.4	10			730180	1875689
0970	EXDS		5109.53	5107.7	10			730653	1876567
0971	EXDS		5104.00	5102.3	10			731590	1878306
0972	EXDS		5141.07	5139.7	10			728031	1877986

ALL DIMENSIONS IN FEET EXCEPT WELL DIAMETER IN INCHES
ALL DEPTHS ARE RELATIVE TO GROUND SURFACE
* CONVERTED TO EXT 8/05
MW MONITOR WELL
EXT GROUND WATER REMEDIATION EXTRACTION WELL
INJ GROUND WATER REMEDIATION INJECTION WELL
EXDS OTHER SUPPLY WELL
** APPROXIMATE

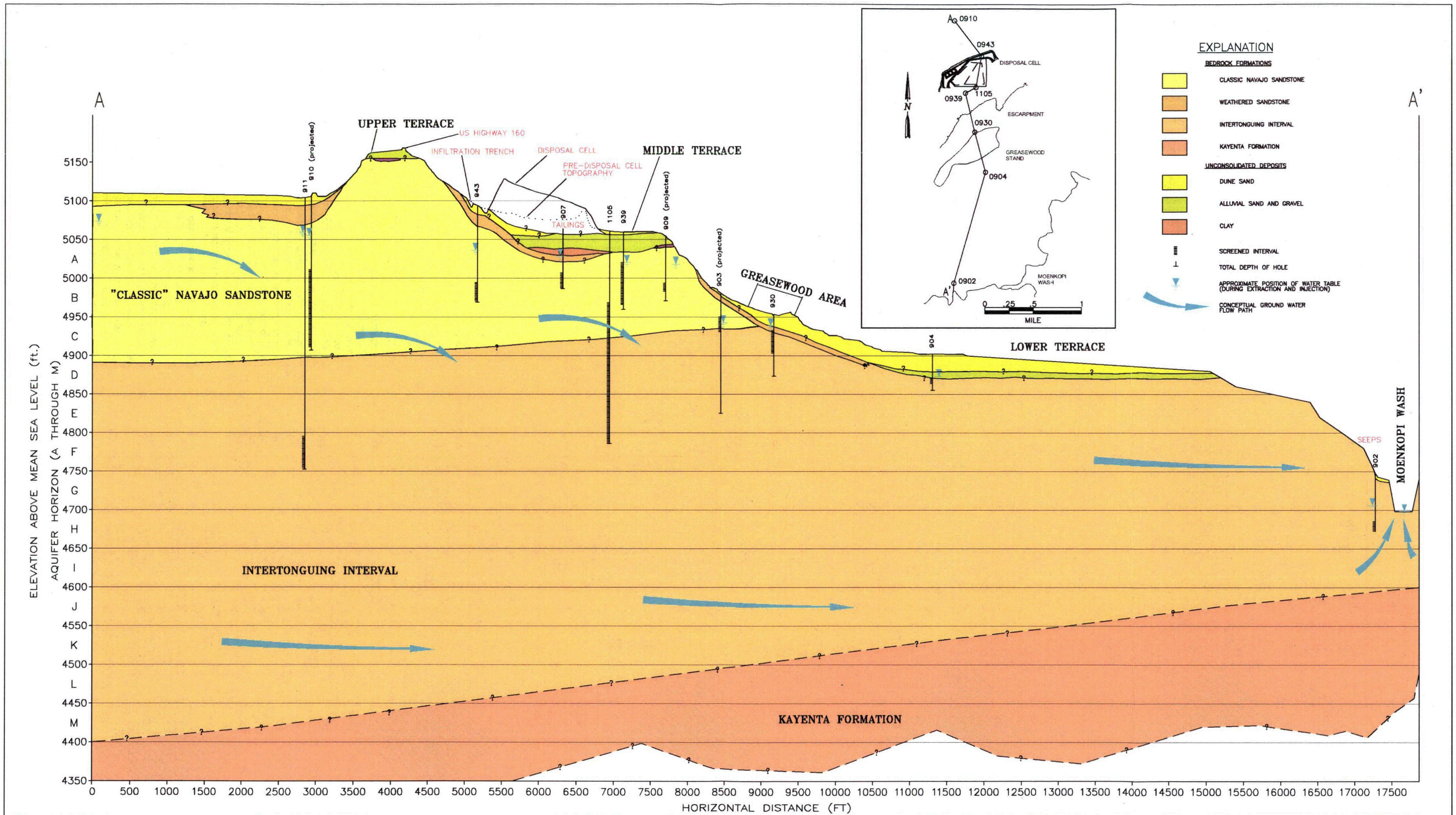

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Figure A–1. Conceptual Model of the Site Hydrogeology

