Department of Energy
Washington, DC 20585

January 19, 2017

WM-00062

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Deputy Director
Mail Stop T8-F5
Washington, DC 20555-0001

Subject: Draft Groundwater Compliance Action Plan for the New Rifle, Colorado, Processing Site (RFN/S01920)

To Whom It May Concern:

Enclosed for U.S. Nuclear Regulatory Commission review and concurrence is the draft *Groundwater Compliance Action Plan (GCAP) for the New Rifle, Colorado, Processing Site.* This revision supports the change in compliance strategy from natural flushing to no remediation with application of alternative concentration limits (ACLs). Institutional controls (ICs) enacted by U.S. Department of Energy Office of Legacy Management (DOE-LM), Colorado Department of Public Health and Environment, the City of Rifle, and Garfield County will be carried forward as an integral component of the revised compliance strategy. The GCAP also provides DOE-LM's plan for compliance monitoring at 16 groundwater and 8 surface water sampling points.

Please call me at (970) 248-6073 if you have any questions. Please address any correspondence to:

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Sincerely,

Richard P. Bush
Site Manager

Enclosure

NMSS20

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LMS/RFN/S01920

Groundwater Compliance Action Plan for the New Rifle, Colorado, Processing Site

December 2016

U.S. DEPARTMENT OF ENERGY | Legacy Management

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Abbreviations

ACL	Alternate Concentration Limits
ALARA	as low as reasonably achievable
AR	activity ratio
BTV	background threshold values
CDPHE	Colorado Department of Public Health and Environment
COC	contaminant of concern
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
ft	feet
GCAP	Groundwater Compliance Action Plan
IC	institutional control
IRIS	Integrated Risk Information System
K_d	soil-water partition coefficient
LM	Office of Legacy Management
µg/L	micrograms per liter
µmho/cm	micromhos per centimeter
MCL	maximum concentration limit
mg/kg	milligram per kilogram
mg/L	milligrams per liter
NRC	U.S. Nuclear Regulatory Commission
POC	point of compliance
POE	point of exposure
RBC	risk-based concentration
SDWA	Safe Drinking Water Act
SOP	standard operating procedures
SOWP	Site Observational Work Plan
UMTRA	Uranium Mill Tailing Remedial Action (Project)
UMTRCA	Uranium Mill Tailings Radiation Control Act of 1978
UPL	upper prediction limits
USL	upper simultaneous limits
UTL	upper tolerance limits

Executive Summary

The New Rifle, Colorado, Processing Site is one of 24 former uranium-ore processing sites identified in the Uranium Mill Tailings Radiation Control Act of 1978 for study and potential remedial action. The site is located in western Colorado approximately 2.3 miles west of the city of Rifle. The U.S. Department of Energy (DOE) completed surface remediation at the site in 1996 in compliance with regulatory requirements. Groundwater in the surficial aquifer at the site is contaminated as a result of historical processing of uranium and vanadium ore. This Groundwater Compliance Action Plan (GCAP) serves as a stand-alone document provided by DOE to the U.S. Nuclear Regulatory Commission for concurrence in the proposed compliance strategy.

DOE conducted studies from 1997 to 1999 at the New Rifle site to understand types, distributions, and interactions of contaminants; to develop a conceptual groundwater contaminant flow and transport model; and to evaluate the risks to human health and the environment from the identified contaminants. The results of these studies supported a compliance strategy of natural flushing for all contaminants of concern (COCs) except vanadium. Vanadium was projected to persist in groundwater at concentrations above its regulatory limit for longer than the maximum allowable duration of a natural flushing strategy (100 years).

Additional studies were conducted from 2000 to 2002, for evaluation of active "pump-and-treat" remediation alternatives to specifically address vanadium removal. Results indicated that vanadium was present in dissolved form in groundwater and was also present as a residual sorbed to subsurface soils. The sorbed form was expected to act as a continuing source of groundwater contamination, through gradual long-term release. This result indicated that an active pump-and-treat groundwater remediation approach to achieve compliance with the regulatory standard for vanadium was not feasible. The geochemical release of sorbed vanadium into groundwater was confirmed in a subsequent study in 2010, which documented elevated concentrations of vanadium in monitoring wells after an area of the New Rifle site was temporarily dewatered for construction activities.

For this GCAP, human health and environmental risks were reevaluated based on current site conditions. The conceptual groundwater contaminant flow and transport model was revised to reflect greater recharge of groundwater from the north and discharge toward the Colorado River. A decade of groundwater monitoring results indicates that concentrations of COCs in onsite wells are not decreasing at the originally projected rate. Concentrations of uranium in far-downgradient locations are considered to be unrelated to the site - representative of natural background concentrations and/or exhibiting a chemical signature precluding the site as a source. Concentrations of nitrate at far-downgradient locations can be attributed to transformation of ammonia to nitrate through the process of nitrification, and again is not attributable to current site conditions as a source. The risk evaluation, revision of the conceptual groundwater model, and further analysis of monitoring data demonstrate that the currently implemented institutional controls (ICs) are protective of human health and the environment.

Based on these results, DOE has now determined that no remediation with the application of alternate concentration limits (ACLs) is the appropriate compliance strategy for the six COCs—arsenic, molybdenum, nitrate, selenium, uranium, and vanadium. Numerical values for proposed

ACLs were based on a statistical analysis of data from source area well 0658. As long as ACLs are met at the proposed point-of-compliance wells, water quality at the proposed point-of-exposure (gravel ponds) will be protective. Fully implemented, overlapping, and rigorous ICs and compliance monitoring are also components of the remedy.

DOE, the Colorado Department of Public Health and Environment (CDPHE), the City of Rifle, and Garfield County have enacted a series of four ICs to prevent humans and livestock from being exposed to site-related contaminants on the former mill site and on downgradient properties. These controls consist of a quitclaim deed on the site proper to ensure that no groundwater will be exposed onsite without written permission of DOE and CDPHE; a large zone overlay to restrict consumption of contaminated groundwater; an environmental covenant between CDPHE and Umetco Minerals Corporation on a downgradient property to limit access to groundwater and to prevent livestock from accessing water in former gravel ponds; and most recently, a Uranium Mill Tailings Remedial Action overlay zone district that further limits activities by the City on the former mill site. DOE provided funding for construction of a water line and a storage tank west of the city along U.S. Highway 6 that provides domestic water to residents.

Compliance monitoring consists of sampling 16 monitoring wells and 8 surface water locations for the COCs, and analyzing ammonia as an environmental indicator. DOE will collect samples annually for the first 5 years after regulatory acceptance of this GCAP. After that time, the monitoring program will be re-evaluated, and if no anomalous trends are identified, the monitoring frequency and number of analytes may be reduced. Details of long-term monitoring are included in this document. No monitoring wells will be decommissioned for the foreseeable future.

1.0 Introduction

This Groundwater Compliance Action Plan (GCAP) is a stand-alone modification to Section E.3.6 of the *Final Remedial Action Plan and Site Design for Stabilization of the Inactive Uranium Mill Tailings Sites at Rifle, Colorado* (DOE 1992) and is the concurrence document for compliance with Subpart B of Title 40 *Code of Federal Regulations* Part 192 (40 CFR 192) for the New Rifle, Colorado, Processing Site.

The New Rifle site is one of two former uranium-ore processing sites at Rifle, Colorado, assigned to the U.S. Department of Energy (DOE) Office of Legacy Management. Previously, GCAPs were submitted for regulatory review with natural flushing as the compliance strategy for most site-related constituents (DOE 1999b, 2003, 2005, 2008a). Based on continued groundwater monitoring results, it does not appear that natural flushing will achieve cleanup goals for the contaminants of concern (COCs) in the 100-year time frame allowed by 40 CFR 192. Therefore, consistent with DOE's decision framework (see Figure 13 and discussion in Section 3), the strategy must be reevaluated. Results of that reevaluation are presented in this GCAP. Section 2 contains technical site information. Section 3 discusses the selection process and rationale for a revised compliance strategy. Implementation measures are described in Section 4.

2.0 Site Information

2.1 Location

The New Rifle site is located approximately 2.3 miles west of the city of Rifle in Garfield County, Colorado (Figure 1). The 142-acre site, which is accessible by U.S. Highway 6, is the location of a former vanadium and uranium mill that operated from 1958 through 1984. It is adjacent to and north of the Colorado River near the northeastern edge of the Colorado Plateau physiographic province.

2.2 Brief Site Background

Historically, vanadium and uranium ores were processed at two different mills located near the city of Rifle. U.S. Vanadium Company constructed the first mill in 1924 for the production of vanadium (Merritt 1971). That plant was located approximately 0.3 miles east of the city and is referred to as the Old Rifle site (Figure 1). Union Carbide and Carbon Corporation (Union Carbide) purchased the assets of the U.S. Vanadium Company in 1926 and established U.S. Vanadium Corporation as a subsidiary (Chenoweth 1982). The subsidiary operated the former Old Rifle plant intermittently until 1946, when it was modified to include the recovery of uranium as well as vanadium. Production continued until 1958 when the old plant was replaced with a new mill located approximately 2.3 miles west of the Old Rifle site. The location of the new mill is now referred to as the New Rifle site (DOE 1999a).

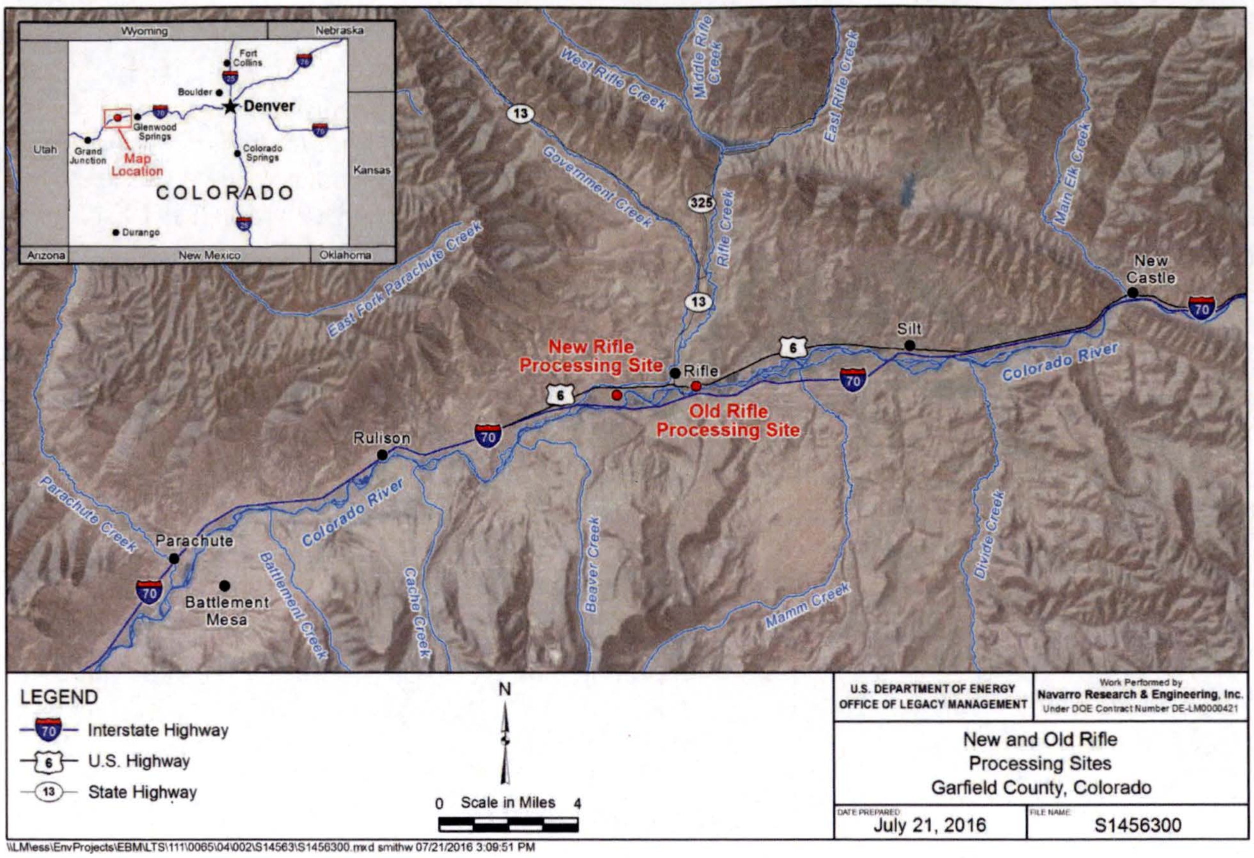

Figure 1. Location of the New Rifle Site

Uranium and vanadium production at the New Rifle mill lasted from 1958 to 1984. Concentrated ore was shipped to the New Rifle mill from 1958 to the early 1960s from a variety of locations in the region. From 1964 to 1967, the New Rifle mill also processed lignite ash. From 1973 to 1984, part of the mill was used to produce vanadium; this operation, which did not produce tailings, involved processing vanadium-bearing solutions.

U.S. Atomic Energy Commission records document that 2,259,000 cubic yards of Old Rifle tailings and 1,802,019 tons of ore were processed. The west-central portion of the New Rifle mill site contained 33 acres of tailings in two distinct piles. The combined piles measured approximately 1600 feet (ft) in the north-south direction and approximately 1150 ft in the east-west direction. Holding ponds for processing wastes (including vanadium and gypsum) were located east of the piles. The locations of tailing piles, evaporation ponds, ore storage area, and mill buildings as they existed in 1974 are shown in Figure 2.

The tailing piles were partially stabilized by Union Carbide with the application of mulch and fertilizer. An irrigation system was installed to promote growth of native grasses that were planted. However, much of the pile did not revegetate, and wind and water eroded some of the tailings. The tailings pile at the beginning phase of surface remediation in 1989 is shown in Figure 3. All tailings, contaminated materials, and associated process buildings and structures were removed from the site during the surface remedial action completed in 1996.

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Figure 2. New Rifle Mill Site Showing the Location of the Northwest and Southwest Tailings Piles, Holding Ponds, Mill Buildings, and the Ore Storage Area. Top of photograph is north—August 1974

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Figure 3. View of the New Rifle Site Looking West During the Early Stages of Surface Remedial Action. Right side of photograph is north—August 1989

Investigations of the site groundwater began in 1997. During groundwater characterization and preparation of the Site Observational Work Plan (SOWP) (DOE 1999a), it was determined that site-related contaminant plumes affected groundwater downgradient (west) of the site on private land. Because the alluvial aquifer was used as a source of drinking water in private wells in and around the Rifle area, controls were needed to prevent the use of contaminated groundwater. Multiple restrictions were placed on the use of onsite and downgradient contaminated groundwater (see Section 4.2) and will remain in perpetuity or until conditions allow lifting of the use restriction. An additional institutional control (IC) was subsequently placed on the adjacent downgradient property owned by Umetco Minerals Corporation. This IC prevents the use of onsite surface water (i.e., in the Roaring Fork ponds) and groundwater for livestock watering. The concentration of molybdenum was the primary driver for this IC.

The State of Colorado transferred the site property to the City of Rifle in 2004. Downgradient properties are privately owned. All property affected by site-related groundwater contamination is zoned agricultural/industrial. A current map of the site features and monitoring locations is shown in Figure 4.

The compliance strategy for the New Rifle site has undergone several iterations over the years as more data have been collected and the site conceptual model has been updated. Cleanup goals for the site were initially established as maximum concentration limit (MCLs) for constituents that had MCLs or risk-based goals that would allow future unrestricted use of groundwater. Although no Uranium Mill Tailings Radiation Control Act (UMTRCA) groundwater standard has been established for vanadium, much time and attention has been spent justifying an appropriate compliance strategy for this COC mainly because of its high concentrations and persistence in the environment. A brief summary of the evolution of the New Rifle compliance strategy is provided below.

At the time the SOWP was completed, natural flushing appeared to be a promising strategy for meeting cleanup goals for all COCs except vanadium. This was the compliance strategy initially selected for most site COCs, with active remediation identified as a possibility for vanadium. A pilot study was implemented to examine the feasibility of using a pump-and-treat system to meet the vanadium risk-based cleanup goal of 0.33 milligrams per liter (mg/L). The pilot study was initiated in January 2001 and operated through November of that year. Extracting and treating 3,000,000 gallons of groundwater from the heart of the plume showed little to no reduction in vanadium concentrations in surrounding wells. Characterization studies indicated that a significant amount of vanadium remains in subsurface materials in the areas beneath the historical vanadium and gypsum ponds. It was concluded that active remediation would be unlikely to achieve the vanadium cleanup goal for unrestricted use (DOE 2002).

However, by 2002, vanadium concentrations were decreasing more rapidly in almost all wells than had been predicted by the numerical flow and transport model in the SOWP. A new assessment of the vanadium concentrations in 12 onsite wells using a simpler analytical model of contaminant transport suggested that vanadium levels in most wells could decrease to a concentration of 0.33 mg/L within 50 years and at all locations within 100 years. Natural flushing was proposed as the compliance strategy for all constituents in a revised GCAP (DOE 2003).

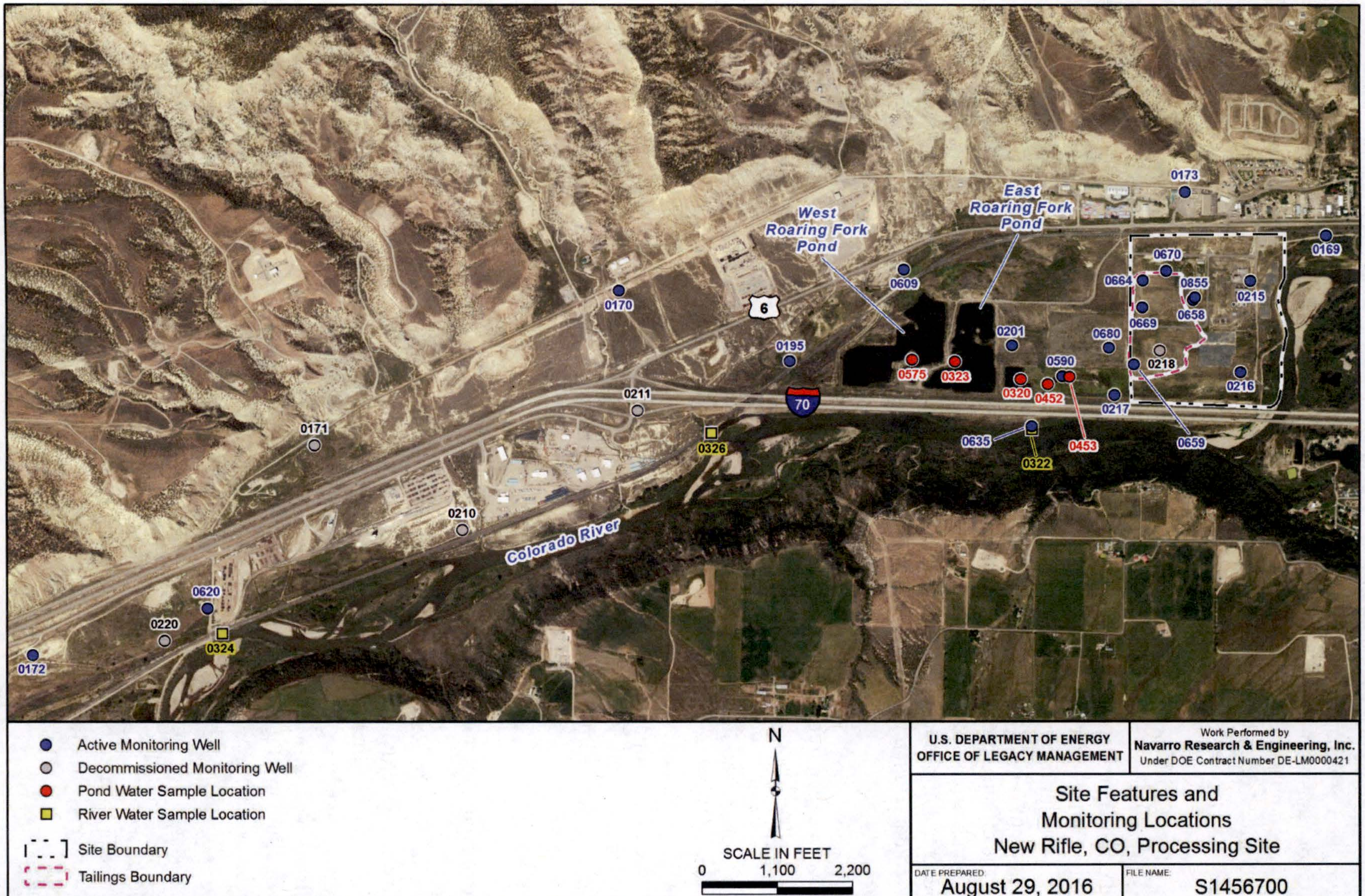

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Figure 4. Current Site Features and Monitoring Locations

The revised GCAP noted that vanadium tended to mobilize when the subsurface was disturbed and that attenuation of vanadium was likely contingent upon preventing such a disturbance. An additional IC for vanadium was proposed to restrict subsurface disturbance in a limited area. The "no dig zone" encompassed the area of highest vanadium concentrations in alluvial groundwater, and a larger, "limited disturbance zone" encompassed an area of lower vanadium concentrations in groundwater. These controls were not formally implemented.

In 2008, the City of Rifle began dewatering the aquifer in the eastern portion of the site (the City's property) to provide dry footing for constructing foundations for a wastewater treatment plant. Dewatering created a cone of depression that extended west into areas of vanadium-contaminated sediments. Concentrations of some COCs, such as arsenic, molybdenum, and vanadium, spiked significantly in nearby wells. This prompted a reevaluation of the proposed compliance strategy. A geochemical study was also undertaken to better understand reactions occurring in the affected area, especially for vanadium. The study concluded that without removal of vanadiferous soils left from milling operations, vanadium was likely to persist at elevated concentrations in local groundwater. This is especially true if contaminated soil layers are in direct contact with a limited volume of groundwater (DOE 2010).

Elevated concentrations of vanadium and other constituents in affected groundwater near the construction area began trending downward shortly after dewatering ceased and groundwater levels equilibrated. This trend has generally persisted through the last sampling round in November 2015, though some concentrations continue to remain above pre-dewatering levels. Overall, COC concentrations in groundwater are not decreasing as quickly as predicted by modeling in the SOWP (see Section 2.3.3). Over some portions of the site, trends for certain constituents appear to be leveling out at concentrations above cleanup goals (see Section 2.4). This GCAP therefore proposes a new compliance strategy of no remediation with ACLs for all COCs in conjunction with ICs and continued monitoring. The proposed COCs are arsenic, molybdenum, nitrate, selenium, uranium, and vanadium.

2.3 Hydrology

2.3.1 Hydrogeologic Units

Groundwater at the New Rifle site resides primarily within a shallow alluvial aquifer north of the Colorado River. The alluvial aquifer consists mostly of Quaternary-age material deposited by the river. The remainder of the alluvium was deposited in alluvial fans associated with north-northwestward-trending watercourses that carry surface water and suspended sediment southward from Webster Mesa and Prefontaine Mesa, located north of the site, to the river area. Both types of alluvium (Figure 5) are heterogeneous and contain fluvial deposits that range from low-permeability, fine-grained materials, such as silt, to high-permeability, coarse-grained sands and gravels.

The thickness of the alluvium ranges from about 10 ft to as much as 100 ft (DOE 1999a). The greatest thicknesses are in areas containing depressions in underlying bedrock and where the ground surface is covered by alluvial fan materials that were deposited at elevations several tens of feet above near-river alluvium.

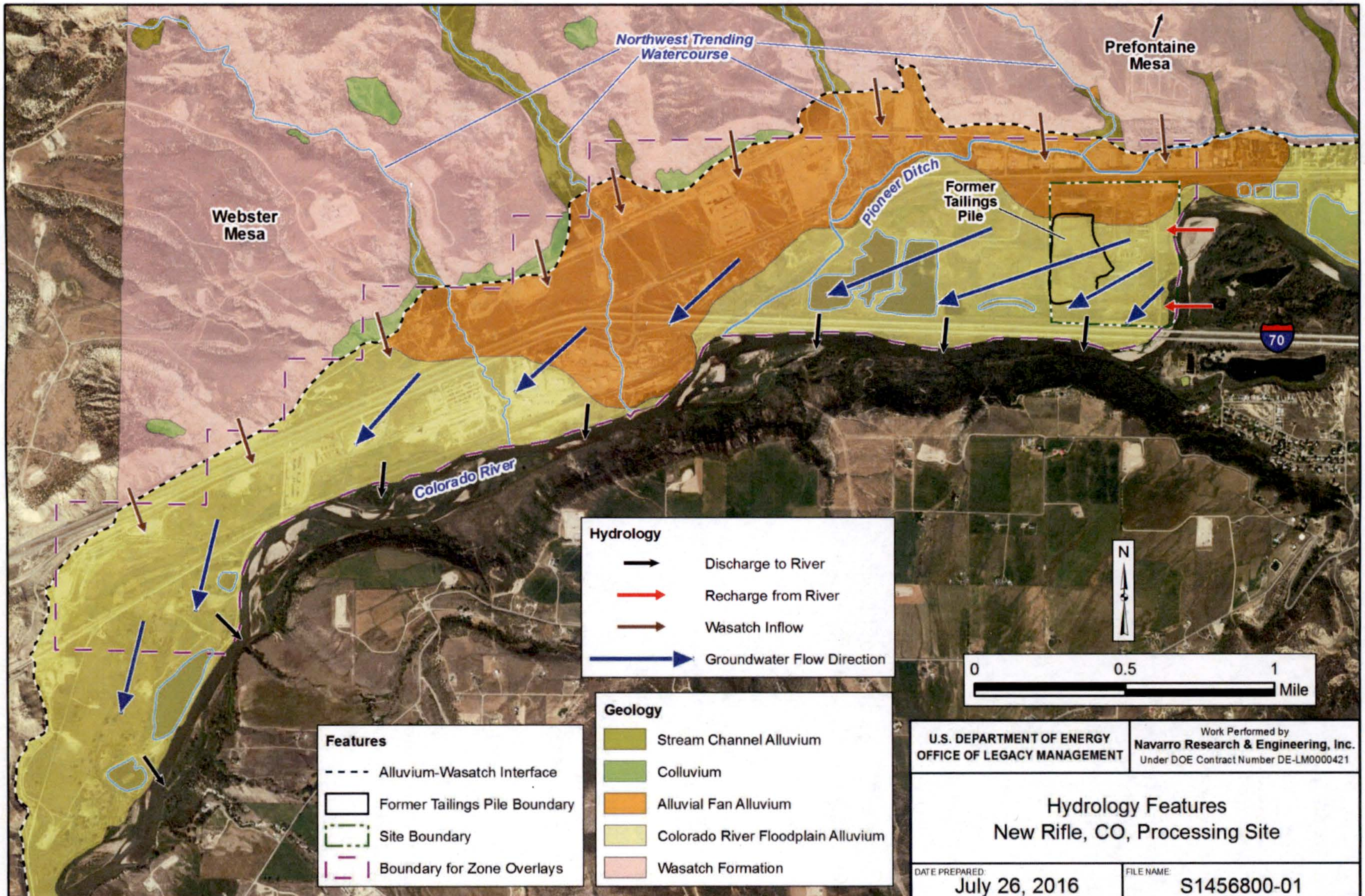

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Figure 5. Groundwater and Surface Water Features

Though the geologic logs for boreholes and wells completed in the alluvium vary considerably from one location to the next, general trends are observed with well depth. In areas covered at ground surface by alluvial fan materials, the uppermost sediments are dominated by fine-grained deposits. These materials are typically described as silt, clay, sandy silt, and loess. Within most of the alluvial fan areas, the fine-grained alluvium is underlain by coarse-grained sands, gravels, cobbles, and boulders. These coarser sediments comprise high-energy fluvial deposits laid down atop bedrock by the Colorado River during prehistoric times. Thicknesses of the river-derived sands, cobbles, and boulders beneath the alluvial fan materials typically range from a few feet to multiple tens of feet. However, at a few wells in alluvial fan areas, the entire thickness of the alluvium is dominated by fine-grained materials, and the coarse-grained, high-energy-deposition sediments are not present.

At wells drilled where floodplain, river-derived alluvium is found at ground surface (i.e., non-fan areas), the uppermost 5 to 10 ft of sediment is described as fine-grained, and typically consists of fine-grained sands, silty sands, sandy silts, silty clay, silt, and clayey silt. At greater depths, the sediments are dominated by sandy gravels and sandy cobbles that sit on top of bedrock. As with the deepest alluvium beneath alluvial fans, these coarser sediments were deposited in high-energy environments created by prehistoric river flows. In most areas with river-derived deposits at ground surface, the thickness of the alluvium is limited to about 10 to 30 ft. However, alluvial thicknesses can approach 40 ft in some locales.

Alluvial materials are underlain everywhere at the site by bedrock of the Tertiary Wasatch Formation, an erosion-resistant geologic unit consisting mostly of variegated strata of claystone, siltstone, and sandstone. The Wasatch is several thousand feet thick beneath the New Rifle site and is generally considered to be a low-permeability, indurated formation. However, the uppermost 8 to 13 ft of this hydrogeologic unit is weathered, which makes it possible for reasonable quantities of subsurface water to move through it. In addition, the Wasatch sandstones, forming lenticular and laterally continuous bodies, tend be more permeable than the siltstones and claystones, thus providing more permeable media in some areas than tends to be ascribed to the formation.

The Wasatch Formation also crops out directly to the north of the alluvium, in areas where the river has not eroded it. Thus, it generally forms the north border of the alluvial aquifer (Figure 5). Colluvium overlies Wasatch bedrock in some locales along the alluvial aquifer's north border. In areas where the north-northwest-trending drainages empty onto alluvial-fan and river-derived alluvium, the surface sediments consist of fluvial sediments deposited by these tributary watercourses.

2.3.2 Groundwater Flow System

Most groundwater flow at the New Rifle site takes place within the alluvial aquifer. Depth to groundwater typically ranges from 5 to 10 ft below land surface, though greater depths to the saturated zone (about 40 to 50 ft) are observed in areas where alluvial fan materials are present. The flow direction in the east third of the aquifer is generally toward the west-southwest and southwest. Horizontal hydraulic gradients range from 0.0019 to 0.004 ft/ft. Results from aquifer pumping tests conducted at the site indicate that hydraulic conductivity of the aquifer ranges from about 55 to 275 ft per day (DOE 1999a). However, the aquifer test results appear to represent coarse-grained sediments in the alluvial aquifer, particularly sand and gravels, which have hydraulic conductivities that are much larger than those for sandy silt, silt, clay, and loess.

Hydraulic conductivities ranging from less than 0.001 ft/day to about 1 ft/day better represent the finer-grained materials. A hydraulic conductivity of 114 ft/day was used to represent the alluvial aquifer in a groundwater flow model developed in support of the SOWP (DOE 1999a), indicating that the model tended to mostly represent flow in the deeper sands, gravels and cobbles. Measured porosities for the alluvium range from 0.25 to 0.35 (dimensionless).

Surface water seepage from the Colorado River into the aquifer constitutes a large, and perhaps the largest, recharge source for the groundwater system. Most of this recharge occurs along the 2000 ft long north-south trending reach of river (DOE 1999a) that constitutes the east boundary of the site. A report on groundwater flow modeling in the SOWP attributed the largest amount of recharge to infiltration of precipitation falling directly on the aquifer's surface. However, more recent assessments of the hydrogeologic conceptual model for the site suggest that recharge from precipitation is probably considerably smaller than was estimated for the groundwater modeling. This is largely because hydrologic research over the past decade has shown that the percentage of annual rainfall and snowfall that recharges shallow aquifers in the western United States is generally quite small (less than 0.5 to a few percent). The SOWP assumed that virtually all of the onsite precipitation during an average year would recharge the alluvial aquifer before removal from groundwater through processes like evapotranspiration. Relatively large recharge sources accounted for in the SOWP that are considered viable and active during several months of each year include conveyance water losses from Pioneer Ditch (Figure 5) and seepage losses from three of the four north-northwest trending watercourses that flow southward to the Colorado River floodplain. Today, three of the watercourses traverse the alluvial fan material and the floodplain and contribute surface water to the river. Surface water in the fourth, which flows onto alluvial fan sediments just north of the former tailings piles, is intercepted by Pioneer Ditch prior to reaching the river.

An additional likely source of groundwater in the alluvial aquifer is the discharge of groundwater from the Wasatch Formation to the alluvial aquifer along its north border. The primary origin of most of this subsurface water is recharge from substantial irrigation and infiltration of precipitation on Webster Mesa and Prefontaine Mesa, both of which lie north of the current New Rifle IC zone overlay area (Figure 5). Additional subsurface inflow along the aquifer's north border in the west half of the current IC area is attributed to recharge from precipitation on the Wasatch Formation at elevations exceeding 5300 ft above mean sea level. A large portion of the subsurface inflow to the aquifer along its north border is expected to occur via discharge to the coarse-grained, river-derived sediments found at greater depths in the aquifer. Though the Wasatch Formation is regarded as a low-permeability geologic unit, the lenticular sandstone bodies within and weathered upper layers of the formation are expected to provide sufficient permeable media for the delivery of subsurface-water inflows to the alluvium across the Wasatch–alluvial aquifer interface.

Groundwater is lost from the alluvial aquifer primarily through three processes. A large amount of the groundwater is lost to surface water via discharge to the Colorado River. Other losses are attributed to evapotranspiration, particularly in parts of the site and IC area populated by phreatophyte vegetation such as cottonwood, tamarisk, and greasewood. Finally, groundwater is lost to the atmosphere as it discharges to onsite surface water bodies and then evaporates. The surface water bodies include the East Roaring Fork (gravel) Pond, the adjacent West Roaring Fork Pond (Figure 6), and the mitigation wetland (south of the former tailings piles) when groundwater levels are above the wetland's bed elevation.

Though the east-west-trending reach of the Colorado River that forms the south border of the alluvial aquifer is mostly a site of groundwater discharge, some surface water probably seeps into the groundwater system throughout each year along this part of the river. The occurrence of sequential pool-and-riffle sequences in the river makes it possible for minor amounts of surface water to flow into the aquifer just upstream of each riffle and, in the process, form hyporheic zones. The hyporheic zones comprise sections of the aquifer where river water enters the aquifer on the downstream end of a pool, only to discharge back to the river at a location farther downstream in the vicinity of the next river pool. Though this river-derived water has the capacity to facilitate multiple biogeochemical processes in near-river locations within the aquifer, hyporheic groundwater is not expected to have a major impact on aquifer flow and contaminant transport processes at locations farther inland. As a consequence, the section of the river downstream of the north-south trending reach that recharges the aquifer represents an area of net groundwater discharge.

Additional surface water flows into the groundwater system each year along all reaches of the river due to runoff caused by spring and early summer snowmelt from surrounding and upstream mountainous terrain. Increasing seasonal runoff is typically observed in May and June but may take place as late as July. As surface water levels rise in response to the high runoff, increased hydraulic heads in the river cause groundwater elevations to rise as well, often as much as 5 ft or more (DOE 1999a). As this "pressure pulse" transmission occurs, river water is forced into near-river portions of the aquifer, where it is stored until river levels decline. Upon passage of peak river flow associated with the snowmelt runoff, the water returns to the river. This temporary process, referred to as bank storage, might last 1 or 2 months. Such a short duration prevents the river-derived water from penetrating much farther than several tens of feet into the aquifer.

As previously mentioned, surface water seeps into the aquifer along the north-south reach of the river on the site's east end throughout the year. The rate at which surface water is lost to the aquifer along this part of the river increases during the bank storage season, helping the river water to temporarily migrate more quickly through the aquifer in its near-river portions.

