Department of Energy
Office of Legacy Management

WM-48

NOV - 8 2005

Ms. Wendy Naugle
Colorado Department of Public Health and Environment
Remedial Programs Section
Hazardous Materials & Waste Management Division
4300 Cherry Creek Drive
Denver, CO 80246-1530

Subject: *Verification Monitoring Report for the Durango, Colorado, Processing Site*

Dear Ms: Naugle

Enclosed for your review are two copies the *Verification Monitoring Report for the Durango, Colorado, Processing Site* (October 2005). This report is based on results of the annual ground water and surface water sampling event performed during June 2005.

Analytical results from the June 2005 sampling event confirm that natural flushing is measurably reducing contaminant concentrations in the unconfined alluvial aquifer, particularly since the completion of surface remediation, and that the observed rate of contaminant flushing is generally consistent with ground water model predictions. The impact on surface water quality from site-related contaminants remains negligible with no adverse impacts to the Animas River or Lightner Creek.

If you have any question or comments, please call me at (970) 248-6197.

Sincerely,

Tracy Plessinger
Site Manager

Enclosures (2)

cc w/enclosures:
B. VonTill, U.S. Nuclear Regulatory Commission
W. Urbonas, San Juan Basin Health Department
Durango Public Library

cc w/o enclosures:
C. Carpenter, Stoller
D. Miller, Stoller
Project Files DUP 410.02 (Thru D. Roberts)

TBP/Durango/VerMON DUR05.doc

DOE–LM/GJ958–2005

Verification Monitoring Report for the Durango, Colorado, Processing Site

October 2005

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.

DOE-LM/GJ958–2005

Office of Legacy Management

Verification Monitoring Report for the Durango, Colorado, Processing Site

October 2005

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

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Acronyms and Abbreviations

ACL	alternate concentration limit
CDPHE	Colorado Department of Public Health and Environment
CG	concentration goal
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
ft	foot (feet)
ft^3/day	cubic feet per day
GCAP	Ground Water Compliance Action Plan
LM	Legacy Management
MCL	maximum concentration limit
mg/L	milligram per liter
POC	point-of-compliance
RBC	risk-based concentration
UMTRA	Uranium Mill Tailings Remedial Action (Project)
UMTRCA	Uranium Mill Tailings Radiation Control Act

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Executive Summary

This annual report summarizes the progress of ground water restoration through June 2005 at the U.S. Department of Energy Office of Legacy Management site in Durango, Colorado, the location of former uranium-ore milling. Ground water within a low-yield surficial aquifer of limited extent remains contaminated by site-related contaminants of concern that include cadmium, manganese, molybdenum, selenium, sulfate, and uranium. The compliance strategy for ground water restoration is natural flushing with institutional controls to prevent exposure to contaminated ground water. This strategy is based in part on ground water modeling that predicted acceptable cleanup times for each contaminant, except possibly cadmium, by natural processes at the site, and in part on historical trends of decreasing contaminant concentrations, particularly since the completion of contaminant source removal in 1991.

As of June 2005, the observed rate of contaminant flushing is generally consistent with ground water model predictions, given that the validation period to date (June 2002 to June 2005) is short compared to predicted flushing periods (60 to 100 years) for the respective contaminant. Only cadmium was identified in the modeling as potentially incapable of flushing to acceptable levels within 100 years. However, at the single location (well 0612) where cadmium is present above the compliance goal (0.01 mg/L), concentrations have decreased more rapidly to current levels (about 0.02 mg/L) than predicted by the model, suggesting that natural flushing for this constituent is viable. As of June 2005, molybdenum concentrations have decreased to below the compliance goal at all locations. For the remaining contaminants, concentration trends imply that the respective compliance goal will be attained within 100 years and therefore; natural flushing remains a valid compliance strategy for these constituents as well. The impact on surface water quality from site-related contamination remains negligible.

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1.0 Introduction

The Durango, Colorado, Processing Site, managed by the U.S. Department of Energy (DOE) Office of Legacy Management (LM), is located in La Plata County approximately 0.25 mile southwest of the central business district of Durango, Colorado (Figure 1). The site (formerly known as the Durango Uranium Mill Tailings Remedial Action (UMTRA) Project site) consists of two separate areas: (1) the mill area, which is the setting of former uranium-ore milling and storage of residual solid wastes (mill tailings), and (2) a raffinate ponds area where liquid process-wastes were impounded during mill operations. The former mill area encompasses about 40 acres on a bedrock-supported river terrace between Smelter Mountain to the west, the Animas River to the east and south, and Lightner Creek to the north (Figure 2). The raffinate ponds area occupies about 20 acres on a separate river terrace located 1,500 feet (ft) south (downstream) of the mill tailings area.

1.1 Purpose of Report

The purpose of this report is to evaluate and compare the observed to expected progress of passive ground water restoration at the Durango mill site area based on the available water quality data through June 2005. The goal is to confirm that natural flushing remains a viable strategy for the site. The compliance strategy for the raffinate ponds area is no further action in conjunction with supplemental standards and so requires no further discussion in this report.

1.2 Compliance Strategy

The compliance strategy for ground water cleanup at the Durango site is described in *Preliminary Final Ground Water Compliance Action Plan* (GCAP) (DOE 2003) and is based on the selection process presented in *Final Programmatic Environmental Impact Statement for the Uranium Mill Tailings Remedial Action Ground Water Project* (DOE 1996). The compliance strategy for the former mill area is natural flushing, institutional controls to prevent exposure to contaminated ground water, water quality monitoring, and an alternate concentration limit (ACL) for selenium. The selection of this strategy was based in part using ground water flow and solute transport modeling (ground water modeling) to predict cleanup times for each contaminant of concern. Baseline conditions of contaminant concentration in the models correspond to results of June 2002 ground water sampling. The ground water model is fully documented in *Site Observational Work Plan for the Durango, Colorado, UMTRA Project Site* (DOE 2002).

As part of the compliance strategy, public health will be protected during the flushing period through an environmental covenant between the State of Colorado and the City of Durango (landowner) that restricts access to contaminated alluvial ground water. Additionally, deed restrictions (which serve as a notice to the public) for the mill tailings area prohibit access to ground water without written permission from the U.S. Department of Energy (DOE) and the Colorado Department of Public Health and Environment (CDPHE).

2.0 Site Conditions

2.1 Remediation Activities

In 1978, the Uranium Mill Tailings Radiation Control Act (UMTRCA) (42 U.S. Code Section 4321 et seq.) was enacted to control and mitigate risks to human health and the environment from residual radioactive material that resulted from processing uranium ore. UMTRCA authorized DOE to perform remedial action at 24 inactive uranium-ore processing sites; subsequently, two sites were deleted from the project. The Durango site was one of the 22 remaining sites identified for cleanup. After completing an Environmental Impact Statement (DOE 1985), DOE began surface cleanup of the mill tailings and raffinate ponds areas in November 1986 to meet the U.S. Environmental Protection Agency (EPA) standards for radium in soil.

A total of 2.5 million cubic yards of contaminated material was relocated to the Bodo Canyon disposal cell several miles southwest of the Durango site. Supplemental cleanup standards were applied to steep slopes of Smelter Mountain and two regions along the banks of the Animas River. In addition, a small lens of uranium ore was left in place at the mill tailings area below layers of slag along portions of the river. The slag deposits, which are 10 to 15 ft thick in some areas (including the location of well 0612) are associated with a lead smelter that operated on the site from 1880 to 1930. To restore the site, approximately 230,000 cubic yards of uncontaminated soil was backfilled, contoured, and seeded. Rip-rap was placed in some sensitive areas along the Animas River to prevent erosion. Remedial action was completed in May 1991.

2.2 Site Hydrogeology

The uppermost aquifer at the mill tailings area comprises alluvial deposits associated with the Animas River and Lightner Creek, and poorly sorted colluvium derived from adjacent Smelter Mountain, rising steeply to the southwest. About 70 ft of colluvium overlies bedrock along the base of the mountain. These deposits thin eastward and transition to sand and gravel deposits up to 15 ft thick closer to the Animas River. The portion of the aquifer underlying the site occupies a narrow fringe, at most about 250 ft wide, along the Animas River. Depth to ground water increases from about 5 ft on the river terrace to about 60 ft near the base of Smelter Mountain. The saturated zone is thin (<10 ft), unconfined, and directly underlain by Mancos Shale bedrock. Ground water flow is generally northwest to southeast, parallel to the Animas River, at an average gradient of approximately 0.02 foot per foot. Hydraulic conductivity of the alluvium ranges from 10 to 70 ft per day.

The colluvium is recharged primarily by runoff and infiltrating precipitation while the river alluvium receives water from Lightner Creek and from river loss along the upstream reach of the prominent meander. Ground water discharge occurs to the Animas River along the upper and lower thirds of the reach adjacent the mill area. Under average conditions, the estimated volume of ground water discharge from the mill area is 1,480 cubic feet per day (ft^3/day); approximately 840 ft^3/day enters the Animas River near the mouth of Lightner Creek, and the remaining 640 ft^3/day enters the Animas River east of the former east tailings pile (DOE 2002). The alluvial aquifer pinches out against bedrock cliffs near the southeast corner of the site at which point ground water discharged to the river is complete (DOE 2002).

2.3 Water Quality

Ground water in the alluvial aquifer is contaminated as a result of uranium-ore processing and tailings storage at the mill tailings area. Although the primary source of ground water contamination (mill tailings) was removed from the site by 1991, concentrations of arsenic, cadmium, lead, molybdenum, net alpha, radium-226+228, selenium, and uranium in the underlying aquifer remained in excess of UMTRA maximum concentration limits (MCLs). Concentrations of arsenic, lead, and radium have since decreased to levels below the UMTRA MCLs, and net alpha was detected only sporadically in a few wells. Monitoring for arsenic, lead, radium, and net alpha was discontinued in 2002 in accordance with provisions of the GCAP (DOE 2003).

Table 1 compares the maximum concentrations of the remaining site contaminants detected in June 2005 to the corresponding compliance goals. As indicated in Table 1, the compliance goals for cadmium, molybdenum, and uranium are UMTRA MCLs. The compliance goal for selenium (0.05 mg/L) is adopted from the U.S. Environmental Protection Agency Safe Drinking Water Act as an alternate concentration limit (ACL) to the UMTRA MCL (0.01 mg/L). An ACL was established for selenium because of naturally abundant selenium in ground water above the UMTRA standard. There are no UMTRA MCLs for manganese and sulfate. The compliance goal for manganese is EPA's Drinking Water Equivalent Level (DWEL). This is a lifetime exposure concentration protective of adverse, non-cancer health effects, that assumes all of the exposure to a contaminant is from drinking water (EPA 2004). The sulfate goal is equivalent to its average background concentration in ground water.

Table 1. Current Ground Water Contaminants and Compliance Goals

Contaminant of Concern	Compliance Goal (mg/L)	Compliance Goal Source	Maximum Concentration Observed in June 2005 (mg/L)
Cadmium	0.01	UMTRA MCL	0.021
Manganese	1.6	DWEL (EPA 2004)	3.4
Molybdenum	0.1	UMTRA MCL	0.087
Selenium	0.05	Alternate Concentration Limit (DOE 2002)	0.069
Sulfate	1,276	Average background (DOE 2002)	2,900
Uranium	0.044	UMTRA MCL	1.3

Current monitoring of the Animas River verifies previous findings in the *Baseline Risk Assessment of Ground Water Contamination at the Uranium Mill Tailings Site near Durango, Colorado* (DOE 1995) that past milling operations have negligible effect on surface water quality. Historical results indicate that constituent concentrations adjacent and downstream of the mill area are indistinguishable from background.

2.4 Water and Land Use

The primary water source for the city of Durango is the Florida River upstream of its confluence with the Animas River; additional water is withdrawn from the Animas River during high-demand periods (usually during the summer) from a location about 2 miles upstream of the mill tailings area. The Animas River bordering the mill tailings area of the Durango site is popular for seasonal boating and fishing. Development plans for the mill tailings area include municipal but not residential use (DOE 2002).

3.0 Water Quality Monitoring

3.1 Scope of Water Quality Monitoring

Annual ground water and surface water monitoring will continue through the first 5 years following U.S. Nuclear Regulatory Commission concurrence with the GCAP (DOE 2003). Monitoring for cadmium will continue annually for the first 10 years following concurrence because of the greater uncertainty of this constituent to flush within the allotted 100-year period under UMTRA. Monitoring data obtained through the initial 5-year period will measure the actual progress of natural flushing of the constituents listed in Table 1. After the five-year annual monitoring period, a Confirmation Report will be prepared to status ground water restoration and ground water model validity. Also at that time, the scope of subsequent monitoring will be addressed in a Long-Term Management Plan.

Monitoring wells 0612, 0617, 0630, 0631, 0633, 0634, 0635, and 0863 have been established as point-of-compliance wells that will be used to monitor the progress of natural flushing in the alluvial aquifer. In accordance with provisions of the GCAP (DOE 2003), natural flushing for a given analyte is complete when its concentration no longer exceeds the respective compliance goal at the compliance wells for three consecutive annual sampling events. Monitoring for that constituent may then be discontinued. Surface water locations 0652, 0584, 0691, and 0586, located along the Animas River, will be monitored on schedule with ground water monitoring to verify continued protection of the aquatic environment. Compliance monitoring requirements and rationale are summarized in Table 2. Ground water and surface water compliance monitoring locations are shown in Figure 2.

Table 2. Annual Ground Water and Surface Water Compliance Monitoring Requirements

Sampling Location	Monitoring Purpose	Analytes	Location
Ground Water Monitoring			
0617, 0630, 0631, 0633, 0634, 0635	Point of compliance/verify natural flushing	Manganese Molybdenum Selenium Sulfate Uranium	On site
0612, 0863	Point of compliance/verify natural flushing; verify cadmium flushing	Cadmium Manganese Molybdenum Selenium Sulfate Uranium	On site downgradient
Surface Water Monitoring			
0652	Surface water background	Cadmium Molybdenum Selenium Uranium	Off site upstream
0584, 0691	Verify no site-related increase above background		Off site; site ground water discharge area
0586	Verify no site-related increase above background		Off site; downstream of site ground water discharge

3.2 Water Quality Monitoring Results

Table 3 summarizes the model-predicted times for natural flushing to achieve the compliance goal for cadmium, manganese, molybdenum, selenium, sulfate, and uranium. The progress of each, based on water quality data through June 2005, is addressed separately in the following subsections. Important reference dates for comparing observed to model-predicted concentration trends include the start of water quality monitoring at some but not all location in 1982, removal of the primary source of ground water contamination between 1986 and 1991, and June 2002 as the ground water model baseline condition (time zero) for contaminant transport. The predicted compliance times listed in Table 3 differ because the contaminants initially were not distributed evenly and vary in degree of contamination above the respective compliance goal, and because each contaminant varies in its mobility in the aquifer.

Table 3. Model-Predicted Ground Water Restoration Times

Analyte	Compliance Goal (mg/L)	Predicted Compliance Time (yr)[a]	Predicted Compliance Date[b]
Cadmium	0.01	>>100	>>2102
Manganese	1.6	70	2072
Molybdenum	0.1	5	2007
Selenium	0.05	60	2062
Sulfate	1,276	100	2102
Uranium	0.044	80	2082

[a] Source: DOE 2002, Appendix G, Table 18.
[b] Model time zero (baseline) is June 2002.

3.2.1 Cadmium

Figure 3 is a map view of the site showing the concentration of cadmium at the compliance wells in June 2005. Figure 4 illustrates observed cadmium concentrations at the compliance wells since monitoring began at the site in 1987. Historically and in June 2005, cadmium in excess of the MCL occurs only at well 0612 while the remaining monitor wells contained only trace levels of this element. Ground water modeling predicted a flushing period of about 500 years for cadmium. This result is not consistent with historical trending at well 0612, which if projected linearly beyond June 2005, implies compliance for cadmium by year 2031, or 29 years from the baseline (trend projection not shown in Figure 4). Trending since completion of surface remediation in 1991 suggests yet more rapid flushing of cadmium than the historical trend. Projecting this trend too far into the future may underestimate the actual restoration period because of non-linear effects that lead to concentration tailing, particularly at later times, that is commonly observed in nature and predicted by the solute transport models. Natural flushing of cadmium however remains a viable strategy because of its very limited distribution at the site, the relatively low magnitude of contamination (only two-times greater than the compliance goal), and the observed net decrease in concentration over time.

3.2.2 Manganese

Figure 6 and 7, respectively, illustrate manganese concentrations in June 2005 and the variation over time of manganese concentrations at the compliance wells. The June 2005 results are typical for manganese in that the compliance goal was exceeded only at well 0612, excepting the anomalous pulse in 1994 – 1995 (Figure 7). Projecting the observed concentration trend at well 0612 since 1982 (extrapolation not shown in Figure 7) implies that natural flushing will be complete at that location in the year 2043, well within the 100 year UMTRA time allotment and in close agreement with the model prediction (Figure 8) which is approximately linear in through the initial 40 years. The net decrease in the concentration of manganese observed through the relatively brief period since June 2005 is not inconsistent with the model prediction for this location. Because well 0612 is very close to the downgradient discharge boundary of the aquifer, contaminant migration from that area will not affect other regions of the aquifer. The flushing period corresponding to well 0612 therefore represents a site-wide maximum for manganese because the goal is not exceeded at any other location. The ground water model also correctly forecast declining concentrations of manganese observed recently at well 0630 (Figure 9), one location other than 0612 where the compliance goal was exceeded on occasion in the past.