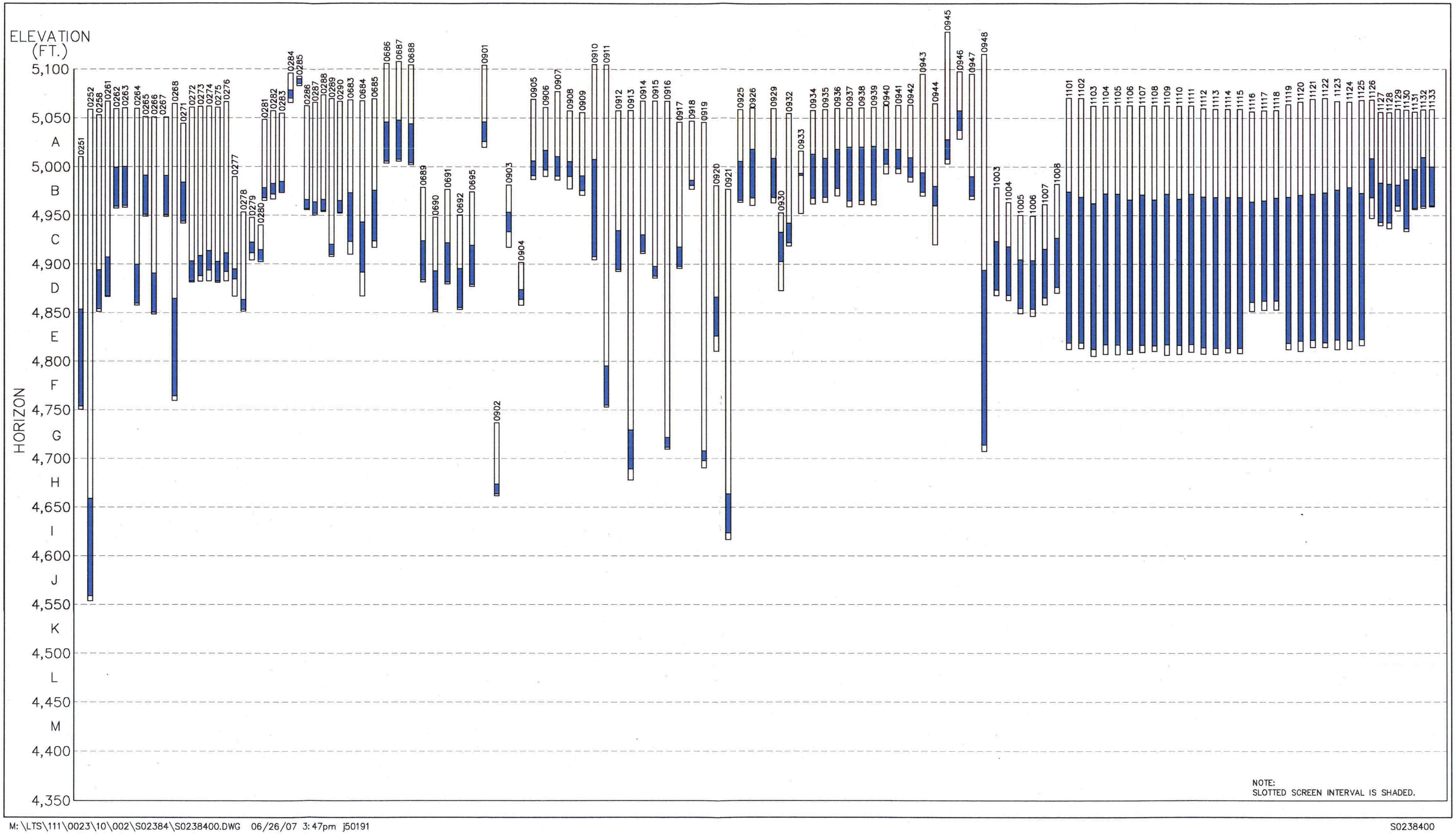

Figure A–2. Well Completions Schematic

Table A- 2. Extraction Well Operation Summary—April 2006 through March 2007

Apr-06						
Plant Time On	28.39	days				
Well	Pumping Time	OST	Gallons	Q1 gpm	Q2 gpm	Q3 gpm
935	0.00	0%	0	0.0	0.0	0.0
936	0.00	0%	0	0.0	0.0	0.0
938	0.00	0%	0	0.0	0.0	0.0
942	1.34	5%	13,524	7.0	0.3	0.3
1101	28.25	100%	260,210	6.4	6.4	6.0
1102	28.24	99%	146,495	3.6	3.6	3.4
1103	28.19	99%	243,290	6.0	6.0	5.6
1104	28.21	99%	155,632	3.8	3.8	3.6
1105	10.71	38%	223,767	14.5	5.5	5.2
1106	28.26	100%	74,851	1.8	1.8	1.7
1107	28.16	99%	149,558	3.7	3.7	3.5
1108	28.26	100%	185,533	4.6	4.5	4.3
1109	28.26	100%	115,032	2.8	2.8	2.7
1110	28.26	100%	55,575	1.4	1.4	1.3
1111	28.24	99%	156,872	3.9	3.8	3.6
1112	28.26	100%	76,495	1.9	1.9	1.8
1113	28.26	100%	40,789	1.0	1.0	0.9
1114	28.26	100%	149,543	3.7	3.7	3.5
1115	28.26	100%	218,880	5.4	5.4	5.1
1116	28.26	100%	154,852	3.8	3.8	3.6
1117	28.38	100%	218,202	5.3	5.3	5.1
1118	28.26	100%	127,778	3.1	3.1	3.0
1119	28.24	99%	120,975	3.0	3.0	2.8
1120	28.26	100%	187,220	4.6	4.6	4.3
1121	28.22	99%	172,764	4.3	4.2	4.0
1122	28.26	100%	67,072	1.6	1.6	1.6
1123	25.22	89%	11,540	0.3	0.3	0.3
1124	28.26	100%	186,070	4.6	4.6	4.3
1125	15.40	54%	68,565	3.1	1.7	1.6
1126	0.00	0%	0	0.0	0.0	0.0
1127	0.28	1%	88	0.2	0.0	0.0
1128	0.65	2%	4,575	4.9	0.1	0.1
1129	0.48	2%	3,588	5.2	0.1	0.1
1130	1.05	4%	8,699	5.8	0.2	0.2
1131	0.00	0%	0	0.0	0.0	0.0
1132	0.73	3%	5,842	5.5	0.1	0.1
1133	0.70	2%	5,653	5.6	0.1	0.1
total gallons			3,609,528			
operating q gpm			88.3			
days/month			30			
os factor			95%			
avg monthly q gpm			84			
avg well q gpm				3.6	2.4	2.3

May-06						
Plant Time On	28.00	days				
Well	Pumping Time	OST	Gallons	Q1 gpm	Q2 gpm	Q3 gpm
935	0.00	0%	0	0.0	0.0	0.0
936	0.00	0%	0	0.0	0.0	0.0
938	0.00	0%	0	0.0	0.0	0.0
942	1.33	5%	13,398	7.0	0.3	0.3
1101	27.99	100%	259,068	6.4	6.4	5.8
1102	27.90	100%	141,436	3.5	3.5	3.2
1103	27.88	100%	239,698	6.0	5.9	5.4
1104	27.97	100%	157,848	3.9	3.9	3.5
1105	10.73	38%	222,046	14.4	5.5	5.0
1106	27.99	100%	74,904	1.9	1.9	1.7
1107	26.13	93%	140,005	3.7	3.5	3.1
1108	27.98	100%	188,734	4.7	4.7	4.2
1109	27.99	100%	116,476	2.9	2.9	2.6
1110	26.60	95%	49,551	1.3	1.2	1.1
1111	27.98	100%	156,574	3.9	3.9	3.5
1112	24.93	89%	68,289	1.9	1.7	1.5
1113	24.93	89%	35,560	1.0	0.9	0.8
1114	27.38	98%	154,648	3.9	3.8	3.5
1115	27.99	100%	216,363	5.4	5.4	4.8
1116	24.93	89%	135,597	3.8	3.4	3.0
1117	26.90	96%	212,718	5.5	5.3	4.8
1118	27.99	100%	124,432	3.1	3.1	2.8
1119	27.97	100%	120,378	3.0	3.0	2.7
1120	27.99	100%	186,296	4.6	4.6	4.2
1121	27.95	100%	174,235	4.3	4.3	3.9
1122	27.99	100%	68,634	1.7	1.7	1.5
1123	22.36	80%	10,281	0.3	0.3	0.2
1124	27.99	100%	185,406	4.6	4.6	4.2
1125	6.37	23%	28,554	3.1	0.7	0.6
1126	0.00	0%	0	0.0	0.0	0.0
1127	0.23	1%	73	0.2	0.0	0.0
1128	0.57	2%	3,963	4.9	0.1	0.1
1129	0.41	1%	3,031	5.2	0.1	0.1
1130	0.84	3%	6,871	5.7	0.2	0.2
1131	0.00	0%	0	0.0	0.0	0.0
1132	0.62	2%	4,974	5.6	0.1	0.1
1133	0.60	2%	4,805	5.6	0.1	0.1
total gallons			3,504,843			
operating q gpm			86.9			
days/month			31			
os factor			90%			
avg monthly q gpm			79			
avg well q gpm				3.6	2.3	2.1