The year-round recharge of the alluvial aquifer by surface water seepage along the north-south reach of the river on the site's east side is the primary source of groundwater that flows west-southwestward to southwestward in the east third of the site. To a large extent, the southward flow component in this part of the aquifer is caused by an additional water source in the form of seepage from the unlined Pioneer Ditch (Figure 5 and Figure 6). The ditch loses water to the subsurface over a distance of 7100 ft, from the east border of the site to the confluence of the ditch with a north-northwestward-trending watercourse emptying onto the floodplain immediately north of the West Roaring Fork Pond (Figure 5). The southward component of groundwater flow beneath the east third of the IC area causes a large fraction of the recharge attributed to river losses on the site's east border to discharge back to the river at relatively short distances downstream, in areas upstream of the Roaring Fork Ponds.

Relatively continuous discharge of groundwater to the river is also expected along a 10,000 ft reach of river extending from just south of the west edge of the West Roaring Fork Pond to where the river begins flowing directly to the southwest. In this area, the southward component of groundwater flow leading to the groundwater loss to surface water is caused by recharge from two of the tributary watercourses entering the floodplain from the north, as well as subsurface inflow from the Wasatch Formation along the aquifer's north border.

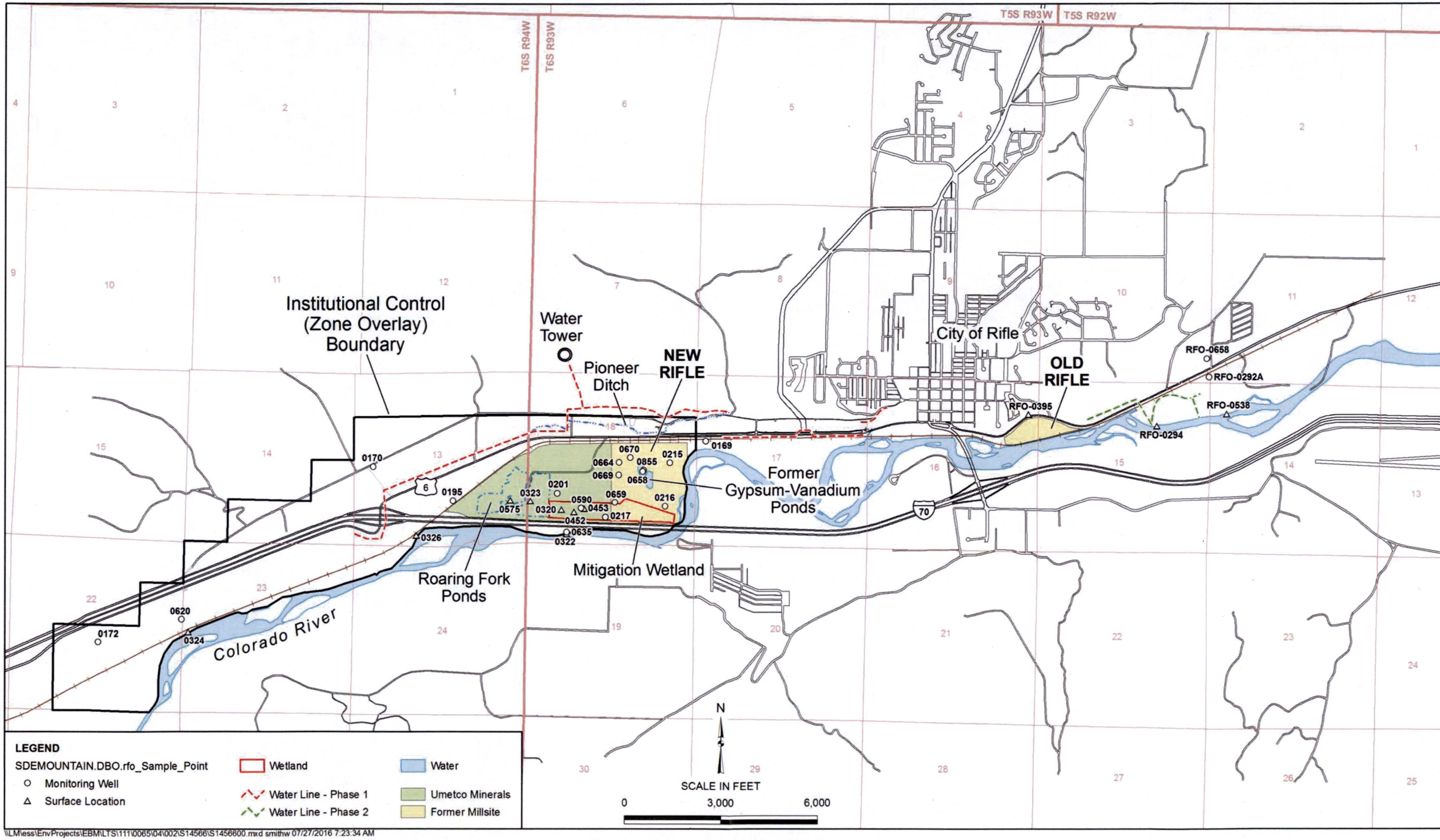


Figure 6. Physical Features, Sample Locations, and Institutional Controls Boundary

Groundwater flow and fate and transport modeling conducted in support of the SOWP (DOE 1999a) assumed that site-related, contaminated groundwater had the potential to migrate more than 18,000 ft (3.4 miles) parallel to the river, such that uranium detected in groundwater near the west end of the current IC area was considered a contaminant stemming from former milling activity near the east end of the IC area. The conceptual model presented in this section revises that assumption because it takes into account the likelihood that contamination originating in the vicinity of the former tailings and raffinate ponds will, under current conditions, discharge to the Colorado River at a considerable distance upgradient of the IC area's west end.

The site conceptual model presented herein acknowledges that, during previous years, some site-related contamination reached groundwater in an area just west of the West Roaring Fork Pond (Figure 4). This contamination is attributed to historical operations of the ponds, in which water pumped from the East Roaring Fork Pond was subsequently discharged to the West Pond. As a consequence, groundwater mounding in areas surrounding the West Pond introduced contaminated water to parts of the aquifer lying to the west. However, with cessation of gravel-mining operations at the ponds in 2003, it is likely that existing groundwater flow processes will cause remaining groundwater contamination to discharge to the river several thousand feet upgradient of the IC area's west boundary. Analyses of chemical data presented in Section 2.4.2 of this report indicates that the chemistry of much of the alluvial groundwater occurring west and southwest of the Roaring Forks Ponds is derived from sources different from those that impact the former mill site. Accordingly, the argument can be made that contaminated water historically related to site operations will eventually discharge to the river within a few thousand feet of the ponds and will not impact the west third of the IC area.

The Wasatch Formation comprises multiple members, with the Shire Member dominating local outcrops of the formation and the bedrock underlying the surficial aquifer at the New Rifle site. Descriptions of the Shire Member in the SOWP (DOE 1999a) from borehole logs of wells drilled into the Wasatch Formation in the IC area indicate that the weathered uppermost 8 to 13 ft of the Shire maintains strong hydraulic communication with the overlying alluvial aquifer. Though the hydraulic communication is clearly present, the vertical hydraulic gradients between the lower alluvium and the weathered Shire sediments are minimal (DOE 1999a). The lack of significant vertical gradients was observed at four well pairs used to monitor hydraulic heads in the two geologic units during the late 1990s; the monitoring indicated the presence of a slight upward hydraulic gradient at two of the well pairs and a slight downward gradient at the other two. It was concluded from this observation that neither the Wasatch Formation nor the alluvial aquifer dominated flow from one to the other.

The relatively low-permeability claystone and siltstone beds of the Shire Member form aquitards that separate the overlying alluvial aquifer from a deeper and more-permeable sandstone within the Wasatch referred to as the Molina Member. The saturated beds of the Molina Member contain a semiconfined to confined aquifer of undetermined thickness. Attempts to identify clear vertical gradients across Shire strata separating the Molina from the surficial aquifer have been complicated by complex gradients within deeper parts of the Shire member that indicate both upward and downward flow. Despite such complexities, the SOWP identifies the Colorado River floodplain as an area of regional groundwater discharge, such that upward flow from deeper parts of the Wasatch Formation to the surface alluvium in the New Rifle IC area is considered to be the rule rather than an exception.

2.3.3 Contaminant Transport in Groundwater

Since the SOWP was issued in 1999, contaminant concentration data from site wells and advances made in contaminant transport and groundwater remediation disciplines suggest strongly that groundwater contaminants at the New Rifle site will not naturally flush from the alluvial aquifer within a 100-year compliance period. Though the concentrations of some contaminants at the site have shown signs of gradually decreasing, trends in temporal plots of concentration indicate that applicable groundwater standards will not be met within the prescribed time period.

The subsurface at the New Rifle site is characterized by significant physical and biogeochemical heterogeneity. This type of porous media complexity was not taken into consideration in the flow and transport modeling that was conducted in support of the SOWP (DOE 1999a), and upon which selection of groundwater remedies was largely based during the late 1990s. For example, each model simulation adopted a uniform hydraulic conductivity for the alluvial aquifer although conductivities can vary by up to 4 or 5 orders of magnitude. This also meant that the conductivities within sediments that appear through quick observation to be homogeneous were treated as uniform, despite the fact that they can actually vary by factors of 3 or more over relatively short distances. Such physical heterogeneity can lead to the creation of a dual-domain groundwater system, in which preferential pathways (mobile domain) are interspersed with less-permeable (immobile domain) zones. In such a system, the preferential pathways convey most of the groundwater migrating across a site, and the lesser permeability zones tend to act as long-lived contaminant sources that slowly bleed contamination to the mobile zones. This phenomenon, sometimes referred to as rate-limited mass transfer, can also be observed at the intragrain scale, wherein contaminants residing within fractures and irregular surface features of individual sediment grains are released very slowly to groundwater via diffusion processes.

The approach taken with the groundwater models developed for the SOWP effectively assumed that the total inventory for each site contaminant was defined by the initial concentrations assigned to the contaminant and a uniform value of the soil-water partition coefficient (K_d) used to represent the contaminant's capacity to adsorb to and desorb from aquifer sediments. As a consequence, it is likely that the actual inventories of the contaminants were underestimated, and that more contaminant mass remains to be flushed from the subsurface than was previously assumed. Research over the past decade, including research on sorption processes at the Old Rifle site (DOE 2011), has shown that K_ds of inorganic chemical contaminants are typically a function of local groundwater chemistry as well as the character of the sediment to which the contaminants sorb. Consequently, it is common for K_ds at sites like New Rifle to vary both in space and time and potentially span a range of more than an order of magnitude. Without the capacity to characterize the complex nature of sorptive processes in the New Rifle subsurface, it is likely that the modeling was overly optimistic with regard to projecting concentration decreases over time.

Transient flow processes at the site, particularly seasonal changes in groundwater elevation, provide additional concerns about the ability of natural flushing processes to succeed over remaining years in the 100-year compliance period. The pressure wave transmissions stemming from the river each May and June, resulting in groundwater-level increases of 5 ft or more, cause the saturated zone to penetrate less permeable sediments overlying river-derived sands and gravels. This leads to the leaching of remnant contamination residing in fine-grained deposits, thereby loading additional contaminant mass to the groundwater system. Because the silts, silty clays, and clays that compose much of the sediment in upper portions of the alluvium play a major role in controlling rate-limited mass transfer, the potential exists for this yearly mass loading to persist for several decades, if not hundreds of years.

2.4 Site-Related Contamination

Groundwater beneath the New Rifle site was contaminated by former vanadium- and uranium-ore-processing operations that were ongoing from 1958 through 1972, from lignite ash processing from 1964 to 1967, and from vanadium processing (which did not produce tailings but may have produced milling solutions) from 1973 to 1984. Site field investigations have shown that the alluvial aquifer is the only aquifer affected by the former milling operations.

The site-related constituents that are currently being monitored include ammonia, arsenic, molybdenum, nitrate, selenium, uranium, and vanadium. Figure 4 shows New Rifle monitoring locations and site features referred to in this report. Figure 6 shows the overall layout of the New and Old Rifle sites and background locations at the Old Rifle Site. Appendix B has spot plots showing the distribution of contaminants based on the most recent sampling event at each location. Time-concentration plots are also provided in this appendix.

2.4.1 Potential Residual Source Areas

As mentioned previously, surface remediation of the site was completed in 1996. This involved removal of tailings and associated surface soils and other materials to meet the UMTRCA standard for radium-226. However, surface cleanup did not take into account the presence of other contaminants in subsurface materials at the site.

Historical photos (Figure 2 and Figure 3) show that process-related materials occupied the entire site. Limited characterization of soils from beneath the former tailings piles and evaporation pond (see locations in Figure 2 and Figure 3) was conducted in support of the SOWP. Results indicated that elevated levels of arsenic, molybdenum, selenium, uranium, and vanadium (compared to background) exists in these areas (DOE 1999a). More extensive characterization for vanadium was done in the former gypsum and vanadium ponds areas in support of the vanadium pilot study (DOE 2000). Results showed that significant quantities of vanadium were present throughout the aquifer thickness in this area, with concentrations ranging up to 2400 milligrams per kilogram (mg/kg). Limited analyses for arsenic, molybdenum, and uranium also indicated significant levels of contamination in the subsurface materials. This is consistent with the high contaminants concentrations observed in wells located in source areas, particularly wells 0855 and 0658, in the vicinity of the former gypsum and vanadium ponds.

2.4.2 Historical Contamination Trends and Spatial Distributions

Appendix B presents graduated symbol ("spot") plots showing the distribution of most COCs monitored in New Rifle alluvial groundwater and surface water (Figures B-2 to B-6). Two different contaminant distributional patterns are shown over time—one for the relatively mobile COCs (nitrate, molybdenum, uranium) and one for the relatively immobile COCs (arsenic, selenium, vanadium). In general, the contaminant plumes for the less-mobile COCs are restricted in areal extent and are still concentrated around the former mill site (e.g., Figure B-6). Elevated concentrations are generally confined to wells immediately downgradient of the site. Concentrations decline relatively rapidly with distance from the site.

Plumes for COCs that are more mobile are more extensive (Figures B-2, B-3, and B-5). Except for nitrate, historical high concentrations for mobile COCs were observed onsite, but over time, these concentrations have decreased and more recently the highest concentrations are observed in offsite wells. For nitrate, highest concentrations have always been observed downgradient of source area wells.

The most conspicuous feature in time-concentration plots of groundwater monitoring data for the last several years is a pronounced spike in concentrations of arsenic, molybdenum, and vanadium in samples collected from well 0855 (Figures B-15, B-20, and B-40). Concentrations of vanadium in samples from this well were more than an order of magnitude higher than in samples from other wells. As discussed in Section 2.2, these concentration increases were attributed to mobilization of contaminants from residual contaminated soils due to dewatering and excavation activities associated with construction of the City's wastewater treatment plant.

Based on the hydrologic characterization in Section 2.3, for purposes of evaluating and interpreting groundwater monitoring results, wells in the monitoring network associated with the New Rifle site can be placed into one of three groups in which the groundwater was affected by distinctly different hydrologic and geochemical processes. Behavior of site-related contamination within each group of wells is similar, while differences between the groups can be noted.

Onsite wells are those within the site boundary. As discussed in Section 2.4.1, residual soil contamination is present below the water table at the New Rifle site. This contamination is most likely to affect groundwater in direct contact with those soils (i.e., onsite wells) by serving as a persistent source of contamination to groundwater. Although onsite wells are all grouped together for the purpose of computing groundwater statistics and comparing the results to historical data, three subgroups of onsite wells were recognized in site Verification Monitoring Reports (e.g., DOE 2008c, DOE 2012) based on patterns of time-concentration plots for the wells (Appendix B includes time-concentration plots). These patterns were interpreted as being related to the wells' location and proximity to former source areas as discussed below.

Wells 0169, 0215, and 0216 are adjacent to the Colorado River and upgradient of the main source of site groundwater contamination—the former raffinate ponds and tailings pile. Concentrations of most COCs in these wells are generally low and have had limited variability over the past 10 years. A notable exception is well 0216, which, in 2008, showed sharp increases in molybdenum, uranium, and vanadium concentrations that remained elevated in 2009 but subsequently declined (Figures B-19, B-34, and B-39). Groundwater concentrations in this area were likely influenced by the groundwater pumping that the City of Rifle conducted during the construction of the wastewater treatment plant.

Locations 0658, 0659, and 0855 are in the footprint of the former gypsum and vanadium ponds and tailings pile. Soil sampling conducted during the vanadium treatment pilot study (DOE 2002) indicated that residual contamination exists in these areas and may have local influence on groundwater quality. These locations are characterized by time-concentration plots with the highest concentrations of most COCs and the greatest degree of variability over time (e.g., Figures B-15, B-30, B-40, and B-41). For the most part, these wells exhibit no clear trends. Adsorption/desorption reactions between groundwater and soils probably occur in this area, and groundwater concentrations are likely sensitive to fluctuations in the water table. As noted above, due to the City's activities, concentrations for a number of COCs in well 0855 increased sharply followed by a return to concentrations within historical ranges (though not necessarily to pre-excavation levels).

The remaining onsite wells—0669, 0664, and 0670—are outside of the main areas of residual contamination. Trends shown in time-concentration plots for these locations are more similar to those for offsite locations (Figures B-21 and B-36). They show some variability but are typically decreasing; uranium and molybdenum remain above MCLs.

Wells in the second group (wells 0201, 0217, 0590, and 0635) are adjacent to and downgradient of the site and upgradient of the Roaring Fork Ponds (Figure 6). These wells represent groundwater contaminated by plume migration. This groundwater was contaminated strictly by downgradient movement of constituents through the groundwater system. Contaminant transport was affected to some degree by the operation of the ponds, as discussed in Section 2.3.2.

Wells in the third group (wells 0170, 0172, 0195, and 0620) are located downgradient of the Roaring Fork Ponds and have been somewhat isolated from the wells in the second group because of historical gravel-mining operations at the ponds. Well 0195 has clearly shown evidence of milling-related contamination (e.g., Figure B-23), likely due to pumping of contaminated water from the East Roaring Fork Pond into the West Roaring Fork Pond (as discussed in Section 2.3.2). It also has shown significant decreases in contamination for the past several years since the cessation of pumping at the gravel operation. It is unclear, however, if site-related contamination has migrated significantly beyond this location.

In previous Verification Monitoring Reports (DOE 2008c, DOE 2012), the westernmost wells were characterized as wells intended for monitoring the middle and leading edge of molybdenum, uranium, and nitrate plumes. This characterization—that is, as part of the downgradient "plume"—was based mainly on the fact that values for uranium here have historically exceeded the applicable 40 CFR 192 groundwater standard. However, the uranium concentrations observed at the westernmost locations have been in the same range as those reported in background wells at the Old Rifle site (maximum of 0.067 mg/L). Uranium in the third group does not display any clear increasing or decreasing trends, except at location 0195, which shows a steady decline in uranium concentrations (Figure 7; note that well 0169 is a background well). Wells from this group are discussed in more detail in Section 2.4.3.

Table 1 and Table 2 provide statistics for the three main groups of wells. Table 1 provides water quality benchmarks for comparison.

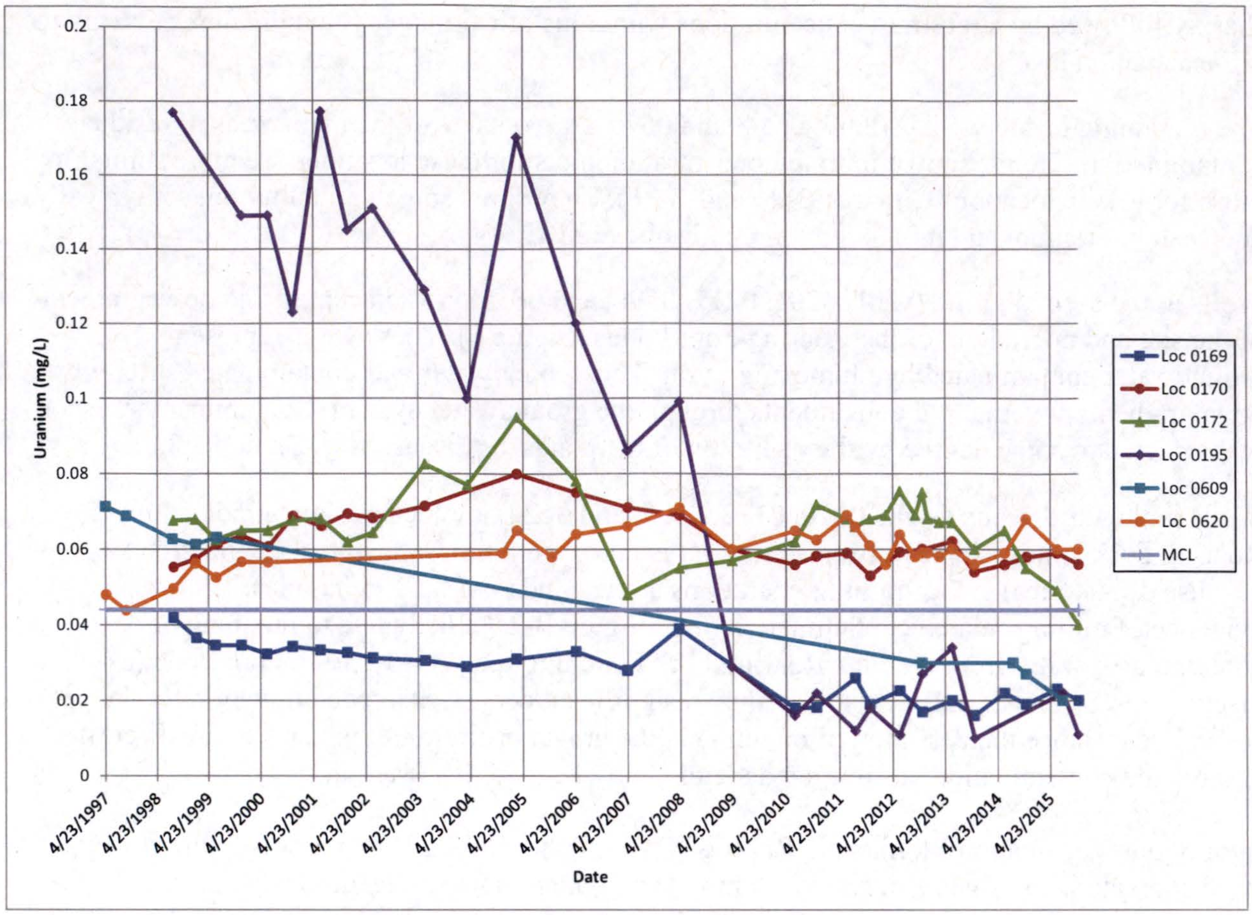


Figure 7. Time-Concentration Plot of Uranium in Westernmost New Rifle Site Wells

Table 1. Mean Concentrations in Groundwater, 1998–1999: Combined June 2015 and November 2015 for the New Rifle Site

Contaminant (all units mg/L)	Benchmark	Onsite[a]		Adjacent to Site[b]		Downgradient[c]	
		1998–1999 mean	June 2015 and November 2015 mean	1998–1999 mean	June 2015 and November 2015 mean	1998–1999 mean	June 2015 and November 2015 mean
Molybdenum	0.1[d]	2.50	0.568	1.928	1.53	0.037	0.0088
Nitrate + Nitrite as Nitrogen	10[d]	13.8	4.47	51.9	9.44	16.6	5.56
Uranium	0.067[e]	0.101	0.0567	0.097	0.104	0.0744	0.0446
Vanadium	NA	5.68	5.79	0.037	0.852	<0.0001	0.00147

Notes:

[a] Includes wells 0215, 216, 0658, 0659, 0664, 0669, 0670, and 0855 (not all wells were sampled for all analytes).
[b] Includes wells 0201, 0217, 0590, and 0635.
[c] Includes wells 0170, 0172, 0195, and 620.
[d] U.S. Environmental Protection Agency groundwater standard (40 CFR 192).
[e] Maximum background value, cleanup goal.

Abbreviation:
NA = not applicable

Table 2. Range of Concentrations in Groundwater, 1998–1999: Combined June 2015 and November 2015 for the New Rifle Site

Contaminant (all units mg/L)	Onsite[a]		Adjacent to Site[b]		Downgradient[c]	
	1998–1999 range	June 2015 and November 2015 range	1998–1999 range	June 2015 and November 2015 range	1998–1999 range	June 2015 and November 2015 range
Molybdenum	0.0237–6.84	0.016–2.0	0.61–3.15	1.3–1.7	0.0041–0.231	0.003–0.013
Nitrate + Nitrite as Nitrogen	<0.003–83.1	<0.01–16	0.089–188	0.016–22	0.012–85.2	<0.01–13
Uranium	0.0103–0.284	0.01–0.11	0.0837–0.120	0.068–0.16	0.050–0.177	0.011–0.06
Vanadium	<0.001–25.3	0.0015–28	<0.001–2.69	0.001–2.3	0.00065–0.0018	0.00034–0.0026

Notes:
[a] Includes wells 0215, 0216, 0658, 0659, 0664, 0669, 0670, and 0855 (not all wells were sampled for all analytes).
[b] Includes wells 0201, 0217, 0590, and 0635.
[c] Includes wells 0170, 0172, 0195, and 0620.

Each of the COCs and ammonia are discussed in the following sections.

Ammonia

Ammonia is not a COC because it is not regulated under 40 CFR 192 and because it has declined to levels that are no longer of concern. However, it is discussed here because nitrate, which is a COC, was likely derived from ammonia at the site through the biologically mediated process of nitrification. From the late 1990s to the present, some of the highest ammonia concentrations have been observed in offsite wells 0590 and 0635 (Figure 12). This is possibly an indication that the main ammonia plume had already moved offsite before monitoring commenced. Ammonia concentrations have declined significantly due to both natural flushing and nitrification. The farthest downgradient observance of ammonia has been at well 0195 (Figure B-13).

Arsenic

Elevated arsenic is limited to four wells. Well 0216 shows some evidence of site-related contamination with concentrations higher than background (at well 0169) but never exceeding the 40 CFR 192 standard of 0.05 mg/L (Figure B-14). Wells 0658, 0659, and 0855 have exceeded the standard, with the highest concentrations observed at well 0855 (Figure B-15). Arsenic did spike in this well during dewatering activities. All other downgradient wells have been below the standard. Minor fluctuations in arsenic concentration have been observed.

Molybdenum

Molybdenum has been one of the most widespread COCs due to its high mobility. It remains elevated in onsite wells and downgradient wells adjacent to the site. Concentrations in well 0855 spiked at an all-time high of 18 mg/L in 2009, but the concentration decreased significantly in November 2012 to 1.2 mg/L and further decreased in November 2015 to 0.39 mg/L (Figure B-20). Mean molybdenum concentrations for all groups of wells have declined over time. However, the relatively high concentrations observed onsite due to dewatering activities suggest that molybdenum could be remobilized and has the potential to affect downgradient areas in the future. Well 0195 is the only well in the westernmost group that has displayed elevated molybdenum (Figure B-23).

Nitrate

The highest concentrations of nitrate are immediately downgradient of the site, though the standard is exceeded as far downgradient as location 0620 based on 2015 sampling results (Figure B-3). The source of much of the nitrate is likely the transformation of ammonia to nitrate through the process of nitrification. Trends (or lack thereof) depend both on ammonia nitrification rates and natural flushing processes. Despite some temporary increases of nitrate in individual wells, presumably because of nitrification (e.g., wells 201 and 0590; Figure B-27), mean concentrations for all well groups have declined over time. It appears that, with declines in ammonia to low levels, nitrate behavior has become less erratic, and concentrations are leveling out. Although nitrate has been observed at concentrations exceeding the MCL in the westernmost wells in the monitoring network, it is not clear that the nitrate in this area is site-related. The nitrate levels observed at these locations could be attributed to local agricultural practices (see further discussion in Section 2.4.3).

Selenium

Natural occurrence of selenium has exceeded the 40 CFR 192 standard of 0.01 mg/L as evidenced by concentrations in background well locations. Therefore the Safe Drinking Water Act (SDWA) standard of 0.05 mg/L has been used as the selenium benchmark. Onsite wells have routinely exceeded this standard and have fluctuated regularly over time. The highest selenium concentrations appear to be correlated with the lowest groundwater levels, similar to a relationship observed for vanadium (DOE 2010). Selenium has exceeded its standard in the offsite wells upgradient of the Roaring Fork ponds, indicating some offsite migration. Based on the November 2015 sampling results, all offsite wells have declined to below the SDWA standard. Unlike the more mobile constituents, there is no evidence that site-related selenium has reached well 0195. However, wells 0620 and 0170 have displayed an upward trend in selenium over about the last 10 years (Figure B-33). These concentrations are within the range of site background levels. A study of the Piceance Basin groundwater quality found that wells in Garfield County had the most frequent exceedances of the selenium drinking water standard, with concentrations ranging up to 1.64 mg/L (Thomas and McMahon 2013) (the study covered Delta, Garfield, Mesa, and Rio Blanco counties). These elevated selenium concentrations were not attributed to any particular source.

Uranium

Elevated uranium concentrations persist throughout the monitoring network. The standard is exceeded as far downgradient as well 0172. However, concentrations at locations downgradient of the Roaring Fork ponds have mostly been in the range of background levels, and it is not clear whether uranium in these downgradient areas is from site-related or ambient sources, as discussed in Section 2.4.3. Time-concentration plots for these downgradient wells show no clear trend except for well 0195, where the uranium concentration has decreased steadily since 2005 (Figure 6). Time-concentration plots for a number of the wells upgradient of the former gravel ponds show no well-defined trend (e.g., 0659, 0590, 0664, and 0670; Figures B-35 through B-37) but fluctuate over a fairly narrow concentration range. Mean concentrations in wells adjacent to the site are nearly the same as they were more than 15 years ago. This distribution may reflect the disturbance caused by operation of the Roaring Fork ponds, or is simply representative of natural variations in concentration observed at monitoring wells.

Vanadium

In spring 2009, vanadium spiked to observed peak concentration of 1600 mg/L in well 0855 (Figure B-40) in response to the City of Rifle's construction work, especially the dewatering of the area around well 0855. The concentration in well 0855 dropped back to 41 mg/L in November 2010 and to 10 mg/L in November 2015. The vanadium concentration in adjacent well 0658 (a shallow well only 5.4 ft deep) was 52 mg/L for a high in 2010 and fell to a recent low of 20 mg/L in June 2015 (Figure B-40). Concentrations have not yet returned to levels observed prior to dewatering activities. Elevated vanadium concentrations are observed only onsite and immediately downgradient of the site (locations 0217 and 0590; Figure B-43).

2.4.3 Extent of Site-Related Contamination

Site-related groundwater contamination has been observed beneath the former mill site and farther west, downgradient beneath the adjacent property. COCs have been detected as far downgradient as well 0195, where historically elevated levels of nitrate, uranium, and molybdenum have been observed. However, all COCs at that well located west of the ponds have since declined to below UMTRCA standards (Figure 8, Figure 9, and Figure 10).

An early evaluation of groundwater quality at the New Rifle site (DOE 1995) noted that increasing trends of several constituents were observed in well 0620, which is located 3 miles downgradient of the mill site (and is still included in the monitoring network). While the observed constituents are often associated with uranium milling (e.g., sulfate, nitrate, chloride), other possible sources were also identified. Results of this evaluation were inconclusive with respect to the source of the contamination. Another study (DOE 1999a) made the assumption that site-related contamination extended as far downgradient as well 0172 because uranium concentrations above the 10 CFR 192 standard of 0.044 mg/L had been detected here. However, uranium levels observed at that well are within the range of concentrations measured at background locations (up to 0.067 mg/L upgradient of the Old Rifle site).

Inspection of the time-concentration plots for the most mobile site COCs (nitrate, uranium, and molybdenum) provides some insight into the western extent of site-related contamination. Figure 8, Figure 9, and Figure 10 show time-concentration plots for well 0195, just west of the west pond, and well 0620, about 1.75 miles farther to the west-southwest. Wells 0210 and 0211, included in the plots, are evenly spaced between wells 0195 and 0620, but they are no longer monitored and concentration data for them cover a shorter time span.