3.2.3 Molybdenum

Molybdenum concentrations in June 2005 were less than the compliance goal of 0.1 mg/L at all locations (Figure 10). With the single exception of well 0617 in 1988, molybdenum in excess of the compliance goal had previously been limited to well 0612 only (Figure 11). Ground water modeling accurately predicted achieving the compliance at well 0612 goal in 2005 (Figure 12). Extrapolating the linear fit to observed concentrations at well 0612 (extrapolation not shown in Figure 11) forecast molybdenum flushing complete in 2006.

3.2.4 Selenium

Figure 13 shows in map view that the compliance goal for selenium (0.05 mg/L) was exceeded in June 2005 at wells 0617 (0.54 mg/L) and 0633 (0.069 mg/L) only. Selenium concentrations commonly exceeded the compliance goal at these locations (Figure 14) in the past, and at well 0612 on occasion until the mid-1990s after which concentrations have remained below the goal (for clarity, the vertical scale has been modified to exclude anomalous results of 1.6 and 1.2 mg/L selenium at well 0612 in 1982 and 1983).

To date, concentrations at well 0617 exhibit a net decline since monitoring began at the site (Figure 14). Extrapolating that trend implies that natural flushing was complete at well 0617 in 1998. The compliance goal was met in 1999 and 2000 at this location, but concentrations have increased slightly since then. Given the marginal level of contamination and historical trend (since 1982), selenium flushing in the area of well 0617 is likely to occur within the model-predicted time (6 years from June 2002, Figure 15).

At well 0633 a consistent trend has not yet established for selenium (Figure 14). Instead, concentrations fluctuate between about one-half and two times the compliance goal. Model-predicted selenium concentrations drop below the ACL by the year 2020 (Figure 16) at this location, a result that is not consistent with the net static condition observed there. Well 0633 is screened 90 percent in Mancos Shale, a recognized source of readily mobilized selenium (DOE 2002).

The low-level selenium contamination at the site may in part be site-related; however, some contribution from natural sources is likely, as evidenced by concentrations greater than 0.01 mg/L at background well 0622 (not shown in figures). Historical results indicate that concentrations of all other uranium-ore processing related constituents are below compliance goals at the background locations.

3.2.5 Sulfate

Sulfate concentrations that exceed background levels are related to the former use of sulfuric acid in the milling process. In June 2005, sulfate exceeded the average background concentration at each compliance well except wells 0631 and 0863 (Figure 17), typically only by a factor of two or less. Observed concentrations since 1982 fluctuate considerably at a given well but generally without obvious trending; however, projecting best-fit lines to the data reveals that sulfate flushing will be complete at most locations by about 2062 (sixty year flushing period since June 2002). Exceptions include positively sloping trends at well 0635, where concentrations have typically been below the compliance goal, and at well 0617. If the low concentrations measured at well 0617 are omitted from linear trend analysis, the flushing period is projected to be about 90 years since June 2002 at this location, which is similar to the corresponding model prediction (Figure 19). The model predicts a similar time frame for well 0612 (Figure 20). Model predicted sulfate concentration decrease linearly throughout the flushing period. Considering only the most recent data (since June 2002), sulfate concentrations at both these locations are declining faster than predicted.

3.2.6 Uranium

The uranium compliance goal was exceeded at each location except wells 0635 and 0863 in June 2005 (Figure 21). This outcome is consistent with previous monitoring results except that concentrations at well 0634 were occasionally below the goal (Figure 22). Well 0612 has historically contained the highest uranium concentration of any well at the site. During the 1980s through the mid 1990s, uranium exceeded 3 mg/L much of the time (Figure 22) at that location but has since more than halved, likely the result of source removal. Similar to well 0612, concentration trends are decreasing at the remaining wells where uranium contamination is greatest (wells 0617, 0631, and 0633) following source removal. Uranium concentrations at remaining locations (wells 0630 and 0634) are relatively steady at or slightly above the compliance goal.

Ground water model predictions indicate that site-wide uranium flushing will be complete within about 80 years as of June 2002. To date, observed concentrations at the two wells having the greatest uranium concentrations (wells 0612 and 0633), which are widely separated in the aquifer, are in close agreement with the model results (Figures 23 and 24, respectively). The predicted flushing period for these two wells (about 45 years from June 2002) differs from the predicted, site-wide time because the last area to flush is south of the downgradient-most monitoring well (well 0612). Linear projection of the observed concentration trends implies site-wide uranium flushing by about year 2027. The model predicts similar rates of flushing through that time to concentrations that only slightly exceed the compliance goal (Figures 23 and 24), followed by a period of much less rapid flushing and marginal levels of contamination (concentration tailing) until the goal is attained.

4.0 Year in Review Summary

- Observed concentration trends, particularly since the completion of source removal, confirm that natural flushing is measurably reducing contaminant concentrations at the site.
- The observed rate of contaminant flushing is generally consistent with ground water model predictions, given that the validation period to date (June 2002 to June 2005) is short compared to predicted flushing periods (60 to 100 years) for the respective contaminants.
- Projected concentration trends and model consistency with observed conditions imply that natural flushing remains a viable compliance strategy for the site.
- At the single location (well 0612) where cadmium is present above the compliance goal (0.01 mg/L), concentrations have recently decreased more rapidly (to about 0.02 mg/L) than predicted by the model. Contrary to the model prediction, this outcome implies that natural flushing of cadmium may be complete within 100 years of the baseline (June 2002). The viability of this developing trend will be evaluated through the additional 5 years of annual monitoring for cadmium prescribed in the GCAP (DOE 2003).
- Molybdenum concentrations decreased to less than the compliance goal at all locations in June 2005.
- The impact on surface water quality from site-related contaminant remains negligible.

5.0 Recommendations

- Continue to monitor ground water and surface water quality at the currently established compliance network.
- Evaluate the need for continued monitoring at well 0863. There is no evidence of site-related contamination at this location past or present. Concentrations of contaminants of concern at this location are indicative of background conditions.
- Analyze all water samples for the same suite of constituents for each sampling event to assist in evaluating contaminant migration trends.

6.0 References

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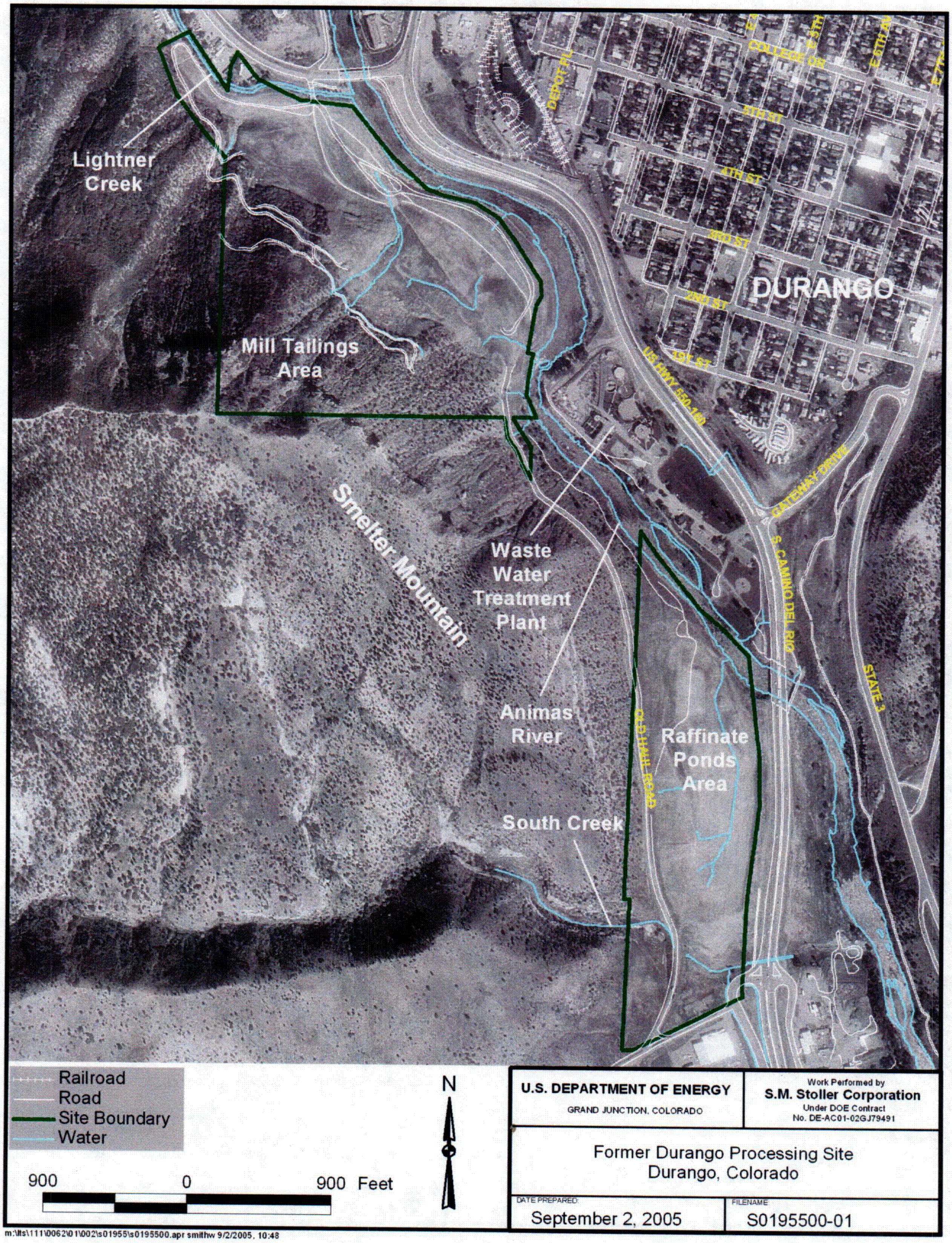

Figure 1. Durango LM Project Site

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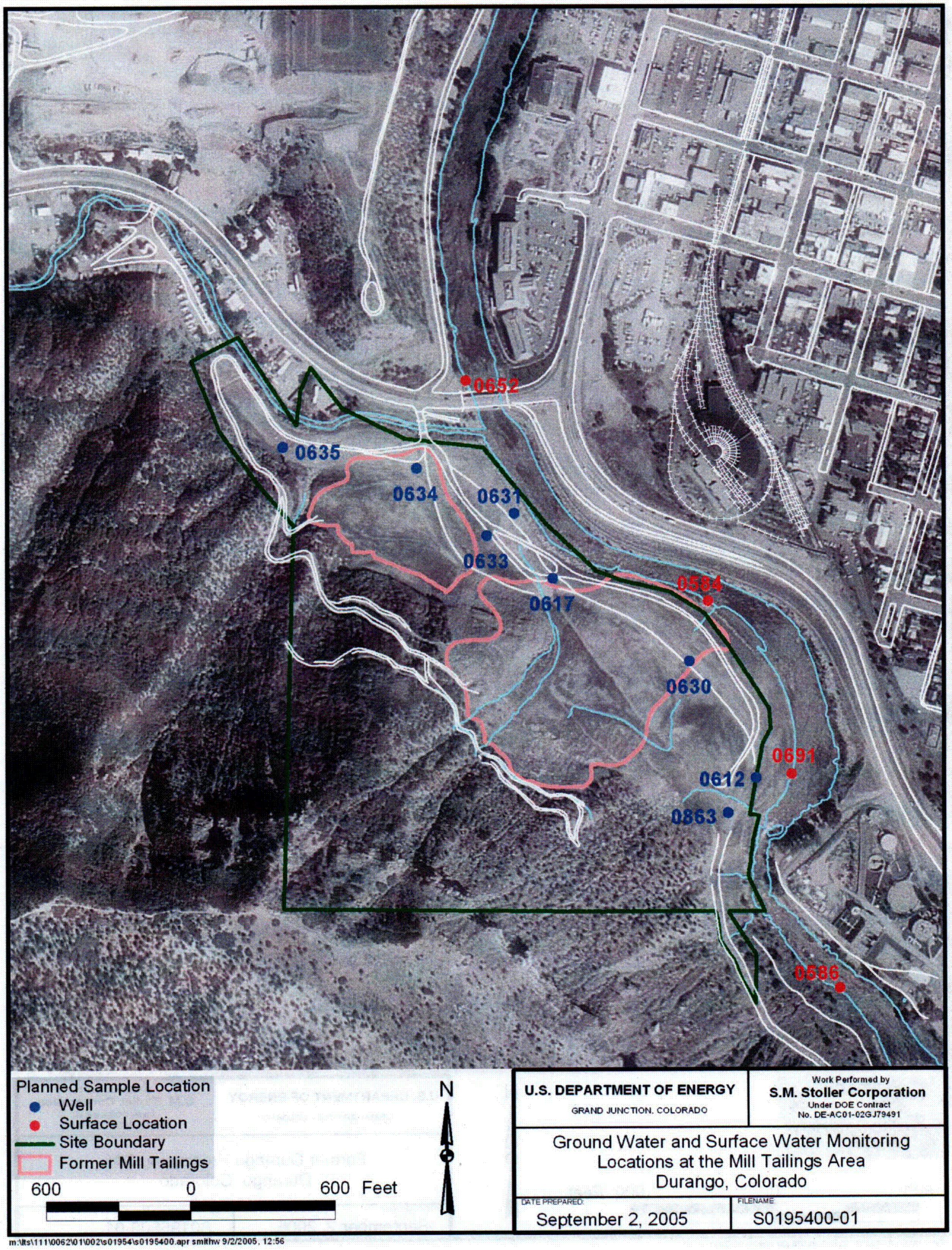

Figure 2. Durango LM Project Site: Mill Tailings Area

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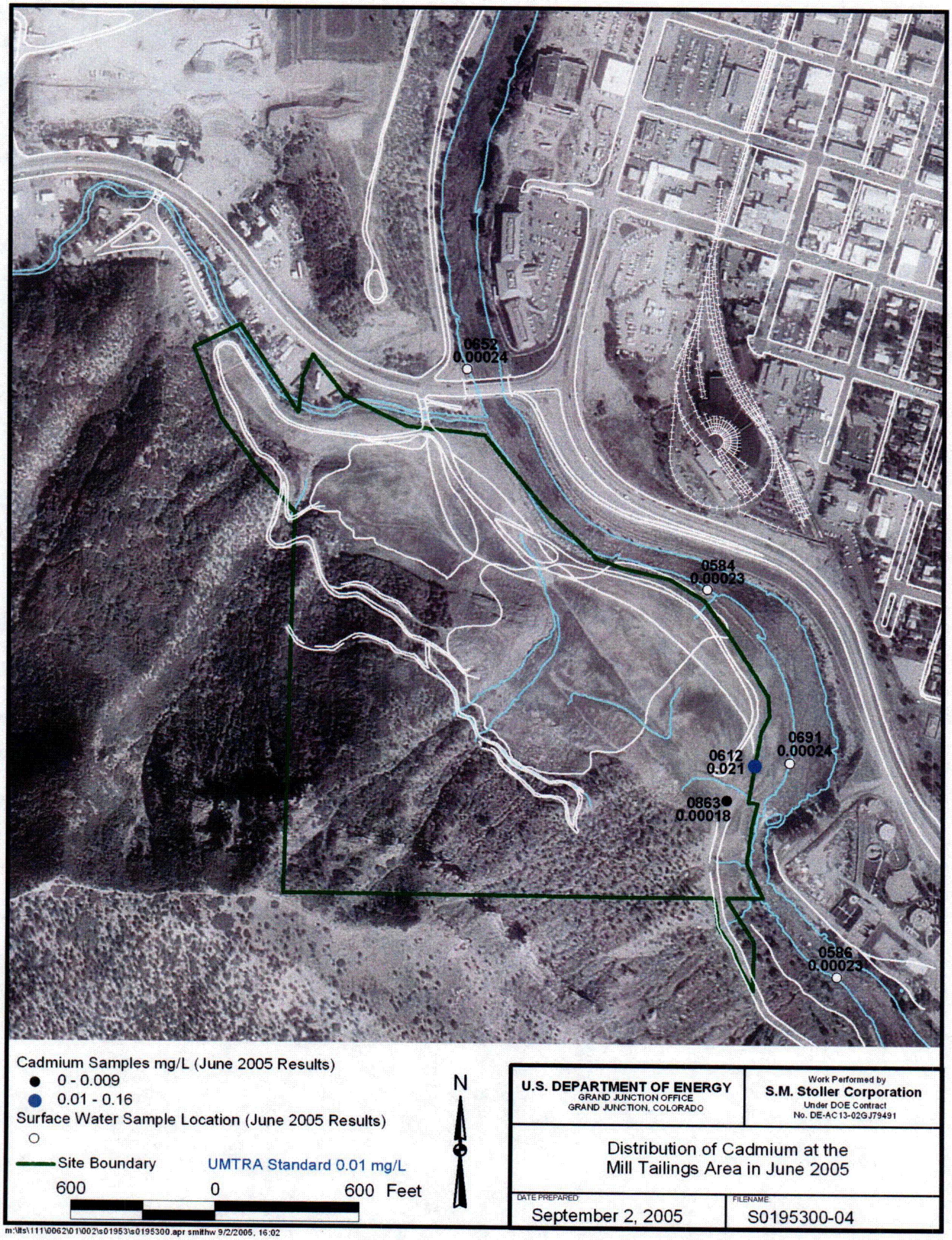