Table A-2 (continued). Extraction Well Operation Summary—April 2006 through March 2007

Jun-06						
Plant Time On	28.57	days				
Well	Pumping Time	OST	Gallons	Q1 gpm	Q2 gpm	Q3 gpm
935	0.00	0%	0	0.0	0.0	0.0
936	0.00	0%	0	0.0	0.0	0.0
938	0.00	0%	0	0.0	0.0	0.0
942	1.48	5%	14,632	6.9	0.4	0.3
1101	28.24	99%	253,452	6.2	6.2	5.9
1102	28.20	99%	146,058	3.6	3.6	3.4
1103	28.15	99%	240,450	5.9	5.8	5.6
1104	28.20	99%	160,660	4.0	3.9	3.7
1105	10.60	37%	222,334	14.6	5.4	5.1
1106	28.25	99%	74,958	1.8	1.8	1.7
1107	28.16	99%	152,542	3.8	3.7	3.5
1108	28.25	99%	192,996	4.7	4.7	4.5
1109	28.25	99%	116,674	2.9	2.8	2.7
1110	28.25	99%	51,323	1.3	1.2	1.2
1111	28.24	99%	157,283	3.9	3.8	3.6
1112	28.51	100%	77,505	1.9	1.9	1.8
1113	28.50	100%	45,011	1.1	1.1	1.0
1114	28.25	99%	152,265	3.7	3.7	3.5
1115	28.51	100%	216,604	5.3	5.3	5.0
1116	28.51	100%	154,297	3.8	3.8	3.6
1117	28.50	100%	218,768	5.3	5.3	5.1
1118	28.50	100%	123,296	3.0	3.0	2.9
1119	28.23	99%	120,820	3.0	2.9	2.8
1120	28.55	100%	188,919	4.6	4.6	4.4
1121	28.19	99%	177,424	4.4	4.3	4.1
1122	28.25	99%	70,959	1.7	1.7	1.6
1123	24.99	87%	11,557	0.3	0.3	0.3
1124	28.26	99%	185,423	4.6	4.5	4.3
1125	2.53	9%	11,688	3.2	0.3	0.3
1126	0.00	0%	0	0.0	0.0	0.0
1127	0.27	1%	74	0.2	0.0	0.0
1128	0.60	2%	4,283	4.9	0.1	0.1
1129	0.45	2%	3,323	5.1	0.1	0.1
1130	0.92	3%	7,475	5.7	0.2	0.2
1131	0.00	0%	0	0.0	0.0	0.0
1132	0.70	2%	5,565	5.6	0.1	0.1
1133	0.66	2%	5,415	5.7	0.1	0.1
total gallons			3,564,033			
operating q gpm			86.6			
days/month			30			
os factor			95%			
avg monthly q gpm			83			
avg well q gpm				3.6	2.3	2.2

Jul-06						
Plant Time On	28.07	days				
Well	Pumping Time	OST	Gallons	Q1 gpm	Q2 gpm	Q3 gpm
935	1.58	6%	14,562	6.4	0.4	0.3
936	0.58	2%	85	0.1	0.0	0.0
938	0.05	0%	76	1.0	0.0	0.0
942	1.31	5%	13,206	7.0	0.3	0.3
1101	27.99	100%	256,447	6.4	6.3	5.7
1102	27.71	99%	142,269	3.6	3.5	3.2
1103	27.82	99%	236,562	5.9	5.9	5.3
1104	6.97	25%	39,018	3.9	1.0	0.9
1105	21.72	77%	180,207	5.8	4.5	4.0
1106	26.27	94%	73,824	2.0	1.8	1.7
1107	25.44	91%	140,248	3.8	3.5	3.1
1108	26.27	94%	183,702	4.9	4.5	4.1
1109	26.27	94%	110,431	2.9	2.7	2.5
1110	26.21	93%	47,309	1.3	1.2	1.1
1111	26.26	94%	146,294	3.9	3.6	3.3
1112	24.32	87%	68,243	1.9	1.7	1.5
1113	23.75	85%	46,531	1.4	1.2	1.0
1114	27.44	98%	151,678	3.8	3.8	3.4
1115	28.02	100%	214,031	5.3	5.3	4.8
1116	27.31	97%	149,401	3.8	3.7	3.3
1117	27.48	98%	211,629	5.3	5.2	4.7
1118	28.01	100%	120,526	3.0	3.0	2.7
1119	27.95	100%	120,454	3.0	3.0	2.7
1120	28.01	100%	189,071	4.7	4.7	4.2
1121	27.89	99%	178,775	4.5	4.4	4.0
1122	28.01	100%	70,564	1.7	1.7	1.6
1123	18.72	67%	9,407	0.3	0.2	0.2
1124	27.96	100%	185,814	4.6	4.6	4.2
1125	0.92	3%	4,192	3.2	0.1	0.1
1126	0.04	0%	564	10.4	0.0	0.0
1127	0.16	1%	69	0.3	0.0	0.0
1128	0.51	2%	3,735	5.1	0.1	0.1
1129	0.38	1%	2,803	5.2	0.1	0.1
1130	0.70	2%	5,598	5.6	0.1	0.1
1131	0.00	0%	0	0.0	0.0	0.0
1132	0.64	2%	5,074	5.5	0.1	0.1
1133	0.56	2%	4,409	5.5	0.1	0.1
total gallons			3,326,811			
operating q gpm			82.3			
days/month			31			
os factor			91%			
avg monthly q gpm			75			
avg well q gpm				3.9	2.2	2.0

Table A-2 (continued). Extraction Well Operation Summary—April 2006 through March 2007