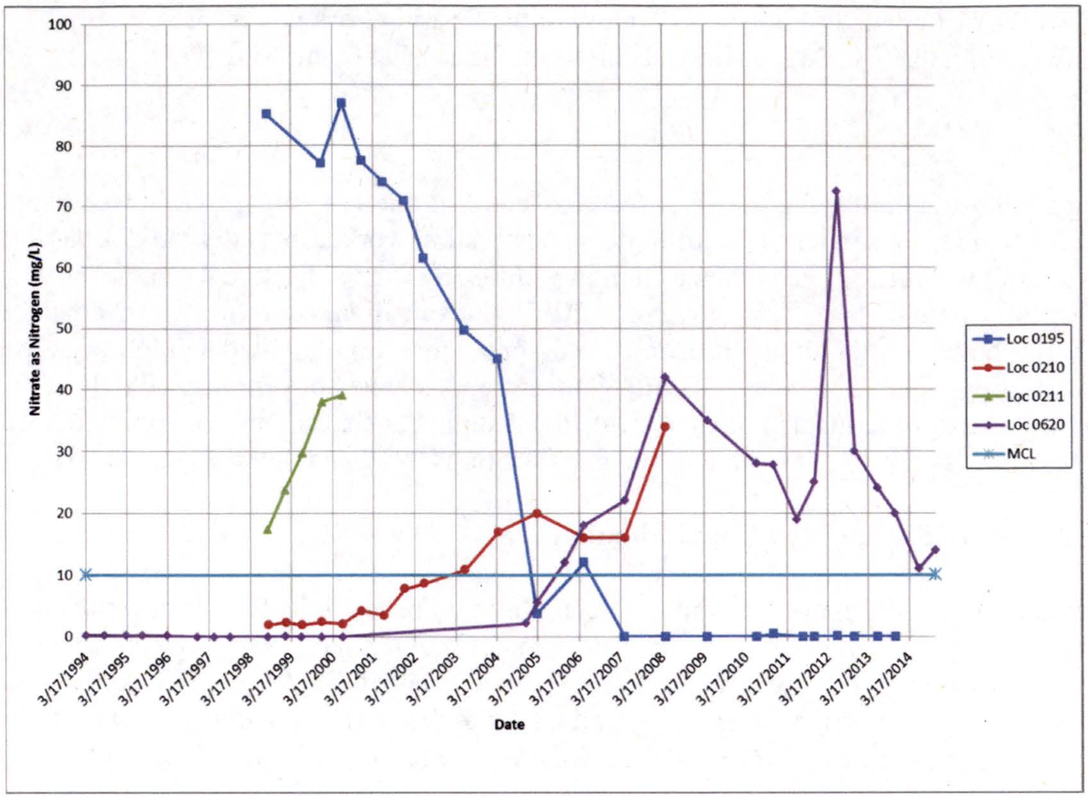


Figure 8. Nitrate Time-Concentration Plot for Selected New Rifle Site Wells, West of the Ponds

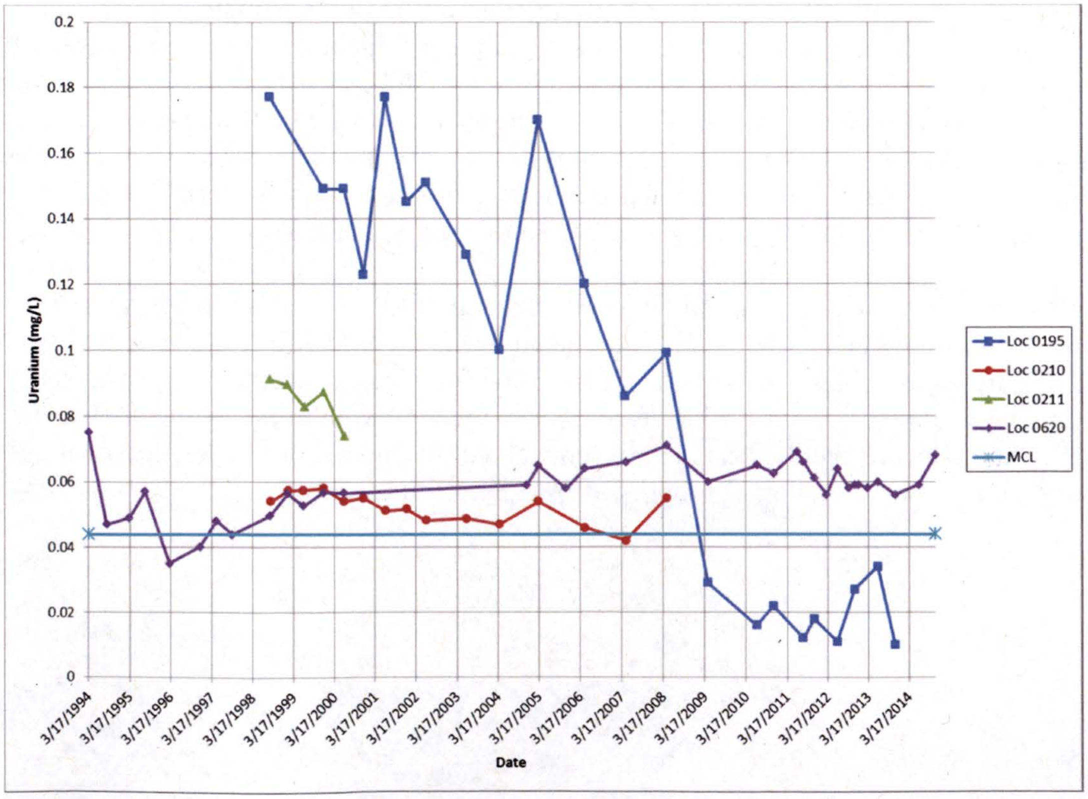


Figure 9. Uranium Time-Concentration Plot for Selected New Rifle Site Wells, West of the Ponds

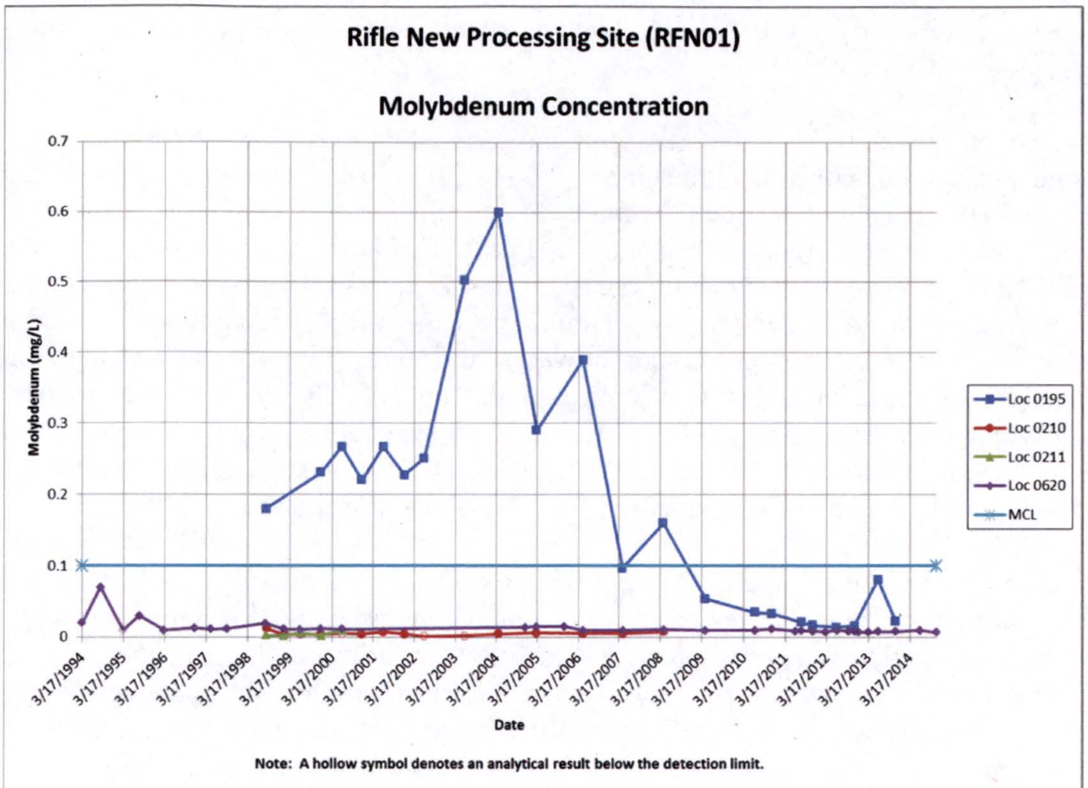


Figure 10. Molybdenum Time-Concentration Plot for Selected New Rifle Site Wells, West of the Ponds

The nitrate, uranium, and molybdenum concentrations observed in well 0195 are almost certainly site-related. Concentrations here are much higher than background levels reported in the SOWP. The declining trends for nitrate and uranium at this location since the late 1990s suggest that concentrations for these constituents at some time before monitoring commenced may have been higher than displayed in Figure 8, Figure 9, and Figure 10. The increase and decrease displayed by molybdenum at well 0195 (Figure 10) suggests the passing of a slug of contamination and suggests that molybdenum transport may be somewhat retarded in comparison to that of uranium and nitrate, with the molybdenum concentration peaking at a later time than observed for the other two contaminants. As discussed in section 2.3.2, operation of the Roaring Fork ponds caused artificial groundwater mounding in the west pond, which could have served as a source of contamination to the westernmost wells. Pumping of the ponds ceased in 2003 and normal groundwater flow conditions have reestablished.

Concentrations of nitrate, uranium, and molybdenum at location well 0195 have declined in recent years to levels below the respective standards for these constituents. Though the same finding does not apply to well 0210 and 0211 because their monitoring time spans do not cover recent years, it should be noted that distinctly increasing trends in nitrate levels were at one time recorded at the two wells, with the highest measured concentrations approaching 30 to 40 mg/L (Figure 8). Similarly, For nitrate levels at well 0620 since 2005 have fluctuated between 10 mg/L on the low end and a peak concentration of about 70 mg/L. Such values are considered above background for the New Rifle site given that the maximum background nitrate concentration for nitrate as reported in the SOWP was less than 5 mg/L. It is important to note, however, that nitrate concentrations at well 0620 have declined in recent years to levels close to the nitrate-as-nitrogen standard of 10 mg/L.

Uranium at levels at well 0211 in the late 1990s and early 2000s exceeded the assumed background level for this constituent (as high as 0.067 mg/L at wells upgradient of the Old Rifle site), ranging between about 0.07 and 0.09 mg/L (Figure 9). However, as discussed earlier, the data for this location and ancillary information regarding local ambient groundwater chemistry are too limited to simply conclude that groundwater this far west of the Roaring Fork ponds (~0.6 miles) was impacted by site-related uranium. The same can be said about concentrations recorded for wells 0210 and 0620, even farther west of the ponds (Figure 4), at which uranium levels have remained relatively steady, in a range of about 0.04 to 0.07 mg/L (Figure 9). The data for molybdenum at wells west of well 0195 are more conclusive regarding it possible impact. Molybdenum concentrations at wells 0211, 0210, and 0620 have mostly been less than 0.01 mg/L (Figure 9), and show no evidence of a passing slug of contaminated water.

An evaluation of chemical signatures suggests that groundwater chemistry in the westernmost wells in the monitoring network may be distinct from that in onsite and downgradient wells known to be impacted by former milling activities. Site monitoring conducted in November 2012 included supplemental analyses of major ions and uranium isotopes that helped identify chemical signatures for groundwater and surface water in different areas monitored for inclusion in annual New Rifle reports. The purpose of this effort was to evaluate whether the source of contamination in westernmost wells was milling-related processes. Chemical signatures of groundwater in different areas were compared using Stiff diagrams, a traditional geochemical plotting tool that displays concentrations of major ions in groundwater. The signatures of uranium isotopes based on $^{234}U/^{238}U$ ratios were also evaluated. These analyses indicated that the groundwater chemistry in the westernmost New Rifle wells is generally different from the chemistry in areas closer to the former mill. This is particularly true for wells 0172 and 0620, which are located more than 1.75 miles west of the West Roaring Fork Pond. The following section summarizes salient findings from the evaluation of chemical signatures.

Major Ion Chemistry

Stiff diagrams of the major cations (Na, K, Ca, and Mg) and anions (Cl, SO_4, HCO_3, and CO_3) provide useful means of distinguishing the general water chemistry of a particular region from that in other regions The Stiff diagrams for sample data from the November 2012 sampling effort (Figure 11) can be evaluated qualitatively by comparing their shapes. For example, the Stiff diagram for westernmost well 0172, with noticeable extensions of both upper apexes (Na, K, and Cl) and lower apexes (Mg and SO4), is clearly different from the diagrams for other wells. The resulting hourglass shape of the diagram for well 0172 is indicative of highly saline groundwater not found at other locations. The Stiff diagram for well 0620, though not as distinctive as the diagram for well 0172, also shows an hourglass shape (Figure 11) that is not seen elsewhere.

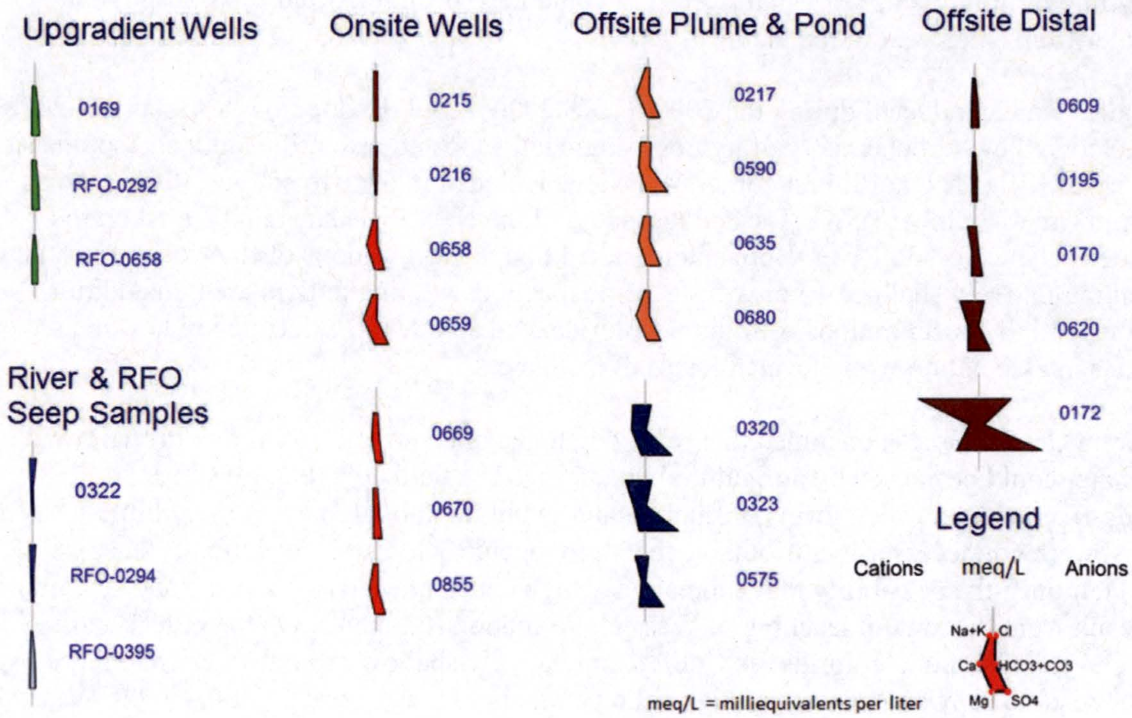


Figure 11. Stiff Diagrams Based on November 2012 Sampling Data
All diagrams have the same scale. As shown above, the Stiff diagrams for well 0172, and to a lesser extent for well 0620, are distinct from those of the remaining samples.

The high salinity of groundwater at well 0172 is reflected in its specific conductivity, which has historically ranged from about 15,000 to 20,000 micromhos per centimeter (µmhos/cm). These values are noticeably higher than specific conductivities at other site wells, which are typically less than or about equal to 5,000 µmhos/cm.

The Stiff diagrams for most onsite wells and wells immediately west of the onsite area, yet upgradient of the ponds, are distinctive for their relatively high calcium concentrations (Figure 11) in comparison to concentrations of sodium or magnesium. Comparable diagrams illustrating the concentrations of major ions in Colorado River samples are also informative because they reflect the generally low salinity of river water fed by runoff from peaks in the Rocky Mountains located to the east. The ionic chemistry of the river in turn strongly influences the Stiff diagrams for the easternmost onsite wells 0215 and 0216, as the predominant source of groundwater for these locations is actually surface water losses to the subsurface along the north-south aligned reach of the river that forms the east border of the site (Figure 5). Thus, though wells 0215 and 0216 might reflect small amounts of the remnant contamination tied to the former mill, contaminant concentrations in this easternmost area tend to be diluted by mixing with influent river water.

Westernmost wells 0172 and 0620 are located near existing gas wells managed by Williams Production RMT Company (Williams). Routine sampling of well 0172 by Williams has revealed concentrations of benzene, toluene, ethylbenzene, and xylenes that are wholly unrelated to former milling activities (DOE 2012). On the basis of these findings and recent chemical and isotopic fingerprinting, it appears that well 0172 could have been impacted by past spills of wastewater from a gas well in the vicinity.

Two studies were conducted during the 2000s (URS 2006; S.S. Papadopulos & Associates 2008) to characterize the hydrochemistry of hydrogeologic units located primarily south and southeast of the City of Rifle. The northwest corner of the area included in the two studies, referred to as the Mamm Creek Field Area, was located just south of the New Rifle site and IC area on the south side of the Colorado River. Both studies noted high concentrations of fluoride, nitrate, and selenium in relatively shallow water wells at some locations within the field area. In addition, anomalously high concentrations of sodium, chloride, and sulfate were detected in key areas, sometimes in association with elevated levels of methane.

The Mamm Creek studies concluded that relatively high concentrations of nitrate in shallow groundwater could be caused by agricultural practices in the field area (e.g., fertilizer application) and that elevated levels of fluoride and selenium, though present in multiple locations, were not necessarily attributable to anthropogenic activities. The latter of these findings left open the possibility that anomalously high concentrations of fluoride and selenium might result from the natural leaching of Wasatch Formation sediments. On the other hand, elevated levels of sodium, chloride, and sulfate in relatively shallow groundwater were more likely the result of upward-migrating, high-salinity waters found at greater depths in the Wasatch Formation, or even the gas-yielding, Cretaceous-age Williams Fork Formation found below the Wasatch. The studies indicated that gas production wells drilled in the study area provided the most likely mechanism by which the sodium, chloride, and sulfate could migrate upwards to shallower depths.

Given the findings from the Mamm Creek investigations (URS 2006; S.S. Papadopulos & Associates 2008), there is a distinct possibility that elevated ion concentrations seen at well 0172 can be attributed to upward-migrating, high-salinity waters originating in deeper parts of the Wasatch or the underlying Williams Fork Formation. While there is a limited possibility that historically high concentrations of nitrate observed at well 0620 were due, at least in part, to milling-related contamination, the relatively low concentrations observed presently at this location suggest they are attributable to local agricultural practices in areas west of the Roaring Fork Ponds (DOE 1995).

Uranium Isotopes

Environmental isotopes are often used in studies of contaminated groundwater to help evaluate groundwater flow and decipher the contaminant sources. In the case of uranium, the ratio of the radioactivity concentrations for uranium-234 and uranium-238 ($^{234}U/^{238}U$), which is referred to as an activity ratio (AR), is used to distinguish anthropogenic (or mill-related) influences from natural uranium sources. The activity concentrations of uranium isotopes in selected groundwater and surface water samples from the November 2012 monitoring event were analyzed to help determine the origin of groundwater contamination in westernmost New Rifle wells. The resulting data indicated that groundwater impacted by former milling operations tends to exhibit ARs that approximate unity (1.0), whereas the ratios associated with natural background processes are typically higher, and generally more than 1.2. The reasons for such differences at former uranium mill sites are explained in more detail by Zielinski (1997).

Figure 12 is a plot of AR versus uranium concentration for all New Rifle samples that have been analyzed for uranium isotopes. Most locations included in this plot were sampled in November 2012, but 1998 data are also used for several wells for which recent uranium isotope data were not available. This latter group includes well 0173, which was formerly used to represent influent, upgradient concentrations for the site, and well 0169, used to represent upgradient concentrations currently and in recent years. The 1998 sampling also included well 0201, which continues to be monitored, and wells 0171, 0210, and 0220, which have since been decommissioned (see Figures 4 and 6 for well locations and monitoring status). Different symbols are employed in Figure 12 to identify wells in four general categories reflective of location and the presence, or lack of presence, of mill-related water chemistry. Solid red squares denote the wells used to reflect influent groundwater from upgradient groundwater (wells 0169 and 0173). The second category is Colorado River chemistry, which for this evaluation is identified by a single X symbol at surface water location 0322. Solid blue diamond symbols identify wells that are clearly influenced by mill-impacted groundwater, such as onsite wells, offsite locations immediately west of the site, and wells that appear to be impacted by seepage of contaminated water from the west pond into groundwater (e.g., wells 0195 and 0609). The fourth category of wells, representing the westernmost locations, is identified by solid green triangles. Note that two wells, 0172 and 0215, are represented twice in the plot because uranium isotope data were available for them in both 1998 and 2012.

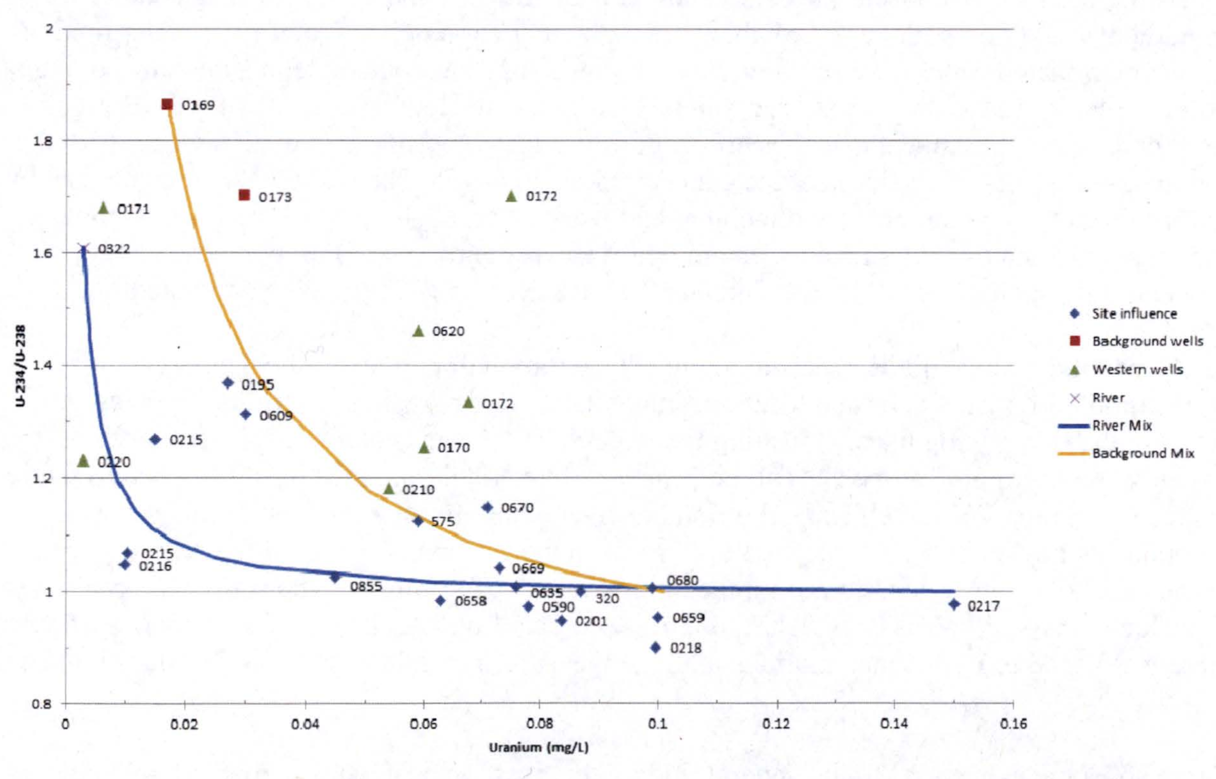


Figure 12. Uranium Isotope Ratios for New Rifle Site Groundwater and Surface Water

One of the most notable features of the plot in Figure 12 is the large quantity of wells with AR values that are close to unity, indicating the presence of mill-related water. Note that these ARs, if not identical to unity, are both more than 1.0 and slightly less than 1.0, which stems from the variability of measured uranium activity concentrations in water samples collected in areas impacted by uranium mill activities (e.g., Zielinski 1997). Though most of the mill-related samples have uranium concentrations that are representative of contamination (e.g., greater than 0.07 mg/L, some are characterized by lower uranium concentrations due to mixing of the contamination with fresh influent river water. This is clearly seen at wells 0215 and 0216 just west of the north-south alignment of the river on the site's east side, which were identified earlier as locations exhibiting the effects of mixing of contaminated groundwater with fresh surface water from local river seepage losses. To a lesser degree, such mixing also appears to affect wells 0855 and 0658 (Figure 12), suggesting that seepage losses from the river where it initially flows southward are sustained enough to deliver fresh water as much as 1,000 ft west of the river's west bank. It should also be noted that the AR values of samples collected from ponds that have contained mill-related, contaminated water (locations 0320 and 0575) are also close to unity.

To identify possible explanations for the occurrence of AR values larger than unity, multiple scenarios involving the mixing of mill-related, contaminated water with other water sources were examined. One scenario considered the mixing of upgradient, background water with contaminated water from the site. The resulting curve reflective of this mixing (background mixing curve in Figure 12) was constructed using different proportions of tailings water, consisting of uranium concentrations at 0680 with an AR of 1, and corresponding data from upgradient well 0169 with an AR of about 1.85. Another curve reflective of river water mixing with contaminated water (river mixing curve in Figure 12) was constructed using data from the Colorado River, at location 0322, and well 0217 which is reflective of tailings water. Both of these curves are determined using specific algorithms that apportion the relative amounts of the end member waters on the basis of the concentrations involved. The curve data are generated by starting from the contaminated end member and working gradually toward the uncontaminated end member, such that ARs tend to remain relatively low and closer to unity over a large concentration span before AR values greater than 1.2 eventually begin to be generated.

As shown in the plots of AR versus uranium concentration in Figure 12, the data points for a large number of onsite wells and locations immediately downgradient of the site fall close to or between the two mixing lines, indicating that the relative amounts of source waters for the groundwater monitored at the site can be explained by variable amounts of mixing between mill-related contamination and either background or river water. In stark contrast to this general observation, however, the ARs for multiple wells in the westernmost part of the region (green triangles) show a clear departure from the mixing lines, suggesting that the source of uranium at these locations (e.g., wells 0170, 0172, 0620) is separate from a mill-related source. In particular, these wells tend to have concentrations in the range of 0.05 to 0.08 mg/l and AR values higher than 1.2

There are some exceptions to the general finding that westernmost wells maintain a distinctive AR and uranium concentration signature. For example, the AR for well 0210 is less than 1.2 (Figure 12). Nonetheless, the symbol for this well generally comports with the locations of green triangles used to differentiate westernmost wells from others in the preceding discussion. Another exception is seen for well 0220, in the farthest west portion of the site, which appears aligned with the mixing curve for river water with contaminated water (Figure 12). This is potentially explained by possible river losses to the subsurface near the well, along a distinctive bend of the river toward the south. Well 0171, with an AR of about 1.7 and a uranium concentration less than 0.01 mg/L, also provides an exception to the above generalization regarding the westernmost wells. However, given this well's location at the boundary between upland areas and the river floodplain (see Figures 4 and 5), the local groundwater chemistry in this area likely maintains its own unique signature. Such an explanation is supported by the observation that well 0171 is likely far north of the path taken by any uranium contamination migrating west-southwest of the West Roaring Fork Pond.

2.4.4 Summary

The evaluation of chemical and isotopic signatures in wells at the New Rifle site samples indicates that the groundwater chemistry in westernmost site wells may be influenced by water sources different from those that impact the former mill site. The possibility that some site-related contamination at one time migrated as far west as well 0620 has been considered in this study, but it appears to be less probable based on various analyses of groundwater chemistry in the New Rifle area. Moreover, the mill-related contamination at well 0195 has dissipated to the extent that it is no longer discernible from background or other anthropogenic sources. These findings suggest that alternate concentration limits need only apply to an area extending west from the eastern boundary of the mill site to approximately the location of well 0195, about 600 ft west of the West Roaring Fork Pond.

2.5 Risk Assessments

This section summarizes the results of an updated human health and ecological risk evaluation based on recent monitoring results from the New Rifle site. The evaluation is not a "baseline" risk assessment but is focused only on potentially complete pathways given restrictions that are currently in place for the site (see Section 4.2). Because of restrictions on groundwater use, the most plausible points of exposure to site-related contamination are the Roaring Fork ponds and wetland area (Figure 6). Those are the focus of the risk evaluation.

2.5.1 Human Health

For the purposes of the human health evaluation, it was assumed that children (the most sensitive receptors) could have access to the Roaring Fork ponds and would swim in those ponds on a regular basis during summer months. Equations and exposure parameters for risk assessment were obtained from the U.S. Environmental Protection Agency's (EPA's) *Risk Assessment Guidance for Superfund* (Part A) (EPA 1989) and EPA's updated *Exposure Factors Handbook 2011 Edition* (EPA 2011). The ponds are not known to be used for swimming; however, values for exposure parameters were chosen to provide conservative estimates of risk.

Maximum risk-based concentrations (RBCs) protective of surface water in a swimming scenario were calculated using information provided in Table 3. The number of swimming events per month is an upper threshold (EPA 2011) for all age groups (181 minutes or an estimated 3 hours per month). Because of the climate in the Rifle area, it was assumed that swimming would only be likely for a maximum of 4 months of the year. An average rate for ingestion of water while swimming was used in the calculations. This probably overestimates ingestion rates for more likely uses, such as wading or playing along the edges of the ponds. The most recent toxicity data from U.S. Environmental Protection Agency (EPA)'s Integrated Risk Information System (IRIS) were used for each constituent in the analysis. Carcinogenic and noncarcinogenic effects were considered in the calculations for arsenic. Noncarcinogenic effects were considered for all other constituents.

Table 3. Risk-Based Concentration Comparison Table

Contaminant	Ingestion Rate (L/event)	Events/year (at 60 min/event)	RfD[a] (mg/kg-d)	Maximum RBC (mg/L)[b]	Maximum Observed in all Ponded Water (mg/L)	Maximum Observed in Persistent Ponds (mg/L)[c]	Maximum Observed in Upgradient Groundwater[d] (mg/L)
Arsenic (n)	0.05[e]	12[f]	0.0003	5.8	0.094	0.043	0.195
Arsenic (c)	0.05	12	1.5 [g]	0.16-16[i]	0.094	0.043	0.195
Molybdenum	0.05	12	0.005	96	12.5	3.2	7.7
Nitrate (as N)	0.05	12	1.6	30,700	250	250	50
Selenium	0.05	12	0.005	96	0.0827	0.033	1.4
Uranium	0.05	12	0.003	59.4	0.435	0.435	0.188
Vanadium [h]	0.05	12	0.0009	17.4	4.63	1.68	14.3

Notes:

[a] From IRIS
[b] Maximum permitted in ponds; equivalent to hazard quotient of 1 or 10^{-6} risk level.
[c] Locations 0320, 0323, and 0575 (2006 to present).
[d] Wells located near site boundary; 0664, 0669, 0659, 0217 (all data through present).
[e] Average rate from EPA 2011.
[f] Upper threshold from EPA 2011 (181 minutes per month; swimming in fresh water); assumed 4 months per year.
[g] Slope factor from IRIS $(mg/kg\text{-}d)^{-1}$.
[h] Vanadium RBC based on proposed RfD that is currently under review (EPA 2011).
[i] RBCs correspond to 10^{-6} to 10^{-4} risk range.

Abbreviations:

c = carcinogenic
L/event = liters per event
mg/kg body weight per day = milligrams per kilogram-day
mg/L = milligrams per liter
min/event = minutes per event
n = noncarcinogenic
RfD = Reference dose

Equations and Assumptions:

Intake (ingestion) = $(CW \times IR \times EF \times ED)/(BW \times AT)$
Intake (absorption) = $(CW \times SA \times PC \times ET \times ED \times CF)/(BW \times AT)$

CW = water concentration
IR = ingestion rate = 0.05 L/event
EF = exposure frequency = 12 events per year
ED = exposure duration = 7 years
BW = body weight = 38.3 kg (child)
AT = averaging time = ED × 365 days per year = 2555 days for noncarcinogens
AT = 365 days per year × 70 years = 25,550 days for carcinogens
SA = skin surface area available for contact = 1.08×10^4 square centimeters (child 6–12; EPA 2011)
PC = dermal permeability constant = 0.001 centimeter per hour
ET = exposure time = 1 hour per event
CF = conversion factor = 1 L per 1000 cubic centimeters

Table 3 shows the maximum RBCs for each constituent under the exposure scenario described above. These concentrations equate to a hazard quotient of 1 (noncarcinogens) or a risk range of 10^{-6} to 10^{-4} (carcinogens) for ingestion of each constituent in surface water. Maximum concentrations of each constituent observed in pond locations over the last 10 years are provided for comparison. Maximum historic concentrations are also provided for upgradient wells near the site boundary.

COC concentrations in pond water have been well below RBCs for the last decade. Historical data for wells located immediately upgradient of the wetlands/ponds indicate that, with the exception of arsenic, maximum observed contaminant concentrations in those wells have not exceeded risk-based levels even though wells on the mill site displayed considerably higher concentrations. The maximum arsenic concentration in one upgradient well did slightly exceed the RBC for the 10^{-6} risk level but was within the acceptable RBC range. Based on the risk calculations and the body of groundwater and surface water data, it can be concluded that current and likely future conditions of the site are protective of human health even for conservative exposure assumptions.

2.5.2 Ecological Risks

In assessing ecological risks, an important first step is the determination of whether any protected species inhabit the site vicinity. Several threatened and endangered species have been identified in Garfield County (USFWS 2016). Of these, the only critical habitat near the site is that for endangered fish in the Colorado River. The endangered species include Colorado pikeminnow and razorback sucker. The segment of the Colorado River that runs through the Rifle area is the uppermost reach of designated critical habitat for these species. Because any site-related contamination that discharges to the Colorado River is quickly diluted, the site will have no impact on these species.

One threatened mammal (the Canada lynx) and one threatened bird (the Mexican spotted owl) are known to exist in Garfield County; these species inhabit primarily forested areas. Any potential contact with contaminants at the New Rifle site would only be through occasional use during migration through the area. The remaining four endangered species are plants; while habitat in the vicinity of the site might be suitable for these species, it is not designated as critical habitat and therefore the site should have little or no impact on them.

Ecological risk screening standards and benchmarks are provided in Table 4. Table 5 summarizes monitoring data collected since 2006 for wetland and pond monitoring locations (shown on Figure 4).

Table 4. New Rifle Ecological Risk Screening Table

Contaminant	Agricultural Standard/ Benchmark (mg/L)	Aquatic Benchmark(s) (mg/L)	EPA Region 3 Biological Technical Assistance Group Freshwater Screening Levels[h]	Terrestrial Wildlife NOAEL-based Benchmarks (water ingestion pathway; mg/L)[i]
Ammonia (total as N)	NA	>2–3[a]	0.019 (un-ionized as N; corresponds to approx. 0.45 mg/L total as N for temperature and pH representative of site surface water)	NA
Arsenic	0.1[b]	0.15[d]	0.005	0.292–156.9
Molybdenum	0.3[b]	0.240–16[c]	0.073	0.60–106.84
Nitrate + Nitrite as N	100[f]	NA	NA	2719–10369
Selenium	0.02[d]	0.0046[d]	0.001	0.857–40.662
Uranium	0.2[g]	2.4–5.16[e]	0.0026	6.995–26.671
Vanadium	0.1[f]	0.019–1.9[c]	0.020	0.835–348

Notes:

[a] Ambient Water Quality Criteria; approximate chronic threshold range for New Rifle site—exact values vary with pH and temperature.

[b] Agriculture; Water Quality Control Commission (WQCC) Regulation No. 31.

[c] Suter and Tsao 1996; ranges from chronic to acute values.

[d] Aquatic life; Colorado WQCC Regulation No. 31.

[e] Colorado WQCC Regulation No. 31; $CaCO_3$ between 150 and 250 mg/L.

[f] Agriculture; Colorado WQCC Regulation No. 41.

[g] Livestock; FAO 2002.

[h] EPA 2016.

[i] Sample et al. 1996.

Abbreviations:

NOAEL = no observed adverse effects level
NA = not applicable

Table 5. COC Concentration Ranges for Surface Water Sampling Locations, New Rifle Ponds and Wetlands (2006–Present)

Contaminant	0320 (mg/L)	0323 (mg/L)	0452 (mg/L)	0453 (mg/L)	0575 (mg/L)
Ammonia (total as N)	2.4–77	15–42	0.24–98	4.6–120	<0.1–3.3
Arsenic	0.0016–0.019	0.0002–0.0017	0.0044–0.0245	0.005–0.0357	0.0003–0.0039
Molybdenum	0.450–3.01	2.00–3.200	0.790–10.0	1.100–6.10	0.034–1.00
Nitrate + Nitrite as N	<0.01–230	15–130	<0.085–130	0.46–97	<0.01–1.6
Selenium	0.0036–0.033	0.0049–0.014	<0.0015–0.0695	0.013–0.0827	0.0003–0.0018
Uranium	0.0519–0.321	0.220–0.353	0.0671–0.250	0.0022–0.210	0.017–0.170
Vanadium	0.015–0.250	0.0027–0.0064	0.210–1.460	0.240–2.400	0.0014–0.0048

A comparison of Table 4 and Table 5 indicates that the very conservative EPA screening benchmarks have been exceeded for all constituents at nearly all locations. Likewise, with the exception of arsenic, most constituents at most locations have exceeded aquatic and/or agricultural standards. Constituents at some locations have exceeded the lowest benchmarks for terrestrial wildlife, but all have been well below the upper end benchmarks.

While the exceedances of aquatic/agricultural standards may indicate that the ponds and wetlands have been affected by site-related contamination, they may not be a good measure of actual "environmental risk" that exists at the site. Water is only continuously present at locations 0323 (the former East Roaring Fork Pond) and 0575 (the former West Roaring Fork Pond). Locations 0452 and 0453 usually dry up during low-water periods in the Colorado River; location 0320 dries up infrequently, during times of very low flow of the Colorado River. Highest surface water concentrations are generally attributed to evaporation effects in these "temporary" locations and are not representative of average water quality. The site is located in an area that is undergoing development and is zoned for industrial purposes; it is bounded by a U.S. highway on the north and an interstate highway on the south. The Roaring Fork pond and the wetland area are artificial features that were created in an area of existing groundwater contamination. Any aquatic communities present in these areas have developed in spite of site-related contamination. In addition, the adjacent Colorado River provides high quality aquatic habitat and is unaffected by contaminated groundwater. Restrictions have been placed on use of the surface water and groundwater for agricultural purposes, so that pathway is incomplete. Surface water conditions are further described below for each COC. Appendix B contains spot plots and time-concentration plots for groundwater and surface water chemistry.