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Figure 3. Distribution of Cadmium in Ground Water and Surface Water, June 2005

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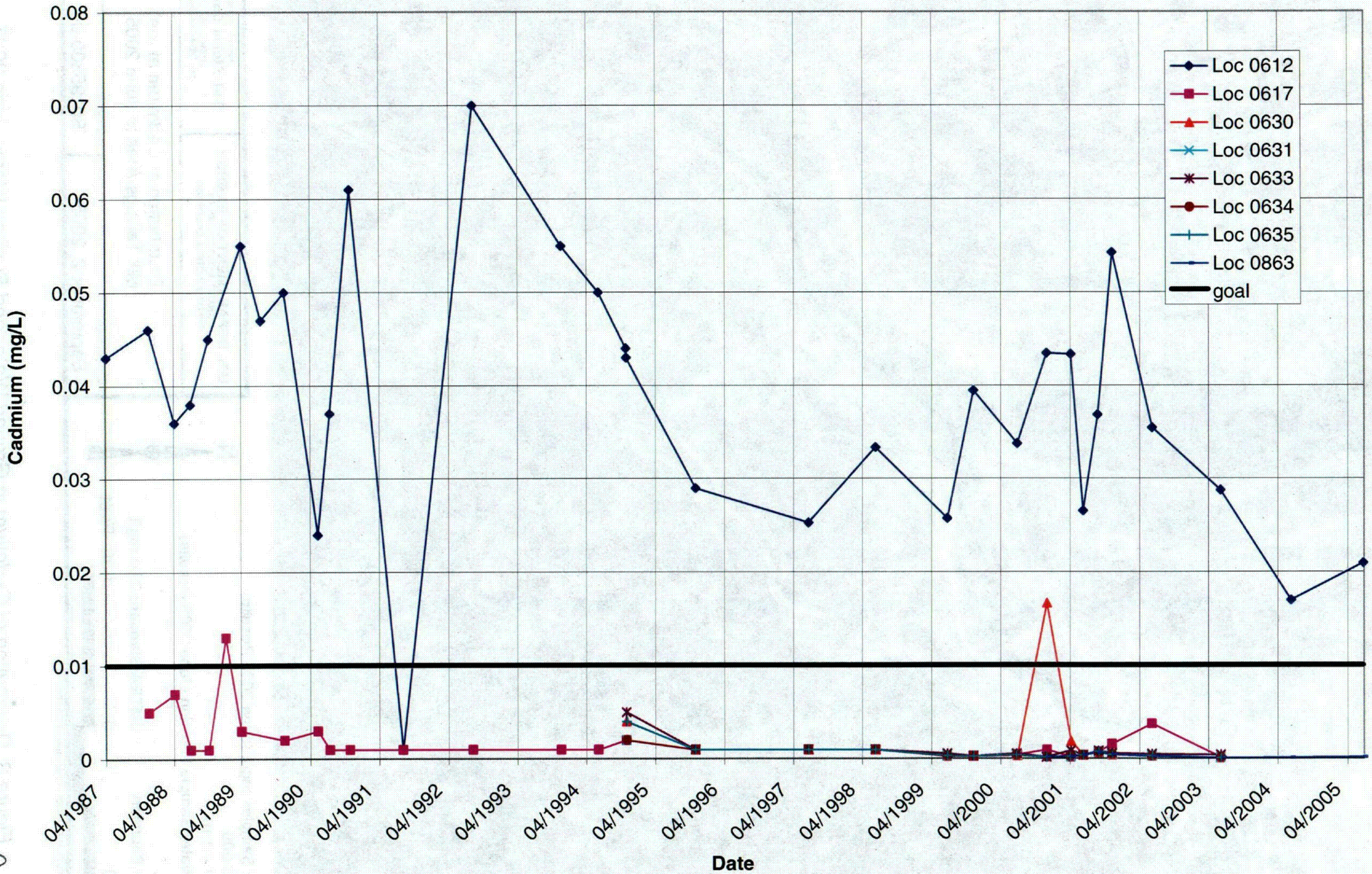

Figure 4. Historical Cadmium Concentrations at Compliance Wells

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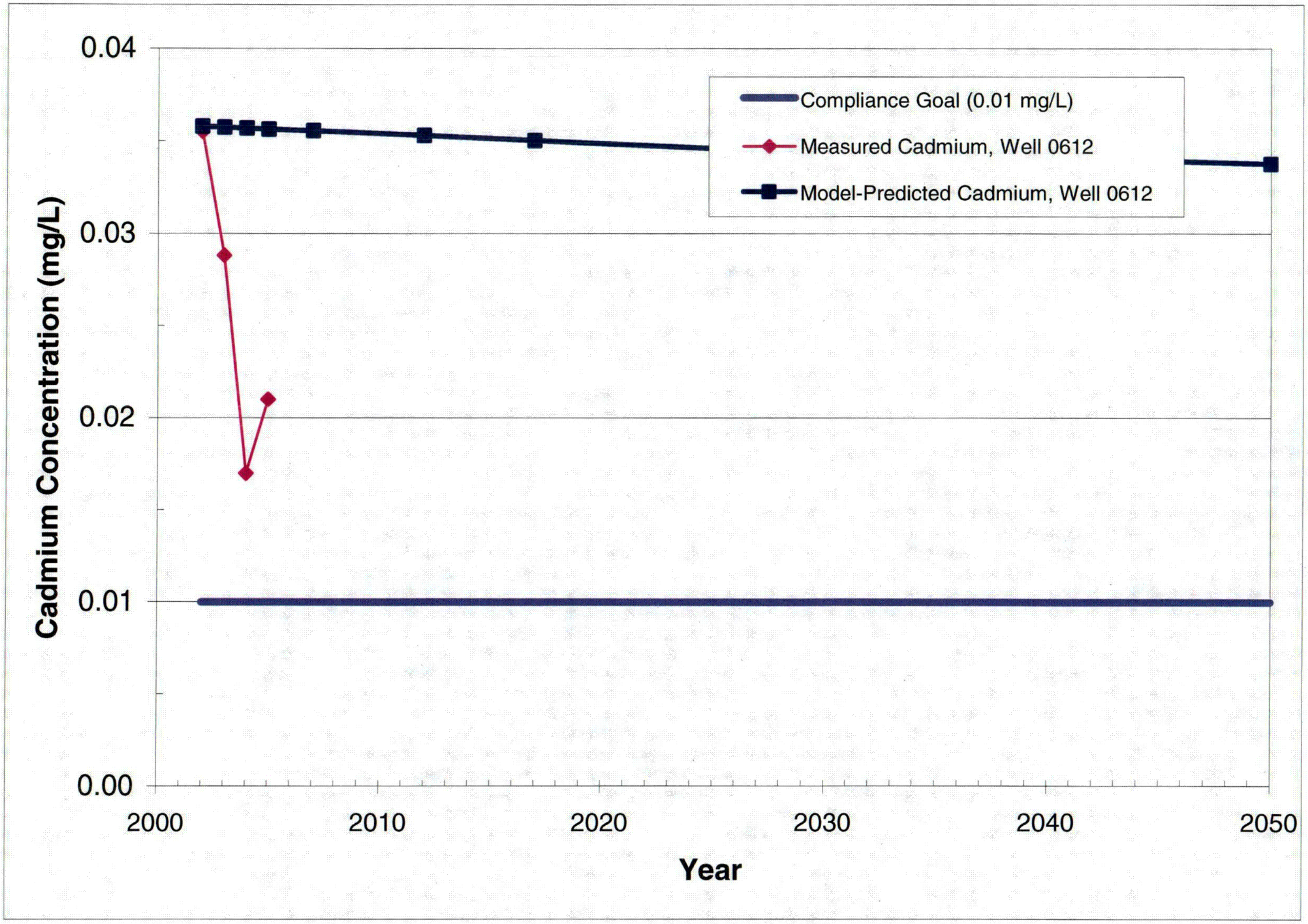

Figure 5. Measured and Model-Predicted Cadmium Concentrations at Well 0612

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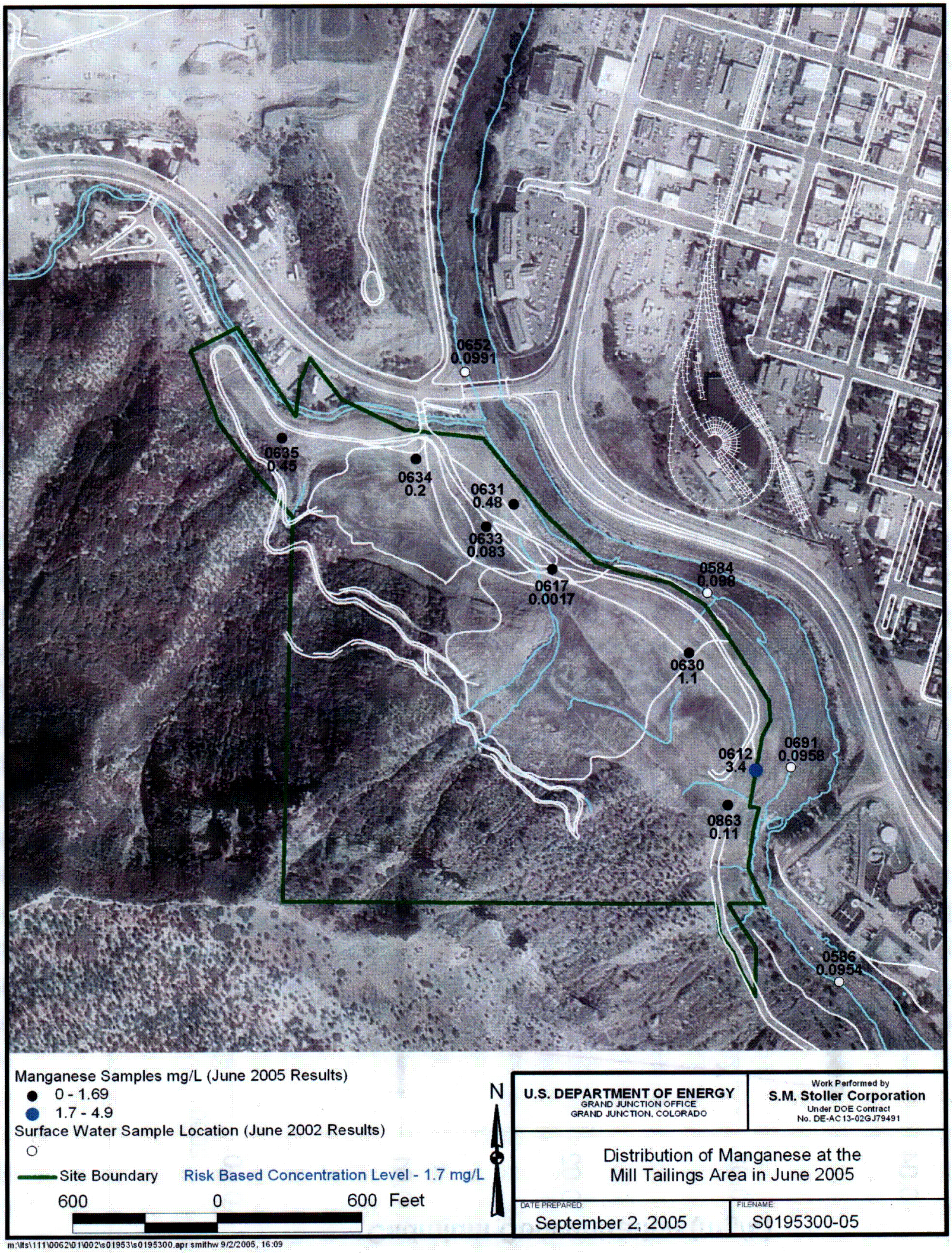

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Figure 6. Distribution of Manganese in Ground Water and Surface Water, June 2005