Aug-06						
Plant Time On	22.90	days				
Well	Pumping Time	OST	Gallons	Q1 gpm	Q2 gpm	Q3 gpm
935	1.97	9%	18,151	6.4	0.6	0.4
936	0.56	2%	169	0.2	0.0	0.0
938	0.05	0%	85	1.3	0.0	0.0
942	1.14	5%	11,442	7.0	0.3	0.3
1101	22.88	100%	204,917	6.2	6.2	4.6
1102	22.62	99%	119,720	3.7	3.6	2.7
1103	22.68	99%	189,269	5.8	5.7	4.2
1104	21.88	96%	119,705	3.8	3.6	2.7
1105	22.85	100%	166,270	5.1	5.0	3.7
1106	22.89	100%	64,211	1.9	1.9	1.4
1107	22.89	100%	126,538	3.8	3.8	2.8
1108	22.88	100%	160,823	4.9	4.9	3.6
1109	22.88	100%	95,469	2.9	2.9	2.1
1110	22.88	100%	39,547	1.2	1.2	0.9
1111	22.88	100%	127,461	3.9	3.9	2.9
1112	22.88	100%	68,179	2.1	2.1	1.5
1113	22.09	96%	46,928	1.5	1.4	1.1
1114	12.56	55%	66,439	3.7	2.0	1.5
1115	22.89	100%	174,599	5.3	5.3	3.9
1116	22.89	100%	124,727	3.8	3.8	2.8
1117	22.56	99%	176,494	5.4	5.4	4.0
1118	22.88	100%	97,286	3.0	3.0	2.2
1119	22.88	100%	98,785	3.0	3.0	2.2
1120	22.88	100%	157,925	4.8	4.8	3.5
1121	22.84	100%	147,597	4.5	4.5	3.3
1122	22.89	100%	58,751	1.8	1.8	1.3
1123	15.68	68%	10,414	0.5	0.3	0.2
1124	22.89	100%	153,167	4.6	4.6	3.4
1125	14.59	64%	63,768	3.0	1.9	1.4
1126	0.14	1%	0	0.0	0.0	0.0
1127	0.01	0%	5	0.4	0.0	0.0
1128	0.46	2%	3,362	5.0	0.1	0.1
1129	0.36	2%	2,588	5.0	0.1	0.1
1130	0.68	3%	5,454	5.6	0.2	0.1
1131	0.00	0%	7	1.2	0.0	0.0
1132	0.63	3%	4,966	5.5	0.2	0.1
1133	0.06	0%	457	5.7	0.0	0.0
total gallons			2,905,674			
operating q gpm			88.1			
days/month			31			
os factor			74%			
avg monthly q gpm			65			
avg well q gpm				3.6	2.4	1.8

Sep-06						
Plant Time On	27.59	days				
Well	Pumping Time	OST	Gallons	Q1 gpm	Q2 gpm	Q3 gpm
935	2.35	9%	21,542	6.4	0.5	0.5
936	2.15	8%	106	0.0	0.0	0.0
938	0.06	0%	90	1.0	0.0	0.0
942	1.53	6%	15,414	7.0	0.4	0.4
1101	27.47	100%	242,942	6.1	6.1	5.6
1102	27.44	99%	143,400	3.6	3.6	3.3
1103	27.27	99%	235,462	6.0	5.9	5.5
1104	27.48	100%	150,343	3.8	3.8	3.5
1105	27.43	99%	194,219	4.9	4.9	4.5
1106	27.48	100%	76,863	1.9	1.9	1.8
1107	27.42	99%	151,806	3.8	3.8	3.5
1108	27.48	100%	192,549	4.9	4.8	4.5
1109	27.48	100%	112,720	2.8	2.8	2.6
1110	27.48	100%	48,617	1.2	1.2	1.1
1111	27.58	100%	154,944	3.9	3.9	3.6
1112	27.48	100%	77,210	2.0	1.9	1.8
1113	27.48	100%	63,861	1.6	1.6	1.5
1114	0.00	0%	0	0.0	0.0	0.0
1115	27.43	99%	209,669	5.3	5.3	4.9
1116	27.48	100%	154,306	3.9	3.9	3.6
1117	27.48	100%	215,426	5.4	5.4	5.0
1118	27.39	99%	119,374	3.0	3.0	2.8
1119	27.45	100%	126,020	3.2	3.2	2.9
1120	27.48	100%	202,723	5.1	5.1	4.7
1121	27.43	99%	174,295	4.4	4.4	4.0
1122	21.56	78%	64,263	2.1	1.6	1.5
1123	20.51	74%	11,642	0.4	0.3	0.3
1124	27.48	100%	181,210	4.6	4.6	4.2
1125	26.98	98%	117,934	3.0	3.0	2.7
1126	0.00	0%	0	0.0	0.0	0.0
1127	0.00	0%	0	0.0	0.0	0.0
1128	0.37	1%	2,546	4.8	0.1	0.1
1129	0.25	1%	1,696	4.6	0.0	0.0
1130	0.53	2%	4,194	5.5	0.1	0.1
1131	0.12	0%	176	1.0	0.0	0.0
1132	0.46	2%	3,477	5.2	0.1	0.1
1133	0.00	0%	0	0.0	0.0	0.0
total gallons			3,471,038			
operating q gpm			87.4			
days/month			30			
os factor			92%			
avg monthly q gpm			80			
avg well q gpm				3.3	2.4	2.2

Table A-2 (continued). Extraction Well Operation Summary—April 2006 through March 2007

Oct-06						
Plant Time On	30.34	days				
Well	Pumping Time	OST	Gallons	Q1 gpm	Q2 gpm	Q3 gpm
935	2.49	8%	22,765	6.3	0.5	0.5
936	8.33	27%	108,454	9.0	2.5	2.4
938	0.05	0%	78	1.2	0.0	0.0
942	1.75	6%	15,720	6.2	0.4	0.4
1101	30.33	100%	265,552	6.1	6.1	5.9
1102	30.33	100%	158,270	3.6	3.6	3.5
1103	30.26	100%	256,573	5.9	5.9	5.7
1104	30.34	100%	166,030	3.8	3.8	3.7
1105	30.29	100%	205,361	4.7	4.7	4.6
1106	30.33	100%	78,408	1.8	1.8	1.8
1107	30.34	100%	164,997	3.8	3.8	3.7
1108	30.33	100%	209,142	4.8	4.8	4.7
1109	30.34	100%	119,174	2.7	2.7	2.7
1110	30.34	100%	51,617	1.2	1.2	1.2
1111	30.33	100%	167,236	3.8	3.8	3.7
1112	30.34	100%	79,242	1.8	1.8	1.8
1113	30.33	100%	66,405	1.5	1.5	1.5
1114	0.00	0%	0	0.0	0.0	0.0
1115	30.33	100%	223,629	5.1	5.1	5.0
1116	30.33	100%	168,689	3.9	3.9	3.8
1117	30.33	100%	235,123	5.4	5.4	5.3
1118	30.34	100%	129,422	3.0	3.0	2.9
1119	30.33	100%	129,416	3.0	3.0	2.9
1120	30.34	100%	221,151	5.1	5.1	5.0
1121	30.31	100%	192,083	4.4	4.4	4.3
1122	30.33	100%	81,715	1.9	1.9	1.8
1123	23.40	77%	12,073	0.4	0.3	0.3
1124	30.34	100%	191,636	4.4	4.4	4.3
1125	30.18	99%	127,756	2.9	2.9	2.9
1126	0.00	0%	0	0.0	0.0	0.0
1127	0.00	0%	0	0.0	0.0	0.0
1128	0.55	2%	3,638	4.6	0.1	0.1
1129	0.44	1%	2,871	4.5	0.1	0.1
1130	0.81	3%	6,220	5.3	0.1	0.1
1131	0.28	1%	408	1.0	0.0	0.0
1132	0.77	3%	5,720	5.2	0.1	0.1
1133	0.00	0%	0	0.0	0.0	0.0
total gallons			3,866,571			
operating q gpm			88.5			
days/month			31			
os factor			98%			
avg monthly q gpm			87			
avg well q gpm				3.5	2.4	2.3