Ammonia. Except for the westernmost gravel pond, ammonia in surface water consistently exceeds both chronic and acute values for aquatic life (Figure B-44). Plant uptake studies completed during preparation of the SOWP (DOE 1999a) suggested that levels of ammonia in groundwater and surface water in the vicinity of the wetland could inhibit development of wetland vegetation. However, concentrations of ammonia in site groundwater have shown consistent declines over time. This is probably attributable to a combination of natural flushing processes (e.g., dispersion) and biological degradation (i.e., nitrification). It is expected that, unlike certain metals, ammonia will continue to decline over time to a point at which it does not limit biologic activity in the surface water bodies.

Arsenic. Arsenic has never exceeded the agricultural or aquatic standard at a surface water location (though detection limits for some early samples were higher than the benchmark values; Figure B-45).

Molybdenum. Molybdenum is of primary concern for agricultural use, and concentrations consistently exceed the Colorado agricultural standard at all surface water locations (Figure B-46). However, concentrations at all locations are also lower than the upper end of the aquatic benchmark range. Molybdenum appears to be persistent at the site. Concentrations in surface water and groundwater at and immediately downgradient of the site have not changed significantly since surface remediation was completed. Molybdenum concentrations spiked (and subsequently declined) in well 0855 after the City of Rifle conducted excavation activities in the vicinity of the remnant soil contamination, indicating that a continuing source of molybdenum contamination likely exists at the site.

Nitrate. The nitrate concentrations in surface water vary widely (Figure B-47). Highest concentrations in the wetland and Eastern Roaring Fork pond have exceeded the Colorado agricultural standard. However, concentrations at all locations have been below the standard part of the time. Nitrate concentrations are affected by ammonia degradation; concentrations have increased as a result of nitrification of ammonia. Nitrate is likely to further degrade through biological processes and will eventually decline to acceptable levels.

Selenium. Most concentrations of selenium exceed the aquatic benchmark (Figure B-48). Highest concentrations of selenium in surface water generally exceed the agricultural standard, but most do not. The lowest standards for aquatic life are generally established based on concerns of bioaccumulation in the food chain.

Uranium. Uranium concentrations are generally less than Colorado aquatic standards for surface water (Figure B-49). The agricultural benchmarks for livestock have been exceeded at all locations.

Vanadium. Vanadium concentrations in the gravel ponds have been below all benchmarks (Figure B-50). Concentrations in the less persistent locations in the wetlands have exceeded aquatic and agricultural benchmarks.

The above discussion centered mostly on aquatic standards and benchmarks. Other receptors at the site could include terrestrial wildlife and birds. Benchmarks are provided for those receptors in Table 2. Benchmark values range up to much higher concentrations than those for aquatic receptors, as would be expected due to the differences in mode of exposure. Additionally, terrestrial receptors are likely to use the site only on an occasional basis because of its location in such a developed area. Because of this, exposures and consequent risks to terrestrial wildlife are considered to be minimal. The fact that site-related effects are transient and localized and do not have the potential to affect any highly protected species suggests that the ecological risk at the site would be considered *de minimis* according to the classification of Suter et al. (2000). *De minimis* ecological risks generally do not require remediation because of their insignificance.

It is possible that contamination could inhibit the development of these areas as viable aquatic habitats. However, high-quality water in the adjacent river provides ample habitat for aquatic life and other wildlife. The only critical habitat for endangered species in the vicinity of the site is the Colorado River, which provides habitat for four endangered species of fish and is unaffected by site-related contamination. The presence of contamination in onsite surface water in ponds and wetlands is unlikely to have any deleterious effects on wildlife, particularly when compared to pressure from nearby development activities. ICs are being placed on affected properties to prohibit use of surface water and groundwater for agricultural purposes. Environmental risks associated with the site are considered *de minimis* and protective based on current and projected site uses.

2.5.3 Summary

Complete exposure pathways currently pose no unacceptable risk to either human or ecological receptors, although water in the Roaring Fork Ponds would be unsuitable for livestock watering if the ponds were their sole source of drinking water. No evidence has been observed to date that site-related contamination has resulted in degradation of aquatic or terrestrial habitats. Based on this analysis, the only driver for groundwater remediation at the New Rifle site is the achievement of regulatory standards. Current site conditions, which incorporate the use of ICs, are protective of human health and the environment for present and projected future site uses.

3.0 Groundwater Compliance

DOE developed the proposed compliance strategy for the New Rifle site from the compliance strategy selection framework described in Section 2.1 of the *Final Programmatic Environmental Impact Statement for the Uranium Mill Tailings Remedial Action Ground Water Project* (DOE 1996). The U.S. Nuclear Regulatory Commission (NRC) has accepted the compliance strategy framework and has incorporated it into their guidance for review of compliance at UMTRCA Title I sites with contaminated groundwater (NUREG-1724, NRC 2000). Based on the Programmatic Environmental Impact Statement framework, compliance strategies will be reevaluated if conditions change or if monitoring indicates that EPA groundwater standards will not be met. Section 2.3 presented information indicating that the previous compliance strategy of natural flushing is not likely to achieve standards. A revised compliance strategy is presented in this section.

3.1 Compliance Strategy Selection

DOE followed the groundwater compliance strategy selection framework summarized in Figure 13 in determining the appropriate compliance strategy for groundwater in the alluvial (uppermost) aquifer at the New Rifle site. Current and projected future site conditions have been determined to be protective of human health and the environment (Section 2.5). Therefore, the proposed compliance strategy for the alluvial aquifer at the New Rifle site for all constituents is no remediation with the application of ACLs, implementation of ICs, and continued groundwater monitoring (Section 4). An explanation of the strategy is summarized in Table 6.

Table 6. Explanation of Compliance Strategy Selection Process

Box (Figure 13)	Action or Question	Result or Decision
1	Characterize plume and hydrological conditions.	See discussion of hydrology and site-related contamination in Sections 2.3 and 2.4. Move to Box 2.
2	Is groundwater contamination present in excess of 40 CFR 192 MCLs or background?	Arsenic, molybdenum, nitrate, selenium, and uranium exceed the 40 CFR 192 MCLs at one or more monitoring points. Vanadium has exceeded its RBC (DOE 1999a). Move to Box 4.
4	Does contaminated groundwater qualify for supplemental standards due to its classification as limited use groundwater?	Alluvial groundwater is a potential source of drinking water and therefore is not classified as limited use. Move to Box 6.
6	Does contaminated groundwater qualify for ACLs based on acceptable human health and environmental risk and other factors?	ICs prevent improper use of contaminated groundwater and surface water. Risks associated with likely use of associated surface water are acceptable. Apply alternate concentration limits.
7		No remediation required. Apply supplemental standards or ACLs.

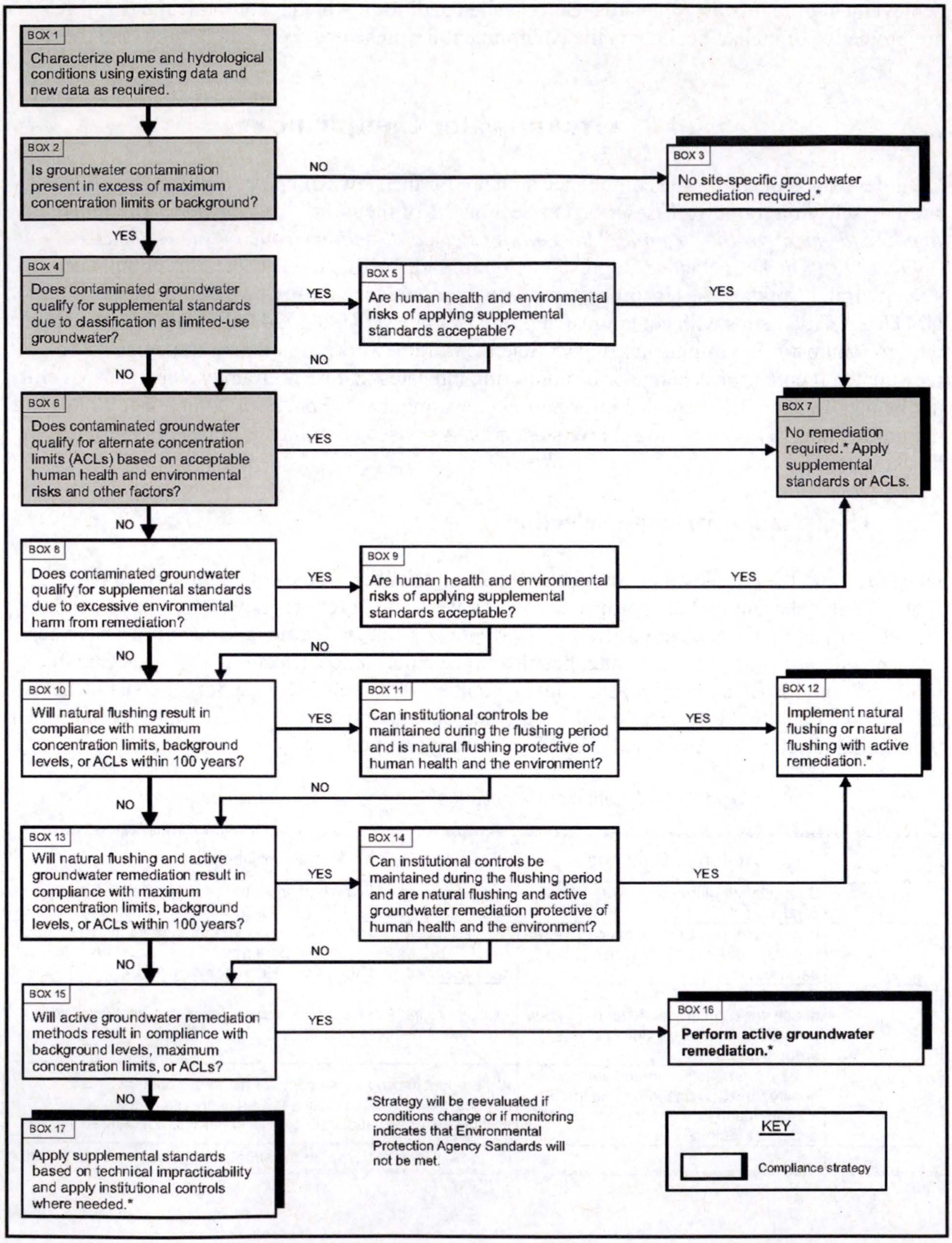


Figure 13. Compliance Strategy Selection Framework for the New Rifle Site

An approach was developed by DOE and Colorado Department of Public Health and Environment (CDPHE) to establish ACLs in a manner that satisfies requirements of both agencies. A decision flow chart was developed to provide a consistent and defensible method for determining ACLs at Office of Legacy Management (LM) sites located in the state of Colorado. A generic flow chart for this process is shown in Figure 14. Generally, the approach first involves identifying the extent of the area requiring ACLs. Statistical analysis of historical data is then used to compute numerical values that may be suitable for use as ACLs. Point of compliance (POC) locations are identified where ACLs apply. ACLs must be demonstrated to be protective at potential point of exposure (POE) locations. The ACL development process is described in more detail in Sections 3.2 and 3.3 as it pertains to the New Rifle site.

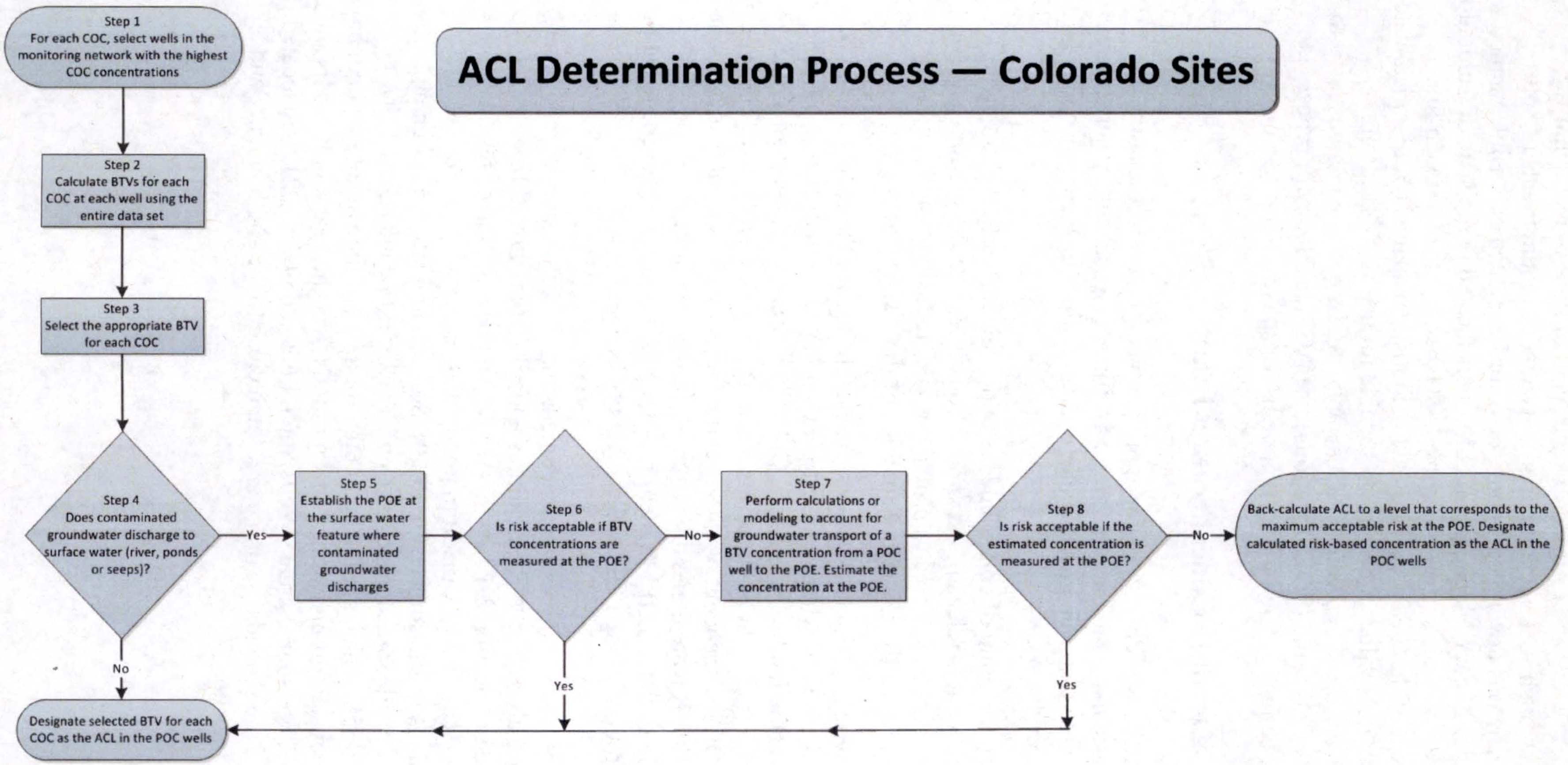
3.2 Area Requiring Alternate Concentration Limits

In general, the concept of ACLs was developed for application at a POC located at the downgradient edge of a "waste management unit" (e.g., a tailings disposal cell) where releases have resulted, or are expected to result, in groundwater contamination. In accordance with NRC regulations (10 CFR 40, Appendix A),

> The objective in selecting the point of compliance is to provide the earliest practicable warning that the impoundment is releasing hazardous constituents to the groundwater. The point of compliance must be selected to provide prompt indication of groundwater contamination on the hydraulically downgradient edge of the disposal area.

Concentrations above otherwise applicable standards are established for the POC that will be protective at some downgradient POE where access to contaminated groundwater is possible (often this is considered to be the facility boundary). Groundwater contamination attenuates between the POC and the POE such that likely exposures at the POE are protective. The type and degree of exposure at the POE is dependent on site-specific factors such as local land and water use, ambient water quality, etc. ICs are generally required for the area from the waste management unit downgradient to the POE. In theory, as long as ACLs are not exceeded at the POC, groundwater concentrations at the POE will remain protective.

At the New Rifle site there is no formal waste management unit. Tailings, sludges, and other materials with concentrations above the ^{226}Ra cleanup standard were removed from the site for offsite disposal. As discussed in Section 2.4.1 of this report, an investigation of residual soil contamination in the former gypsum and vanadium pond areas indicated that considerable residual contamination remains in site soils (DOE 2000). Soil contamination also remains in the footprint of the former tailings pile, ore storage area, and evaporation pond (DOE 1999a). Wells RFN-0855 and RFN-0658, which are located in the footprint of the vanadium pond, have exhibited the most highly elevated groundwater concentrations over the years. POC wells should be located downgradient of these source areas. Wells 0664, 0669, 0659, and 0217 are located just outside and downgradient of the secondary source areas and close to the site boundary and are proposed as POC wells for the site.



Notes:

- BTV = Background threshold value
- This proposed approach applies to Title I processing sites in Colorado.
- ICs are in place that encompass site-related groundwater plumes; therefore, there is no unacceptable exposure to contaminated groundwater, and the only potential exposure is where groundwater discharges to the surface.
- ACL is based on actual monitoring data using accepted statistical methods — the ACL will be based on the appropriate BTV calculated for each COC (one ACL for each COC) and applied to all POC wells.
- Entire data set (including pre-surface-remediation data) will be used to calculate the USL_{95} to account for residual source that could be mobilized by high water levels or construction activities.
- If the selected BTV is protective (based on available benchmarks), then modeling or risk assessment is not required.
- If risk needs to be assessed, receptors and risk scenarios need to be identified.
- Modeling or calculations may be required to estimate the concentration at the POE accounting for dilution, dispersion, and attenuation as groundwater migrates from the POC to the POE.

Figure 14. ACL Determination Process—Colorado Sites

Wells upgradient of the POC locations in the source areas may occasionally have concentrations above the established ACLs, but these concentrations should decline to the ACLs by the time groundwater reaches the POCs. Groundwater concentrations downgradient of the POC wells should be less than the established ACLs, but may be elevated above otherwise applicable standards (e.g., MCLs). Because ICs prevent the use of untreated groundwater at all downgradient locations, there are no actual groundwater POEs at the New Rifle site. However, it is proposed that the area requiring alternate standards extend only as far downgradient as well RFN-0195; MCLs or background will be met beyond this location. As demonstrated above, there is no indication that significant site-related contamination currently occurs downgradient of this location. The proposed POEs are where groundwater discharges to surface water—in the former Roaring Fork ponds and the Colorado River.

3.3 Establishment of ACL Values

Existing NRC and EPA ACL guidance does not specify nor recommend any particular statistical tests for establishing ACL values. A review of NRC-approved ACLs for Title II sites indicates that ACL values are most commonly set based on maximum groundwater concentrations associated with source areas at a site (e.g., WNI 1999; Umetco 2001; Pathfinder 2002). Oftentimes the numerical values for the ACLs are established based on a statistical evaluation of historical site data.

EPA's *ProUCL Version 5.0.00 Technical Guide* (EPA 2013) discusses statistical measures that are commonly used as "background threshold values" (BTVs). These measures are typically used to estimate the upper limits of a background dataset for use in detection monitoring programs at potentially contaminated sites. An exceedance of a BTV is generally considered to be evidence of site-related contamination and is often used to trigger corrective action. EPA describes several commonly used BTVs including upper percentiles, upper prediction limits (UPLs), upper tolerance limits (UTLs) and upper simultaneous limits (USLs). These measures are usually assigned confidence coefficients that reflect the degree of confidence in these estimated limits. The most commonly used confidence coefficient for these limits is 0.95 (e.g., a 95% USL or USL95); additionally, a coverage probability of 0.95 is commonly associated with a UTL (e.g., a 95% UTL with 95% coverage or a UTL95-95).

Both parametric and nonparametric BTVs are available and are calculated by ProUCL. Nonparametric tests do not require a specific data distribution, but may not provide the specified coverage when sample sizes are small (<60; EPA 2013). Parametric statistical tests assume some underlying distribution of the observed data. While a normal distribution is often chosen as the default for statistical testing, other distributions may be more appropriate for application to environmental data. Gamma and lognormal distributions have both used for this purpose (Gilbert 1987). EPA notes that in corrective action monitoring, where groundwater is known to have been impacted, a default presumption of lognormality can often be made. However, rather than deferring to an assumed default distribution, EPA recommends use of a goodness-of-fit test when the dataset is of ample size (8 or more; EPA 2009). ProUCL performs these goodness-of-fit tests for normal, gamma, and lognormal distributions.

EPA (2013) discusses advantages and disadvantages of various BTVs. UPL95s are commonly used for detection and compliance monitoring purposes (e.g., Gibbons 1990, 1991; ASTM D7048-04). However, to correctly apply this measure, it is necessary to specify in advance the number of future measurements (k) to which the UPL95 will be compared; the computed UPL95 is valid only for that number of comparisons. For example, a facility may collect 4 upgradient (background) and 4 downgradient samples each year and do a yearly comparison of all background and downgradient wells (k=1). The UPL95 would be computed using previous background data, if any, plus the 4 new analyses. The UPL would be valid for only the one end-of-year comparison. A new UPL would be computed for the next year's comparison after collecting 4 additional background samples.

For the New Rifle site, it is desirable to have a single value for an ACL that can be used for an unspecified number of future comparisons. Generally, when a BTV is needed to compare with many future observations, EPA recommends the use of a USL95 or UTL95-95 over a UPL (EPA 2013). A parametric UTL is recommended over a nonparametric UTL, although it is noted that a lognormal UTL can produce "unrealistically high" values. A USL95 tends to result in fewer false positives than a UTL95-95 particularly with a larger size dataset. There is no single "right" statistic for use in any particular situation. The selection should be based on whether a value seems "reasonable" for its intended purpose (EPA 2013).

It should be noted that the statistics discussed here are most often used for establishing BTVs for use in detection monitoring. Statistics are computed using data from wells unaffected by site-related processes. If concentrations in downgradient wells exceed a BTV, it is assumed this is due to releases from the intervening waste management unit. In the case of the New Rifle site, the "background" concentrations are actually those in the source area. The statistical calculations are being applied to monitoring results in areas representing new post-surface-cleanup baseline conditions. The goal of the monitoring is not to detect contamination, but to demonstrate source area stability and confirm attenuation of constituents at downgradient locations.

For the New Rifle site, the ACLs need to be established based on an understanding that source material still remains in the subsurface across the site. Therefore, ACLs need to be high enough to minimize potential exceedances (false positives) and low enough to be as low as reasonably achievable (ALARA). Historical monitoring results were evaluated to select wells that represent locations where maximum COC concentrations are likely to be observed in the future. Upper threshold values were then computed for those wells. Well 0658 was selected as the most appropriate well for calculation of BTVs. It is located in the source area, but has not had the extreme high concentrations such as those observed for well 0855 (resulting from one-time construction activity).

Upper threshold statistics were computed using EPA's ProUCL software (EPA 2013, version 5.0.00). Duplicate analyses were eliminated, but otherwise, all data available for well RFN-0658 were used. There were no nondetects in the dataset for the constituents of interest. ProUCL calculates multiple BTVs assuming different distributions of the data (e.g., normal, lognormal). Nonparametric statistics are also calculated. Table 7 summarizes the statistical results for well RFN-0658 for the contaminants of concern. ProUCL output is included in Appendix D.

Table 7. Upper Threshold Statistics for Source Area Well RFN-0658

Distribution	Statistic	Arsenic	Nitrate-N	Molybdenum	Selenium	Uranium	Vanadium
Normal	UTL95-95	0.266	65.95	8.574	1.546	0.406	46.48
	USL95	0.307	78.89	9.915	1.777	0.476	54.56
Gamma	WH UTL95-95	0.292	93.09	11.4	2.203	0.521	54.16
	HW UTL95-95	0.299	105.1	12.15	2.41	0.551	56.25
	WH USL95	0.369	136.5	14.97	2.922	0.697	71.14
	HW USL95	0.386	164.3	16.5	3.325	0.763	75.87
Lognormal	UTL95-95	0.332	222.2	16.1	3.705	0.707	66.43
	USL95	0.468	541.4	25.8	6.39	1.158	101.6
Nonparametric	UTL95-95	0.313	75	7.3	1.43	0.364	52
	USL95	0.313	75	7.3	1.43	0.364	52

None of the data sets for any of the six constituents conformed to a normal distribution. Arsenic, nitrate, and vanadium had apparent gamma and lognormal distributions. Molybdenum, selenium, and uranium did not follow any discernible distribution. The nonparametric USL95 statistic, which is identical to the nonparametric UTL95-95 statistic for each constituent, was selected as the appropriate statistic for establishing the ACLs. The nonparametric USL95 is lower than the gamma or lognormal USLs for the constituents conforming to those distributions. Therefore, this statistical measure is considered to be ALARA.

Figure 15 through Figure 20 show time-concentration plots for the proposed POC wells. Currently, concentrations at all POC wells are well below the proposed ACLs, though in the past individual wells have approached or exceeded these values. Table 8 compares proposed ACLs with RBCs for human health. With the exception of arsenic and vanadium, all proposed ACLs are well below their respective RBCs, indicating that if ACLs are met at the POC wells, they should be protective at the POEs. Figure 10 shows that there have been only a few exceedances of the arsenic RBC (0.16 mg/L) at one POC well; concentrations at POE locations have typically been an order of magnitude or so below the RBC. While onsite concentrations of vanadium have exceeded the RBC (17.4 mg/L), POC wells have all been below this level (Figure 20). Because more than an order of magnitude attenuation of arsenic and vanadium is observed between source area wells and POC wells, similar attenuation would be expected between the POC wells and POE, resulting in concentrations well below risk-based values. The strong attenuation capacity of site soils will ensure that offsite arsenic and vanadium concentrations in groundwater remain low. The data presented here indicate that the proposed ACL values are reasonable—not unrealistically high or low. They strike a balance by being high enough to prevent excessive false positives but low enough to be considered ALARA. Table 9 summarizes the ACL determination process for the New Rifle site.

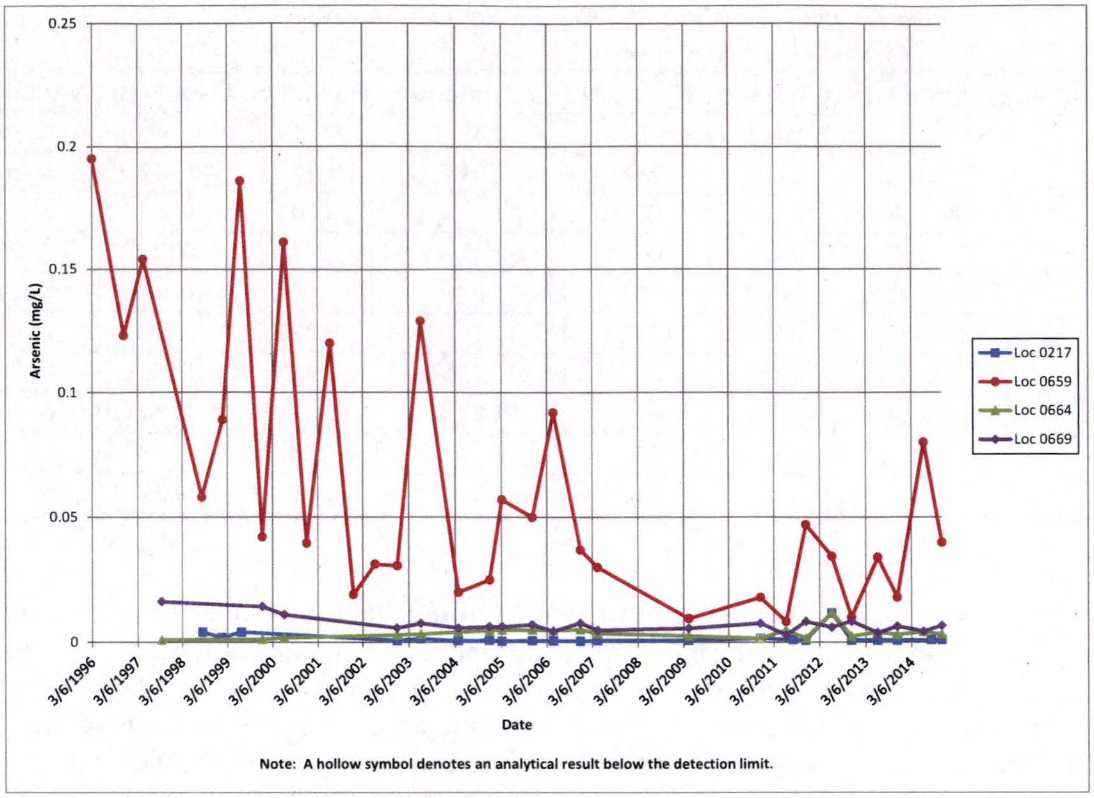


Figure 15. Arsenic Time-Concentration Plot for POC Wells (USL95 = 0.313 mg/L)

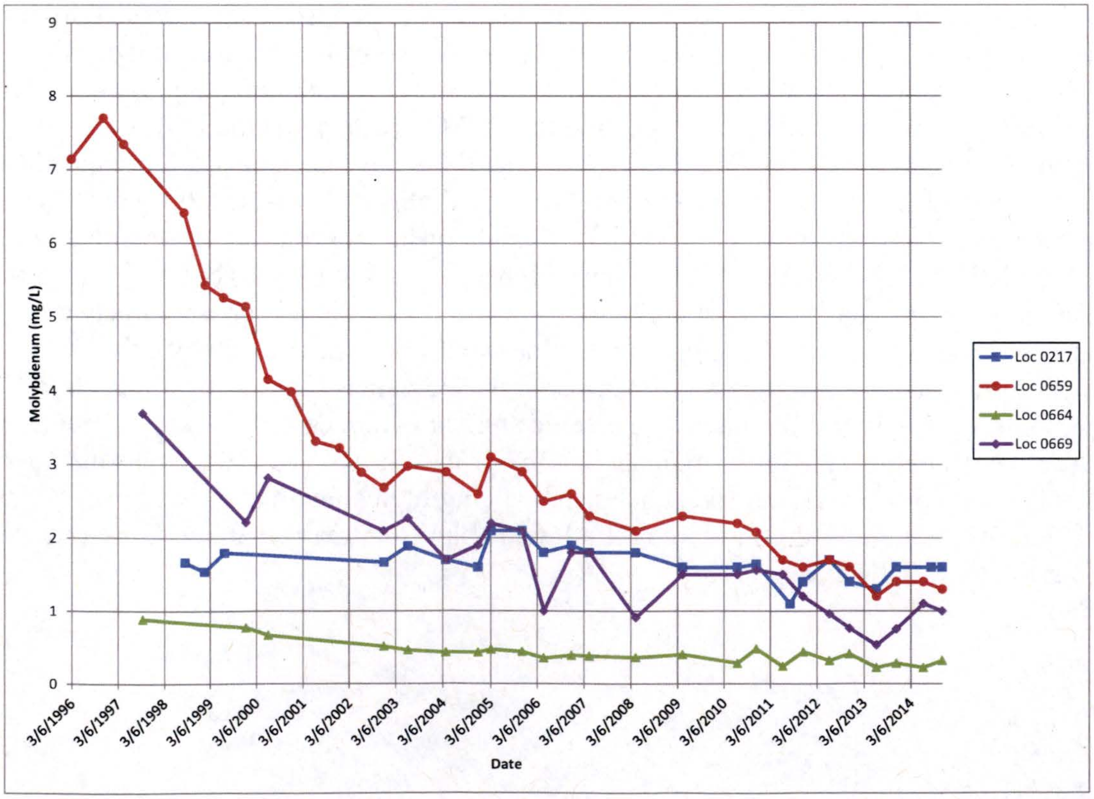


Figure 16. Molybdenum Time-Concentration Plot for POC Wells (USL95 = 7.3 mg/L)

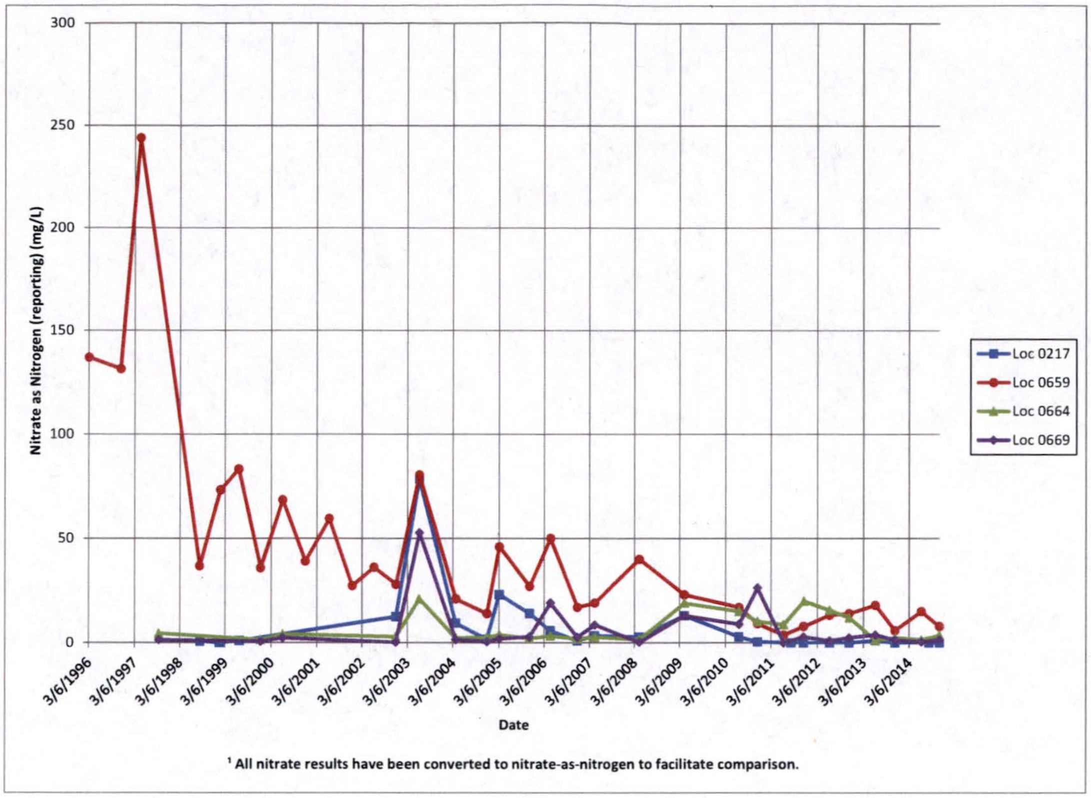


Figure 17. Nitrate (as N) Time-Concentration Plot for POC wells (USL95 = 75 mg/L)