C-06

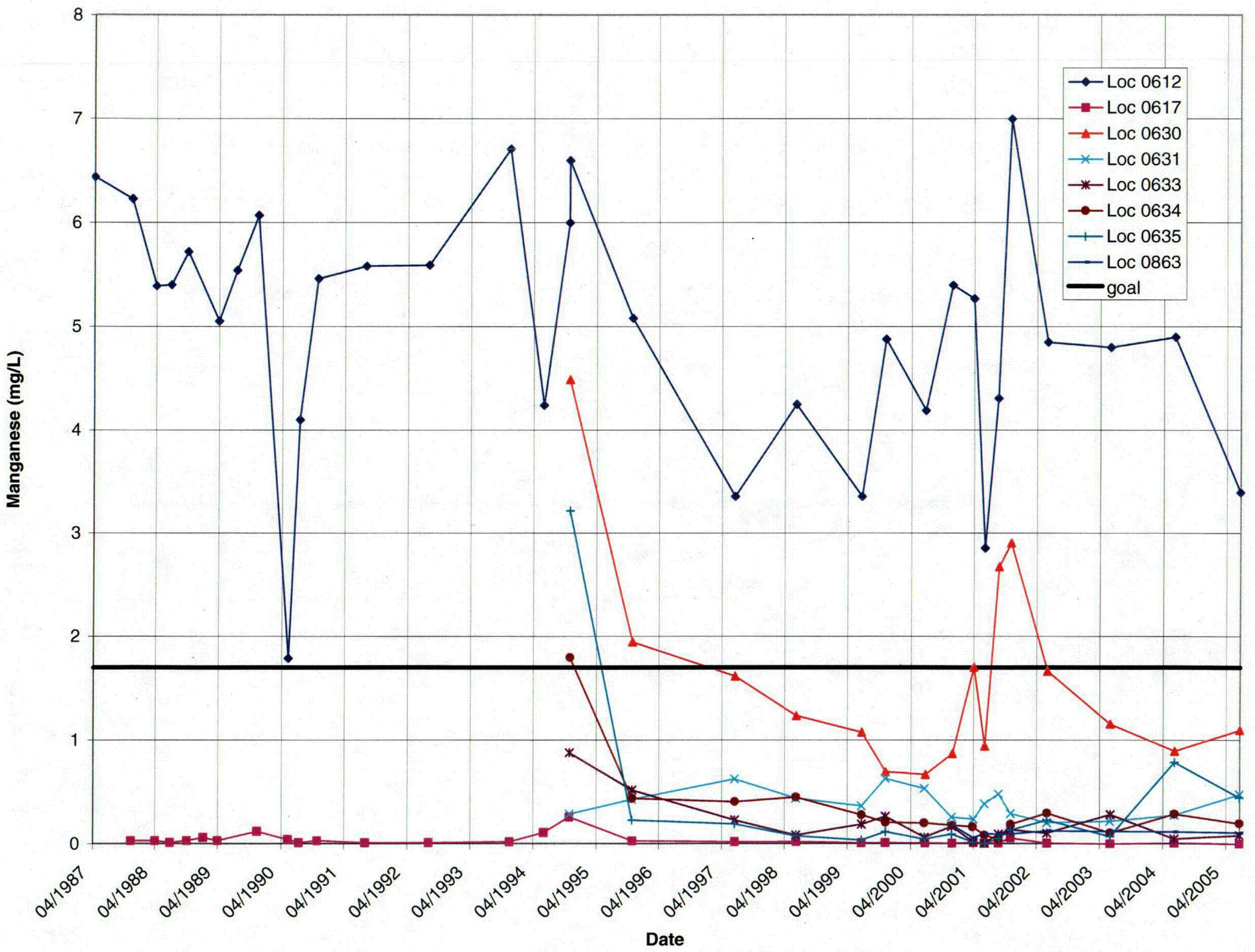

Figure 7. Historical Manganese Concentrations at Compliance Wells

C-07

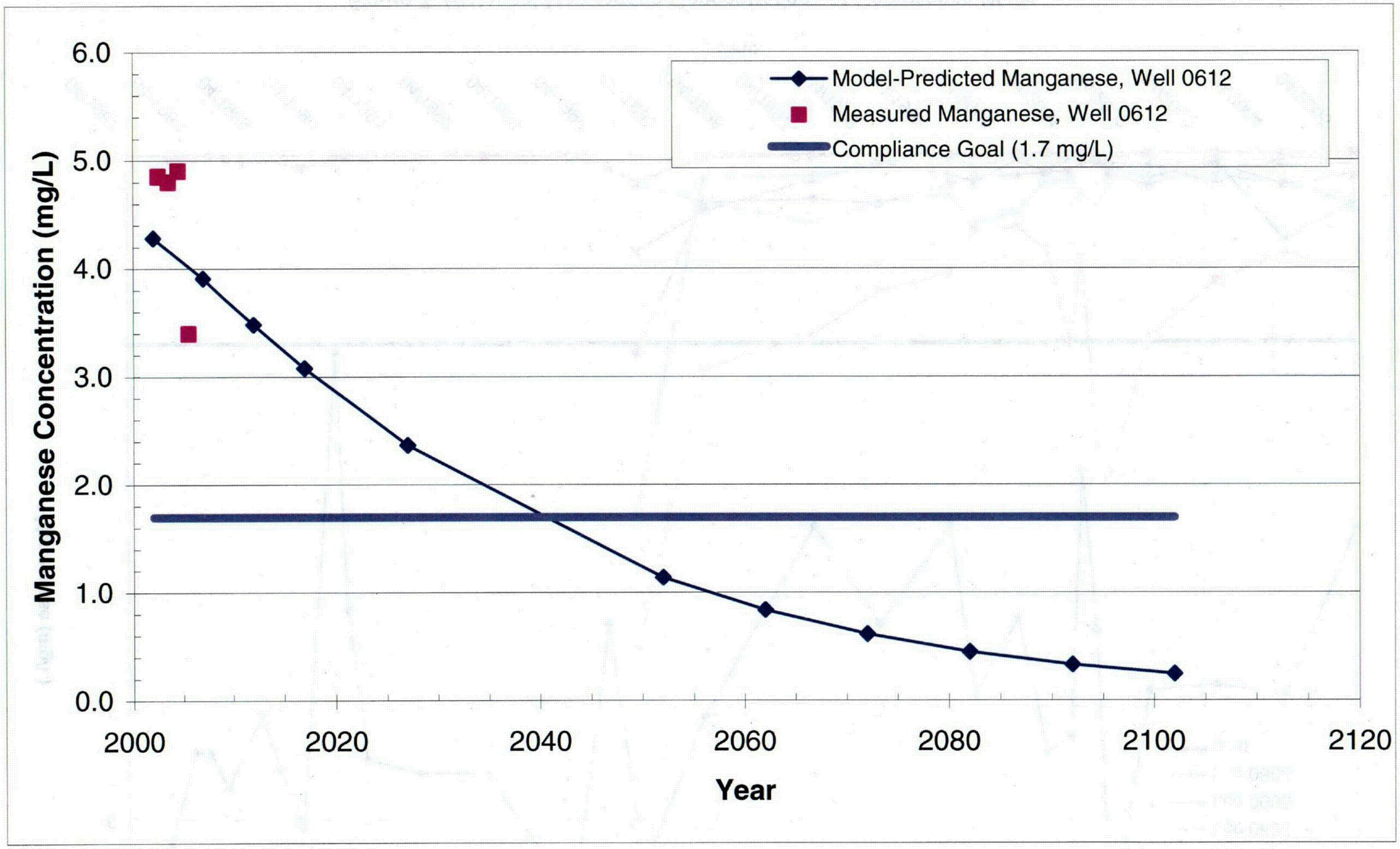

Figure 8. Measured and Model-Predicted Manganese Concentrations at Well 0612

C-086

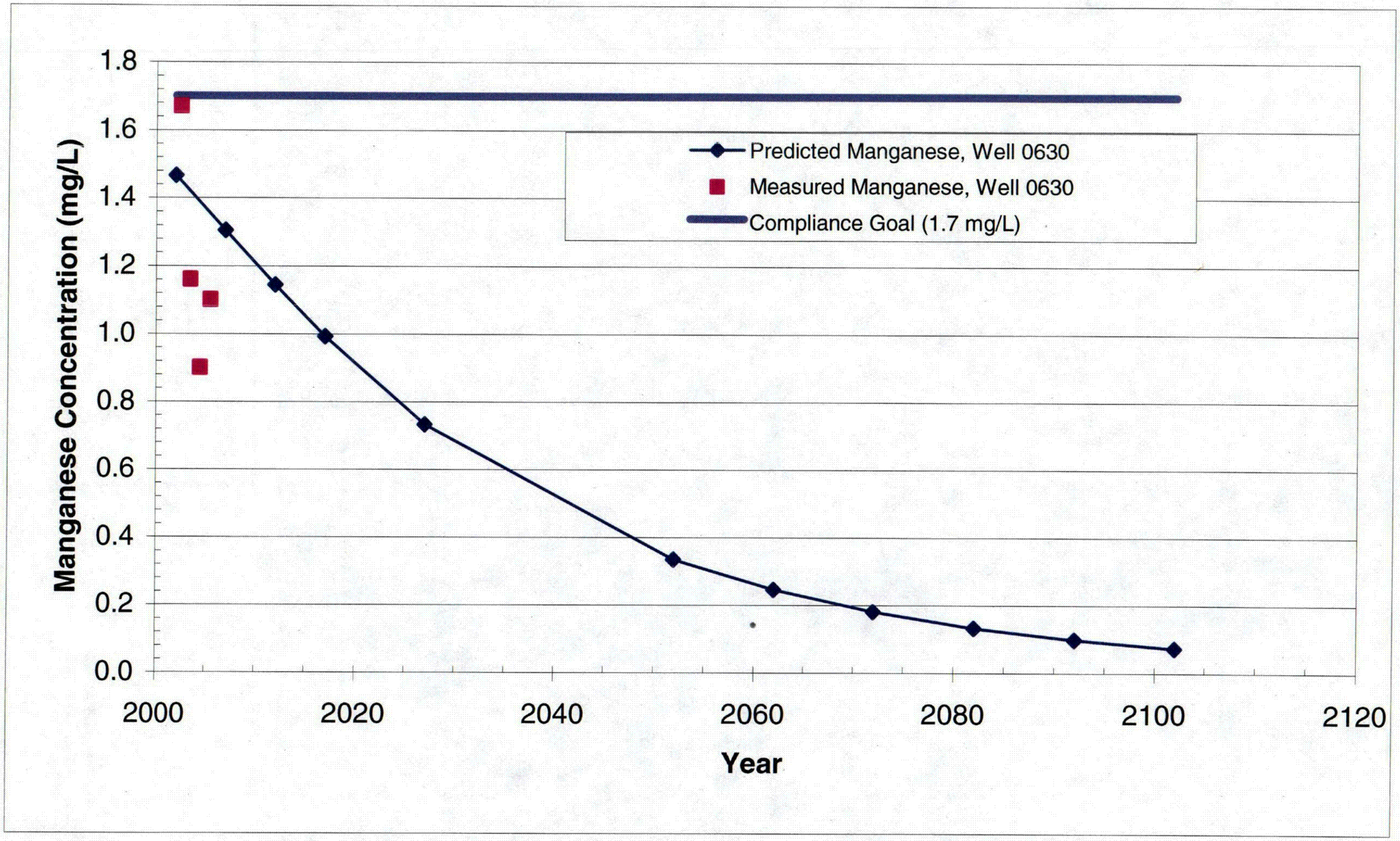

Figure 9. Measured and Model-Predicted Manganese Concentrations at Well 0630

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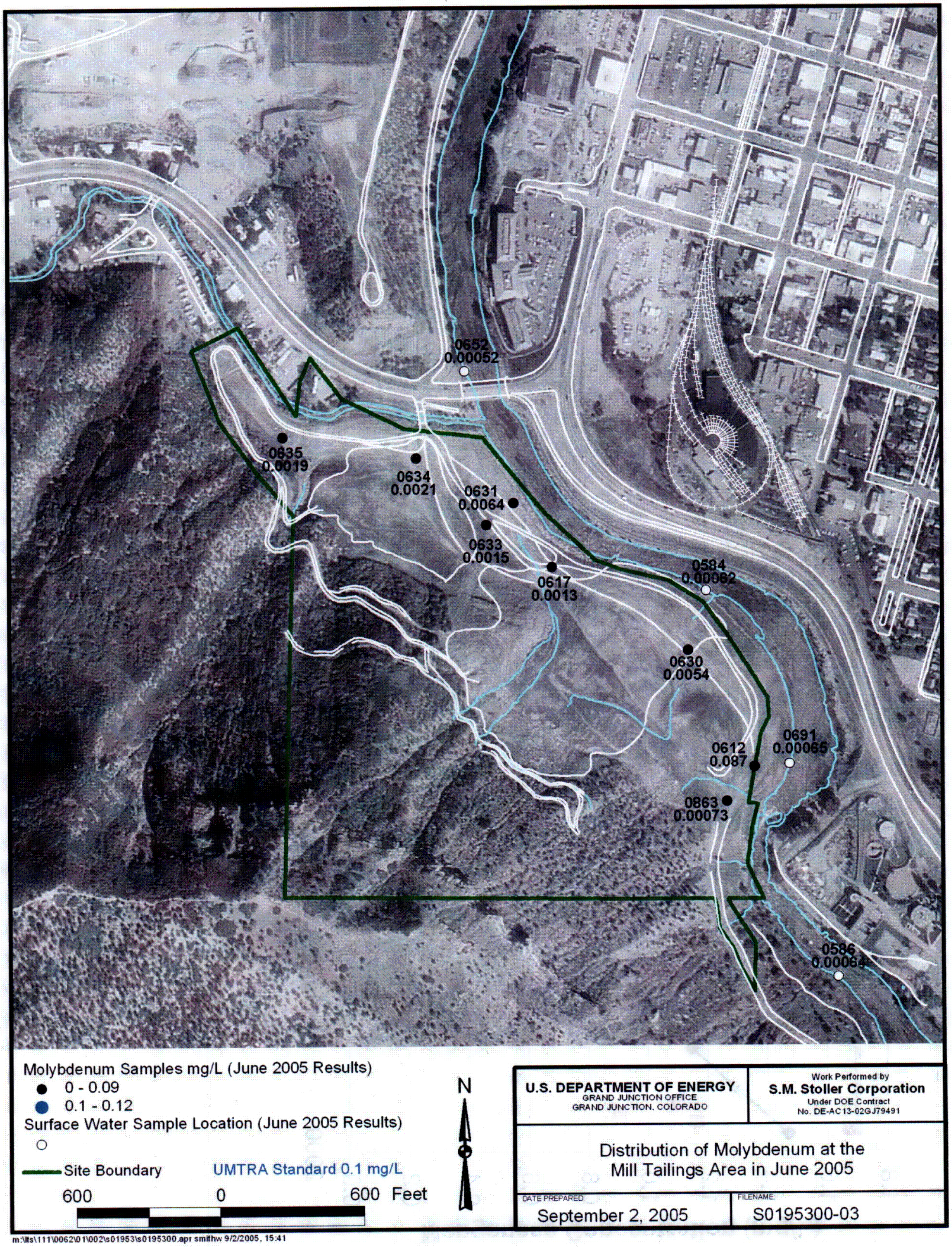

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Figure 10. Distribution of Molybdenum in Ground Water and Surface Water, June 2005