Nov-06						
Plant Time On	27.84	days				
Well	Pumping Time	OST	Gallons	Q1 gpm	Q2 gpm	Q3 gpm
935	2.23	8%	20,107	6.3	0.5	0.5
936	7.01	25%	90,345	9.0	2.3	2.1
938	0.08	0%	179	1.5	0.0	0.0
942	1.68	6%	14,364	5.9	0.4	0.3
1101	25.97	93%	230,562	6.2	5.8	5.3
1102	25.75	92%	135,331	3.6	3.4	3.1
1103	25.87	93%	219,124	5.9	5.5	5.1
1104	26.30	94%	143,936	3.8	3.6	3.3
1105	25.91	93%	185,425	5.0	4.6	4.3
1106	25.97	93%	68,089	1.8	1.7	1.6
1107	25.97	93%	145,585	3.9	3.6	3.4
1108	25.98	93%	185,908	5.0	4.6	4.3
1109	15.70	56%	65,027	2.9	1.6	1.5
1110	25.97	93%	44,290	1.2	1.1	1.0
1111	1.02	4%	5,591	3.8	0.1	0.1
1112	25.93	93%	78,735	2.1	2.0	1.8
1113	25.93	93%	56,627	1.5	1.4	1.3
1114	26.75	96%	148,169	3.8	3.7	3.4
1115	25.97	93%	183,714	4.9	4.6	4.3
1116	25.97	93%	140,174	3.7	3.5	3.2
1117	25.97	93%	195,320	5.2	4.9	4.5
1118	25.97	93%	105,645	2.8	2.6	2.4
1119	25.97	93%	109,919	2.9	2.7	2.5
1120	25.97	93%	190,030	5.1	4.7	4.4
1121	25.95	93%	166,375	4.5	4.2	3.9
1122	25.97	93%	74,112	2.0	1.8	1.7
1123	8.16	29%	4,867	0.4	0.1	0.1
1124	25.97	93%	173,011	4.6	4.3	4.0
1125	24.58	88%	104,483	3.0	2.6	2.4
1126	0.00	0%	0	0.0	0.0	0.0
1127	0.00	0%	0	0.0	0.0	0.0
1128	0.50	2%	3,324	4.6	0.1	0.1
1129	0.40	1%	2,688	4.7	0.1	0.1
1130	0.75	3%	5,756	5.3	0.1	0.1
1131	0.29	1%	414	1.0	0.0	0.0
1132	0.71	3%	5,331	5.2	0.1	0.1
1133	0.00	0%	0	0.0	0.0	0.0
total gallons			3,302,558			
operating q gpm			82.4			
days/month			30			
os factor			93%			
avg monthly q gpm			76			
avg well q gpm				3.6	2.2	2.1

Table A-2 (continued). Extraction Well Operation Summary—April 2006 through March 2007

Dec-06						
Plant Time On	30.54	days		gpm	gpm	gpm
Well	Pumping Time	OST	Gallons	Q1 gpm	Q2 gpm	Q3 gpm
935	2.40	8%	21,491	6.2	0.5	0.5
936	8.19	27%	105,580	9.0	2.4	2.4
938	0.09	0%	366	2.9	0.0	0.0
942	1.49	5%	18,642	8.7	0.4	0.4
1101	30.53	100%	265,562	6.0	6.0	5.9
1102	29.88	98%	177,936	4.1	4.0	4.0
1103	30.50	100%	252,483	5.7	5.7	5.7
1104	30.50	100%	166,896	3.8	3.8	3.7
1105	30.50	100%	204,672	4.7	4.7	4.6
1106	30.54	100%	73,275	1.7	1.7	1.6
1107	30.54	100%	168,339	3.8	3.8	3.8
1108	30.53	100%	218,513	5.0	5.0	4.9
1109	0.00	0%	0	0.0	0.0	0.0
1110	30.53	100%	49,320	1.1	1.1	1.1
1111	0.00	0%	0	0.0	0.0	0.0
1112	30.53	100%	88,031	2.0	2.0	2.0
1113	30.52	100%	66,012	1.5	1.5	1.5
1114	30.99	101%	168,052	3.8	3.8	3.8
1115	30.53	100%	206,965	4.7	4.7	4.6
1116	30.53	100%	164,055	3.7	3.7	3.7
1117	30.53	100%	227,916	5.2	5.2	5.1
1118	30.54	100%	123,316	2.8	2.8	2.8
1119	30.53	100%	123,383	2.8	2.8	2.8
1120	30.53	100%	219,250	5.0	5.0	4.9
1121	30.52	100%	193,157	4.4	4.4	4.3
1122	30.53	100%	78,490	1.8	1.8	1.8
1123	14.63	48%	8,592	0.4	0.2	0.2
1124	30.53	100%	192,856	4.4	4.4	4.3
1125	26.34	86%	111,684	2.9	2.5	2.5
1126	0.00	0%	0	0.0	0.0	0.0
1127	0.00	0%	0	0.0	0.0	0.0
1128	0.51	2%	3,329	4.5	0.1	0.1
1129	0.43	1%	2,721	4.4	0.1	0.1
1130	0.74	2%	5,397	5.1	0.1	0.1
1131	0.31	1%	450	1.0	0.0	0.0
1132	0.77	3%	5,655	5.1	0.1	0.1
1133	0.00	0%	0	0.0	0.0	0.0
total gallons			3,712,383			
operating q gpm			84.4			
days/month			31			
os factor			99%			
avg monthly q gpm			83			
avg well q gpm				3.5	2.3	2.2