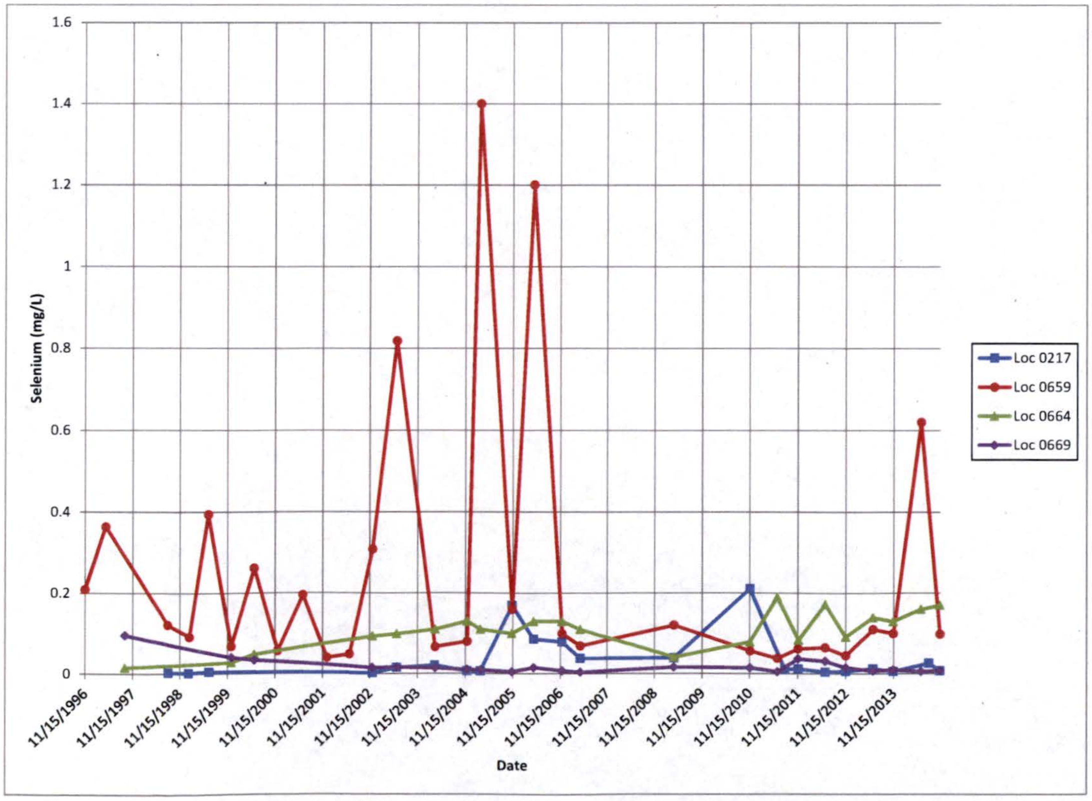


Figure 18. Selenium Time-Concentration Plot for POC Wells (USL95 = 1.43 mg/L)

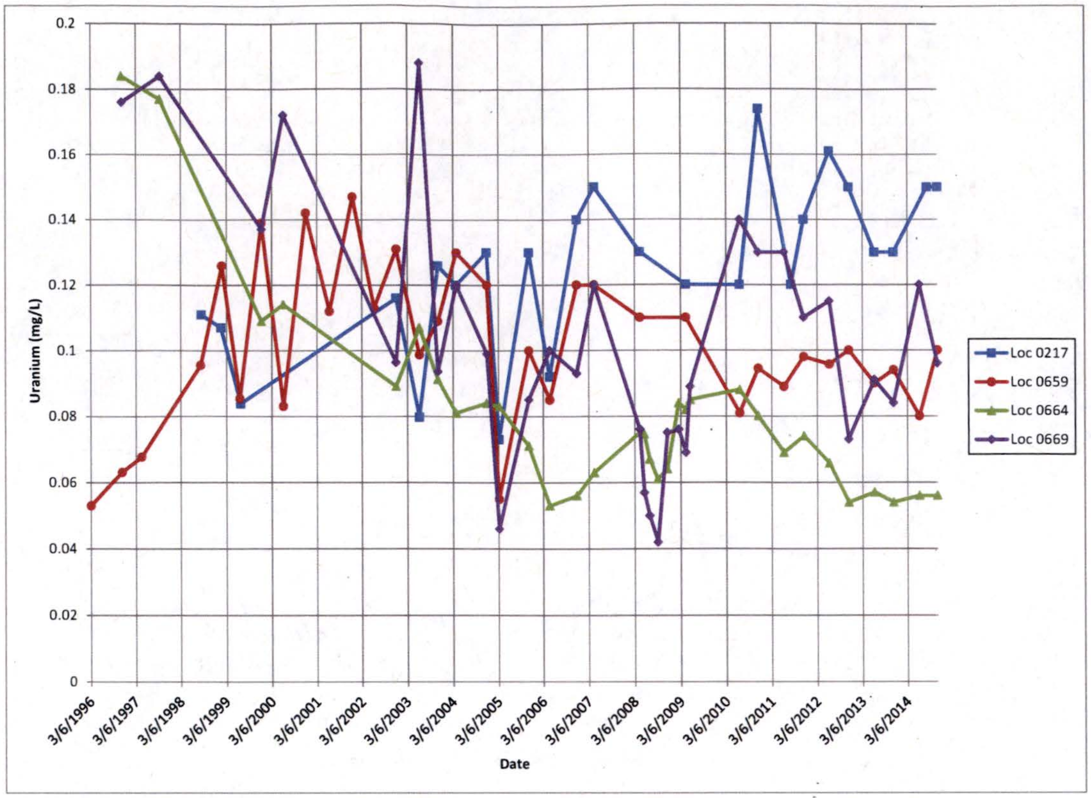


Figure 19. Uranium Time-Concentration Plot for POC Wells (USL95 = 0.364 mg/L)

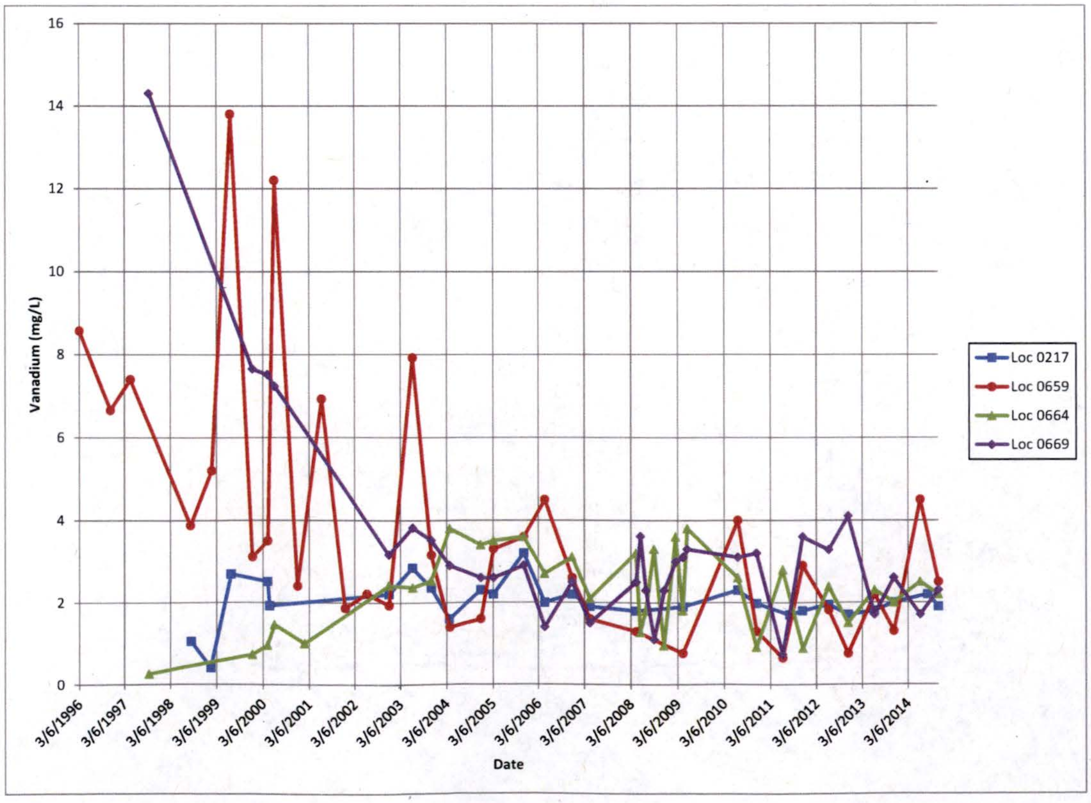


Figure 20. Vanadium Time-Concentration Plot for POC Wells (USL95 = 52 mg/L)

Table 8. Comparison of Proposed ACLs with RBCs

COC	Proposed ACLs	RBC
Arsenic	0.313	0.16[a]
Molybdenum	7.3	96
Nitrate (as N)	75	30,700
Selenium	1.43	96
Uranium	0.364	59.4
Vanadium	52	17.4

Note:
[a] Based on 10^{-6} risk level

Table 9. Summary of ACL Determination Process for the New Rifle Site

Step	Action or Question	Result or Decision
1	For each COPC, select wells in the monitoring network with the highest COC concentrations.	Monitoring wells 0855 and 0658 had highest COC concentrations. Because of extreme values for well 0855, well 0658 was selected for determining ACLs.
2	Calculate BTVs for each COC at each well using the entire data set.	BTVs were calculated for the dataset from well 0658 using EPA's ProUCL statistical software.
3	Select the appropriate BTV for each COC.	The nonparametric USL_{95} /$UTL_{95\text{-}95}$ was selected as the ACL for each COC (summarized in Table 8).
4	Does contaminated groundwater discharge to surface water (river, ponds or seeps) within the area for which the ACL is being established?	Yes, contaminated groundwater discharges to the gravel-pit ponds downgradient of the former mill site.
5	Establish the POE at the surface water feature where contaminated groundwater discharges.	The POE is established at location 0323 located on one of the gravel-pit ponds.
6	Is risk acceptable if selected BTV concentrations are measured at the POE?	RBCs were established for gravel-pit ponds for human health. All RBCs except arsenic and vanadium are higher than the proposed ACLs and are considered protective.
7	Account for groundwater transport of a BTV concentration from a POC well to the POE.	Arsenic and vanadium show attenuation between source area wells and POC wells of more than an order of magnitude. If similar attenuation occurs between POC wells and POE, arsenic and vanadium will be well below risk-based levels.
8	Is risk acceptable at the POE?	Yes.
	Designate BTV for each COC as the ACL in the POC wells.	The ACLs are established as the nonparametric USL_{95} /$UTL_{95\text{-}95}$ (Table 8).

Based on an evaluation of historical data and trending for the COCs, the proposed ACLs have been set to prevent frequent and potentially spurious exceedances, while satisfying the ALARA principle. However, it should be noted from a statistical standpoint that the confidence coefficients achieved by the nonparametric UPL/USL values were less than 0.95—the confidence coefficients ranged from 0.785 for selenium to 0.834 for vanadium. If ACLs were ever to be exceeded at a POC well at the New Rifle site, it could be because the ACLs were set too low and not because the exceedance represents an unexpected event. The lower than desired confidence coefficients should be factored into any exceedance evaluation (see Section 4.1 for a discussion of potential ACL exceedances).

4.0 Compliance Strategy Implementation

4.1 Groundwater Monitoring Program

Figure 6 shows the groundwater and surface water locations included in the New Rifle site monitoring network. It also shows background wells at Old Rifle. Wells 0664, 0669, 0659, and 0217 have been designated as POC wells that must maintain compliance with ACLs. Sampling and analysis is conducted according to procedures in the *Sampling and Analysis Plan for U.S. Department of Energy Office of Legacy Management Sites* (DOE 2008b).

Background locations have been sampled to determine the degree of natural variability of COCs. Background locations have included well 0169 and Old Rifle wells, RFO-0292A and RFO-0658 (shown in Figure 6). Seep location RFO-0395 at the Old Rifle site is also considered a background location. The background dataset is believed to be adequate at present. It is proposed that background monitoring be discontinued for the time being; however, background wells 0169, RFO-0292A and RFO-0658 will be retained in the event that additional background data are deemed necessary in the future.

Surface water locations to be monitored include pond and wetland locations 0320, 0322, 0323, 0324, 0452, 0453, and 0575. These are considered to be POE locations. Water quality will also be monitored in the Colorado River at upstream location RFO-0538 and at downstream locations 0322 and 0324. All COCs are analyzed at POE locations with the same regularity as POC wells to verify that groundwater concentrations are protective where it discharges to surface water.

Sampling of each well and surface location will take place annually for the first 5 years following regulators' concurrence with this GCAP. After the first 5 years of monitoring, DOE will evaluate the monitoring results and adjust the monitoring strategy as appropriate. It is expected that a reduction in further monitoring may be justified, with the possible exception of POC wells and POE locations. A frequency of once every 5 years for a period of 30 years may be adequate. Downgradient wells will be analyzed for ammonia, nitrate, molybdenum, and uranium only, as the other COCs, arsenic, selenium and vanadium, have never been detected in these wells. Far-downgradient wells 0172 and 0620 may be eliminated or monitored less frequently. At any time, if the monitoring results indicate that contaminants have begun to spread beyond the current plume boundaries, or if some other unexpected changes in contaminant trends are noted, the sampling plan may also be reevaluated and adjusted at that time. As part of the monitoring program, DOE will also evaluate the effectiveness of the ICs on a regular basis (see Section 3). Monitoring requirements are summarized in Table 10 along with the rationales for the monitoring locations.

Table 10. Summary of Monitoring Requirements

Locations	Monitoring Purpose	Analytes	Frequency
0215, 0216, 0658, 0659, 0664, 0669, 0670, 855	**Onsite wells**: monitor COCs flushing in main body of site.	Ammonia, molybdenum, nitrate (as N), uranium, vanadium, selenium, and arsenic	All wells and locations, annually for first 5 years after GCAP accepted. Monitoring requirements will be reevaluated at that time. Suggested frequencies of monitoring after 5 years are provided in the text.
0201, 0217, 0590, 0635	**Adjacent to site wells**: monitor COCs flushing downgradient of main site.	Ammonia, molybdenum, nitrate (as N), uranium, vanadium, selenium, and arsenic	
0170, 0172, 0195, 620	**Downgradient wells**: monitor COCs that have traveled farthest offsite.	Ammonia, molybdenum, nitrate (as N), and uranium	
0320, 0322, 0323, 0324, 0452, 0453, RFO-538, 0575	Monitor surface water to determine impact of groundwater discharge to surface water and ecological receptors; RFO-538 is an upgradient river location shown on Figure 6.	Ammonia, molybdenum, nitrate (as N), uranium, vanadium, selenium, and arsenic	

[a] Figure 6 shows the background monitor well and upgradient river locations.

4.1.1 Compliance Monitoring Evaluation

Monitoring results for each POC well will be compared to ACLs for each constituent. Routine monitoring will be conducted as long as results remain below the ACLs. If the analytical result for any well exceeds an ACL, an evaluation will be conducted to determine if the exceedance is realistic and represents a true and unexpected degradation of groundwater quality. If this is the case, the well will be resampled. If well resampling results remain above the ACL, quarterly sampling will be required. If concentrations decline to below the ACL again, routine monitoring will be resumed. If concentrations remain above the ACL, this may signal that the ACL was set at too low a level and a revision of the ACL may be needed. Figure 21 shows the decision process for an ACL exceedance.

4.2 Institutional Controls

ICs are restrictions to land or resources that effectively protect public health and the environment by limiting access to a contaminated medium. At the New Rifle site, the contaminated medium is alluvial groundwater. To be effective, ICs must prevent intrusion into contaminated groundwater and restrict access to or use of contaminated groundwater for unacceptable purposes. ICs are required to:

- Protect public health and the environment.
- Have a high degree of permanence.
- Satisfy beneficial uses of groundwater.
- Be enforceable by administrative or judicial branches of government entities.
- Be implemented in a manner that can be effectively maintained and verified.

A comprehensive ICs program has been implemented to prevent future use of contaminated groundwater associated with the New Rifle site (Appendix A). Figure 22 shows the areas impacted by various overlapping ICs. The ICs program consists of several enforceable mechanisms that can be combined into four types of administrative categories:

1. Quitclaim deed restrictions covering the former mill site property
2. Zone overlays from the City of Rifle and Garfield County covering uses of groundwater in an expanded area of potentially contaminated groundwater
3. State of Colorado Environmental Covenant with Umetco Minerals Corporation covering agricultural uses of groundwater at an adjacent and downgradient vicinity property
4. City of Rifle Uranium Mill Tailings Remedial Action (UMTRA)[1] zone overlay to address new growth issues that could arise at the former mill site

Where these restrictions are required, DOE must ensure that the beneficial uses of the groundwater, had they not been restricted, could be satisfied. DOE funded two water line extensions to the current municipal system to ensure the availability of potable water to properties affected by site-related contamination. Because the water line extension did not cover the full extent of the contaminated groundwater plume, DOE has provided funding in the past for reverse osmosis systems for users who are within the ICs boundary but beyond the reach of the water line. There are no longer any alluvial domestic wells in use within the IC boundary (DOE 2014). In the past few years, the City has extended the city limit boundary to the west along the water line extension and required residents to use municipal water.

4.2.1 Quitclaim Deed for Former Mill Site

The State of Colorado and DOE anticipated the need for ICs at the former mill site at completion of surface remediation when the property was designated for transfer to the City of Rifle. Quitclaim deed restrictions were imposed on the property title to prohibit use of contaminated groundwater and prohibit excavation of contaminated soil that may cause surface expression of the groundwater. As conditions of the title transfer and by accepting the property, the City of Rifle agrees:

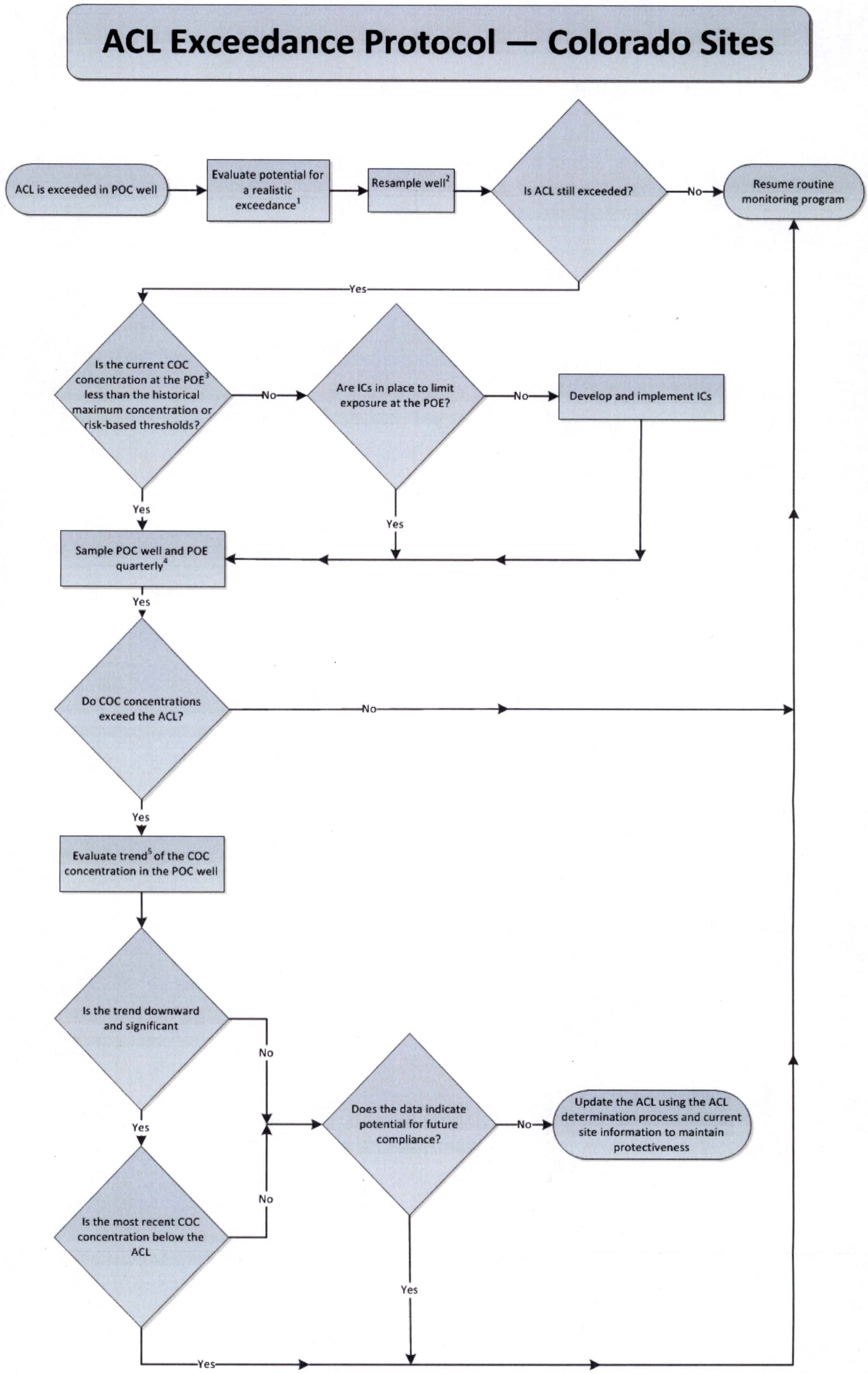
(i) to comply with applicable provisions of UMTRCA, 42 U.S.C. #7901 as amended;

(ii) not to use groundwater from the site for any purpose, and not to construct wells or any means of exposing groundwater to the surface unless prior written approval for such use is given by the Grantor [State of Colorado] and U.S. Department of Energy;

(iii) not to sell or transfer the land to anyone other than a government entity within the state;

(iv) that any sale or transfer of the property described in this deed shall have prior written approval from the Grantor and the U.S. Department of Energy; and that any deed or other document created for such sale or transfer and any subsequent sale of transfer will include information stating that the property was once used as a uranium milling site and all other information regarding the extent of residual radioactive materials removed from the property as required by Section 104(d) of the Uranium Mill Tailings [Radiation Control Act], 42, U.S.C. sec. 7014(d), and as set forth in the Annotation attached hereto;

[1] UMTRA is the Uranium Mill Tailings Remedial Action Project, established by DOE pursuant to UMTRCA to remediate, stabilize, and control mill tailings and contaminated groundwater at 24 designated uranium-ore processing sites, including the New and Old Rifle sites.



Notes:

[1]Evaluate potential causes of the exceedance including climate, hydrology, and/or anthropogenic stressors and if the exceedance is expected to be short-lived. Compare concentration to other computed benchmark threshold values to determine the significance of the exceedance.
[2]The POC well will be sampled as soon as practical following the discovery of the ACL exceedance pending the results of the evaluation in Step 2.
[3]If the POE is not in the current monitoring network, it will be sampled at the same time as the resampling of the POC well, and it will be added to the monitoring program.
[4]Quarterly sampling will commence with the first sampling event after the initial ACL exceedance. If COC concentration is below the ACL after the last quarterly sampling event, then quarterly sampling will be discontinued; if not, quarterly sampling will continue for an additional 4 quarters.
[5]Trend based on Mann-Kendall test at a 95% level of significance. Normalization of the COC concentration data may be needed to account for seasonally variable water levels.

Figure 21. Generic ACL Exceedance Protocol for Colorado Sites

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(v) not to perform construction and/or excavation or soil removal of any kind on the property without permission from the Grantor and the U.S. Department of Energy unless prior written approval of construction plans is given by the Grantor and the U.S. Department of Energy;

(vi) that any habitable structures constructed on the property shall employ a radon ventilation system or other radon mitigation measures;

(vii) that its use of the property shall not adversely impact groundwater quality, nor interfere in any way, with groundwater remediation under UMTRCA activities, and

(viii) to use the property and any profits or benefits derived therefrom only for public purposes as required by UMTRCA sec 104 (e)(1)(C), 42 U.S.C. 7914 (e)(1)(C).

This language was effective upon transfer of the site from the State (CDPHE) to the City of Rifle and is binding on all future owners, ensuring that any future landowner is subject to the same restrictions. This title transfer fulfills the deed restriction requirement for permanence and enforceability by government entities and serves as a perpetual IC. A copy of the deed restriction is included in Appendix A, Part A1.

Verification that the City has upheld the quitclaim deed restrictions is accomplished throughout the year by (1) discussions with City officials about construction projects and possible incursions of groundwater that could result from these activities, (2) physical inspection of the site by State and/or DOE and/or contractor staff, usually at the time of the annual Rifle, Colorado, Disposal Site inspection, and (3) observations by groundwater sampling staff at other times of the year.

4.2.2 Zone Overlays for Potential Contaminated Groundwater Plume

DOE asked the local governmental agencies to apply a zone overlay with groundwater restrictions to an area downgradient of the former mill site. DOE defined the ICs boundary on the basis of the estimated extent of uranium contamination, the most widespread contamination associated with the site. To ensure that the area was protective of human health, a substantial buffer zone was included downgradient at the western boundary. The zone overlay boundary follows quarter-quarter section lines and natural features such as the Colorado River for easy delineation, as shown in Appendix A2 and on Figure 22.

The zone overlay (IC) boundary encompasses property currently under jurisdiction of Garfield County and the City of Rifle. Garfield County passed a resolution requiring residents to prove a potable source of water in order to develop property within the defined area. The resolution does not require connection to the city water system but does establish a drinking water constraint zone in which any source of water intended for human consumption must meet applicable standards. Both Garfield County and City of Rifle overlays were requested, because land along the Interstate-70 corridor, which was County land at the time ICs were established, would over time become part of the City of Rifle and would fall under City of Rifle jurisdiction with regard to water use.

Most of the land within the IC boundary has been identified as a growth corridor for the City of Rifle; some has been annexed by the City. To ensure a safe source of domestic water, the City of Rifle passed an ordinance requiring any resident within the IC boundary to tap into the city's municipal water system when annexation occurs. DOE, the City of Rifle, and Garfield County entered into a cooperative agreement, No. DE FC13 01FJ79492, to provide potable water to residents along a corridor within the IC boundary west of Rifle. A copy of this agreement is provided in Appendix A3. The agreement addresses the Phase I installation of a water line and provisions for supplying reverse osmosis systems to users along US Highway 6 & 50 to the West Rifle interchange and south under I-70 for about 300 yards. This system is sized to provide potable water for current and future residents in an area affected by groundwater contamination from the New Rifle site. DOE provided 90 percent of the funding, and the State of Colorado provided 10 percent. Phase II provides for additional, related water system infrastructure improvements, including construction of a raw water pump house and settling pond, and transmission lines to the treatment facility (Figure 6).

4.2.3 UMTRA Overlay Zone District, Ordinance No. 9 Series of 2008

The City of Rifle created the UMTRA Overlay Zone District and included the Old (East) and New (West) Rifle sites (Appendix A3 and Figure 22) in the district. The purpose of the district was to establish procedures and restrictions governing property development in a new municipal code (Section 16 3 540). The new ordinance reiterated Requirements (i) to (viii) in the quitclaim deed and provided eight standard operating procedures (SOPs) for conducting activities within the UMTRA Overlay Zone District (i.e., the Old and New Rifle sites) and was signed on June 2008.

The SOPs require the City to secure written permission from the State and DOE when intrusive work is planned for the site, to formalize training for subcontractors working on the site, to include a Materials Handling Plan as needed, and to submit a Completion Report to the State for all projects. In addition, the City manager is required to provide an annual summary of activities to City officials regarding these SOPs, deed restrictions, and environmental covenants. While neither CDPHE nor DOE are signatories to a zone overlay, the restrictions it contains are covered in the quitclaim deed, and the quitclaim deed mandates CDPHE and DOE approval for proposed actions at the site.

4.2.4 Environmental Covenant

Uranium, molybdenum, and nitrate contamination have migrated in alluvial groundwater downgradient from the New Rifle site to Umetco Mineral Corporation property containing a former gravel pit operation. Groundwater concentrations exceed MCLs and state groundwater standards. Concentrations of these contaminants also exceed MCLs in the eastern onsite pond. To prevent inappropriate water use, an environmental covenant was adopted between Umetco and CDPHE (Figure 22).

The environmental covenant places four restrictions on the property: (1) no wells or drilling or pumping in the alluvial aquifer or Wasatch Formation beneath the property; (2) no stock watering using the alluvial aquifer or Wasatch Formation beneath the property, including the Roaring Fork Ponds; (3) no activities that would damage or interfere with existing DOE wells or monitoring of those wells; and (4) access shall be granted to DOE for all activities required for monitoring and remediation. The covenant was completed and signed by all parties on August 24, 2010. A copy of the signed agreement is shown in Appendix A4.

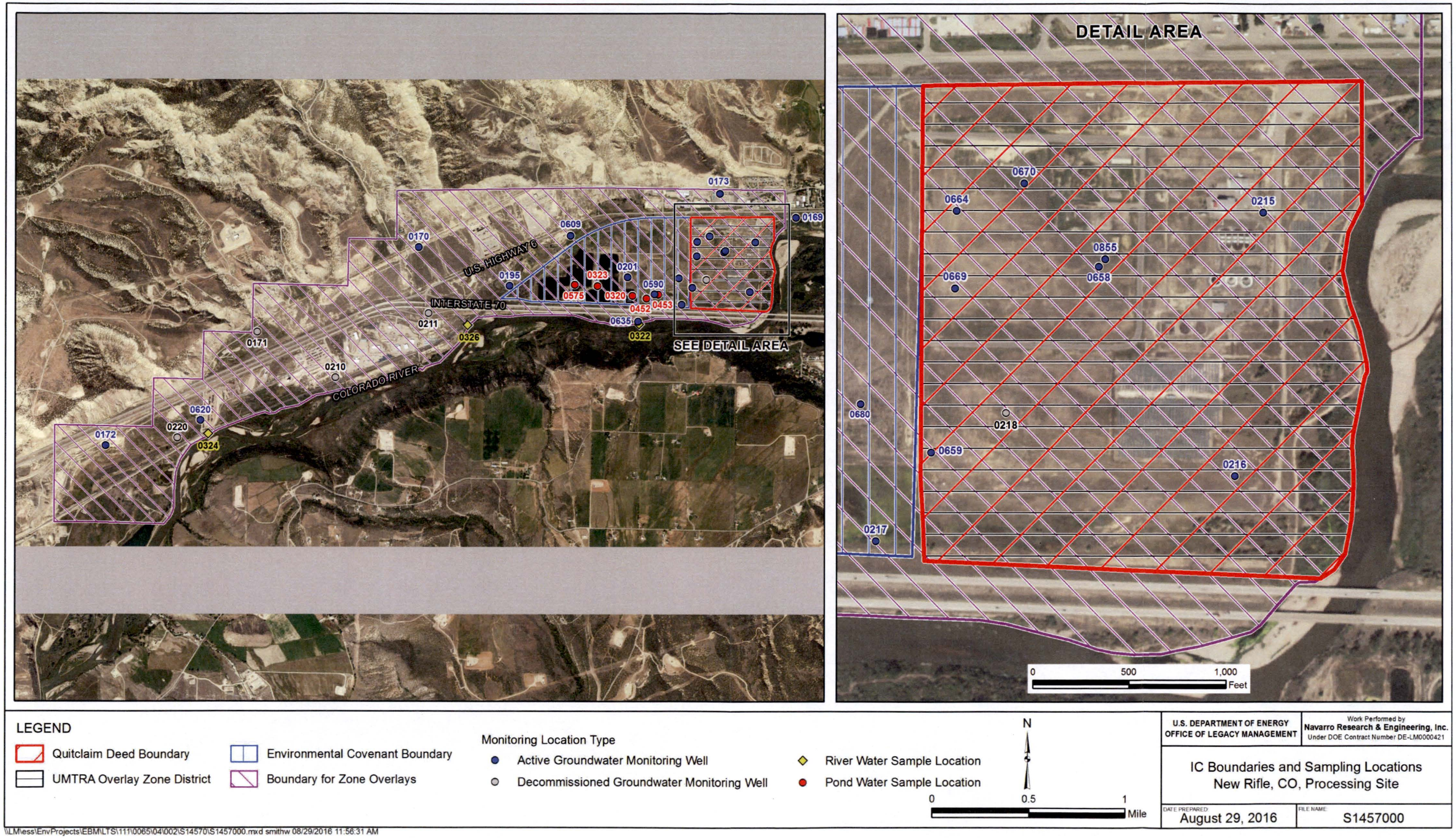

Figure 22. Institutional Control Boundaries, New Rifle, Colorado, Processing Site

4.2.5 Institutional Controls Monitoring

To verify that the described ICs are being maintained, DOE will conduct regular inspections and hold discussions with City of Rifle staff and other affected parties. As with the quitclaim deed verification, DOE will accomplish this by (1) discussions with City officials about construction projects and possible incursions of groundwater that could result from these activities, (2) physical inspection of the site by State and/or DOE and/or contractor staff, usually at the time of the annual Rifle, Colorado, Disposal Site inspection, and (3) observations by groundwater sampling staff at other times of the year. At a minimum, this will include a report of these evaluations, which will be submitted to CDPHE and NRC on a 5-year basis.

5.0 References

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Appendix A

Institutional Controls for the New Rifle, Colorado, Site

Part A1—Quitclaim and Deed Restrictions for Mill Site Property

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Recorded at ___ 653729 06/09/2004 12:02P B1594 P897 M ALSDORF
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QUIT CLAIM DEED

The Colorado Department of Public Health and the Environment ("Grantor"), whose address is 4300 Cherry Creek Drive South, Denver, Colorado, 80222-1530, City and County of Denver, State of Colorado, pursuant to 42 U.S.C.§ 7914 (e) (1) (B) and C.R.S. § 25-11-303, hereby donates and quit claim(s) to the City of Rifle ("Grantee"), whose address is 202 Railroad Avenue, Rifle, Colorado, 81650, City of Rifle, County of Garfield, State of Colorado, the following real property in the County of Garfield, State of Colorado, to wit: A parcel of land containing One hundred forty two (142) acres, more or less, described as follows:

That portion of land located in the S1/2 of the S1/2 of the NE1/4 of Section 18, Township 6 South, Range 93 West, of the 6th P.M., lying adjacent to and south of the South right-of-way line of the D&RG Railroad, except the east 297 feet, also Lot 5, Section 18, Township 6 South, Range 93 West, Lot 6, Section 18, Township 6 South, Range 93 West, except the east 297 feet of said Lot 6, also Lots 7 & 8 in Section 18, Township 6 South, Range 93 West, lying adjacent to and north of the Interstate 70 right-of-way line. Also two tracts of meander land situated in the S1/2 of Section 18, Township 6 South, Range 93 West, 6th P.M. described as follows:

Meander Land Tract 1

Beginning at the Southeast corner of Lot 6, and the East line of said Section 18; thence North 86 degrees 45 minutes West 594 feet; thence South 76 degrees 45 minutes West 660 feet; thence South 58 degrees 00 minutes West 1188 feet; thence South 75 degrees 00 minutes West 330 feet; thence South 250 feet; thence Southeasterly to the Westermost point of Lot 8 described above; thence North 49 degrees 13 minutes East 330 feet; thence North 79 degrees 45 minutes East 594 feet; thence North 45 degrees 30 minutes East 844.8 feet; thence South 69 degrees 00 minutes East 990 feet to the East line of said Section 18; thence North to the POINT OF BEGINNING.

Meander Land Tract 2

Beginning at the Southeast corner of Lot 7 and the East line of said Section 18; thence South 336.6 feet; thence South 75 degrees 55 minutes West 55.44 feet; thence South 61 degrees 00 minutes West 152.91 feet; thence South 61 degrees 00 minutes West, more or less, to the North right-of-way line of U.S. Interstate 70; thence West 810 feet to the South line of said Lot 7; thence North 62 degrees 15 minutes East 660 feet; thence North 75 degrees 30 minutes East 554.4 feet to the POINT OF BEGINNING.

Subject to: (i) any coal, oil, gas, or other mineral rights in any person; (ii) existing rights-of-way for roads, railroads, telephone lines, transmission lines, utilities, ditches, conduits, or pipelines on, over, or across said lands; (iii) court liens, judgments, or financial encumbrances such as deeds of trust for which a formal consent or order has been obtained from a court for the lien holder; (iv) other rights, interests, reservation or exceptions of record; and the following terms, conditions, rights, reservations and covenants:

Grantor reserves to (i) itself, the U. S. Department of Energy, their employees, agents and contractors the right of access to the property as may be necessary to complete activities under the Uranium Mill Tailings Radiation Control Act of 1978, 42 U.S.C. § 7901 et seq. ("UMTRCA") and for other lawful purposes, until such time as Grantor and the U.S. Department of Energy determine that all remedial activities are complete; and (ii) to itself any non-tributary groundwater underlying this parcel, the right to develop tributary groundwater, and the right to surface access for groundwater development.