C-10

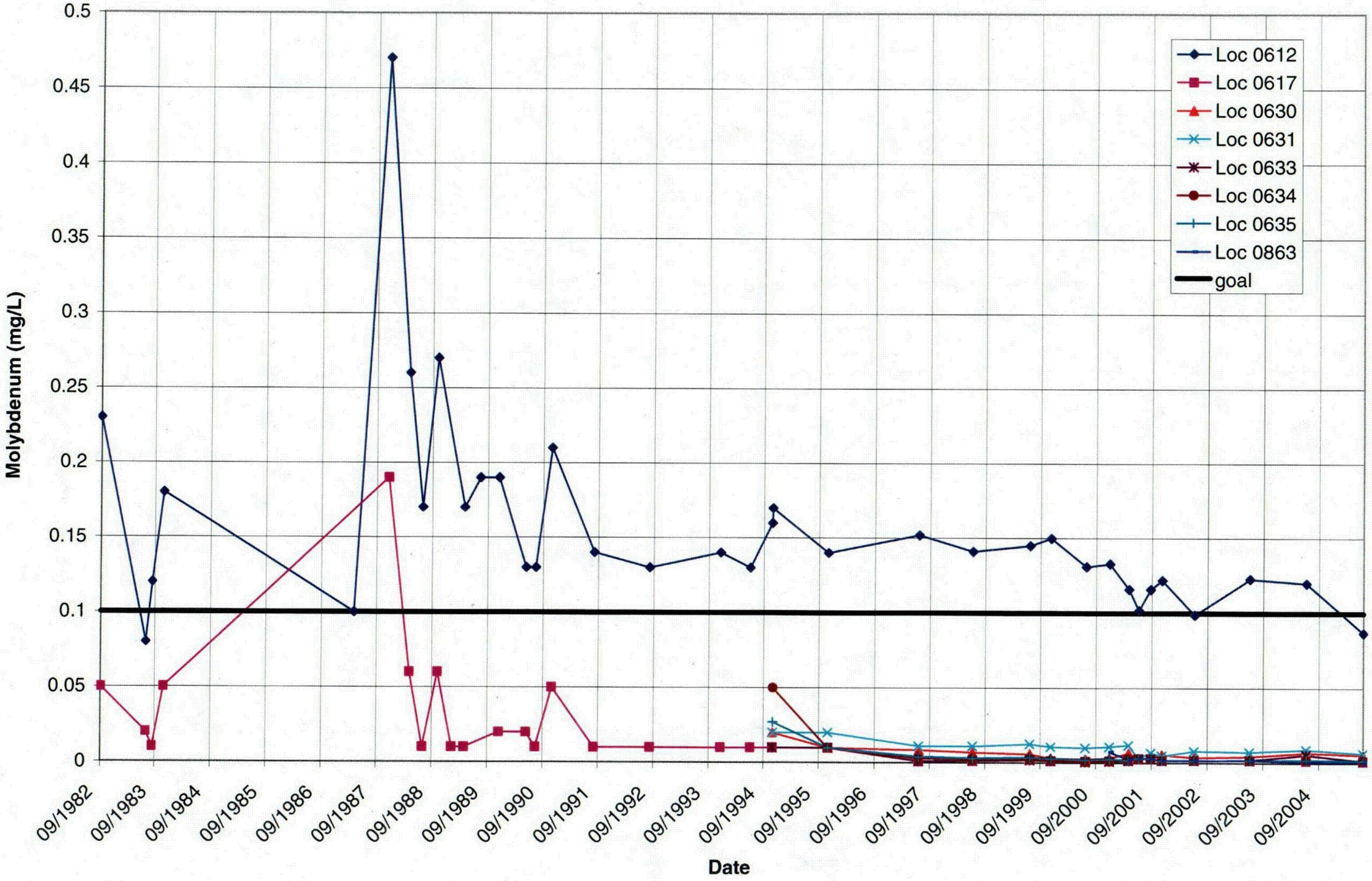


Figure 11. Measured and Model-Predicted Manganese Concentrations at Well 0612

C-11

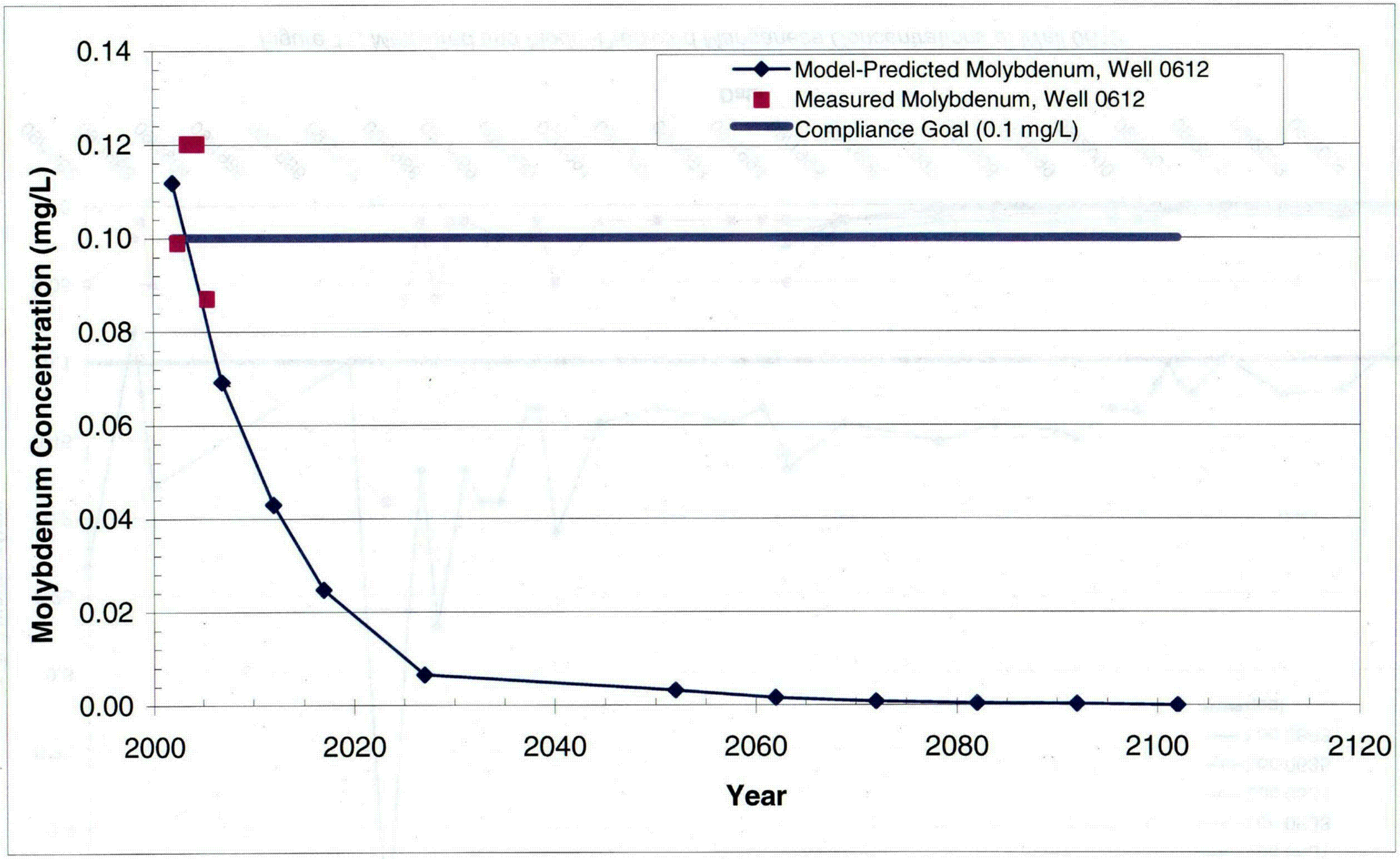
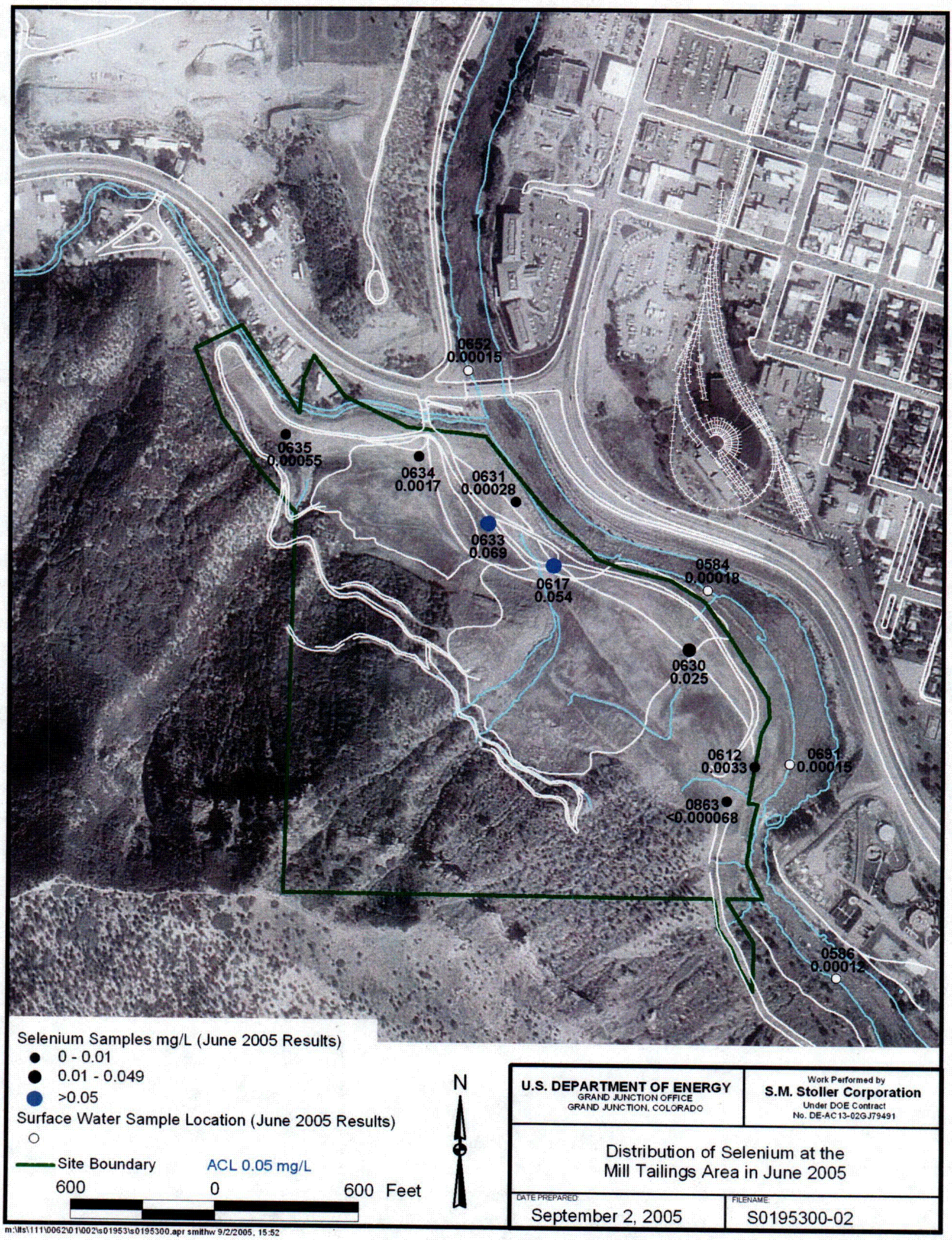