Jan-07						
Plant Time On	30.88	days		gpm	gpm	gpm
Well	Pumping Time	OST	Gallons	Q1 gpm	Q2 gpm	Q3 gpm
935	2.35	8%	21,012	6.2	0.5	0.5
936	8.48	27%	110,391	9.0	2.5	2.5
938	0.08	0%	120	1.0	0.0	0.0
942	1.51	5%	16,209	7.4	0.4	0.4
1101	30.88	100%	274,490	6.2	6.2	6.1
1102	30.32	98%	158,294	3.6	3.6	3.5
1103	30.88	100%	245,447	5.5	5.5	5.5
1104	30.88	100%	168,948	3.8	3.8	3.8
1105	30.88	100%	204,372	4.6	4.6	4.6
1106	30.88	100%	70,764	1.6	1.6	1.6
1107	30.88	100%	169,412	3.8	3.8	3.8
1108	30.88	100%	220,324	5.0	5.0	4.9
1109	0.00	0%	0	0.0	0.0	0.0
1110	30.88	100%	48,192	1.1	1.1	1.1
1111	0.00	0%	0	0.0	0.0	0.0
1112	30.88	100%	87,768	2.0	2.0	2.0
1113	30.88	100%	66,928	1.5	1.5	1.5
1114	31.00	100%	167,007	3.7	3.8	3.7
1115	30.88	100%	202,331	4.6	4.6	4.5
1116	30.88	100%	165,574	3.7	3.7	3.7
1117	30.88	100%	229,706	5.2	5.2	5.1
1118	30.88	100%	122,910	2.8	2.8	2.8
1119	30.88	100%	121,340	2.7	2.7	2.7
1120	30.88	100%	219,976	4.9	4.9	4.9
1121	30.88	100%	195,182	4.4	4.4	4.4
1122	30.88	100%	75,786	1.7	1.7	1.7
1123	15.10	49%	8,625	0.4	0.2	0.2
1124	30.88	100%	189,848	4.3	4.3	4.3
1125	26.54	86%	116,003	3.0	2.6	2.6
1126	0.00	0%	0	0.0	0.0	0.0
1127	0.00	0%	0	0.0	0.0	0.0
1128	0.49	2%	3,172	4.5	0.1	0.1
1129	0.43	1%	2,682	4.4	0.1	0.1
1130	0.70	2%	5,048	5.0	0.1	0.1
1131	0.33	1%	468	1.0	0.0	0.0
1132	0.77	2%	5,546	5.0	0.1	0.1
1133	0.00	0%	0	0.0	0.0	0.0
total gallons			3,693,873			
operating q gpm			83.1			
days/month			31			
os factor			100%			
avg monthly q gpm			83			
avg well q gpm				3.3	2.2	2.2

Table A-2 (continued). Extraction Well Operation Summary—April 2006 through March 2007

Feb-07						
Plant Time On	27.95	days				
Well	Pumping Time	OST	Gallons	Q1 gpm	Q2 gpm	Q3 gpm
935	2.09	7%	18,551	6.2	0.5	0.5
936	7.68	27%	99,933	9.0	2.5	2.5
938	0.06	0%	90	1.0	0.0	0.0
942	1.33	5%	14,353	7.5	0.4	0.4
1101	27.95	100%	253,517	6.3	6.3	6.3
1102	27.93	100%	145,506	3.6	3.6	3.6
1103	27.95	100%	216,018	5.4	5.4	5.4
1104	27.92	100%	152,760	3.8	3.8	3.8
1105	27.86	100%	182,725	4.6	4.5	4.5
1106	27.95	100%	62,954	1.6	1.6	1.6
1107	27.95	100%	151,564	3.8	3.8	3.8
1108	27.95	100%	195,276	4.9	4.9	4.8
1109	14.50	52%	57,027	2.7	1.4	1.4
1110	27.95	100%	43,248	1.1	1.1	1.1
1111	14.41	52%	81,436	3.9	2.0	2.0
1112	27.86	100%	75,717	1.9	1.9	1.9
1113	27.87	100%	56,774	1.4	1.4	1.4
1114	28.00	100%	147,151	3.6	3.7	3.6
1115	27.95	100%	177,097	4.4	4.4	4.4
1116	27.95	100%	149,102	3.7	3.7	3.7
1117	27.97	100%	206,539	5.1	5.1	5.1
1118	27.95	100%	108,863	2.7	2.7	2.7
1119	27.95	100%	105,415	2.6	2.6	2.6
1120	27.95	100%	198,956	4.9	4.9	4.9
1121	27.95	100%	176,630	4.4	4.4	4.4
1122	27.95	100%	66,607	1.7	1.7	1.7
1123	17.10	61%	9,031	0.4	0.2	0.2
1124	27.95	100%	168,728	4.2	4.2	4.2
1125	25.23	90%	110,266	3.0	2.7	2.7
1126	0.00	0%	0	0.0	0.0	0.0
1127	0.00	0%	0	0.0	0.0	0.0
1128	0.44	2%	2,786	4.4	0.1	0.1
1129	0.39	1%	2,426	4.3	0.1	0.1
1130	0.62	2%	4,396	4.9	0.1	0.1
1131	0.25	1%	366	1.0	0.0	0.0
1132	0.68	2%	4,977	5.1	0.1	0.1
1133	0.00	0%	0	0.0	0.0	0.0
total gallons			3,446,787			
operating q gpm			85.6			
days/month			28			
os factor			100%			
avg monthly q gpm			85			
avg well q gpm				3.5	2.3	2.3

Mar-07						
Plant Time On	31.00	days				
Well	Pumping Time	OST	Gallons	Q1 gpm	Q2 gpm	Q3 gpm
935	2.24	7%	19,884	6.2	0.4	0.4
936	8.51	27%	110,838	9.0	2.5	2.5
938	0.00	0%	0	0.0	0.0	0.0
942	1.53	5%	15,414	7.0	0.3	0.3
1101	31.00	100%	275,709	6.2	6.2	6.2
1102	31.00	100%	161,484	3.6	3.6	3.6
1103	31.00	100%	235,393	5.3	5.3	5.3
1104	30.94	100%	169,290	3.8	3.8	3.8
1105	30.97	100%	201,667	4.5	4.5	4.5
1106	31.00	100%	65,915	1.5	1.5	1.5
1107	31.00	100%	164,813	3.7	3.7	3.7
1108	31.00	100%	210,713	4.7	4.7	4.7
1109	31.00	100%	117,482	2.6	2.6	2.6
1110	31.00	100%	48,443	1.1	1.1	1.1
1111	31.00	100%	174,742	3.9	3.9	3.9
1112	31.00	100%	78,773	1.8	1.8	1.8
1113	31.00	100%	57,234	1.3	1.3	1.3
1114	31.00	100%	156,693	3.5	3.5	3.5
1115	31.00	100%	189,089	4.2	4.2	4.2
1116	31.00	100%	163,443	3.7	3.7	3.7
1117	31.00	100%	227,096	5.1	5.1	5.1
1118	31.00	100%	117,801	2.6	2.6	2.6
1119	31.00	100%	112,393	2.5	2.5	2.5
1120	31.00	100%	219,937	4.9	4.9	4.9
1121	31.00	100%	195,839	4.4	4.4	4.4
1122	31.00	100%	73,173	1.6	1.6	1.6
1123	20.73	67%	10,640	0.4	0.2	0.2
1124	31.00	100%	185,544	4.2	4.2	4.2
1125	28.96	93%	126,604	3.0	2.8	2.8
1126	0.00	0%	0	0.0	0.0	0.0
1127	0.00	0%	0	0.0	0.0	0.0
1128	0.48	2%	3,004	4.4	0.1	0.1
1129	0.43	1%	2,630	4.3	0.1	0.1
1130	0.67	2%	4,747	4.9	0.1	0.1
1131	0.24	1%	348	1.0	0.0	0.0
1132	0.75	2%	5,443	5.0	0.1	0.1
1133	0.00	0%	0	0.0	0.0	0.0
total gallons			3,902,217			
operating q gpm			87.4			
days/month			31			
os factor			100%			
avg monthly q gpm			87			
avg well q gpm				3.4	2.4	2.4