Grantee covenants to hold harmless the Grantor and the Department of Energy for any liability associated with disruption of any public purpose ventures on the property conveyed by this deed, the disruption of any improvement on said property made by the Grantee, its successors and assigns, and any temporary or permanent limitations to the use of the property, should the Grantor and the Department of Energy be required to perform additional surface remedial activities on the property conveyed by this deed.

Grantee covenants (i) to comply with the applicable provisions of UMTRCA, 42 U.S.C. #7901 et. seq., as amended; (ii) not to use ground water from the site for any purpose, and not to construct wells or any means of exposing ground water to the surface unless prior written approval for such use is given by the Grantor and the U.S. Department of Energy; (iii) not to sell or transfer the land to anyone other than a governmental entity within the state; (iv) that any sale or transfer of the property described in this deed shall have prior written approval from the Grantor and the U.S. Department of Energy; and that any deed or other document created for such sale or transfer and any subsequent sale or transfer will include information stating that the property was once used as a uranium milling site and all other information regarding the extent of residual radioactive materials removed from the property as required by Section 104(d) of the Uranium Mill Tailings, 42 U.S.C. sec. 7014(d), and as set forth in the Annotation attached hereto; (v) not to perform construction and/or excavation or soil removal of any kind on the property without permission from the Grantor and the U.S. Department of Energy unless prior written approval of construction plans (e.g., facilities type and location), is given by the Grantor and the U.S. Department of Energy; (vi) that any habitable structures constructed on the property shall employ a radon ventilation system or other radon mitigation measures; and (vii) that its use of the property shall not adversely impact groundwater quality, nor interfere in any way, with groundwater remediation under UMTRCA activities; and (viii) to use the property and any profits or benefits derived therefrom only for public purposes as required by UMTRCA sec. 104(e)(1)(C), 42 U.S.C. 7914 (e)(1)(C).

These covenants are made in favor and to the benefit of Grantor, shall run with the land and be binding upon Grantee and its successors and assigns, and shall be enforceable by Grantor;

Grantee acknowledges that the property was once used as a uranium milling site, and that the Grantor makes no representations or warranties that the property is suitable for Grantee's purposes:

IN WITNESS WHEREOF:

APPROVED AS TO FORM:

David Kreutzer - Assistant Attorney General

GRANTOR:

STATE OF COLORADO
Bill Owens, Governor
Acting by and through
The Department of Public Health and Environment

By: ______________
Executive Director

By: ______________
Program Approval

ACCEPTANCE OF DEED
AND COVENANTS

GRANTEE:

City of Rifle, Colorado
(Full Legal Name of Agency)

By: ______________
Name Keith Lambert

Title: Mayor

Signed this ____ day of ________, 19

STATE OF COLORADO, } ss.
County of Garfield

The foregoing instrument was acknowledged before me this 21st day of April ~~, 19~~ 2004, by Keith Lambert

My commission expires 8-2004

Witness my hand and official seal

NOTARY PUBLIC
ELLEN J. GAUGLER
STATE OF COLORADO

______________ Notary Public.

ATTACHMENT A

LAND ANNOTATION

NEW RIFLE, COLORADO PROCESSING SITE

The Uranium Mill Tailings Radiation Control Act (Public Law 95-604), Section 104, requires that the State notify any person who acquires a designated processing site of the nature and extent of residual radioactive materials removed from the site, including notice of the date when such action took place, and the condition of the site after such action. The following information is provided to fulfill this requirement.

The New Rifle, Colorado processing site consists of one land parcel which contained a large tailings pile, the mill building, and associated structures. Approximately 3,232,000 cubic yards of contaminated materials which included 1) tailings; 2) subpile soils; 3) surficial materials in the mill yard; 4) windblown materials; and 5) mill demolition debris were removed from the mill site from 1988-1996. The remediation was conducted in accordance with regulations promulgated by the U.S. Environmental Protection Agency, in 40 CFR 192. These regulations require that the concentration of radium-226 in land averaged over any area of 100 square meters shall not exceed the background level by more than: 5 pCi/g (picocuries per gram), averaged over the first 15 cm (centimeters) of soil below the surface, and 15 pCi/g averaged over 15 cm thick layers of soil more than 15 cm below the surface. Verification measurements were conducted at the site by dividing the site into approximately 30-foot by 30-foot grids. A soil sample was collected and analyzed for contaminants from each grid to verify that the standards had been met.

After remediation was complete the site was backfilled with clean fill material, graded for drainage and revegetated. Backfill materials were routinely analyzed for radium-226 and were determined to have concentrations near background (1.5 pCi/g). To replace old wetland areas on the site, new wetlands were constructed in accordance with Army Corp of Engineer (COE) requirements. These wetland areas should not be disturbed without COE approval.

Excavation of residual radioactive material was also conducted for thorium-230 beneath the tailings pile in the subpile soils. For thorium-230, the cleanup standard was determined as a projected 1,000 year radium-226 concentration based on the eventual decay of the thorium to radium. The average thorium in-growth at depth was calculated to be 3.8 pCi/g.

All verification grids on the site met the EPA standards for radium and thorium, except grids M-08-07 and M-08-10. These areas are shown on the attached map. Additional information regarding the depth to the remaining deposits is available upon request from Colorado Department of Public Health and Environment and has been provided to Garfield County. When excavating in these areas, worker protection should be assured, and the material should be replaced at depth in the excavation. The EPA standards also allow for contamination to be left in place where removal would present a risk of injury to workers, would result in environmental harm, or where the cost of removal clearly outweighs the benefit in terms of risk reduction. At the New Rifle site, these areas where contamination was left (called "supplemental standards") are the following. The supplemental standards areas are shown on the attached map.

1) Approximately 400 cubic yards of tailings were left under the Corps of Engineers dike east of the site. The deposit is covered with clean fill and poses no risk.

2) Deposits remain north of the site along U.S. Highway 6 and 24, and the Union Pacific right-of-way. These deposits extend approximately 1/4 mile east and west of the site boundary.

The groundwater beneath the New Rifle mill site remains contaminated and will be addressed during Phase II of the uranium mill tailings remedial action project. Several groundwater monitor wells are present on and downgradient of the site and will remain in place until the U.S. Department of Energy determines that they can be removed.

Any person who acquires a designated processing site shall apply for any permits, including U.S. Army Corps of Engineers Section 404 permits regarding construction in or near wetlands, as required by law.

Additional information concerning the remedial action, and groundwater conditions is available from the Colorado Department of Public Health and Environment, Hazardous Materials and Waste Management Division.

Part A2—Zone Overlays for Mill Site Property City and County

CITY OF RIFLE, COLORADO
ORDINANCE NO. 24
SERIES OF 2001

AN ORDINANCE OF THE CITY OF RIFLE, COLORADO, AMENDING TITLES 10, 16 AND 17 OF THE RIFLE MUNICIPAL CODE PROHIBITING THE USE OF GROUNDWATER FOR POTABLE PURPOSES WITHIN THE URANIUM MILL TAILINGS REMEDIATION PROJECT RIFLE INSTITUTIONAL CONTROL BOUNDARY.

WHEREAS, past uranium mining activities in the vicinity of the City of Rifle resulted in a plume of contaminated groundwater, which plume is shown on the Rifle Institutional Control Boundary Map; and

WHEREAS, to ensure that contaminated groundwater is not consumed for potable purposes, it is necessary for the public health to prohibit such use; and

WHEREAS, the Rifle City Council finds and determines that amending the Rifle Municipal Code to require owners of property within the Rifle Institutional Control Boundary to connect to the City's potable water supply is in the best interest of the citizens of Rifle.

NOW, THEREFORE, THE COUNCIL OF THE CITY OF RIFLE, COLORADO, ORDAINS THAT:

1. The City Council incorporates the foregoing recitals as findings by the City Council.

2. Amendment. Title 10 of the Rifle Municipal Code is hereby amended as follows:

10.04.010 Definitions

[in the correct alphabetical order]

* "DOE" means the United States Department of Energy.

* "Rifle Institutional Control Boundary" means the boundary of a geographic area in and adjacent to the City of Rifle that has been identified and mapped by the United States Department of Energy within which lands are subject to non-potable polluted groundwater.

"Rifle Institutional Control Boundary Map" means a map recorded with the Garfield County Clerk and Recorder as Reception No. 600936 that depicts the Rifle Institutional Control Boundary and subject lands.

City of Rifle
Wanda Jones
202 Railroad Ave.
Rifle CO 81650

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10.04.050 Service Outside City--Policy

It is the policy of the City to decline to extend water service to property lying outside the corporate limits of the City, except for areas located within the Rifle Institutional Control Boundary, unless (a) the lack of municipal water creates a real hardship upon the owner of the property, (b) the property is capable of being annexed to the City within a reasonable time, as determined by the City Council, and (c) the owners, for themselves, their successors and assigns, sign a binding agreement to annex the property to the City at such time as it becomes eligible for annexation. The City expressly reserves the right, as may be limited by state or federal law, to impose such conditions as it may see fit relative to the furnishing of such service and to refuse such service in its discretion.

All provisions of this chapter apply to those areas outside the corporate limits of the City, except those areas covered by a contract which expressly establishes other rules for the area served under the contract.

All of the provisions of this chapter also apply to those areas which were located within the boundaries of the Rifle Village South Metropolitan District on June 1, 1988, except as expressly modified by an agreement between the City and the District incorporated into Ordinance No. 1, Series of 1988 and areas which are located within the Rifle Institutional Control Boundary.

10.04.080 Connection Required

The owner of any house or other building occupied for business or residence purposes, situated within the City and abutting any street, alley or right-of-way in which there is now located or may in the future be located a water distribution main of the City, is required at such owner's expense to connect such building by means of a service line directly with the distribution main in accordance with the provisions of this chapter. Further, any such owner located within the Rifle Institutional Control Boundary is prohibited from accessing groundwater for potable purposes or from connecting groundwater in any way to the municipal water system. The point or points at which connection is made to the distribution main shall be determined by the City Manager.

10.04.090 Connection Requirement - Exception

Except for property located within the Rifle Institutional Control Boundary, connection to the water supply system of the City shall not be required for any property which is served by an existing well or other water supply system, which system is approved by the City's Public Works Director and which system serves said property in substantially the same manner as it would be served by the water supply system of the City.

This section shall apply solely to property located outside of the Rifle Institutional Control Boundary served by an existing well or other water supply system prior to connection to the

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water supply system of the City, and shall not be construed to permit any person already connected to the water supply system of the City, whose property may subsequently be served by a well or other water supply system, to disconnect from the water supply system of the City.

10.04.230 Disconnection

For the purposes of this section, "customer" shall mean the person designated on City records as the person responsible for payment of charges incurred for the use at his premises of the water supply system of the City.

Except for property located within the Rifle Institutional Control Boundary, the City shall disconnect the service line of any premises at the curb stop, upon request of the customer.

***

10.04.530 Unlawful Acts

***

It shall be unlawful for any person to connect a surface or groundwater source or otherwise create a water connection or cross connection to the municipal water system.

It shall be unlawful for any person located within the area identified as the Rifle Institutional Control Boundary to access groundwater for potable purposes or in any way connect a groundwater source to the municipal water system.

3. Amendment. Title 16 of the Rifle Municipal Code is hereby amended as follows:

16.06.020 Amendments

***

(2) Section 106.4.1 entitled "Issuance" is amended to include the following paragraphs:

A building permit will not be issued in the City of Rifle jurisdiction until all construction drawings, applications, and permit fees are submitted and approved, including those for plumbing, and mechanical portions of the project. Additionally, a building permit will not be issued in the City of Rifle jurisdiction within the Rifle Institutional Control Boundary unless the plans indicate a connection to the Rifle municipal water system with no access to groundwater for potable purposes.

Notwithstanding the foregoing, a footing and foundation permit may be issued prior to reception of other permit information if adequate structural and site plan information is provided.

16.20.060 Prohibitions

***

F. No person shall occupy any new building, factory-built housing unit, manufactured home or mobile home until sewage disposal facilities, meeting the minimum standards of the Colorado Department of Health and the ordinances of the City have been installed and have been approved. No person shall occupy any building, factory-built housing unit, manufactured home or mobile home unless potable domestic water facilities have been installed and have been approved, in writing, by the City.

G. No person within the Rifle Institutional Control Boundary and within the Rifle municipal limits shall construct or occupy any structure, building, factory built housing unit, manufactured home or mobile home that requires or utilizes a water source without first connecting to the City of Rifle potable municipal water system.

16.22.020 Waiver of Permit Requirements

Except for property within the Rifle Institutional Control Boundary, the Building Official may waive any permit requirements contained within this title or the codes adopted by reference thereunder only after a determination is made that the effect of such a waiver is minor and will not affect the health, safety and welfare of the citizens of the City.

16.22.060 Permits--General Conditions

***

D. All structures within the Rifle Institutional Control Boundary that require potable water service shall be connected to the City of Rifle potable municipal water system.

16.22.100 Issuance of Certificate of Occupancy

In addition to the requirements for the issuance of a certificate of occupancy contained in the codes adopted by reference in this title, no certificate of occupancy shall be issued until the following improvements have been installed in the development where the building or structure is located and have been approved by the Public Works Director or his/her designee:

***

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I. For property within the Rifle Institutional Control Boundary, a connection is made to the Rifle potable municipal water system and no access is made to groundwater sources for potable purposes.

4. Amendment. Title 17 of the Rifle Municipal Code is hereby amended as follows:

17.01.200 Definitions

[in the correct alphabetical order]

* "DOE" means the United States Department of Energy.

Rifle Institutional Control Boundary means the boundary of a geographic area in and adjacent to the City of Rifle that has been identified and mapped by the United States Department of Energy within which lands are subject to non-potable polluted groundwater

Rifle Institutional Control Boundary Map means a map recorded with the Garfield County Clerk and Recorder as Reception No. 600936 that depicts the Rifle Institutional Control Boundary and subject lands.

17.02.145 Pre-annexation Agreements for Property within the Rifle Institutional Control Boundary

Any owner of property that requests municipal services within the Rifle Institutional Control Boundary, as shown on the Rifle Institutional Control Boundary Map and outside the Rifle municipal limits, shall enter into a pre-annexation agreement with the City, which agreement shall prohibit the property from utilizing groundwater for potable purposes and require connection to the municipal water supply. Any owner of property within the Rifle Institutional Control Boundary that enters into a pre-annexation agreement will be eligible to receive water service from the City when available.

INTRODUCED on September 5, 2001, read by title, passed on first reading, and ordered published as required by the Charter.

INTRODUCED a second time at a regular meeting of the Council of the City of Rifle. Colorado, held on September 19, 2001, passed with amendment, approved, and ordered published in full as required by the Charter.

Dated this 19th day of September, 2001

600937 04/09/2002 02:07P 81344 P694 M RLSDORF
6 of 6 R 30.00 D 0.00 GARFIELD COUNTY CO

CITY OF RIFLE, COLORADO

By Keith Lambert
Mayor

ATTEST:

Wanda Nelson Jones
City Clerk

CITY OF RIFLE SEAL GARFIELD COUNTY, COLORADO

CITY OF RIFLE, COLORADO
ORDINANCE NO. 6
SERIES OF 2002

AN ORDINANCE OF THE CITY OF RIFLE, COLORADO, APPROVING THE INSTITUTIONAL CONTROL BOUNDARY MAP AS REFERENCED IN ORDINANCE NO. 24, SERIES OF 2001.

WHEREAS, the Department of Energy conducted numerous studies of a contaminated groundwater plum that is a result of uranium mining in the vicinity of the City of Rifle, which studies culminated and are referenced in a draft Environmental Assessment of Ground Water Compliance at the New Rifle Mill Tailings Site prepared by the U.S. Department of Energy Grand Junction Office dated November 2001; and

WHEREAS, the Department of Energy relied on these studies in formulating and drafting the Rifle Institutional Control Boundary Map that defines the approximate location of the contaminated groundwater plume; and

WHEREAS, the City, by Ordinance No. 24, Series of 2001, enacted Institutional Controls applicable to property within the Institutional Control Boundary as defined by the Rifle Institutional Control Boundary Map prohibiting the use of ground water for potable purposes; and

WHEREAS, the Department of Energy has finalized the Rifle Institutional Control Boundary Map dated November 15, 2001, attached hereto as Exhibit A, which the City desires to formally adopt for the application of Ordinance No. 24, Series of 2001.

NOW, THEREFORE, THE COUNCIL OF THE CITY OF RIFLE, COLORADO, ORDAINS THAT:

1. The City Council incorporates the foregoing recitals as findings by the City Council, including the studies referenced in the draft Environmental Assessment of Ground Water Compliance at the New Rifle Mill Tailings Site prepared by the U.S. Department of Energy Grand Junction Office dated November 2001.

2. The Rifle Institutional Control Boundary Map attached hereto as Exhibit A is hereby adopted by the City of Rifle for the application of Ordinance No. 24, Series of 2001.

3. The City Clerk shall record the Institutional Control Boundary Map with the Garfield County Clerk and Recorder and insert the recording information in Ordinance No. 24, Series of 2001.

INTRODUCED on March 20, 2002, read by title, passed on first reading, and ordered published as required by the Charter.

INTRODUCED a second time at a regular meeting of the Council of the City of Rifle, Colorado, held on April 3, 2002, passed without amendment, approved, and ordered published in full as required by the Charter.

Dated this 3rd day of April, 2002

CITY OF RIFLE, COLORADO

By Keith Lambert
Mayor

ATTEST:

Andrea Glass
City Clerk
Deputy

CITY OF RIFLE GARFIELD COLORADO SEAL

EXHIBIT

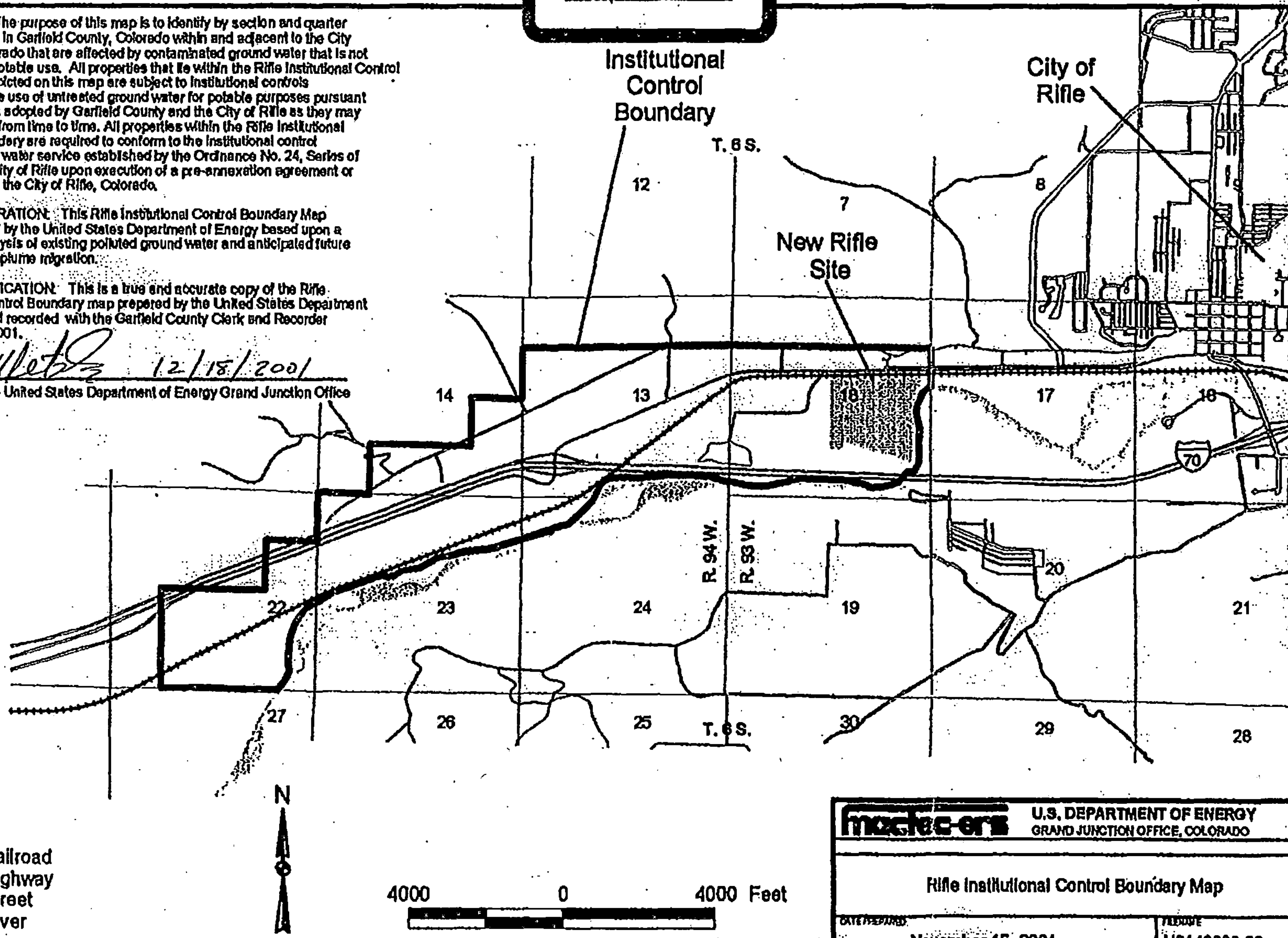
PURPOSE: The purpose of this map is to identify by section and quarter section lands in Garfield County, Colorado within and adjacent to the City of Rifle, Colorado that are affected by contaminated ground water that is not suitable for potable use. All properties that lie within the Rifle Institutional Control Boundary depicted on this map are subject to institutional controls prohibiting the use of untreated ground water for potable purposes pursuant to regulations adopted by Garfield County and the City of Rifle as they may be amended from time to time. All properties within the Rifle Institutional Control Boundary are required to conform to the institutional control standards for water service established by the Ordinance No. 24, Series of 2001 of the City of Rifle upon execution of a pre-annexation agreement or annexation to the City of Rifle, Colorado.

MAP PREPARATION: This Rifle Institutional Control Boundary Map was prepared by the United States Department of Energy based upon a scientific analysis of existing polluted ground water and anticipated future ground water plume migration.

MAP CERTIFICATION: This is a true and accurate copy of the Rifle Institution Control Boundary map prepared by the United States Department of Energy and recorded with the Garfield County Clerk and Recorder in October, 2001.

12/18/2001

Don Metzler - United States Department of Energy Grand Junction Office

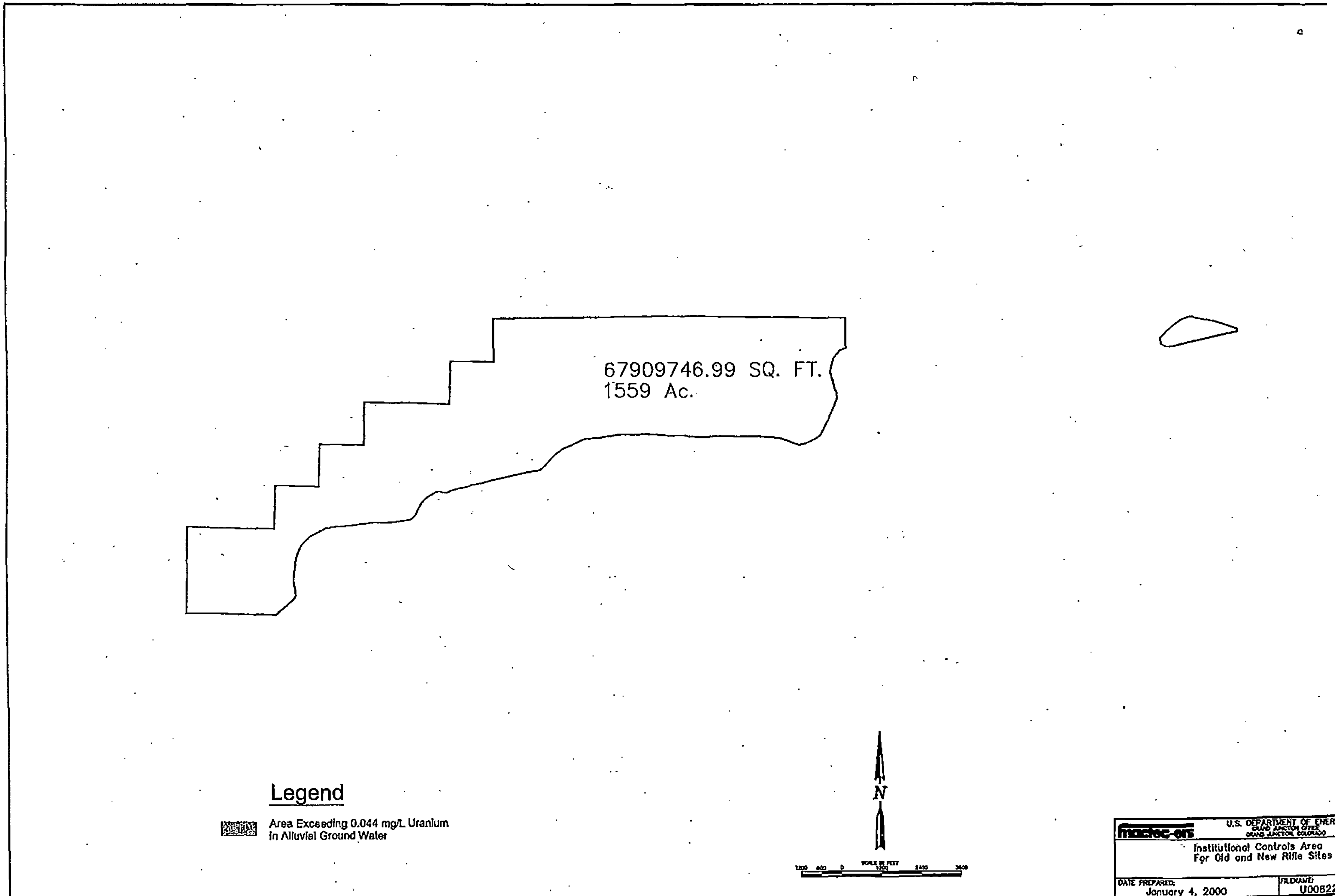


U.S. DEPARTMENT OF ENERGY
GRAND JUNCTION OFFICE, COLORADO

Rifle Institutional Control Boundary Map

DATE PREPARED: November 15, 2001

FIGURE: U0142300-02


67909746.99 SQ. FT.
1559 Ac.
N
Legend
Area Exceeding 0.044 mg/L Uranium in Alluvial Ground Water
mactec-ers
U.S. DEPARTMENT OF ENER
Institutional Controls Area For Old and New Rifle Sites
DATE PREPARED:
January 4, 2000
U0082

838

STATE OF COLORADO)
)ss
County of Garfield)

At a meeting of the Board of County Commissioners for Garfield County, Colorado, held in the Commissioners' Meeting Room, Garfield County Courthouse, in Glenwood Springs on Monday, the 8th day of October,2001, there were present:

John Martin, Commissioner Chairman
Larry McCown, Commissioner
Walt Stowe, Commissioner
Don DeFord, County Attorney
Mildred Alsdorf, Clerk of the Board
Ed Green, County Manager

when the following proceedings, among others were had and done, to-wit:

RESOLUTION NO. 2001-72

A RESOLUTION CONCERNED WITH THE APPROVAL OF A ZONE DISTRICT AMENDMENT FOR AN AREA WEST OF RIFLE TO DRINKING WATER CONSTRAINT (DWC).

WHEREAS, the Board of County Commissioners of Garfield County proposed to rezone the herein described property in Garfield County to Drinking Water Constraint (DWC).

WHEREAS, the Board of County Commissioners of Garfield County have heretofore adopted and enacted a Zoning Resolution for Garfield County, Colorado, including as a part thereof, certain zoning maps regulating permitted uses upon the lands within Garfield County, Colorado; and

WHEREAS, sections 30-28-109 through 30-28-116 C.R.S.. as amended, provide for the approval of all zoning plans and the adoption and amendment of regulations and resolutions to implement such zoning plans by the Board of County Commissioners of a given county; and

WHEREAS, the County has given notice of public hearing upon such application by publication in a newspaper of general circulation in Garfield County and provided notice of said hearing to all property owners adjacent to said property subject to the zone district amendment, and such hearing having been held on September 17, 2001, which was continued to September 24, 2001 and this Board having given full consideration to the evidence; and

447
(3)

589783 10/09/2001 01:16P B1292 P939 M ALSDORF
2 of 3 R 0.00 D 0.00 GARFIELD COUNTY CO

WHEREAS, based upon the evidence, testimony, exhibits, review of the Comprehensive Plan for the unincorporated area of the County, recommendation from the Garfield County Planning Commission, comments of the Garfield County Planning Department, comments of public officials and agencies and comments from all interested parties in connection with said application, this Board makes the following findings in respect thereto, to-wit:

1. That all applicable regulations regarding a Zone District Amendment have been complied with including, but not limited to, Section 10.00 of the Garfield County Zoning Resolution of 1978, as amended.

2. That proper publication and public notice was provided as required by law for the hearing before the Board of County Commissioners.

3. That the public hearing before the Board of County Commissioners was extensive and complete, that all pertinent facts, matters and issues were submitted and that all interested parties were heard at the meeting.

NOW, THEREFORE, BE IT RESOLVED by the Board of County Commissioners of Garfield County, Colorado, that the following described area and the property included therein, be rezoned Drinking Water Constraint (DWC).

LEGAL DESCRIPTION

All of that property located north of the northern bank of the Colorado River located in the S1/2 of Section 18, T. 6 S., R. 93 W.; and the S1/2 of Section 13; the E1/2 SE1/4; SW1/4 SE1/4, SE1/4SW1/4 of Section 14; the SE1/4NE1/4, SE1/4, E1/2 SW1/4 of Section 22; N1/2 of Section 23 and the NW1/4 of Section 24, T. 6 S., R. 94 W. of the 6th P. M..

Dated this 8th day of October, A.D. 2001.

ATTEST:

GARFIELD COUNTY BOARD OF COMMISSIONERS, GARFIELD COUNTY, COLORADO

Mildred Alsdorf
Clerk of the Board

[signature]
Chairman

Upon motion duly made and seconded the foregoing Resolution was adopted by the following vote:

COMMISSIONER CHAIRMAN JOHN F. MARTIN ______, Aye
COMMISSIONER WALTER A. STOWE ______, Aye
COMMISSIONER LARRY L. MCCOWN ______, Aye

STATE OF COLORADO)
)ss
County of Garfield)

I, ______________, County Clerk and ex-officio Clerk of the Board of County Commissioners, in and for the County and State aforesaid, do hereby certify that the annexed and foregoing Resolution is truly copied from the Records of the Proceeding of the Board of County Commissioners for said Garfield County, now in my office.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the seal of said County, at Glenwood Springs, this ____ day of ______________, A.D. 2001.

County Clerk and ex-officio Clerk of the Board of County Commissioners

____

EXHIBIT

A

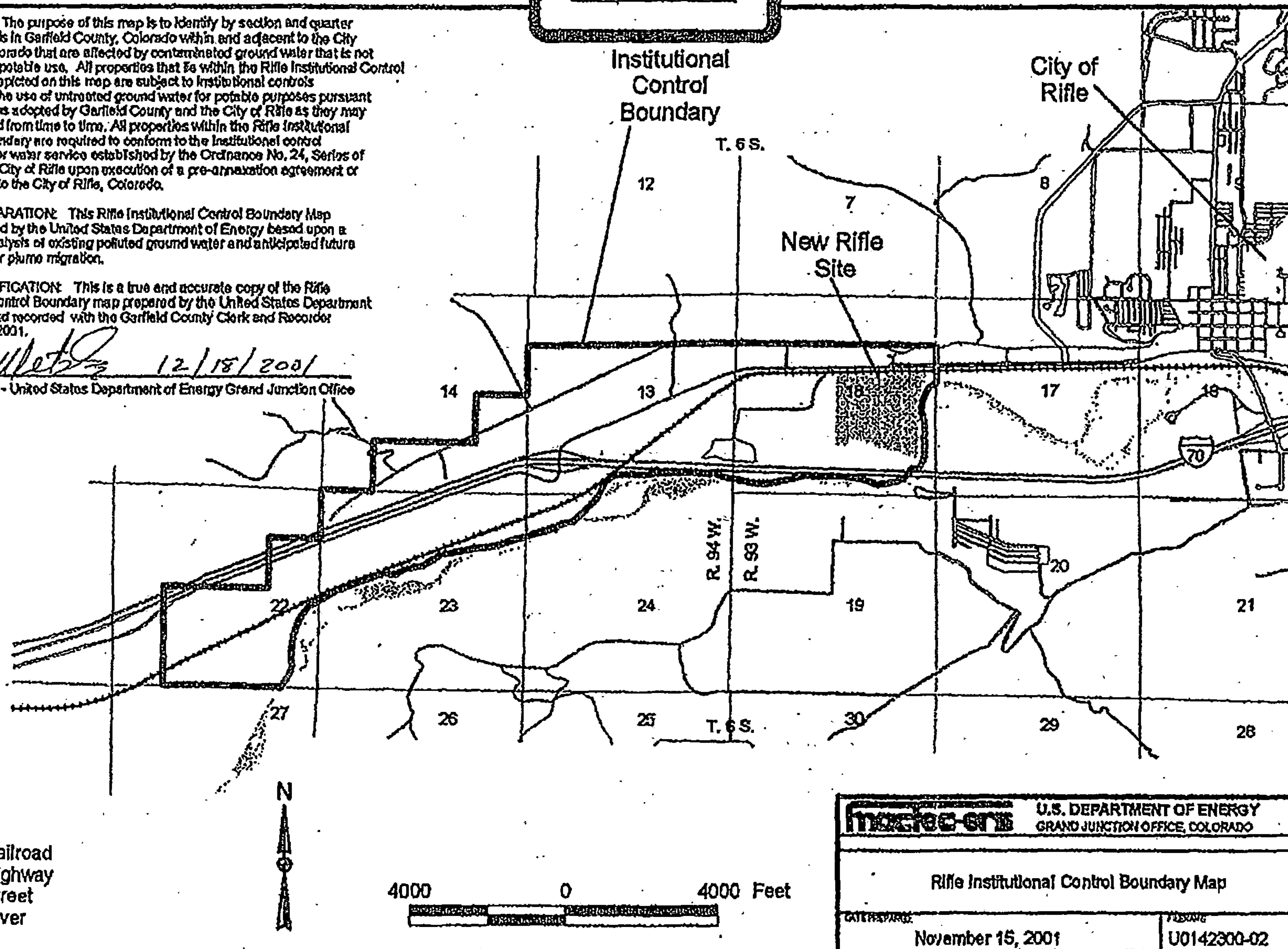
PURPOSE: The purpose of this map is to identify by section and quarter section lands in Garfield County, Colorado within and adjacent to the City of Rifle, Colorado that are affected by contaminated ground water that is not suitable for potable use. All properties that lie within the Rifle Institutional Control Boundary depicted on this map are subject to institutional controls prohibiting the use of untreated ground water for potable purposes pursuant to regulations adopted by Garfield County and the City of Rifle as they may be amended from time to time. All properties within the Rifle Institutional Control Boundary are required to conform to the Institutional control standards for water service established by the Ordinance No. 24, Series of 2001 of the City of Rifle upon execution of a pre-annexation agreement or annexation to the City of Rifle, Colorado.