Figure 12. Measured and Model-Predicted Manganese Concentrations at Well 0612



m:\lts\111\0062\01\002\s01953\s0195300.apr smithw 9/2/2005, 15:52

Figure 13. Distribution of Selenium in Ground Water and Surface Water, June 2005

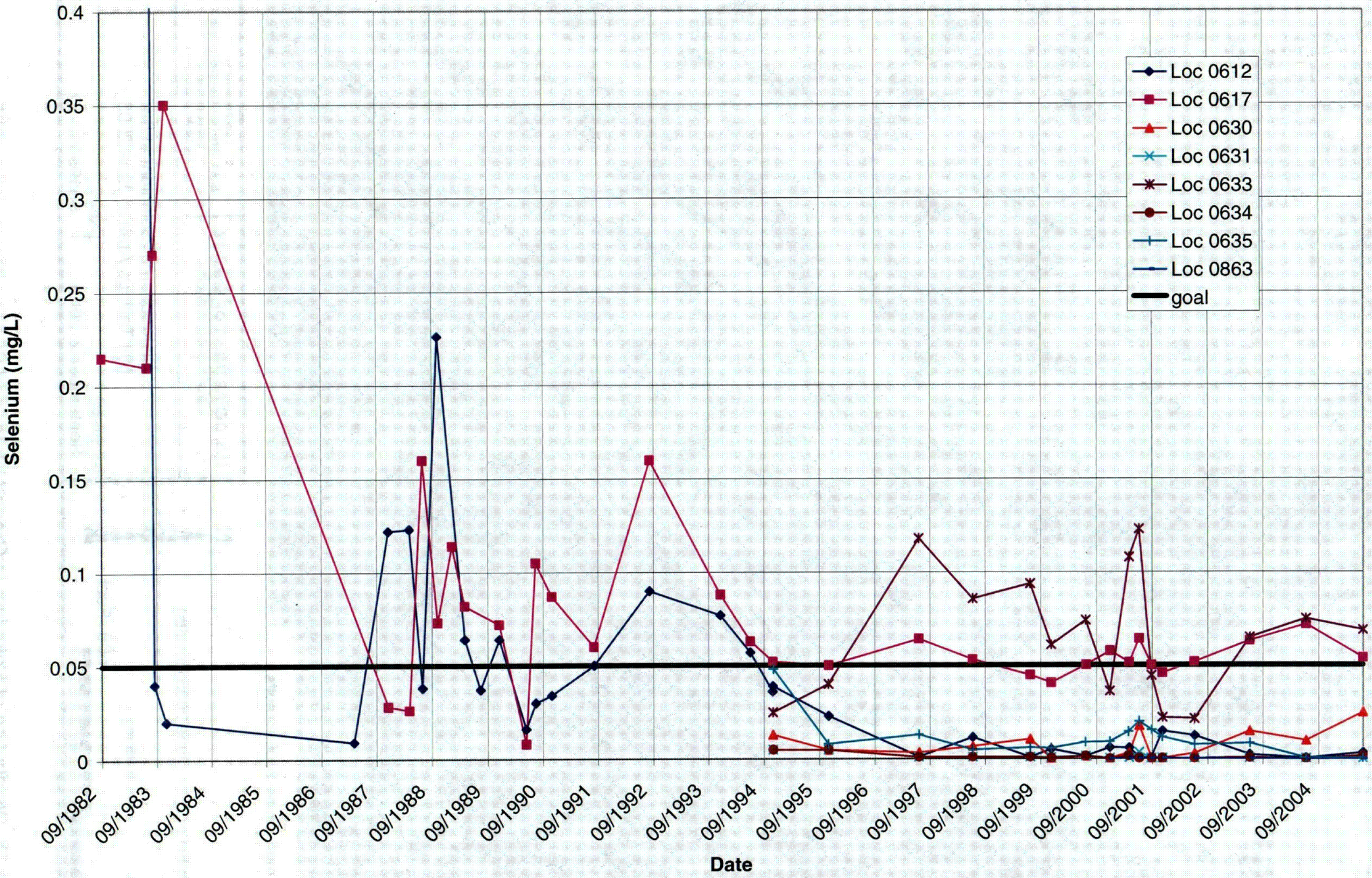


Figure 14. Historical Selenium Concentrations at Compliance Wells

C-14

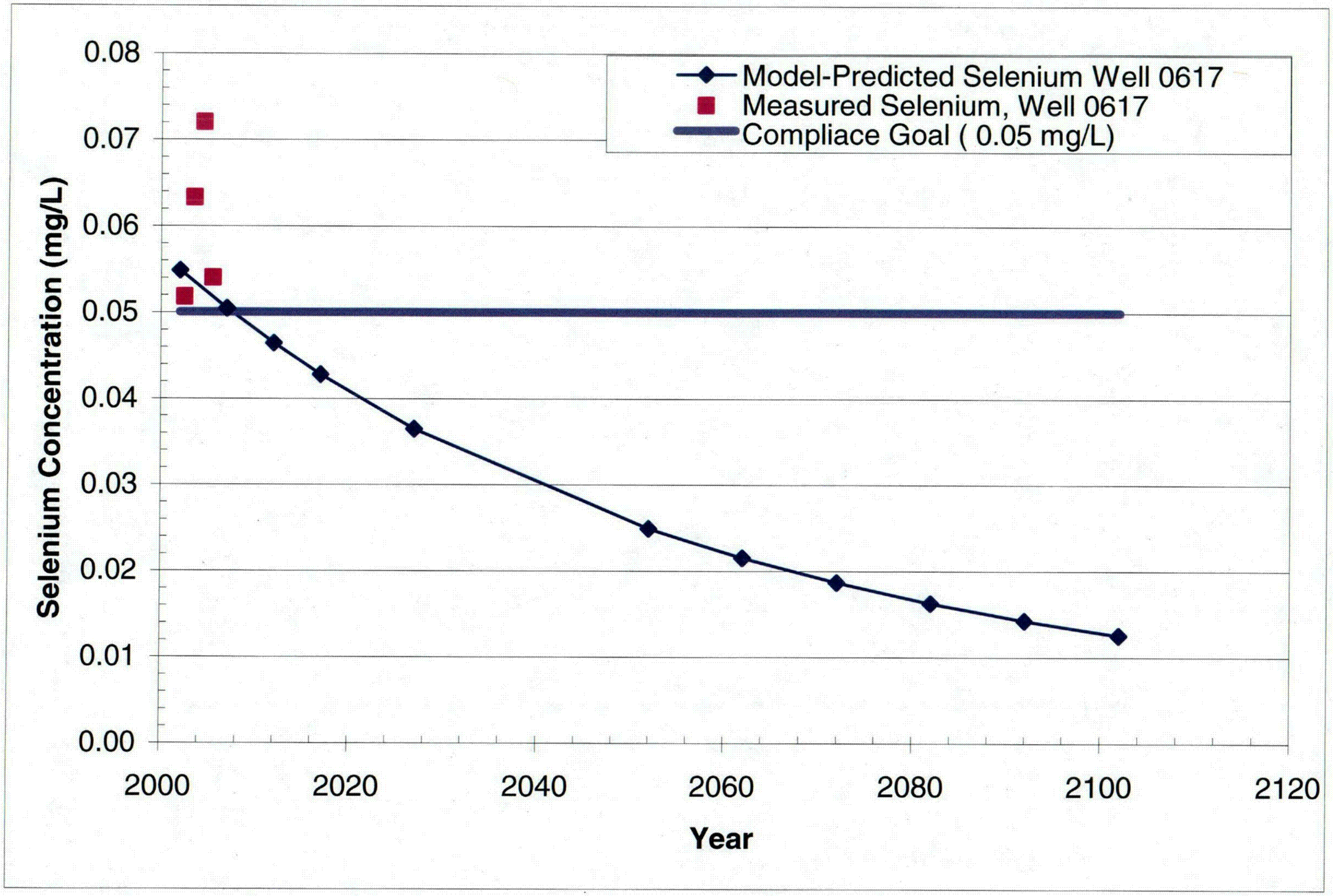


Figure 15. Measured and Model-Predicted Selenium Concentrations at Well 0617

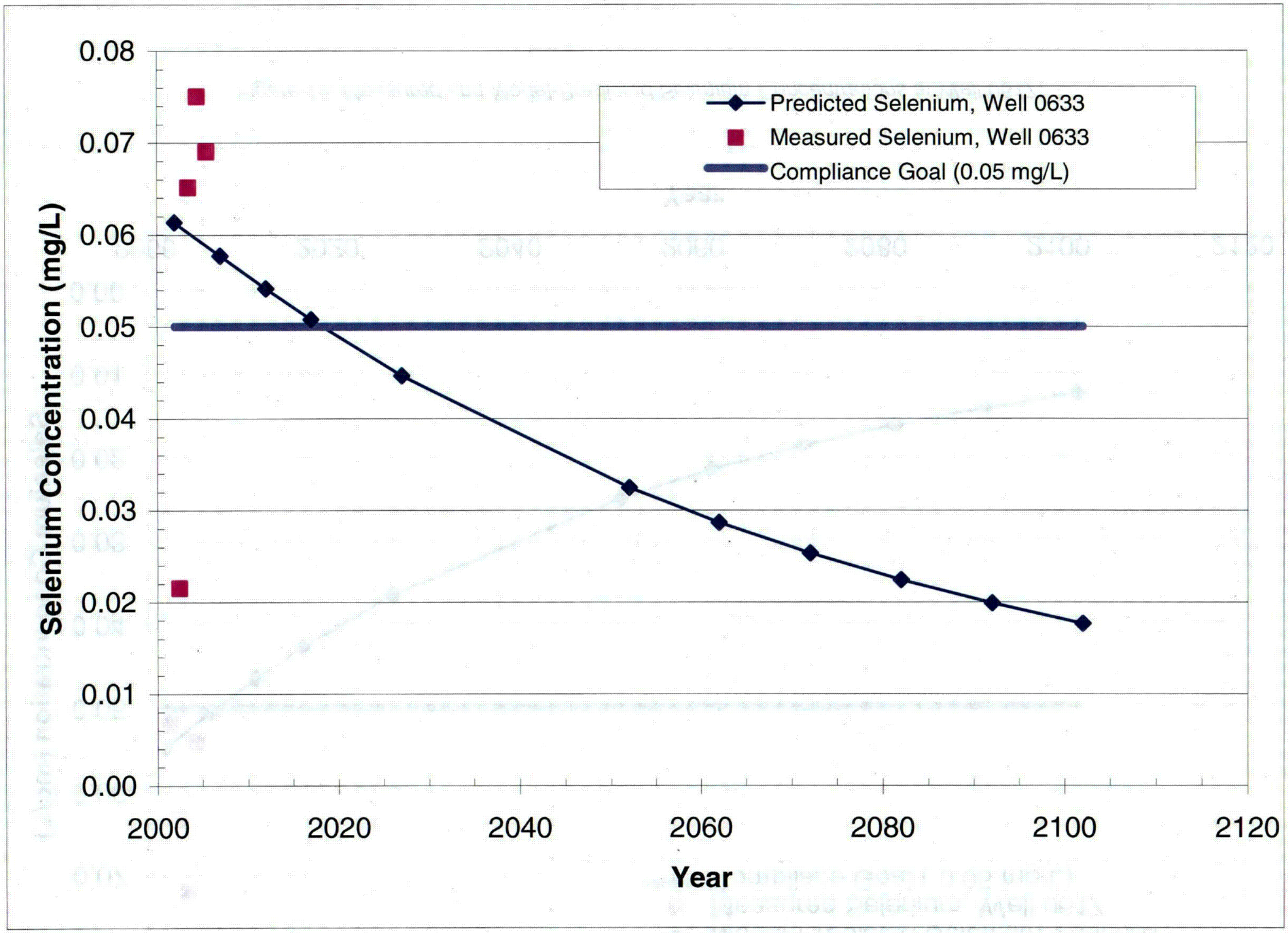


Figure 16. Measured and Model-Predicted Selenium Concentrations at Well 0633

C-16

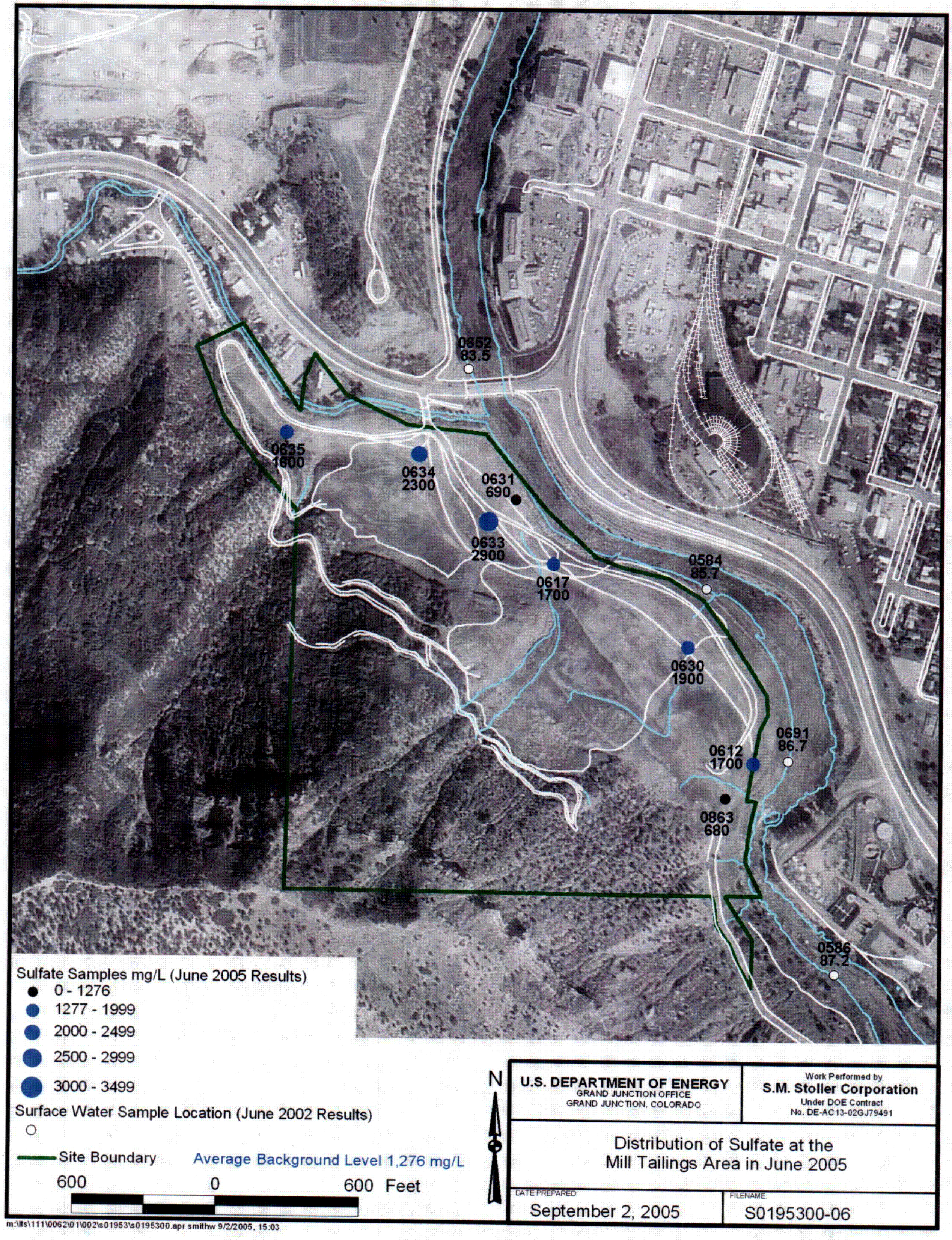


Figure 17. Distribution of Sulfate in Ground Water and Surface Water, June 2005

C-17

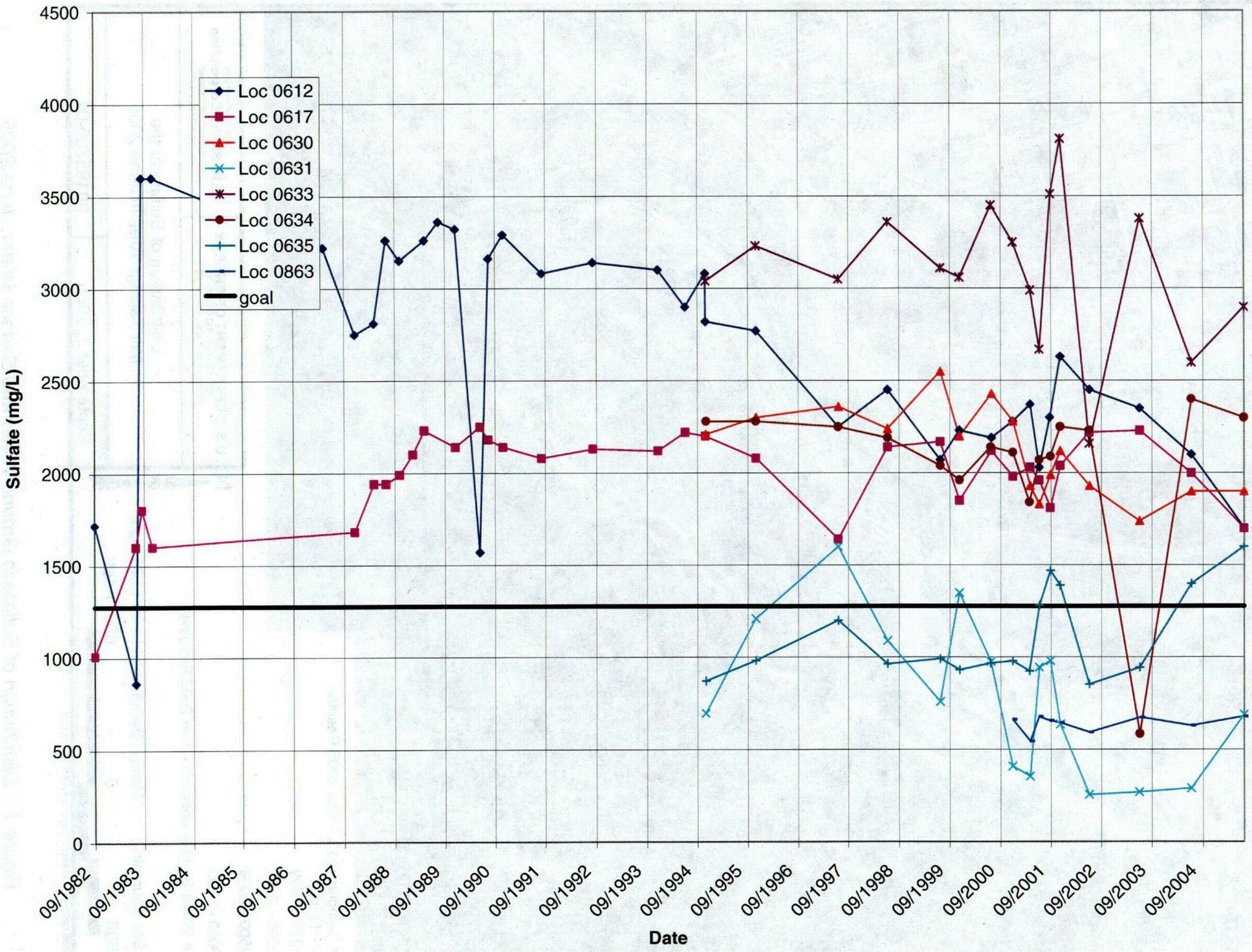


Figure 18. Historical Sulfate Concentrations at Compliance Wells

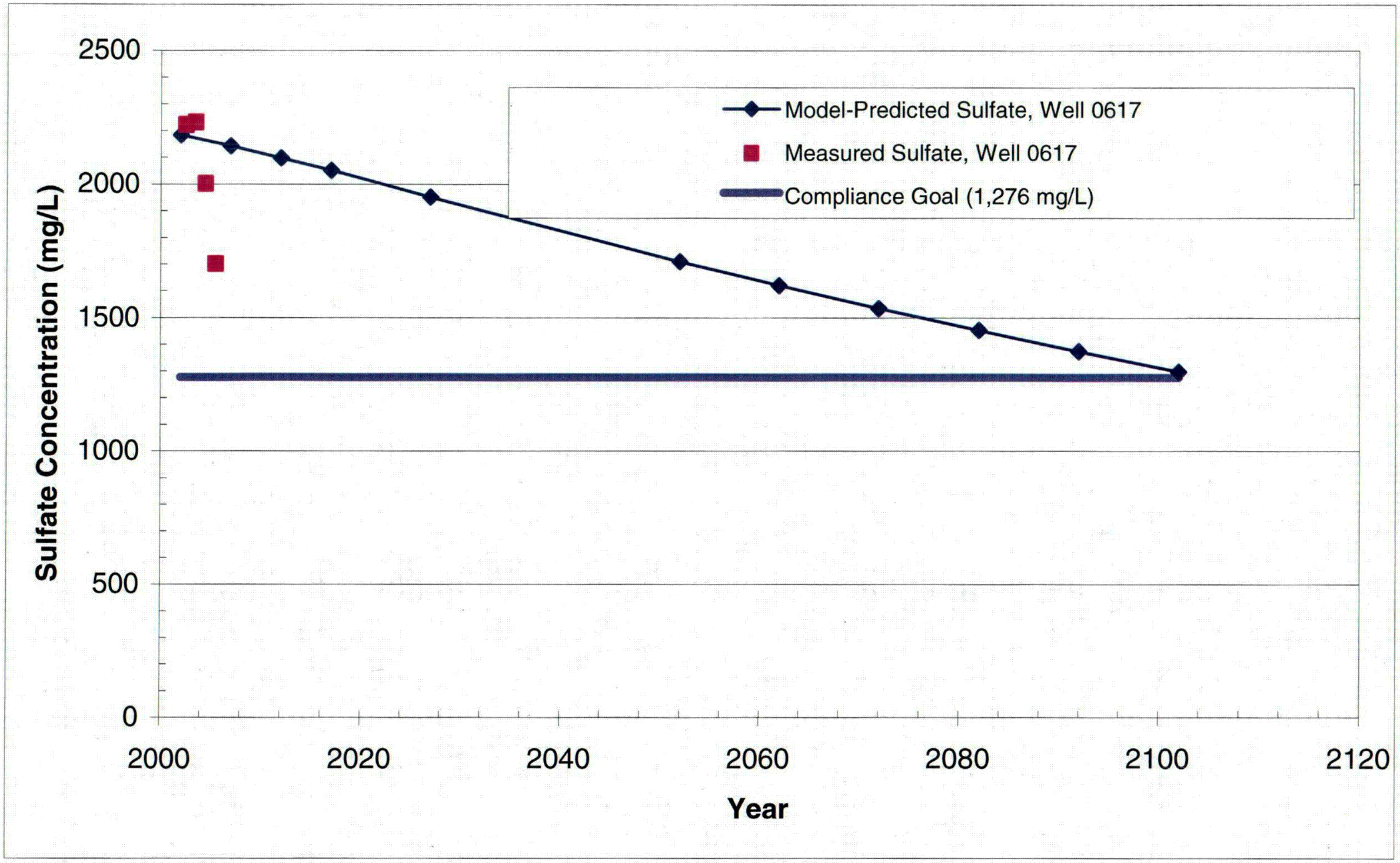


Figure 19. Measured and Model-Predicted Sulfate Concentrations at Well 0617

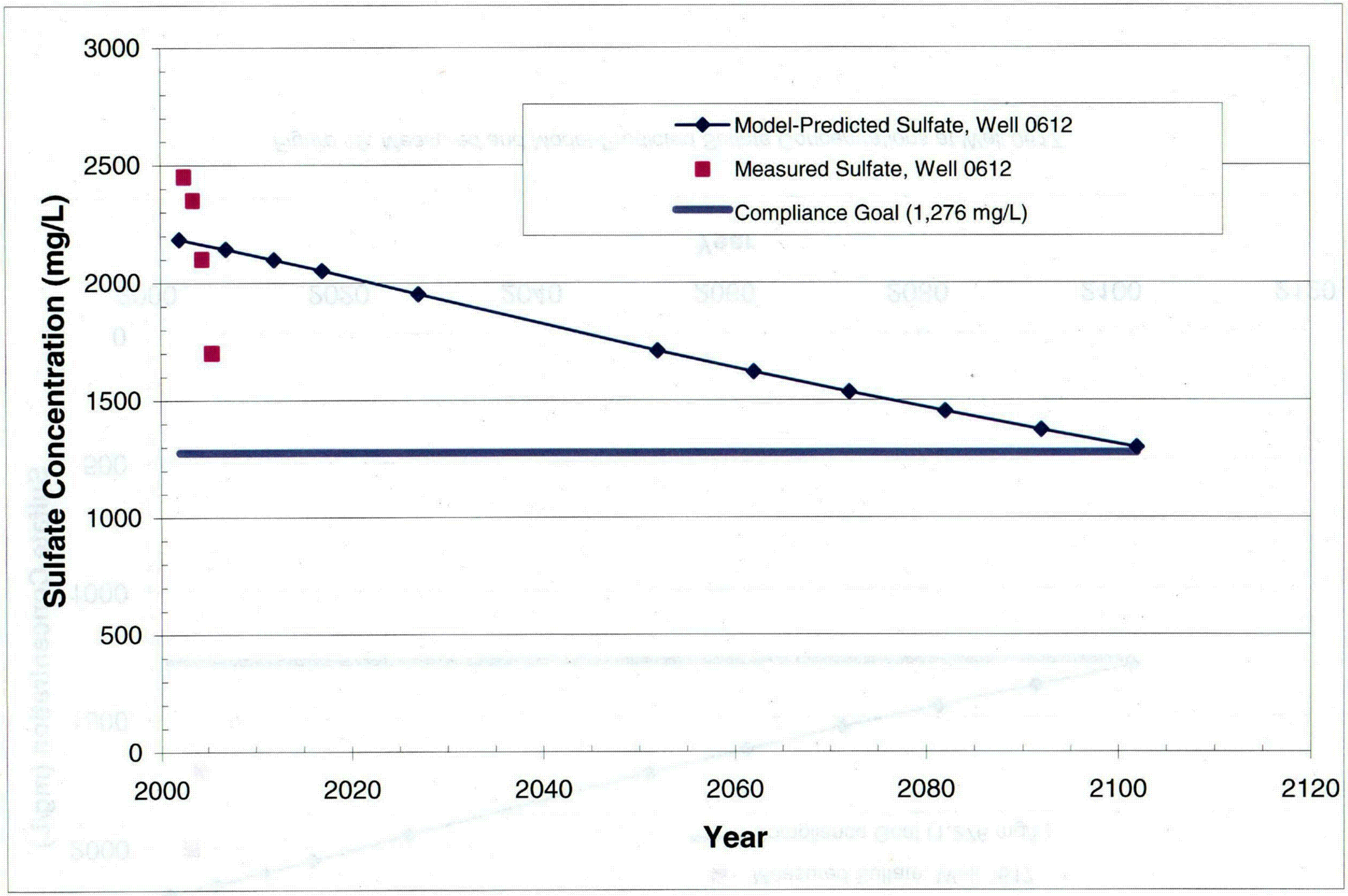
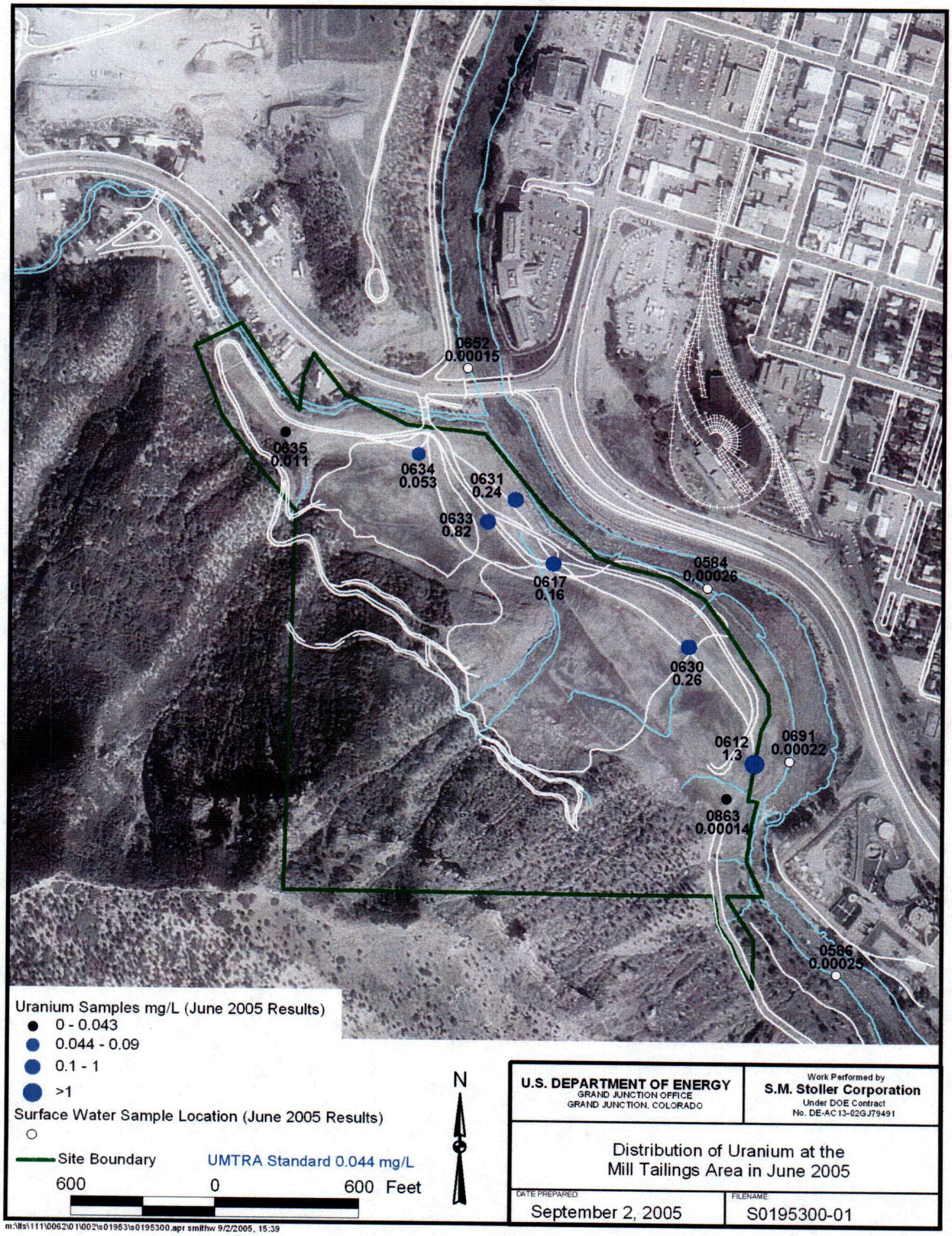