SUMMARY	
Total days on for 12-month period	342
Total days in period	365
Net onstream factor calc	94%
Total gals out	42,306,316
Avg operating Q gpm	86
Net Q gpm	80

KEY
total time on = number of days in month that pumps are operating
total time = number of days in month of pump on-cycle; excludes off-cycle time
ost (on stream time) = total time on / total time
Q1 = instantaneous pumping rate
Q2 = effective pumping rate on-cycle plus off-cycle time
Q3 = monthly pumping rate including downtime

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Appendix B

Nitrate, Sulfate,
and
Uranium Plume Maps

(See text for an explanation of contouring methods and well-selection criteria)

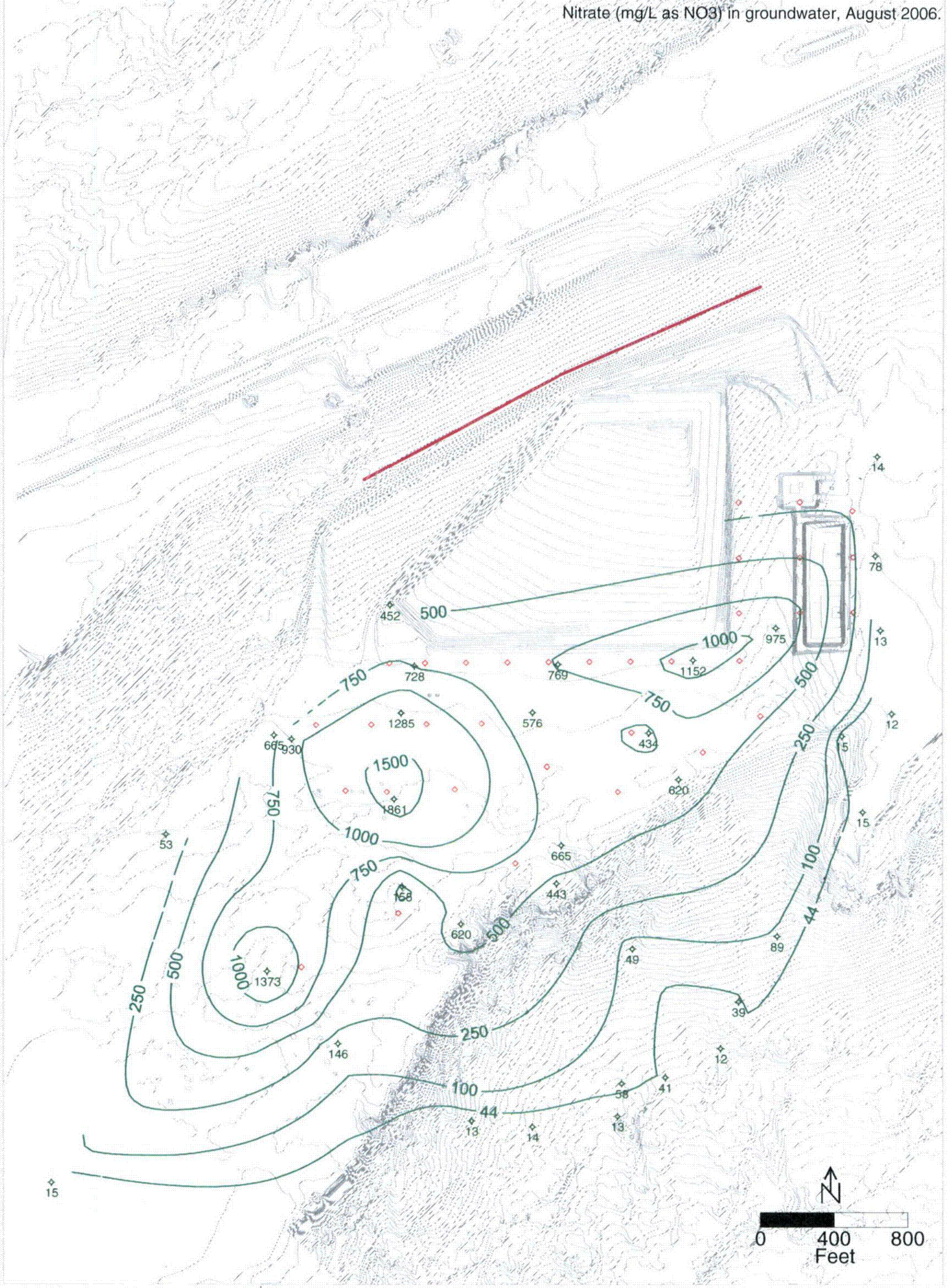

Table B–1. Nitrate (mg/L as NO_3) Plume Map

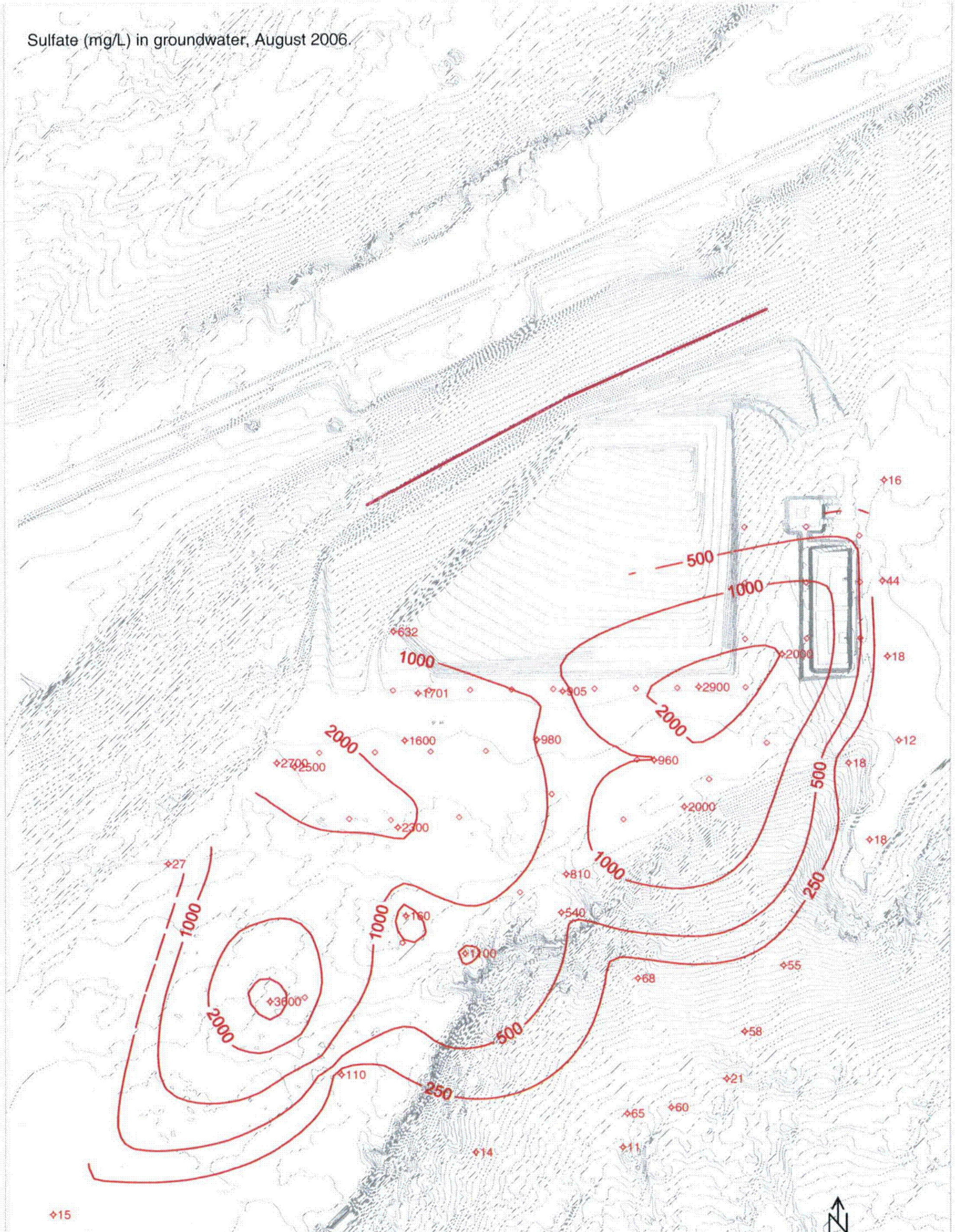

Table B–2. Sulfate (mg/L) Plume Map

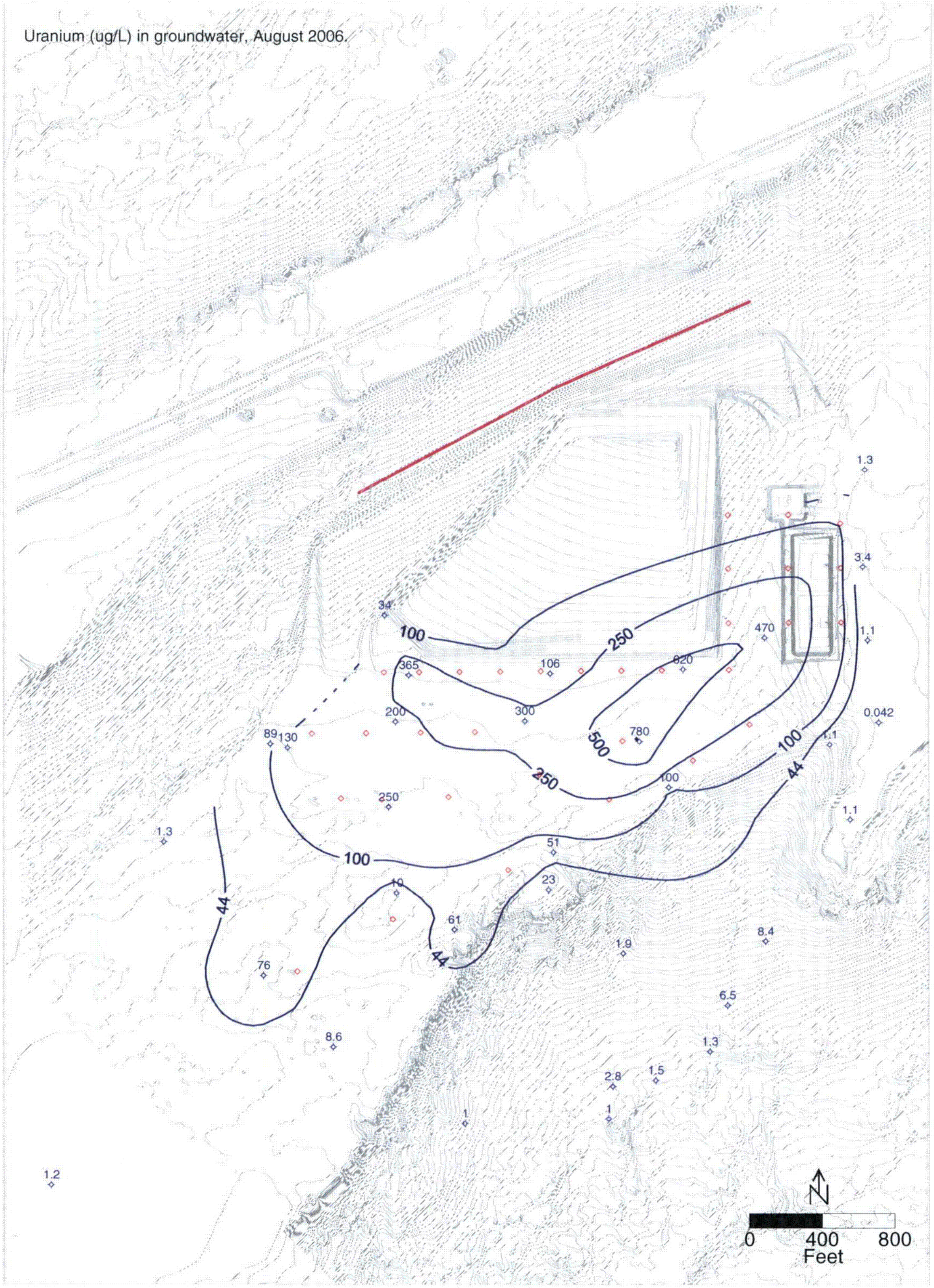

Table B–3. Uranium (µg/L) Plume Map

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