MAP PREPARATION: This Rifle Institutional Control Boundary Map was prepared by the United States Department of Energy based upon a scientific analysis of existing polluted ground water and anticipated future ground water plume migration.

MAP CERTIFICATION: This is a true and accurate copy of the Rifle Institution Control Boundary map prepared by the United States Department of Energy and recorded with the Garfield County Clerk and Recorder in October, 2001.

[signature] 12/18/2001

Don Metzler - United States Department of Energy Grand Junction Office



U.S. DEPARTMENT OF ENERGY
GRAND JUNCTION OFFICE, COLORADO

Rifle Institutional Control Boundary Map

November 15, 2001

U0142300-02

(970) 384-3670

STATE OF COLORADO)
)ss
County of Garfield)

At a regular meeting of the Board of County Commissioners for Garfield County, Colorado, held in the Commissioners' Meeting Room, Garfield County Courthouse, in Glenwood Springs on Monday, the 8th of October, 2001, there were present:

John Martin	, Commissioner Chairman
Larry McCown	, Commissioner
Walt Stowe	, Commissioner
Don DeFord	, County Attorney
Mildred Alsdorf	, Clerk of the Board
Ed Green	, County Manager

when the following proceedings, among others were had and done, to-wit:

RESOLUTION NO. 2001-73

A RESOLUTION CONCERNED WITH AMENDING THE GARFIELD COUNTY ZONING RESOLUTION OF 1978 BY THE ADDITION OF SECTION 3.14, DRINKING WATER CONSTRAINT (DWC) ZONE DISTRICT.

WHEREAS, on the 2nd day of January, 1979, the Board of County Commissioners of Garfield County, Colorado, adopted Resolution No. 79-1 concerning a Zoning Resolution for the County of Garfield, State of Colorado; and

WHEREAS, the Board is authorized by the provisions of Sections 30-28-109 through 30-28-116, C.R.S. 1973, as amended, to provide for the approval of amendments to such Zoning Resolution, and the Board has so amended the said Resolution; and

WHEREAS, on December 16, 1991, the Board adopted a codified version of the Garfield County Zoning Resolution of 1978 and all subsequent amendments; and

WHEREAS, on September 14, 2001, the Garfield County Planning Commission recommended approval of the proposed text amendment;

WHEREAS, a public hearing was held on the 17th day of September 2001 and continued to the 24th day of September, 2001, before the Board of County Commissioners of Garfield County, Colorado, at the Commissioners meeting room, Suite 301, Garfield County Courthouse, 109 8th Street, Glenwood Springs, Colorado, as to which hearing, public notice was given in accordance with requirements of Section 10 of the Garfield County Zoning Resolution;

WHEREAS, the Board on the basis of evidence produced at the aforementioned hearing has made the following determination of fact:

1. That an application for a zone district text amendment was made consistent with the

requirements of Section 10.00 of the Garfield County Zoning Resolution of 1978, as amended;

2. That the Board of County Commissioners is authorized by the provisions of Section 30-28-116, C.R.S. 1973, as amended, to provide for the approval of amendments to the Garfield County Zoning Resolution;

3. That the public hearing before the Board of County Commissioners was extensive and complete, that all pertinent facts, matters and issues were submitted and that all interested parties were heard at the hearing;

4. That the Garfield County Planning Commission has reviewed the proposed zone district text amendment and made a recommendation as required by Section 10.04 of the Garfield County Zoning Resolution of 1978, as amended;

5. That the proposed text amendment are in the best interest of the health, safety, morals, convenience, order, prosperity and welfare of the citizens of Garfield County.

NOW, THEREFORE, BE IT RESOLVED by the Board of County Commissioners of Garfield County, Colorado, that the Garfield County Zoning Resolution, adopted on the 2nd day of January, 1979, and identified as its Resolution No. 79-1, as subsequently amended by this Board, shall be and hereby is amended and said language will be incorporated into the codified Garfield County Zoning Resolution adopted by the Board on December 16, 1991 as follows:

3.14 <u>Drinking Water Constraint Zone</u> (DWC)

3.14.01 <u>uses. by right</u>: :

Agricultural, including farm, garden, greenhouse, nursery, orchard, ranch, small animal farm for production of poultry, fish, fur-bearing and other small animals, and customary accessory uses including buildings for shelter and enclosure of persons, animals or property employed in any of the above uses; retail establishment for sale of goods processed from raw materials produced on the lot;

Buildings for shelter and enclosure of persons employed in any of the uses by right, kennel, riding stable and veterinary clinic, guiding and outfitting;

Manufactured home as the principal use of the lot meeting standards contained in Section 5.03.01(2);

Single-family dwelling; customary accessory uses only where it is accessory to the uses listed above.

3.14.02 <u>Uses. conditional</u>:

Aircraft landing strip, airport-utility, salvage yard, sanitary landfill and storage, Home occupation

3.14.03 Uses, special:

Pumping facilities, electrical distribution, water impoundments, access routes, utility lines, pipelines;

Camper park, agriculture-related business, resort, airport - air carrier, plant for fabrication of goods from processed natural resources; material handling, warehouse facilities/staging areas, fabrication areas, storage areas, extraction, processing; public gatherings; commercial park; recreational support facilities; guest houses.

3.14.04 Minimum Lot Area: Two (2) acres.

3.14.05 Maximum Residential Lot Coverage: fifteen percent (15%).

3.14.06 Minimum Setback (Unless otherwise permitted by special use permit.)

(1) Front yard: (a) arterial streets: seventy-five (75) feet from centerline or fifty (50) feet from lot line, whichever is greater; (b) local streets: fifty (50) feet from street centerline or twenty-five (25) feet from front lot line, whichever is greater;
(2) Rear yard: twenty-five (25) feet from rear lot line;
(3) Side yard: ten (10) feet from side lot line, or one-half (1/2) the building height, whichever is greater.

3.14.07 Maximum Height of Buildings: Forty (40) feet. (Unless otherwise permitted by special use permit.)

3.14.08 Additional Requirements: All uses shall be subject to the provisions of Section 5 (Supplementary Regulations).
All of the uses listed a use by right, conditional use or special use, will be allowed provided any use that includes the human consumption of ground water, shall have an approved domestic water supply. An approved domestic water supply shall be either an approved community water system as defined by the Colorado Department of Health and Environment, Drinking Water Standards or from a ground water source on the property that is treated by a reverse osmosis water treatment system that meets the water quality standards promulgated under the criteria cited in CRS § 25-8-204(1) & (2).

Dated this 8th day of October, 2001.

ATTEST:

GARFIELD COUNTY BOARD OF COMMISSIONERS, GARFIELD COUNTY, COLORADO

SEAL GARFIELD COUNTY COLORADO

Clerk of the Board

Chairman

Upon motion duly made and seconded the foregoing Resolution was adopted by the following vote:

COMMISSIONER CHAIRMAN JOHN F. MARTIN ____________, Aye
COMMISSIONER WALTER A. STOWE ____________, Aye
COMMISSIONER LARRY L. MCCOWN ____________, Aye

STATE OF COLORADO)
)ss
County of Garfield)

I, ____________________, County Clerk and ex-officio Clerk of the Board of County Commissioners, in and for the County and State aforesaid, do hereby *certify* that the annexed and foregoing Resolution is truly copied from the Records of the Proceeding of the Board of County Commissioners for said Garfield County, now in my office.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the seal of said County, at Glenwood Springs, this _____ day of ______________, A.D. 2001.

County Clerk and ex-officio Clerk of the Board of County Commissioners

____

Part A3—Environmental Covenant between Colorado Department of Public Health and Environment and Umetco Minerals

7 PAGE DOCUMENT

RECEPTION #: 2547633, BK 5062 PG 949 09/29/2010 at 10:16:48 AM, 1 OF 7, R $40.00 S $1.00
Janice Rich, Mesa County, CO CLERK AND RECORDER

APR 0 8 2009

This property is subject to an Environmental Covenant held by the Colorado Department of Public Health and Environment pursuant to Section 25-15-321, C.R.S.

ENVIRONMENTAL COVENANT

Umetco Minerals Corporation, a Delaware corporation with an office address at 2745 Compass Drive, Suite 280, Grand Junction, Colorado 81506 (the "Grantor") hereby grants an Environmental Covenant (the "Covenant") dated this 3rd day of April, 2009 to the Hazardous Materials and Waste Management Division of the Colorado Department of Public Health and the Environment (the "Department") pursuant to § 25-15-321 of the Colorado Hazardous Waste Act, § 25-15-101, *et seq*. The Department's office address is 4300 Cherry Creek Drive South, Denver, Colorado 80246-1530.

WHEREAS, as of the date hereof, Grantor is the current record owner of certain property commonly referred to as the New Rifle Site, located approximately two (2) miles southwest of the City of Rifle, State of Colorado, more particularly described by metes and bounds in Attachment A, attached hereto and incorporated herein by reference as though fully set forth (hereinafter referred to as "the Property"); and

WHEREAS, pursuant to that certain U.S. Department of Energy Site Observational Work Plan for the UMTRA Project New Rifle Site, (the "Work Plan"), the Property is the subject of remedial action pursuant to the Uranium Mill Tailings Radiation Control Act, P.L. 95-604 ("UMTRCA") and UMTRCA regulations, 40 C.F.R.§ 192 Subpart B, and;

WHEREAS, the purpose of this Covenant is to enhance protection of human health and the environment by minimizing opportunity for potential exposure to residual radioactive materials through restrictions on penetration of the ground surface, and to minimize opportunity for potential exposure to contaminated groundwater, and

WHEREAS, Grantor and the Department mutually desire to subject the Property to those certain covenants and restrictions set forth herein below as provided in Article 15 of Title 25, Colorado Revised Statutes, which said covenants and restrictions shall burden the Property and bind Grantor in its capacity as current record owner, all subsequent owners, and all parties having any right, title or interest in the Property, or any part thereof, their heirs, successors and assigns, and any persons using the land, as described herein, for the benefit of Grantor, subsequent record owners of the Property, the Department, and the U.S. Department of Energy.

NOW, THEREFORE, Grantor hereby grants this Environmental Covenant to the Department, with the U.S. Department of Energy as a third party beneficiary, and declares that the Property as described in Attachment A shall hereinafter be bound by, held, sold, and conveyed subject to the following requirements set forth in the paragraphs below, which shall run with the Property in perpetuity and be binding on Grantor in its capacity as current record owner, all subsequent owners, and all parties having any right, title or interest in the Property, or any part thereof, their heirs, successors and assigns, and any persons using the land, as described herein. As used in this Environmental Covenant, the term OWNER means the then current record owner of the Property and, if any, any other person or entity otherwise legally authorized to make decisions regarding the transfer of the Property or placement of encumbrances on the Property, other than by the exercise of eminent domain.

1) Use restrictions.

A. No wells or drilling or pumping whatsoever shall be permitted or allowed on the Property that would impact the alluvial aquifer underlying the Property without modification of this Covenant pursuant to paragraph 2 herein below. The only exception to the foregoing is for monitoring and remedial wells installed by Grantor,0 OWNER, the Department, or the Department of Energy, in connection with the on-going, approved remedial activities at the Property pursuant to the Work Plan, as the same may be amended from time to time.

B. No stock watering or grazing utilizing the alluvial aquifer or the Wasatch formation, including use of the former Roaring Fork Gravel Pit, shall be allowed. Appropriate measures such as fencing shall be used as necessary to restrict grazing and access of cattle or other stock to the former Roaring Fork Gravel Pit.

C. No activities that will interfere with any existing or future monitoring or remedial wells installed by Grantor, OWNER, the Department, or the Department of Energy, in connection with the on-going, approved remedial activities at the Property pursuant to the Work Plan, as the same may be amended from time to time, or interfere with the maintenance, operation, or monitoring of said wells is permitted or allowed, without modification of this Covenant pursuant to paragraph 2 herein below.

D. OWNER shall grant access to the Department and the U.S. Department of Energy to perform any and all activities pursuant to the Work Plan, as the same may be amended from time to time, required to monitor or implement the remedy for the Property pursuant to the Work Plan, as the same may be amended from time to time.

2) Modifications.

A. This Covenant, and the restrictions and requirements contained herein, runs with the land and is perpetual, unless modified or terminated pursuant to this paragraph in accordance with then current statutory requirements. OWNER may request that the Department approve a modification or termination of the Covenant in accordance with then current statutory requirements. As of the date hereof, the current statutory requirements for modification or termination of this Covenant are set forth in § 25-15-319, C.R.S. No modification or termination of this Covenant shall be effective unless the Department has approved such modification or termination in writing in accordance with statutory requirements.

B. Upon receipt of any request of any OWNER to modify or terminate this Covenant, the Department shall give notice thereof to Grantor, or to its direct parent corporation Union Carbide Corporation, or to its indirect parent corporation The Dow Chemical Company, affording reasonable advance opportunity to comment to the Department on the advisability of granting any such request.

3) Conveyances. OWNER shall notify the Department at least fifteen (15) days in advance of the closing on any sale or other conveyance of title to any or all of the Property.

4) Notice to Lessees. OWNER agrees to incorporate either in full or by reference the restrictions of this Covenant in any leases, licenses, or other written instruments granting a right to use the Property.

5) Notification for proposed construction and land use. OWNER shall notify the Department contemporaneously when OWNER submits any application to a local government entity either (i) for a building permit on the Property and/or (ii) for a change in land use on the Property.

6) Inspections. The Department shall have the right of entry to the Property at reasonable times with prior notice for the purpose of determining compliance with the terms of this Covenant. Nothing in this Covenant shall impair any other authority the Department may otherwise have to enter and inspect the Property.

7) No Liability. The Department does not acquire any liability under State law by virtue of accepting this Covenant, nor does any other named beneficiary of this Covenant acquire any liability under State law by virtue of being such a beneficiary.

8) Enforcement. The Department may enforce the terms of this Covenant pursuant to §25-15-322. C.R.S. Grantor and the U.S. Department of Energy may file suit in district court to enjoin actual or threatened violations of this Covenant.

9) Non- Compliance Report. In the event that OWNER becomes aware to its actual knowledge of an incident on the Property that is not in compliance with the requirements of this Covenant, OWNER shall execute and file an Incident Report thereof with the Department. Not more than once annually, the Department may request OWNER to certify to its actual knowledge as to whether any such incident of non-compliance has occurred on the Property. .

10) Recordation. Contemporaneously with the full mutual execution hereof, the Department shall file this Covenant on the public land records of the County in which the Property is located.

11) Notices. Any notices, documents, or communications required to be given under this Covenant shall be effective one (1) day after being placed in the hands of a reputable national overnight delivery service, and (3) days after being placed in the hands of the US Postal Service, certified mail, return receipt requested, and, in each case, addressed respectively as follows:

If to the Department:

Hazardous Materials and Waste Management Division
Attention: UMTRA Project Manager
Colorado Department of Public Health and the Environment
4300 Cherry Creek Drive South
Denver, Colorado 80246-1530

If to the US Department of Energy:

U.S. Department of Energy
Attention: Remedial Programs Director
Grand Junction Office
2597 B3/4 Road
Grand Junction, CO 81503

If to the Grantor:

Umetco Minerals Corporation
Attention: Remediation Leader
2745 Compass Drive
Grand Junction, Colorado 81506

Cc: Stephen J. Murray, Esq.
Of Counsel, Mahoney & Keane, LLP
14 Pilgrim Lane
Weston, CT 06883

If to Union Carbide Corporation and/or The Dow Chemical Company

Union Carbide Corporation
c/o The Dow Chemical Company
Attn: Global Real Estate Director
2030 Dow Center
Midland, MI 48674

Cc: Umetco Minerals Corporation
Attention: Remediation Leader
2745 Compass Drive
Grand Junction, Colorado 81506

Cc: Stephen J. Murray, Esq.
Of Counsel, Mahoney & Keane, LLP
14 Pilgrim Lane
Weston, CT 06883

IN WITNESS WHEREOF, Grantor has caused this instrument to be executed this 3rd day of April, 2009.

Umetco Minerals Corporation

By: [signature]
Name: Gregory G. Cochran
Title: President

STATE OF Michigan)
) ss:
COUNTY OF Midland)

The foregoing instrument was acknowledged before me this 3rd day of April, 2009 by Gregory G. Cochran on behalf of Umetco Minerals Corporation.

[signature]
Notary Public

Address

My commission expires: March 19, 2012

Accepted by the **Colorado Department of Public Health and Environment** this 24th day of August, ~~2009~~ 2010

Department of Public Health and Environment,
State of Colorado

By: [signature]
Name: Gary W. Baughman
Title: Director, HMWMD

STATE OF Colorado)
) ss:
COUNTY OF Arapahoe)

The foregoing instrument was acknowledged before me this 24th day of August, ~~2009~~ 2010 by Gary W. Baughman on behalf of the Colorado Department of Public Health and Environment.

[signature]
Notary Public
4300 Cherry Creek Drive South
Address
Denver Co 80246

My commission expires: 2-29-2012

ATTACHMENT A

METES AND BOUNDS DESCRIPTION

NEW RIFLE SITE

UMETCO PROPERTY IN WEST RIFLE, CO

PROPERTY DESCRIPTION

That certain tract of land in the west one-half of Section 18, Township 6 South, Range 93 West, and in the east one-half of Section 13, Township 6 South, Range 94 West of the 6th Principal Meridian, Garfield County, Colorado, the perimeter of which is described as follows:

Commencing at a Garfield County Survey Marker for the Meander Corner on the westerly line of said Section 18, whence an original stone monument for the northwest corner of said Section 18 bears N00°25'50"W for a distance of 2567.10 feet; thence S00°02'10"E for a distance of 1908.21 feet to the northerly right-of-way line of Interstate 70 and the point of beginning; thence, continuing on said right-of-way line, N89°22'30"W for a distance of 1712.17 feet; thence N80°07'30"W for a distance of 304.10 feet; thence N89°35'00"W for a distance of 487.81 feet to the intersection with the southerly right-of-way line of the Union Pacific Railroad; thence, leaving said highway right-of-way line, Northeasterly, on and along the southerly right-of-way line of said railroad to the northwest corner of the lands belonging to the State of Colorado; thence, leaving said southerly right-of-way, S00°43'47"E for a distance of 2424.60 feet to the southwest corner of said State lands and the northerly right-of-way line of said Interstate 70; thence, on said northerly right-of-way line, N89°35'00"W for a distance of 1350.82 feet; thence N83°52'30"W for a distance 201.00 feet; thence N89°22'30"W for a distance of 1087.83 feet to the point of beginning. to the point of beginning.

Containing 196.70 acres, more or less.

This description was derived from a survey done by Rolland Engineering, dated 4/14/1999, which can be found in the Deposit of Survey Records of Garfield County, Colorado, and was prepared by Richard Mason for Rolland Engineering, 405 Ridges Blvd., Grand Junction, CO.

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Part A4—UMTRA Overlay Zone District Ordinance No. 9

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CITY OF RIFLE, COLORADO
ORDINANCE NO. 9
SERIES OF 2008

AN ORDINANCE OF THE CITY OF RIFLE, COLORADO, CREATING THE UMTRA OVERLAY ZONE DISTRICT AND INCLUDING WITHIN THE DISTRICT THE CITY'S EAST AND WEST UMTRA SITES.

WHEREAS, the City of Rifle is the owner of an approximately 21.76 acre parcel of land known as the East UMTRA Site and an approximately 142 acre parcel of land known as the West UMTRA Site, both of which parcels were acquired from the Colorado Department of Public Health and Environment ("CDPHE) following successful remediation of the sites in partnership with the U.S. Department of Energy under the Uranium Mill Tailings Radiation Control Act ("UMTRA"); and

WHEREAS, pursuant to Rifle Municipal Code ("RMC") Section 16-6-140, the Planning Commission initiated an application to create an UMTRA Overlay Zone District for the purpose of establishing procedures and restrictions governing development of East and West UMTRA Sites, which are both zoned Public Zone District; and

WHEREAS, on April 29, 2008, the City of Rifle Planning Commission considered the zoning overlay application and found that creation of the UMTRA Overlay Zone District was appropriate given development constraints on the UMTRA parcels created by the presence of residual contaminants from former uranium mining operations and deed restrictions placed on the parcels by CDPHE's conveyance of the sites to the City; and

WHEREAS, the Planning Commission recommended adoption of regulations governing the UMTRA Overlay Zone District by the creation of a new Section 16-3-540 of the Rifle Municipal Code ("RMC") and further recommended the City's East and West UMTRA Sites be included within the new overlay zone district; and

WHEREAS, the City Council reviewed the zoning application at its May 21, 2008 and June 4, 2008 meetings and concurred with the Planning Commission's findings; and

WHEREAS, the City of Rifle Planning Commission and the Rifle City Council have held duly-noticed public hearings as required by the Rifle Municipal Code, and now wish to create the UMTRA Overlay Zone District as a new overlay zone district within the City and to include the East and West UMTRA Sites within said UMTRA Overlay Zone District.

NOW, THEREFORE, THE COUNCIL OF THE CITY OF RIFLE, COLORADO, ORDAINS THAT:

Section 1. The aforementioned recitals are hereby fully incorporated herein.

Section 2. A new Section 16-3-540 of the Rifle Municipal Code, entitled "UMTRA Overlay Zone District," is hereby adopted to read as follows.

Section 16-3-540. UMTRA Overlay Zone District.

(a) Description. The intent of the UMTRA overlay zoning district is to set forth the procedures and restrictions governing development on the City-owned East and West UMTRA sites. Due to the presence of residual contaminants on the two UMTRA sites, the City must obtain prior written consent before conducting any operations on either site that will disturb the soil, wetlands or groundwater. Special handling of both soil and groundwater will be required, and the City shall adopt a Materials Handling Plan that details how human health and the environment will be protected during any activities on the sites.

(b) Uses. The uses permitted on sites within the UMTRA Overlay Zone District will be that of the underlying zone district.

(c) Restrictions on use of UMTRA sites. The City must comply with the following applicable provisions of UMTRCA, 42 U.S.C. Sec. 7901, et seq., as amended:

(1) Ground water from the site shall not be used for any purpose, nor shall anyone construct wells or any means of exposing ground water to the surface unless prior written approval for such use is given by the Colorado Department of Public Health and Environment ("CDPHE) and the U.S. Department of Energy ("DOE).

(2) The land shall not be sold or transferred to anyone other than a governmental entity within the state.

(3) Any sale or transfer of the property described in this deed shall have prior written approval from the CDPHE and the DOE; and that any deed or other document created for such sale or transfer and *any* subsequent sale or transfer will include information stating that the property was once used as a uranium milling site and all other information regarding the extent of residual radioactive materials removed from the property as required by Section 104(d) of the Uranium Mill Tailings Radiation Control Act, 42 U.S.C. Sec. 7014(d), and as set forth in the Annotation attached hereto.

(4) Construction and/or excavation or soil removal of any kind shall not occur on the property without permission from the CDPHE and DOE unless prior written approval of construction plans (e.g., facilities type and location), is given by the CDPHE and DOE.

(5) Any habitable structures constructed on the property shall employ a radon ventilation system or other radon mitigation measures.

(6) Use of the UMTRA sites shall not adversely impact groundwater quality, nor interfere in any way, with groundwater remediation under UMTRCA Sec. 104(e)(1)(c), 42 U.S.C. Sec. 7914 (e)(1)(C).

(d) Procedure. The following are the City's Standard Operating Procedures for conducting activities within the UMTRA Overlay Zone District:

(1) The City of Rifle shall install and maintain a sign at the entrance of both UMTRA sites stating "Any excavation of material or exposure of groundwater on this Property must be approved by the City of Rifle, Colorado Department of Public Health and Environment and U.S. Department of Energy."

(2) When a use is proposed for an UMTRA site, City staff will review the project with the Planning Director. The Planning Director will review the GIS maps and identify the special procedures that must be followed. Staff shall also hold preliminary discussions with DOE and CDPHE to identify any preliminary issues about the use of the property for the proposed project and further define the project for City Council approval of contracts for design and plan preparation.

(3) Staff shall hire consulting engineers or work with the developer's engineers to refine design development project and to identify and obtain other permits or approvals necessary for the project (e.g. USACE permitting, storm water permits, site plan application, etc.).

(4) Staff shall develop a letter of request including a project description (detailing building footprints, location, depth of bury, radon mitigation system design), applicable maps and drawings, and for approval of defined project by CDPHE and DOE. The City Attorney shall review the letter to ensure compliance with deed restrictions and environmental covenants prior to submission to DOE and CDPHE.

(5) Upon written approval by both DOE and CDPHE and approval of the Site Plan by the Planning Department, the City Council shall authorize issuance of a Notice to Proceed with construction and the execution of construction contract. The project will then be eligible for issuance of a building permit.

(6) Appropriate training shall be provided to ensure that all project personnel are aware of the contaminants on site, restrictive covenants, and the requirements of the

Materials Handling Plan. The City shall periodically inspect the site to confirm compliance with all Code requirements.

(7) Upon completion of the project, the developer shall submit a Completion Report to CDPHE containing a construction summary and identifying any deviations from the original proposal. The Completion Report shall also document compliance with the Materials Handling Plan and detail the final disposal and disposition of any uranium mill tailings encountered on the site.

(8) The City Manager shall annually inform all City department heads of these Standard Operating Procedures, deed restrictions, and environmental covenants affecting the UMTRA sites.

Section 3. The City's East and West UMTRA Sites are hereby included within the UMTRA Overlay Zone District established at Section 16-3-540 of the Rifle Municipal Code. The underlying Public Zone District ("PZ") designation for the parcels shall remain in full force and effect.

Section 4. Within thirty (30) days after the effective date of this Ordinance, the City Clerk shall incorporate the terms of this Ordinance into the Geographical Information System described in RMC §16-3-20 shall cause a printed copy of the amendment to the City Zone District Map to be made, which shall be dated and signed by the Mayor and attested to by the City Clerk, and which shall bear the seal of the City. The amended map shall include the number of this Ordinance. The signed original printed copy of the Zoning Map shall be filed with the City Clerk. The Clerk shall also record a certified copy of this Ordinance with the Garfield County Clerk and Recorder. The City staff is further directed to comply with all provisions of the Rifle Land Use Regulations, RMC §16-1-10 *et seq.*, to implement the provisions of this Ordinance.

INTRODUCED on May 21, 2008, read by title, passed on first reading, and ordered published as required by the Charter.

INTRODUCED a second time at a regular meeting of the Council of the City of Rifle, Colorado, held on June 4,2008, passed without amendment, approved, and ordered published in full as required by the Charter.

DATED this 9 day of June, 2008.

CITY OF RIFLE, COLORADO

By Keith J. Lambert
Mayor

ATTEST:

Wanda Nelson
City Clerk

SEAL
CITY OF RIFLE
GARFIELD COUNTY, COLORADO

RECEPTION #: 2547533, BK 5062 PG 949 09/29/2010 at 10:16:48 AM, 1 OF 7, R $40.00 S $1.00
Janice Rich, Mesa County, CO CLERK AND RECORDER

This property is subject to an Environmental Covenant held by the Colorado Department of Public Health and Environment pursuant to Section 25-15-321, C.R.S.

ENVIRONMENTAL COVENANT

Umetco Minerals Corporation, a Delaware corporation with an office address at 2745 Compass Drive, Suite 280, Grand Junction, Colorado 81506 (the "Grantor") hereby grants an Environmental Covenant (the "Covenant") dated this 3rd day of April, 2009 to the Hazardous Materials and Waste Management Division of the Colorado Department of Public Health and the Environment (the "Department") pursuant to § 25-15-321 of the Colorado Hazardous Waste Act, § 25-15-101, *et seq.* The Department's office address is 4300 Cherry Creek Drive South, Denver, Colorado 80246-1530.

WHEREAS, as of the date hereof, Grantor is the current record owner of certain property commonly referred to as the New Rifle Site, located approximately two (2) miles southwest of the City of Rifle, State of Colorado, more particularly described by metes and bounds in Attachment A, attached hereto and incorporated herein by reference as though fully set forth (hereinafter referred to as "the Property"); and

WHEREAS, pursuant to that certain U.S. Department of Energy Site Observational Work Plan for the UMTRA Project New Rifle Site, (the "Work Plan"), the Property is the subject of remedial action pursuant to the Uranium Mill Tailings Radiation Control Act, P.L. 95-604 ("UMTRCA") and UMTRCA regulations, 40 C.F.R.§ 192 Subpart B, and;

WHEREAS, the purpose of this Covenant is to enhance protection of human health and the environment by minimizing opportunity for potential exposure to residual radioactive materials through restrictions on penetration of the ground surface, and to minimize opportunity for potential exposure to contaminated groundwater, and

WHEREAS, Grantor and the Department mutually desire to subject the Property to those certain covenants and restrictions set forth herein below as provided in Article 15 of Title 25, Colorado Revised Statutes, which said covenants and restrictions shall burden the Property and bind Grantor in its capacity as current record owner, all subsequent owners, and all parties having any right, title or interest in the Property, or any part thereof, their heirs, successors and assigns, and any persons using the land, as described herein, for the benefit of Grantor, subsequent record owners of the Property, the Department, and the U.S. Department of Energy.

NOW, THEREFORE, Grantor hereby grants this Environmental Covenant to the Department, with the U.S. Department of Energy as a third party beneficiary, and declares that the Property as described in Attachment A shall hereinafter be bound by, held, sold, and conveyed subject to the following requirements set forth in the paragraphs below, which shall run with the Property in perpetuity and be binding on Grantor in its capacity as current record owner, all subsequent owners, and all parties having any right, title or interest in the Property, or any part thereof, their heirs, successors and assigns, and any persons using the land, as described herein. As used in this Environmental Covenant, the term OWNER means the then current record owner of the Property and, if any, any other person or entity otherwise legally authorized to make decisions regarding the transfer of the Property or placement of encumbrances on the Property, other than by the exercise of eminent domain.

1) Use restrictions.

A. No wells or drilling or pumping whatsoever shall be permitted or allowed on the Property that would impact the alluvial aquifer underlying the Property without modification of this Covenant pursuant to paragraph 2 herein below. The only exception to the foregoing is for monitoring and remedial wells installed by Grantor,0 OWNER, the Department, or the Department of Energy, in connection with the on-going, approved remedial activities at the Property pursuant to the Work Plan, as the same may be amended from time to time.

B. No stock watering or grazing utilizing the alluvial aquifer or the Wasatch formation, including use of the former Roaring Fork Gravel Pit, shall be allowed. Appropriate measures such as fencing shall be used as necessary to restrict grazing and access of cattle or other stock to the former Roaring Fork Gravel Pit.

C. No activities that will interfere with any existing or future monitoring or remedial wells installed by Grantor, OWNER, the Department, or the Department of Energy, in connection with the on-going, approved remedial activities at the Property pursuant to the Work Plan, as the same may be amended from time to time, or interfere with the maintenance, operation, or monitoring of said wells is permitted or allowed, without modification of this Covenant pursuant to paragraph 2 herein below.

D. OWNER shall grant access to the Department and the U.S. Department of Energy to perform any and all activities pursuant to the Work Plan, as the same may be amended from time to time, required to monitor or implement the remedy for the Property pursuant to the Work Plan, as the same may be amended from time to time.

2) Modifications.

A. This Covenant, and the restrictions and requirements contained herein, runs with the land and is perpetual, unless modified or terminated pursuant to this paragraph in accordance with then current statutory requirements. OWNER may request that the Department approve a modification or termination of the Covenant in accordance with then current statutory requirements. As of the date hereof, the current statutory requirements for modification or termination of this Covenant are set forth in § 25-15-319, C.R.S. No modification or termination of this Covenant shall be effective unless the Department has approved such modification or termination in writing in accordance with statutory requirements.

B. Upon receipt of any request of any OWNER to modify or terminate this Covenant, the Department shall give notice thereof to Grantor, or to its direct parent corporation Union Carbide Corporation, or to its indirect parent corporation The Dow Chemical Company, affording reasonable advance opportunity to comment to the Department on the advisability of granting any such request.

3) Conveyances. OWNER shall notify the Department at least fifteen (15) days in advance of the closing on any sale or other conveyance of title to any or all of the Property.

4) Notice to Lessees. OWNER agrees to incorporate either in full or by reference the restrictions of this Covenant in any leases, licenses, or other written instruments granting a right to use the Property.

5) Notification for proposed construction and land use. OWNER shall notify the Department contemporaneously when OWNER submits any application to a local government entity either (i) for a building permit on the Property and/or (ii) for a change in land use on the Property.

6) Inspections. The Department shall have the right of entry to the Property at reasonable times with prior notice for the purpose of determining compliance with the terms of this Covenant. Nothing in this Covenant shall impair any other authority the Department may otherwise have to enter and inspect the Property.

7) No Liability. The Department does not acquire any liability under State law by virtue of accepting this Covenant, nor does any other named beneficiary of this Covenant acquire any liability under State law by virtue of being such a beneficiary.

8) Enforcement. The Department may enforce the terms of this Covenant pursuant to §25-15-322. C.R.S. Grantor and the U.S. Department of Energy may file suit in district court to enjoin actual or threatened violations of this Covenant.

9) Non- Compliance Report. In the event that OWNER becomes aware to its actual knowledge of an incident on the Property that is not in compliance with the requirements of this Covenant, OWNER shall execute and file an Incident Report thereof with the Department. Not more than once annually, the Department may request OWNER to certify to its actual knowledge as to whether any such incident of non-compliance has occurred on the Property..

10) Recordation. Contemporaneously with the full mutual execution hereof, the Department shall file this Covenant on the public land records of the County in which the Property is located.

11) Notices. Any notices, documents, or communications required to be given under this Covenant shall be effective one (1) day after being placed in the hands of a reputable national overnight delivery service, and (3) days after being placed in the hands of the US Postal Service, certified mail, return receipt requested, and, in each case, addressed respectively as follows:

If to the Department:

Hazardous Materials and Waste Management Division
Attention: UMTRA Project Manager
Colorado Department of Public Health and the Environment
4300 Cherry Creek Drive South
Denver, Colorado 80246-1530

If to the US Department of Energy:

U.S. Department of Energy
Attention: Remedial Programs Director
Grand Junction Office
2597 B3/4 Road
Grand Junction, CO 81503

If to the Grantor:

Umetco Minerals Corporation
Attention: Remediation Leader
2745 Compass Drive
Grand Junction, Colorado 81506

Cc: Stephen J. Murray, Esq.
Of Counsel, Mahoney & Keane, LLP
14 Pilgrim Lane
Weston, CT 06883

If to Union Carbide Corporation and/or The Dow Chemical Company

Union Carbide Corporation
c/o The Dow Chemical Company
Attn: Global Real Estate Director
2030 Dow Center
Midland, MI 48674

Cc: Umetco Minerals Corporation
Attention: Remediation Leader
2745 Compass Drive
Grand Junction, Colorado 81506

Cc: Stephen J. Murray, Esq.
Of Counsel, Mahoney & Keane, LLP
14 Pilgrim Lane
Weston, CT 06883

IN WITNESS WHEREOF, Grantor has caused this instrument to be executed this 3rd day of April, 2009.

Umetco Minerals Corporation

By: [signature]
Name: Gregory G. Cochran
Title: President

STATE OF Michigan)
) ss:
COUNTY OF Midland)

The foregoing instrument was acknowledged before me this 3rd day of April, 2009 by Gregory G. Cochran on behalf of Umetco Minerals Corporation.