Figure 20. Measured and Model-Predicted Sulfate Concentrations at Well 0612

C-20



m:\lts\111\0062\01\002\s01953\s0195300.apr smithw 9/2/2005, 15:39

Figure 21. Distribution of Uranium in Ground Water and Surface Water, June 2005

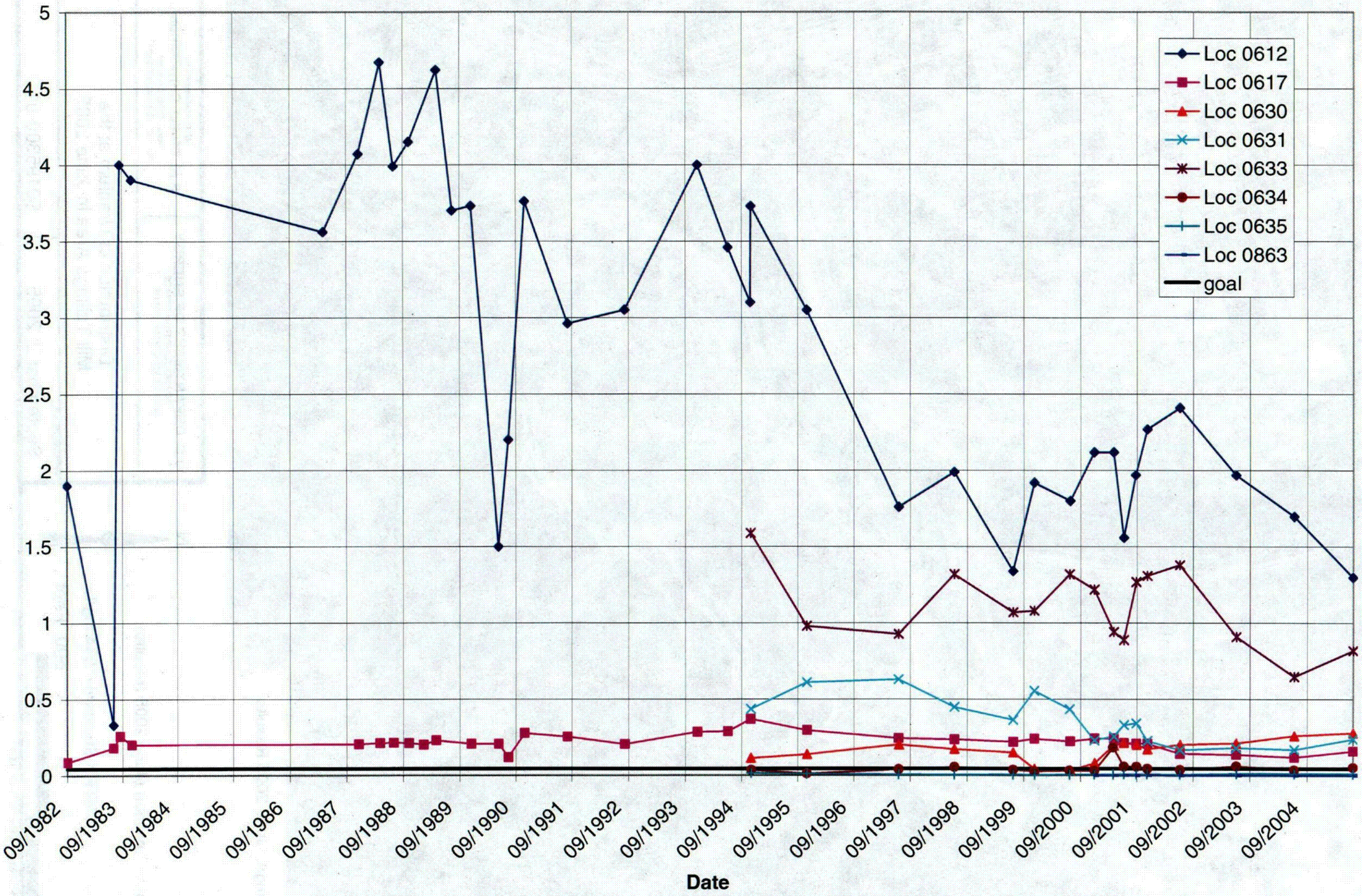


Figure 22. Historical Uranium Concentrations at Compliance Wells

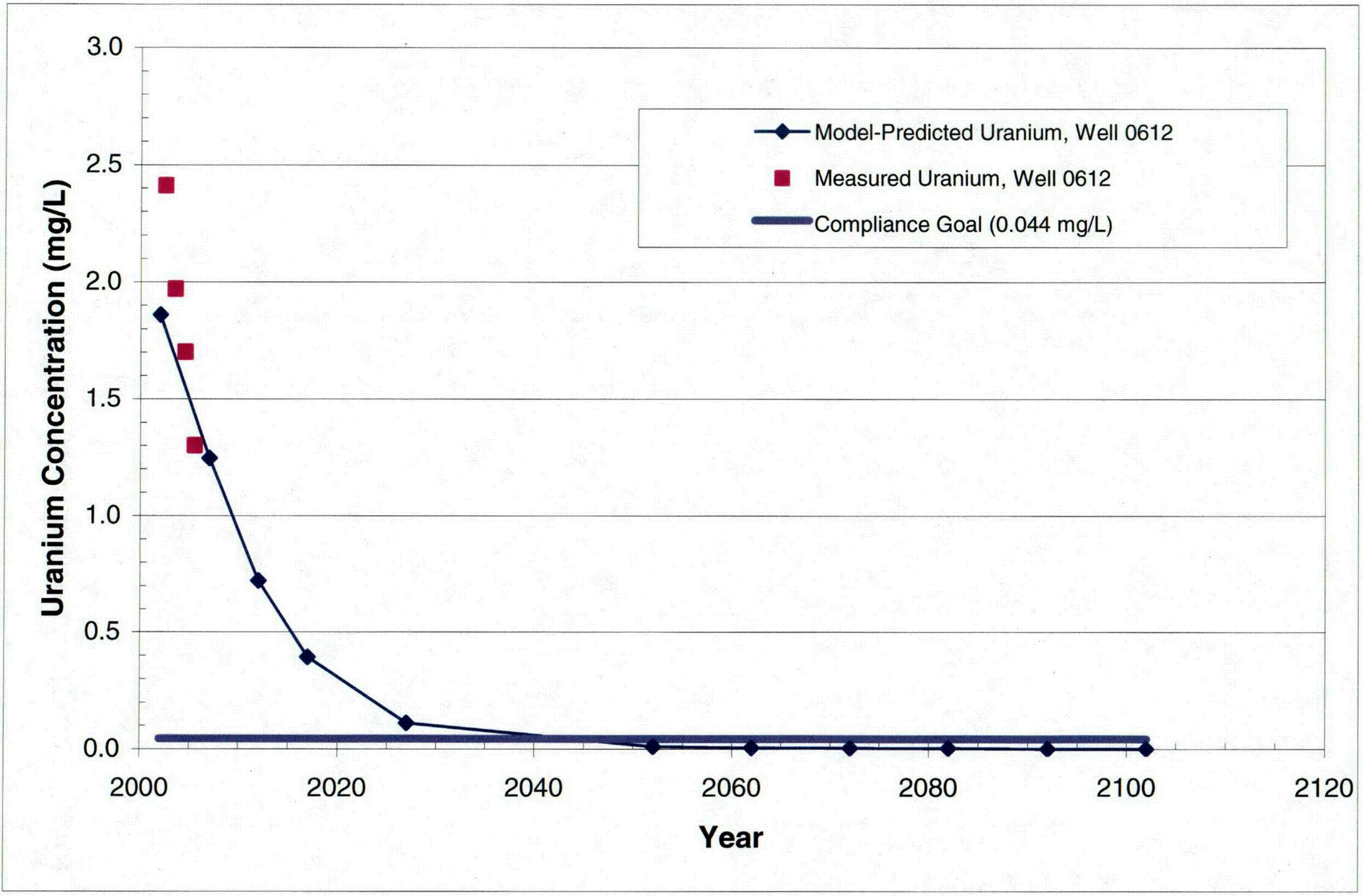


Figure 23. Measured and Model-Predicted Uranium Concentrations at Well 0612

C-23

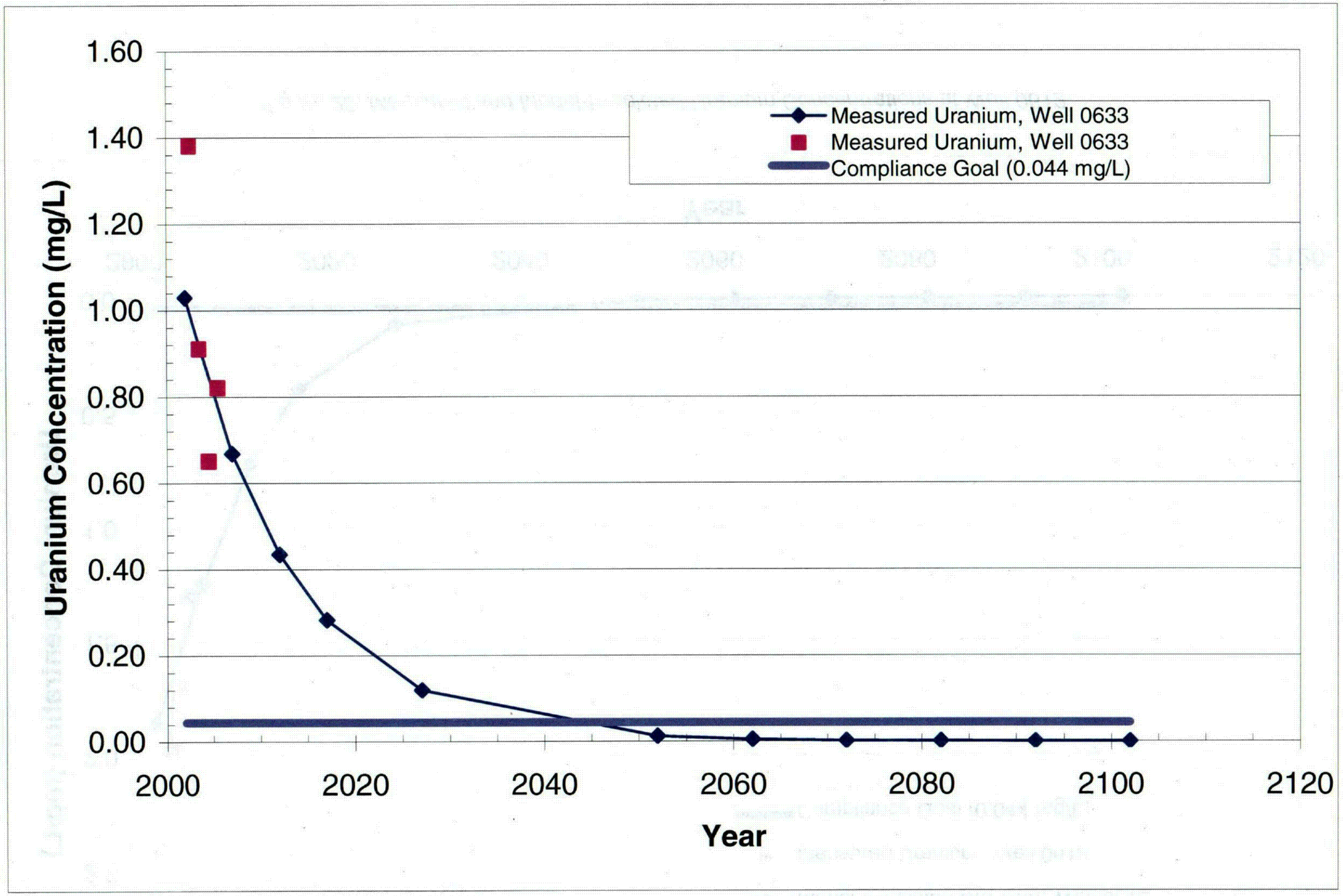


Figure 24. Measured and Model-Predicted Uranium Concentrations at Well 0630

Appendix A

Ground Water Quality Data by Parameter

GROUND WATER QUALITY DATA BY PARAMETER WITH DEPTH (USEE200) FOR SITE DUR01, Durango Mill Tailings Process Site
REPORT DATE: 9/22/2004 11:28 am

PARAMETER	UNITS	LOCATION ID	LOCATION TYPE	SAMPLE: DATE	ID	DEPTH RANGE (FT BLS)	RESULT	QUALIFIERS: LAB	DATA	QA	DETECTION LIMIT	UN-CERTAINTY
Alkalinity, Total (As CaCO3)	mg/L	0612	WL	06/09/2004	0001	37.41 - 57.41	463		F	#	-	-
	mg/L	0617	WL	06/10/2004	0001	14.00 - 29.00	425		F	#	-	-
	mg/L	0630	WL	06/10/2004	0001	28.30 - 38.30	286		F	#	-	-
	mg/L	0631	WL	06/10/2004	0001	6.00 - 16.00	317		F	#	-	-
	mg/L	0633	WL	06/10/2004	0001	4.00 - 14.00	377		F	#	-	-
	mg/L	0634	WL	06/10/2004	0001	8.00 - 18.00	458		Q	#	-	-
	mg/L	0635	WL	06/10/2004	0001	5.50 - 15.50	417		Q	#	-	-
	mg/L	0863	WL	06/09/2004	0001	58.00 - 67.50	517		F	#	-	-
Cadmium	mg/L	0612	WL	06/09/2004	0001	37.41 - 57.41	0.017		F	#	0.00013	-
	mg/L	0863	WL	06/09/2004	0001	58.00 - 67.50	0.00013	B	UF	#	1.3E-05	-
Calcium	mg/L	0863	WL	06/09/2004	0001	58.00 - 67.50	150.000		F	#	0.0063	-
Chloride	mg/L	0863	WL	06/09/2004	0001	58.00 - 67.50	88		F	#	4	-
Iron	mg/L	0863	WL	06/09/2004	0001	58.00 - 67.50	1.400		F	#	0.013	-
Magnesium	mg/L	0863	WL	06/09/2004	0001	58.00 - 67.50	100.000		F	#	0.01	-
Manganese	mg/L	0612	WL	06/09/2004	0001	37.41 - 57.41	4.900		F	#	0.00034	-
	mg/L	0617	WL	06/10/2004	0001	14.00 - 29.00	0.011		F	#	0.00034	-
	mg/L	0630	WL	06/10/2004	0001	28.30 - 38.30	0.900		F	#	0.00034	-
	mg/L	0631	WL	06/10/2004	0001	6.00 - 16.00	0.280		F	#	0.00034	-
	mg/L	0633	WL	06/10/2004	0001	4.00 - 14.00	0.050		F	#	0.00034	-
	mg/L	0634	WL	06/10/2004	0001	8.00 - 18.00	0.290		Q	#	0.00034	-
	mg/L	0635	WL	06/10/2004	0001	5.50 - 15.50	0.790		Q	#	0.00034	-
	mg/L	0863	WL	06/09/2004	0001	58.00 - 67.50	0.120		F	#	0.00034	-
Molybdenum	mg/L	0612	WL	06/09/2004	0001	37.41 - 57.41	0.120		FJ	#	0.00093	-
	mg/L	0617	WL	06/10/2004	0001	14.00 - 29.00	0.0017		UF	#	9.3E-05	-

GROUND WATER QUALITY DATA BY PARAMETER WITH DEPTH (USEE200) FOR SITE DUR01, Durango Mill Tailings Process Site
REPORT DATE: 9/22/2004 11:28 am

PARAMETER	UNITS	LOCATION ID	LOCATION TYPE	SAMPLE: DATE	ID	DEPTH RANGE (FT BLS)	RESULT	QUALIFIERS: LAB	DATA	QA	DETECTION LIMIT	UN-CERTAINTY
Molybdenum	mg/L	0630	WL	06/10/2004	0001	28.30 - 38.30	0.007		FJ	#	9.3E-05	-
	mg/L	0631	WL	06/10/2004	0001	6.00 - 16.00	0.0089		FJ	#	9.3E-05	-
	mg/L	0633	WL	06/10/2004	0001	4.00 - 14.00	0.0056		FJ	#	9.3E-05	-
	mg/L	0634	WL	06/10/2004	0001	8.00 - 18.00	0.0018		UQ	#	9.3E-05	-
	mg/L	0635	WL	06/10/2004	0001	5.50 - 15.50	0.0022		QJ	#	9.3E-05	-
	mg/L	0863	WL	06/09/2004	0001	58.00 - 67.50	0.00075	B	UF	#	9.3E-05	-
Oxidation Reduction Potenti:	mV	0612	WL	06/09/2004	N001	37.41 - 57.41	-158.6		F	#	-	-
	mV	0617	WL	06/10/2004	N001	14.00 - 29.00	-162.5		F	#	-	-
	mV	0630	WL	06/10/2004	N001	28.30 - 38.30	-146.8		F	#	-	-
	mV	0631	WL	06/10/2004	N001	6.00 - 16.00	-211.9		F	#	-	-
	mV	0633	WL	06/10/2004	N001	4.00 - 14.00	-187.0		F	#	-	-
	mV	0634	WL	06/10/2004	N001	8.00 - 18.00	-178.9		Q	#	-	-
	mV	0635	WL	06/10/2004	N001	5.50 - 15.50	-173.3		Q	#	-	-
	mV	0863	WL	06/09/2004	N001	58.00 - 67.50	-163.1		F	#	-	-
pH	s.u.	0612	WL	06/09/2004	N001	37.41 - 57.41	6.88		F	#	-	-
	s.u.	0617	WL	06/10/2004	N001	14.00 - 29.00	7.05		F	#	-	-
	s.u.	0630	WL	06/10/2004	N001	28.30 - 38.30	6.93		F	#	-	-
	s.u.	0631	WL	06/10/2004	N001	6.00 - 16.00	7.35		F	#	-	-
	s.u.	0633	WL	06/10/2004	N001	4.00 - 14.00	7.10		F	#	-	-
	s.u.	0634	WL	06/10/2004	N001	8.00 - 18.00	7.07		Q	#	-	-
	s.u.	0635	WL	06/10/2004	N001	5.50 - 15.50	6.90		Q	#	-	-
	s.u.	0863	WL	06/09/2004	N001	58.00 - 67.50	7.13		F	#	-	-
Potassium	mg/L	0863	WL	06/09/2004	0001	58.00 - 67.50	11.000		F	#	0.064	-
Selenium	mg/L	0612	WL	06/09/2004	0001	37.41 - 57.41	0.00038		F	#	1.4E-05	-
	mg/L	0617	WL	06/10/2004	0001	14.00 - 29.00	0.072		F	#	0.00014	-

GROUND WATER QUALITY DATA BY PARAMETER WITH DEPTH (USEE200) FOR SITE DUR01, Durango Mill Tailings Process Site
REPORT DATE: 9/22/2004 11:28 am

		LOCATION	LOCATION	SAMPLE:		DEPTH RANGE		QUALIFIERS:			DETECTION	UN-
PARAMETER	UNITS	ID	TYPE	DATE	ID	(FT BLS)	RESULT	LAB	DATA	QA	LIMIT	CERTAINTY
Selenium	mg/L	0630	WL	06/10/2004	0001	28.30 - 38.30	0.0098		F	#	0.00014	-
	mg/L	0631	WL	06/10/2004	0001	6.00 - 16.00	0.00026		F	#	1.4E-05	-
	mg/L	0633	WL	06/10/2004	0001	4.00 - 14.00	0.075		F	#	0.00014	-
	mg/L	0634	WL	06/10/2004	0001	8.00 - 18.00	0.000014	U	Q	#	1.4E-05	-
	mg/L	0635	WL	06/10/2004	0001	5.50 - 15.50	0.00051		Q	#	1.4E-05	-
	mg/L	0863	WL	06/09/2004	0001	58.00 - 67.50	0.000014	U	F	#	1.4E-05	-
Sodium	mg/L	0863	WL	06/09/2004	0001	58.00 - 67.50	170.000		F	#	0.07	-
Specific Conductance	umhos/cm	0612	WL	06/09/2004	N001	37.41 - 57.41	4032		F	#	-	-
	umhos/cm	0617	WL	06/10/2004	N001	14.00 - 29.00	3475		F	#	-	-
	umhos/cm	0630	WL	06/10/2004	N001	28.30 - 38.30	3002		F	#	-	-
	umhos/cm	0631	WL	06/10/2004	N001	6.00 - 16.00	1109		F	#	-	-
	umhos/cm	0633	WL	06/10/2004	N001	4.00 - 14.00	4020		F	#	-	-
	umhos/cm	0634	WL	06/10/2004	N001	8.00 - 18.00	3966		Q	#	-	-
	umhos/cm	0635	WL	06/10/2004	N001	5.50 - 15.50	2501		Q	#	-	-
	umhos/cm	0863	WL	06/09/2004	N001	58.00 - 67.50	1949		F	#	-	-
Sulfate	mg/L	0612	WL	06/09/2004	0001	37.41 - 57.41	2100		F	#	25	-
	mg/L	0617	WL	06/10/2004	0001	14.00 - 29.00	2000		F	#	25	-
	mg/L	0630	WL	06/10/2004	0001	28.30 - 38.30	1900		F	#	25	-
	mg/L	0631	WL	06/10/2004	0001	6.00 - 16.00	290		F	#	10	-
	mg/L	0633	WL	06/10/2004	0001	4.00 - 14.00	2600		F	#	100	-
	mg/L	0634	WL	06/10/2004	0001	8.00 - 18.00	2400		Q	#	25	-
	mg/L	0635	WL	06/10/2004	0001	5.50 - 15.50	1400		Q	#	10	-
	mg/L	0863	WL	06/09/2004	0001	58.00 - 67.50	630		F	#	10	-
Temperature	C	0612	WL	06/09/2004	N001	37.41 - 57.41	13.25		F	#	-	-
	C	0617	WL	06/10/2004	N001	14.00 - 29.00	11.48		F	#	-	-

GROUND WATER QUALITY DATA BY PARAMETER WITH DEPTH (USEE200) FOR SITE DUR01, Durango Mill Tailings Process Site
REPORT DATE: 9/22/2004 11:28 am

PARAMETER	UNITS	LOCATION ID	LOCATION TYPE	SAMPLE: DATE	ID	DEPTH RANGE (FT BLS)	RESULT	QUALIFIERS: LAB	DATA	QA	DETECTION LIMIT	UN-CERTAINTY
Temperature	C	0630	WL	06/10/2004	N001	28.30 - 38.30	11.53		F	#	-	-
	C	0631	WL	06/10/2004	N001	6.00 - 16.00	11.23		F	#	-	-
	C	0633	WL	06/10/2004	N001	4.00 - 14.00	13.64		F	#	-	-
	C	0634	WL	06/10/2004	N001	8.00 - 18.00	12.06		Q	#	-	-
	C	0635	WL	06/10/2004	N001	5.50 - 15.50	11.46		Q	#	-	-
	C	0863	WL	06/09/2004	N001	58.00 - 67.50	13.60		F	#	-	-
Turbidity	NTU	0612	WL	06/09/2004	N001	37.41 - 57.41	1.84		F	#	-	-
	NTU	0617	WL	06/10/2004	N001	14.00 - 29.00	2.64		F	#	-	-
	NTU	0630	WL	06/10/2004	N001	28.30 - 38.30	21.8		F	#	-	-
	NTU	0631	WL	06/10/2004	N001	6.00 - 16.00	0.53		F	#	-	-
	NTU	0633	WL	06/10/2004	N001	4.00 - 14.00	2.20		F	#	-	-
	NTU	0634	WL	06/10/2004	N001	8.00 - 18.00	2.18		Q	#	-	-
	NTU	0635	WL	06/10/2004	N001	5.50 - 15.50	11.6		Q	#	-	-
	NTU	0863	WL	06/09/2004	N001	58.00 - 67.50	9.15		F	#	-	-
Uranium	mg/L	0612	WL	06/09/2004	0001	37.41 - 57.41	1.700		F	#	0.00028	-
	mg/L	0617	WL	06/10/2004	0001	14.00 - 29.00	0.120		F	#	2.8E-05	-
	mg/L	0630	WL	06/10/2004	0001	28.30 - 38.30	0.260		F	#	2.8E-05	-
	mg/L	0631	WL	06/10/2004	0001	6.00 - 16.00	0.170		F	#	2.8E-05	-
	mg/L	0633	WL	06/10/2004	0001	4.00 - 14.00	0.650		F	#	2.8E-05	-
	mg/L	0634	WL	06/10/2004	0001	8.00 - 18.00	0.035		Q	#	2.8E-06	-
	mg/L	0635	WL	06/10/2004	0001	5.50 - 15.50	0.010		Q	#	2.8E-06	-
	mg/L	0863	WL	06/09/2004	0001	58.00 - 67.50	0.00013		UF	#	2.8E-06	-

GROUND WATER QUALITY DATA BY PARAMETER WITH DEPTH (USEE200) FOR SITE DUR01, Durango Mill Tailings Process Site
REPORT DATE: 9/22/2004 11:28 am

PARAMETER	UNITS	LOCATION ID	LOCATION TYPE	SAMPLE: DATE	ID	DEPTH RANGE (FT BLS)	RESULT	QUALIFIERS: LAB	DATA	QA	DETECTION LIMIT	UN-CERTAINTY

RECORDS: SELECTED FROM USEE200 WHERE site_code='DUR01' AND quality_assurance = TRUE AND (data_validation_qualifiers IS NULL OR data_validation_qualifiers NOT LIKE '%R%' AND data_validation_qualifiers NOT LIKE '%X%') AND DATE_SAMPLED between #1/1/2004# and #9/30/2004#

SAMPLE ID CODES: 000X = Filtered sample (0.45 µm). N00X = Unfiltered sample. X = replicate number.

LOCATION TYPES: WL WELL

LAB QUALIFIERS:

*	Replicate analysis not within control limits.
+	Correlation coefficient for MSA < 0.995.
>	Result above upper detection limit.
A	TIC is a suspected aldol-condensation product.
B	Inorganic: Result is between the IDL and CRDL. Organic: Analyte also found in method blank.
C	Pesticide result confirmed by GC-MS.
D	Analyte determined in diluted sample.
E	Inorganic: Estimate value because of interference, see case narrative. Organic: Analyte exceeded calibration range of the GC-MS.
H	Holding time expired, value suspect.
I	Increased detection limit due to required dilution.
J	Estimated
M	GFAA duplicate injection precision not met.
N	Inorganic or radiochemical: Spike sample recovery not within control limits. Organic: Tentatively identified compund (TIC).
P	> 25% difference in detected pesticide or Arochlor concentrations between 2 columns.
S	Result determined by method of standard addition (MSA).
U	Analytical result below detection limit.
W	Post-digestion spike outside control limits while sample absorbance < 50% of analytical spike absorbance.
X	Laboratory defined (USEPA CLP organic) qualifier, see case narrative.
Y	Laboratory defined (USEPA CLP organic) qualifier, see case narrative.
Z	Laboratory defined (USEPA CLP organic) qualifier, see case narrative.

DATA QUALIFIERS:

F	Low flow sampling method used.	G	Possible grout contamination, pH > 9.	J	Estimated value.
L	Less than 3 bore volumes purged prior to sampling.	Q	Qualitative result due to sampling technique	R	Unusable result.
U	Parameter analyzed for but was not detected.	X	Location is undefined.		

QA QUALIFIER: # = validated according to Quality Assurance guidelines.

Appendix B

Surface Water Quality Data by Parameter

SURFACE WATER QUALITY DATA BY PARAMETER (USEE800) FOR SITE DUR01, Durango Mill Tailings Process Site
REPORT DATE: 9/22/2004 11:28 am

		LOCATION	SAMPLE:			QUALIFIERS:			DETECTION	UN-
PARAMETER	UNITS	ID	DATE	ID	RESULT	LAB	DATA	QA	LIMIT	CERTAINTY
Alkalinity, Total (As CaCO3)	mg/L	0584	06/10/2004	0001	39			#	-	-
	mg/L	0586	06/09/2004	0001	42			#	-	-
	mg/L	0652	06/10/2004	0001	38			#	-	-
	mg/L	0691	06/09/2004	0001	40			#	-	-
Cadmium	mg/L	0584	06/10/2004	0001	0.0001	B	U	#	1.3E-05	-
	mg/L	0586	06/09/2004	0001	0.0001	B	U	#	1.3E-05	-
	mg/L	0652	06/10/2004	0001	0.0001	B	U	#	1.3E-05	-
	mg/L	0691	06/09/2004	0001	0.0001	B	U	#	1.3E-05	-
Molybdenum	mg/L	0584	06/10/2004	0001	0.0006	B	U	#	9.3E-05	-
	mg/L	0586	06/09/2004	0001	0.0006	B	U	#	9.3E-05	-
	mg/L	0652	06/10/2004	0001	0.0005	B	U	#	9.3E-05	-
	mg/L	0691	06/09/2004	0001	0.0006	B	U	#	9.3E-05	-
Oxidation Reduction Potenti	mV	0584	06/10/2004	N001	-131.4			#	-	-
	mV	0586	06/09/2004	N001	-67			#	-	-
	mV	0652	06/10/2004	N001	-151.3			#	-	-
	mV	0691	06/09/2004	N001	-134.9			#	-	-
pH	s.u.	0584	06/10/2004	N001	7.89			#	-	-
	s.u.	0586	06/09/2004	N001	6.90			#	-	-
	s.u.	0652	06/10/2004	N001	7.56			#	-	-
	s.u.	0691	06/09/2004	N001	7.63			#	-	-
Selenium	mg/L	0584	06/10/2004	0001	0.0000	B		#	1.4E-05	-
	mg/L	0586	06/09/2004	0001	0.0001			#	1.4E-05	-
	mg/L	0652	06/10/2004	0001	0.0000	B		#	1.4E-05	-
	mg/L	0691	06/09/2004	0001	0.0000	B		#	1.4E-05	-
Specific Conductance	umhos/cm	0584	06/10/2004	N001	210			#	-	-
	umhos/cm	0586	06/09/2004	N001	184			#	-	-
	umhos/cm	0652	06/10/2004	N001	363			#	-	-
	umhos/cm	0691	06/09/2004	N001	221			#	-	-
Temperature	C	0584	06/10/2004	N001	10.51			#	-	-
	C	0586	06/09/2004	N001	10.49			#	-	-
	C	0652	06/10/2004	N001	10.38			#	-	-
	C	0691	06/09/2004	N001	11.91			#	-	-
Turbidity	NTU	0584	06/10/2004	N001	28.6			#	-	-
	NTU	0586	06/09/2004	N001	10.3			#	-	-
	NTU	0652	06/10/2004	N001	32.1			#	-	-
	NTU	0691	06/09/2004	N001	33.3			#	-	-

SURFACE WATER QUALITY DATA BY PARAMETER (USEE800) FOR SITE DUR01, Durango Mill Tailings Process Site
REPORT DATE: 9/22/2004 11:28 am

		LOCATION	SAMPLE:			QUALIFIERS:			DETECTION	UN-
PARAMETER	UNITS	ID	DATE	ID	RESULT	LAB	DATA	QA	LIMIT	CERTAINTY
Uranium	mg/L	0584	06/10/2004	0001	0.0001		U	#	2.8E-06	-
	mg/L	0586	06/09/2004	0001	0.0001		U	#	2.8E-06	-
	mg/L	0652	06/10/2004	0001	0.0002		U	#	2.8E-06	-
	mg/L	0691	06/09/2004	0001	0.0001		U	#	2.8E-06	-

RECORDS: SELECTED FROM USEE800 WHERE site_code='DUR01' AND quality_assurance = TRUE AND (data_validation_qualifiers IS NULL OR data_validation_qualifiers NOT LIKE '%R%' AND data_validation_qualifiers NOT LIKE '%X%') AND DATE_SAMPLED between #1/1/2004# and #9/30/2004#

SAMPLE ID CODES: 000X = Filtered sample (0.45 µm). N00X = Unfiltered sample. X = replicate number.

LAB QUALIFIERS:

*	Replicate analysis not within control limits.
+	Correlation coefficient for MSA < 0.995.
>	Result above upper detection limit.
A	TIC is a suspected aldol-condensation product.
B	Inorganic: Result is between the IDL and CRDL. Organic: Analyte also found in method blank.
C	Pesticide result confirmed by GC-MS.
D	Analyte determined in diluted sample.
E	Inorganic: Estimate value because of interference, see case narrative. Organic: Analyte exceeded calibration range of the GC-MS.
H	Holding time expired, value suspect.
I	Increased detection limit due to required dilution.
J	Estimated
M	GFAA duplicate injection precision not met.
N	Inorganic or radiochemical: Spike sample recovery not within control limits. Organic: Tentatively identified compund (TIC).
P	> 25% difference in detected pesticide or Arochlor concentrations between 2 columns.
S	Result determined by method of standard addition (MSA).
U	Analytical result below detection limit.
W	Post-digestion spike outside control limits while sample absorbance < 50% of analytical spike absorbance.
X	Laboratory defined (USEPA CLP organic) qualifier, see case narrative.
Y	Laboratory defined (USEPA CLP organic) qualifier, see case narrative.
Z	Laboratory defined (USEPA CLP organic) qualifier, see case narrative.

DATA QUALIFIERS:

F	Low flow sampling method used.	G	Possible grout contamination, pH > 9.
J	Estimated value.	L	Less than 3 bore volumes purged prior to sampling.
Q	Qualitative result due to sampling technique	R	Unusable result.
U	Parameter analyzed for but was not detected.	X	Location is undefined.

QA QUALIFIER: # = validated according to Quality Assurance guidelines.