Connie Bailey
Notary Public

Address

My commission expires: March 19, 2012

Accepted by the **Colorado Department of Public Health and Environment** this 24th day of August, ~~2009.~~ 2010

Department of Public Health and Environment, State of Colorado

By: [signature]
Name: Gary W. Baughman
Title: Director, HMWMD

STATE OF Colorado)
) ss:
COUNTY OF Arapahoe)

The foregoing ~~instrument~~ was acknowledged before me this 24th day of August, ~~2009.~~ 2010 by ~~[illegible]~~ Gary W. Baughman on behalf of the Colorado Department of Public Health and Environment.

[signature]
Notary Public
4300 Cherry Creek Dr South
Address
Denver Co 80246

My commission expires: 2-29-2012

ATTACHMENT A

METES AND BOUNDS DESCRIPTION

NEW RIFLE SITE

UMETCO PROPERTY IN WEST RIFLE, CO

PROPERTY DESCRIPTION

That certain tract of land in the west one-half of Section 18, Township 6 South, Range 93 West, and in the east one-half of Section 13, Township 6 South, Range 94 West of the 6th Principal Meridian, Garfield County, Colorado, the perimeter of which is described as follows:

Commencing at a Garfield County Survey Marker for the Meander Corner on the westerly line of said Section 18, whence an original stone monument for the northwest corner of said Section 18 bears N00°25'50"W for a distancc of 2567.10 feet; thence S00°02'10"E for a distance of 1908.21 feet to the northerly right-of-way line of Interstate 70 and the point of beginning; thence, continuing on said right-of-way line, N89°22'30"W for a distance of 1712.17 feet; thence N80°07'30"W for a distance of 304.10 feet; thence N89°35'00"W for a distance of 487.81 feet to the intersection with the southerly right-of-way line of the Union Pacific Railroad; thence, leaving said highway right-of-way line, Northeasterly, on and along the southerly right-of-way line of said railroad to the northwest corner of the lands belonging to the State of Colorado; thence, leaving said southerly right-of-way, S00°43'47"E for a distance of 2424.60 feet to the southwest corner of said State lands and the northerly right-of-way line of said Interstate 70; thence, on said northerly right-of-way line, N89°35'00"W for a distance of 1350.82 feet; thence N83°52'30"W for a distance 201.00 feet; thence N89°22'30"W for a distance of 1087.83 feet to the point of beginning. to the point of beginning.

Containing 196.70 acres, more or less.

This description was derived from a survey done by Rolland Engineering, dated 4/14/1999, which can be found in the Deposit of Survey Records of Garfield County, Colorado, and was prepared by Richard Mason for Rolland Engineering, 405 Ridges Blvd., Grand Junction, CO.

Appendix B

Spot Plots and Time-Concentrations Graphs for COCs at the New Rifle, Colorado, Site

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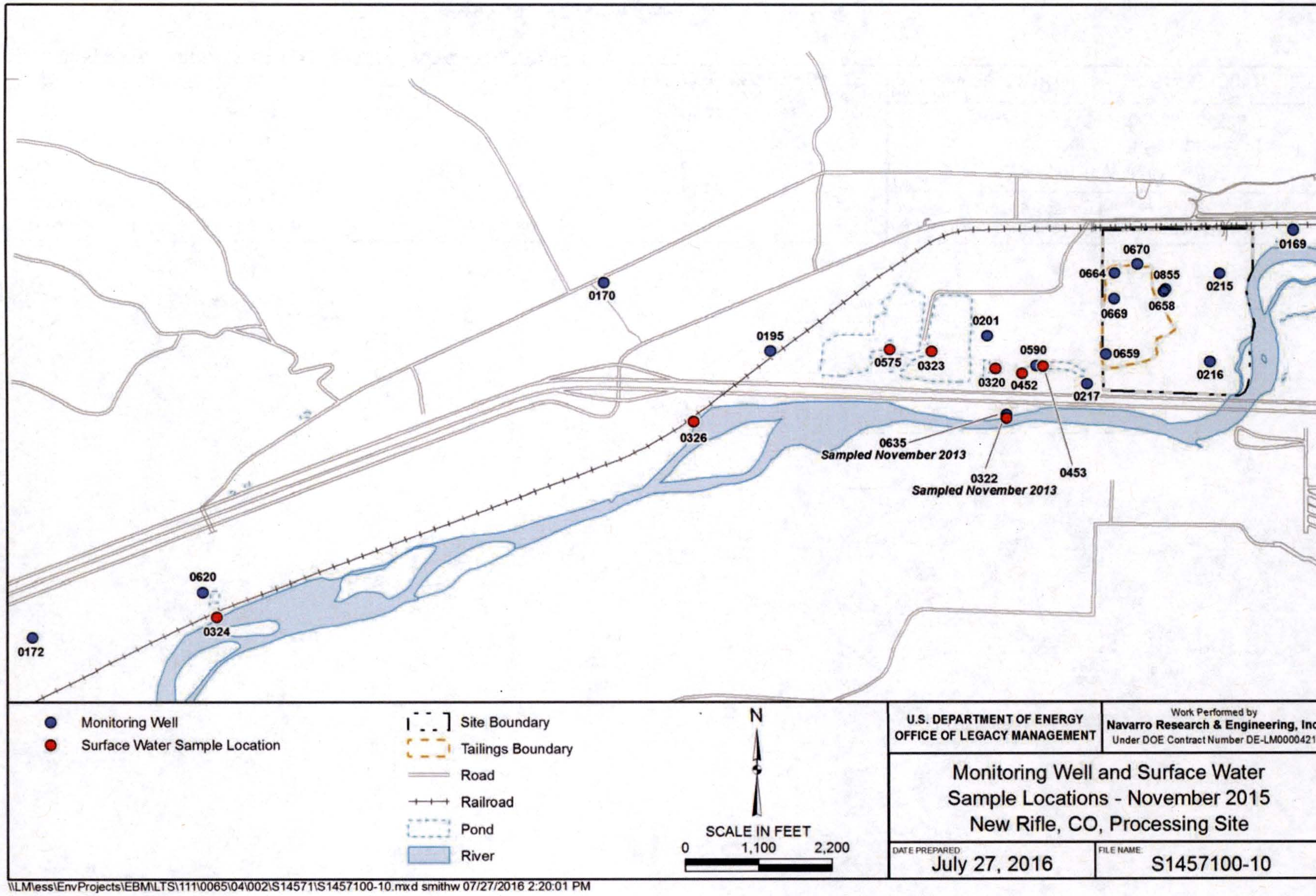


Figure B-1. Groundwater and Surface Water Monitoring Locations at New Rifle Site

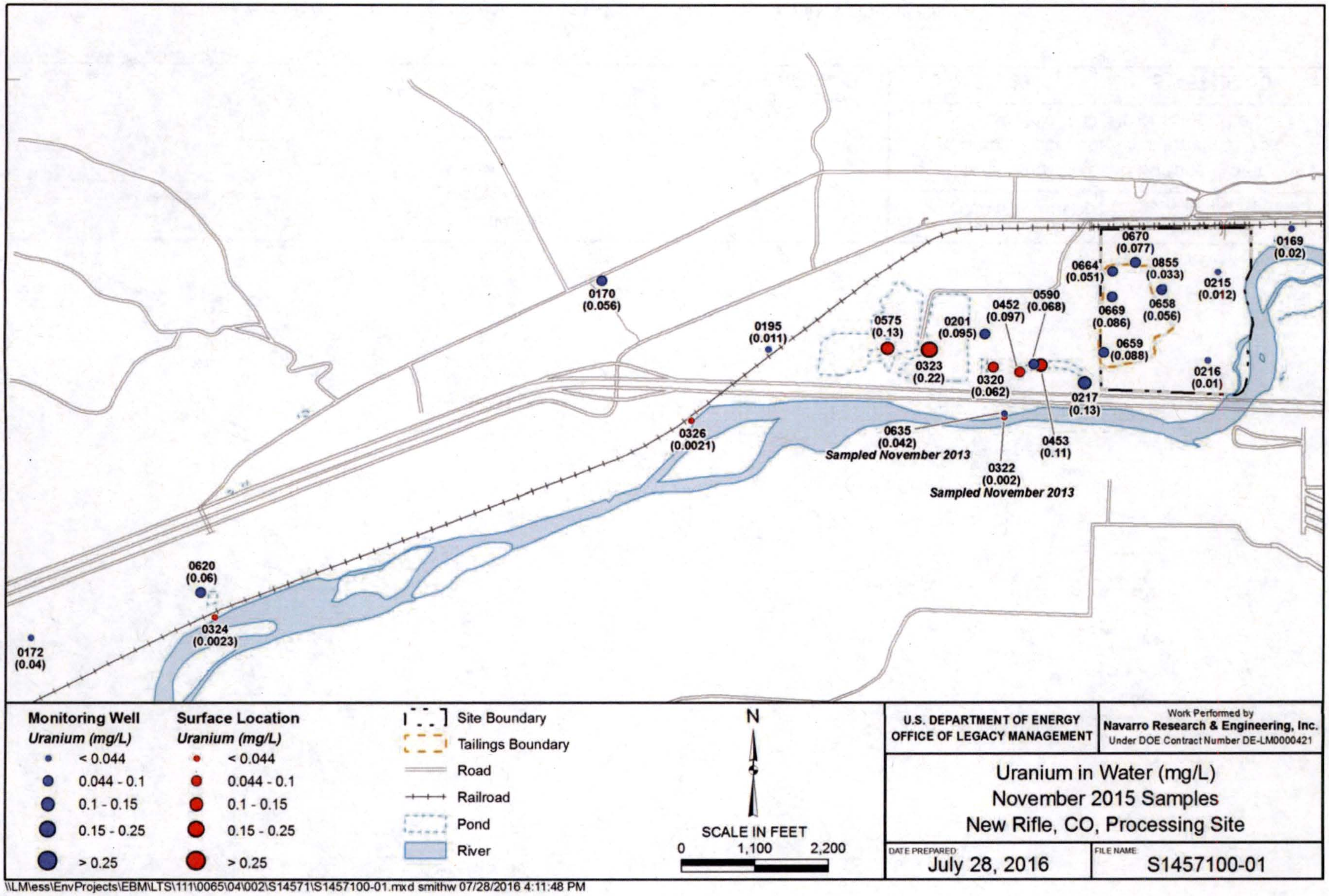


Figure B-2. Uranium Distribution at New Rifle Site

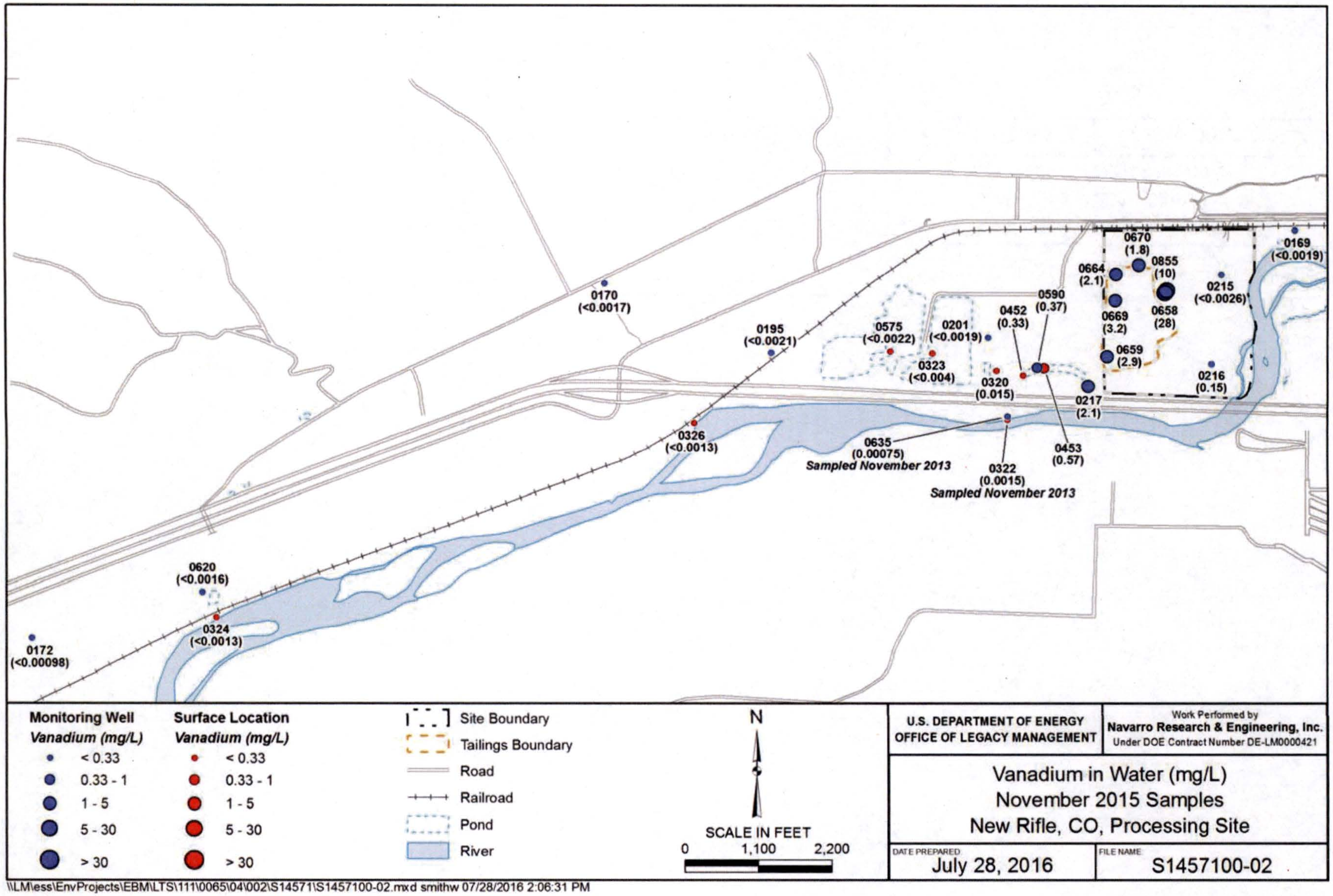


Figure B-3. Vanadium Distribution at New Rifle Site

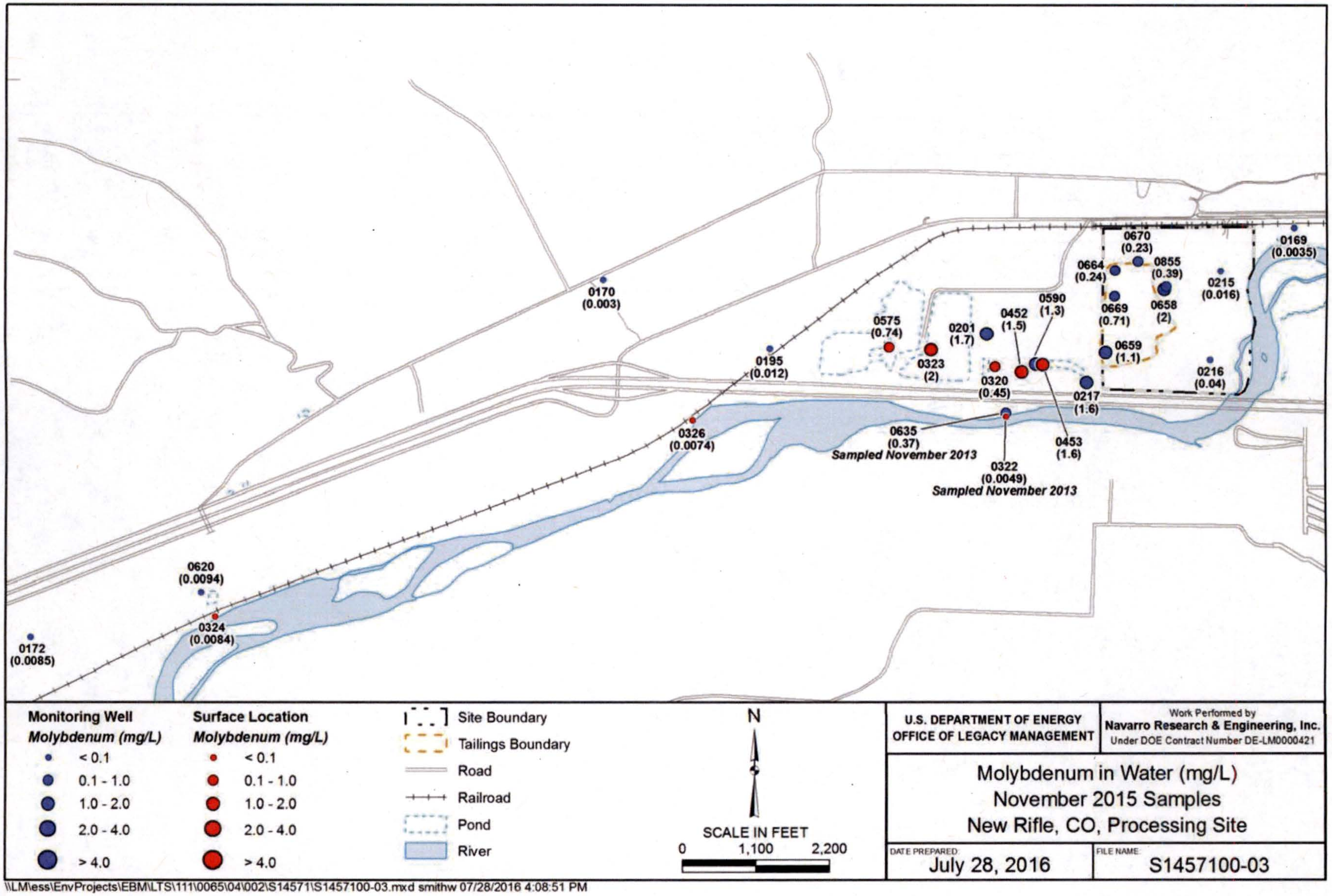


Figure B-4. Molybdenum Distribution at New Rifle Site

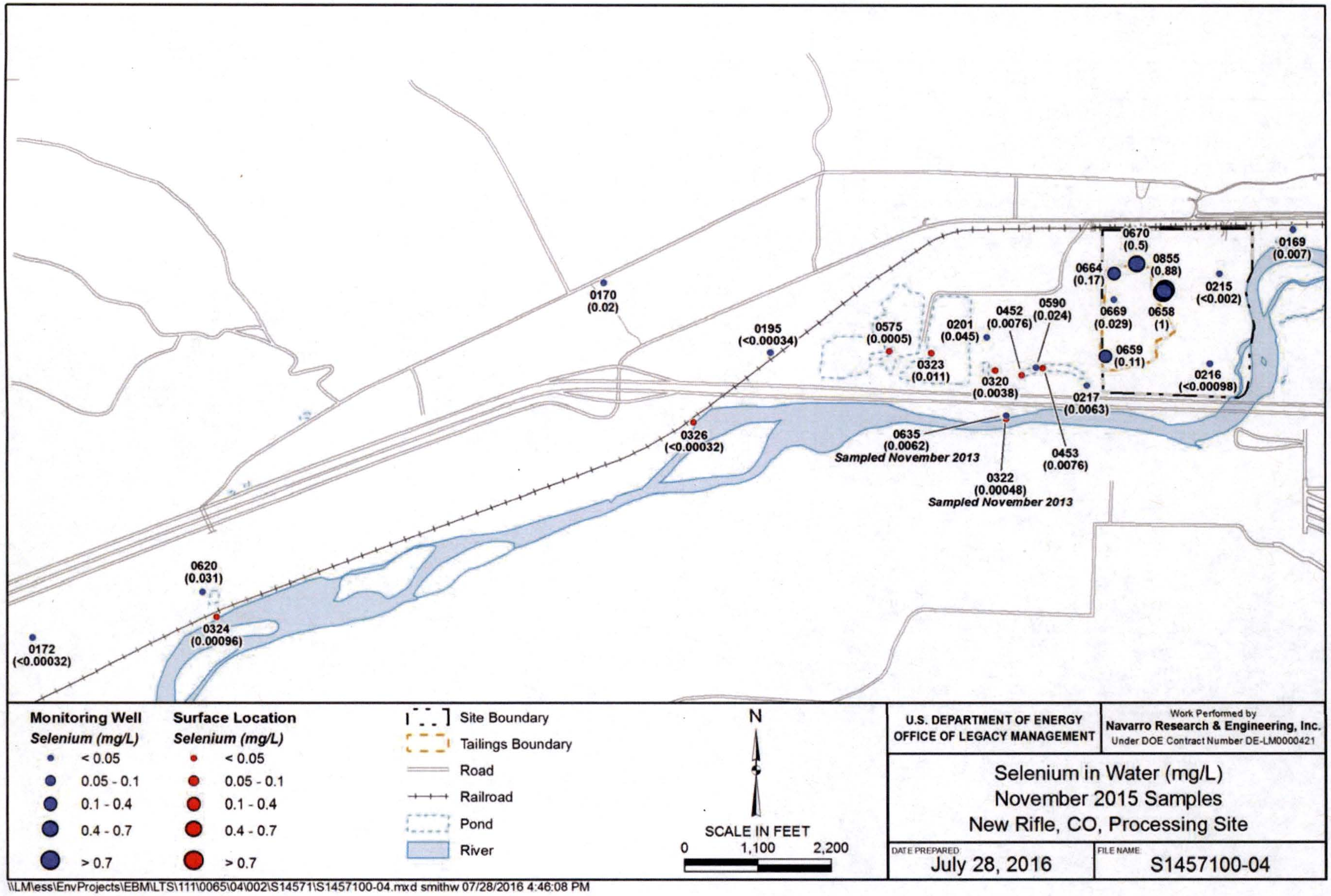


Figure B-5. Selenium Distribution at New Rifle Site

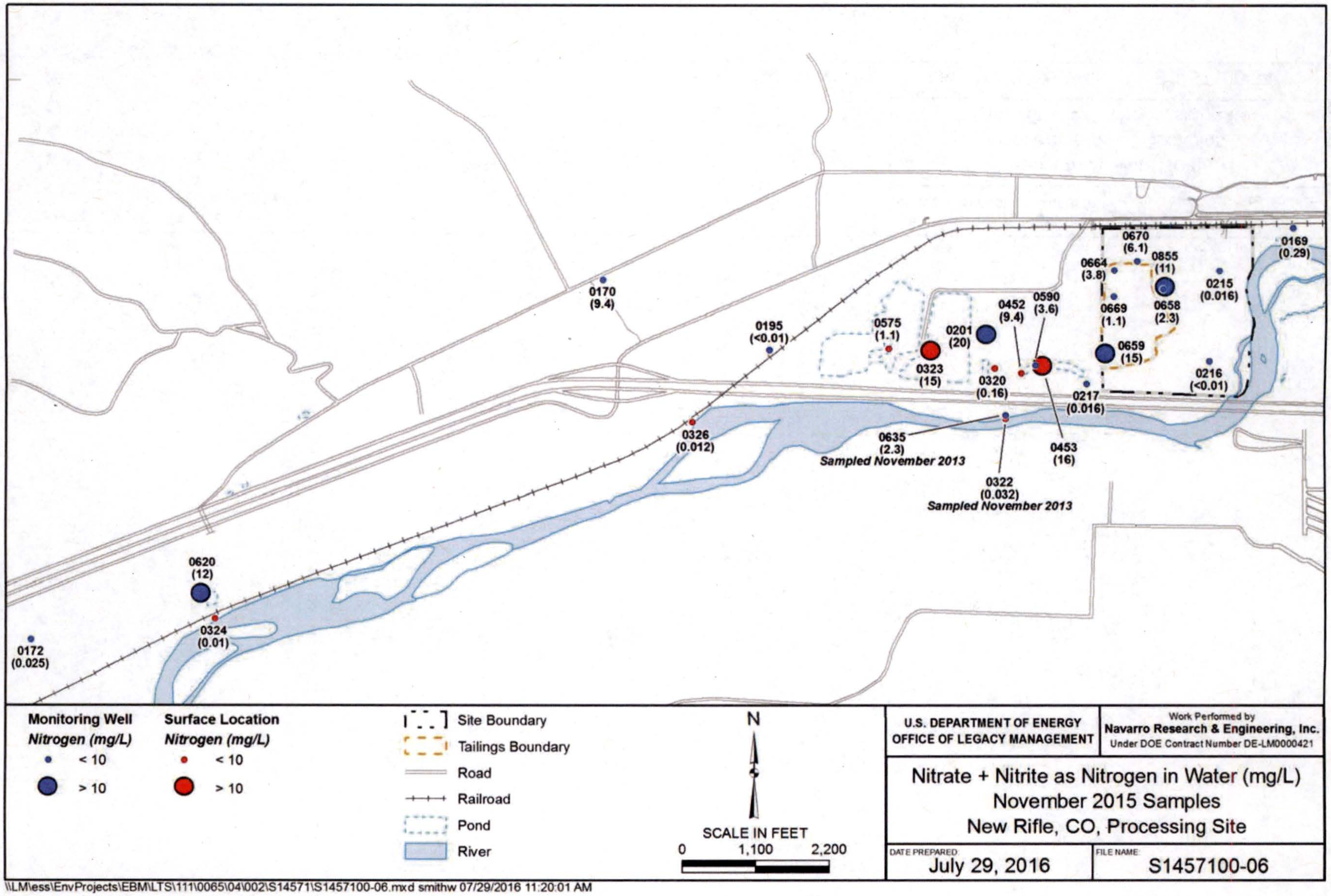


Figure B-6. Nitrate Distribution at New Rifle Site

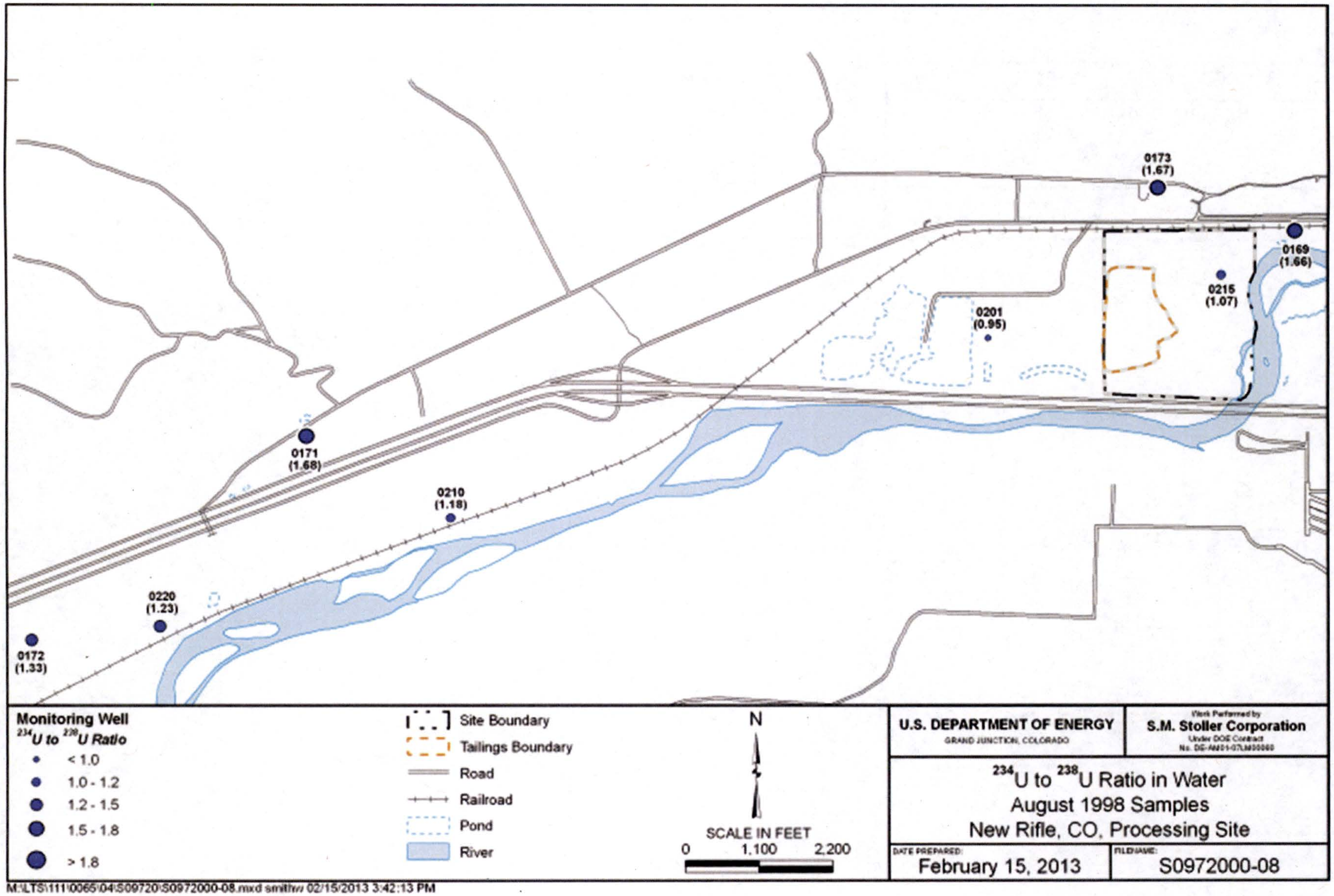


Figure B-7. August 1998 Uranium ($^{234}U/^{238}U$) Activity Ratios for New Rifle Site

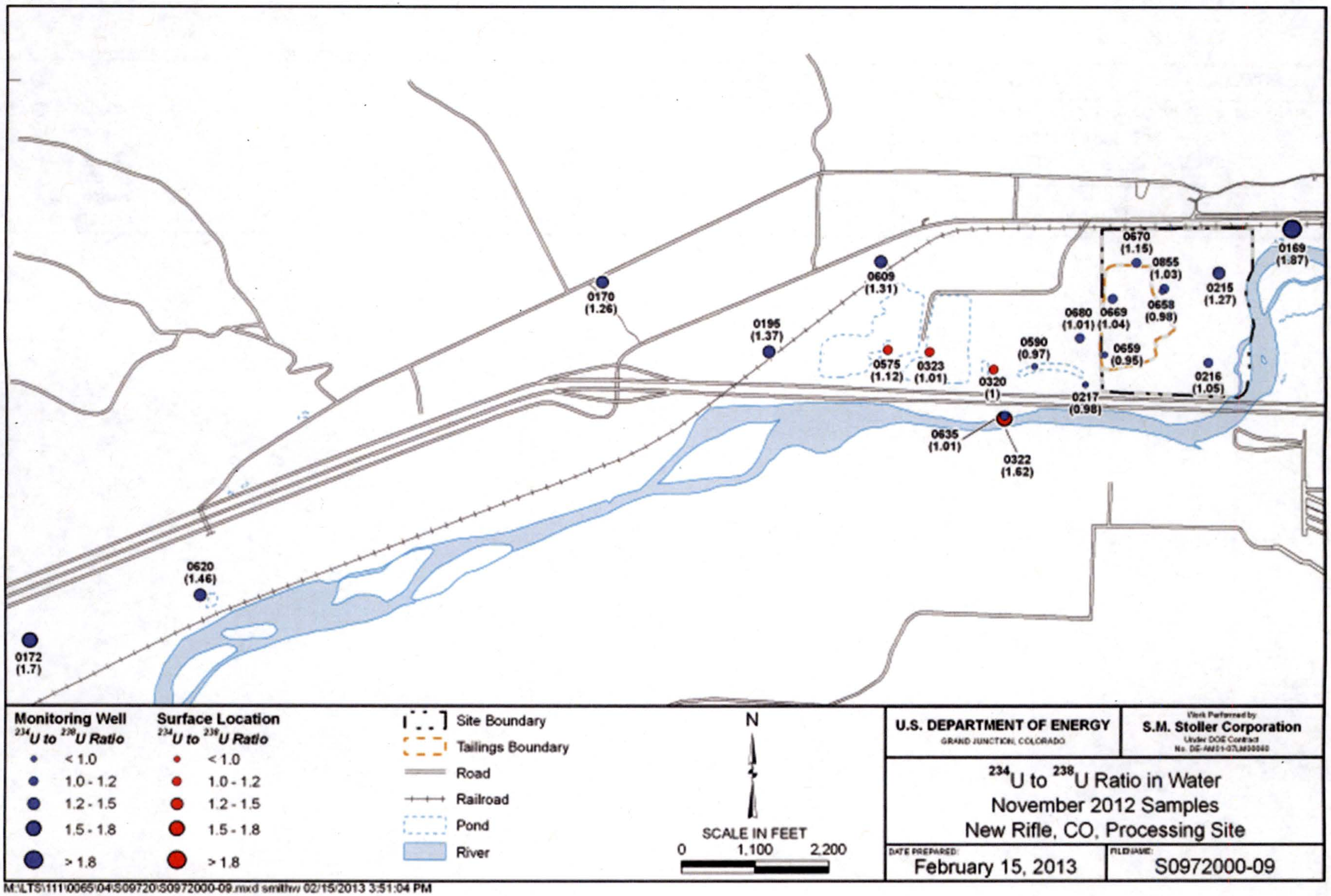


Figure B-8. November 2012 Uranium ($^{234}U/^{238}U$) Activity Ratios for New Rifle Site

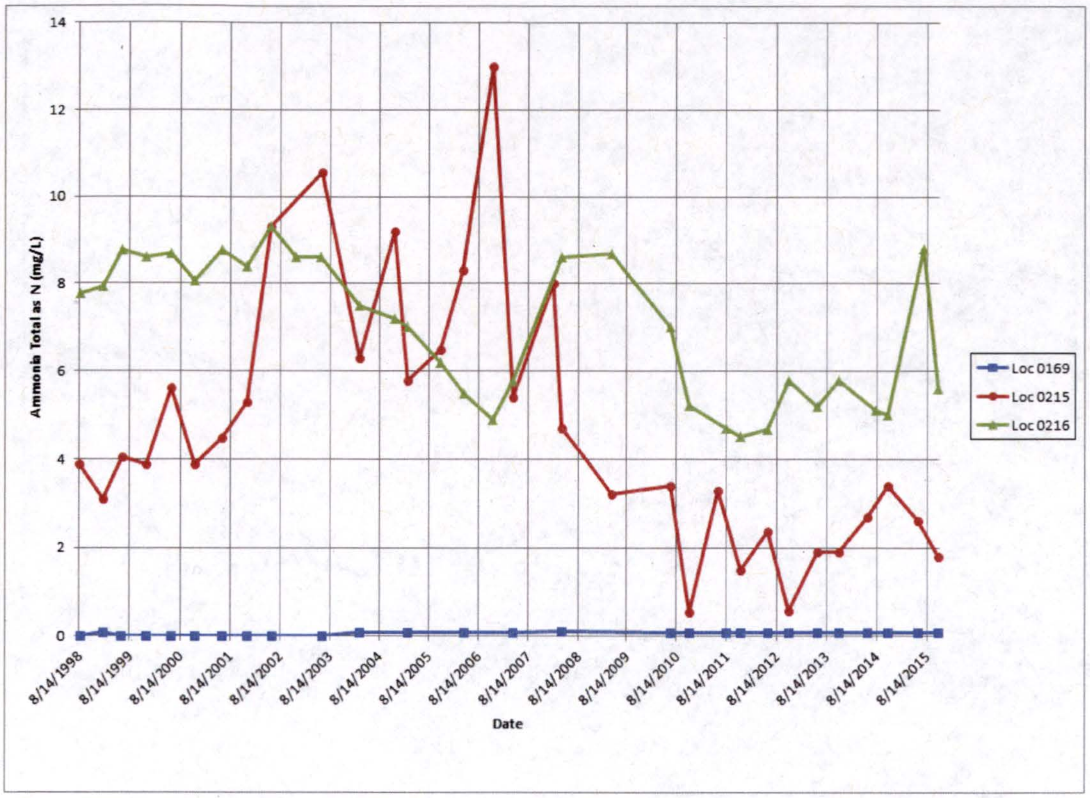


Figure B-9. Ammonia Time-Concentration Plot for Selected Wells

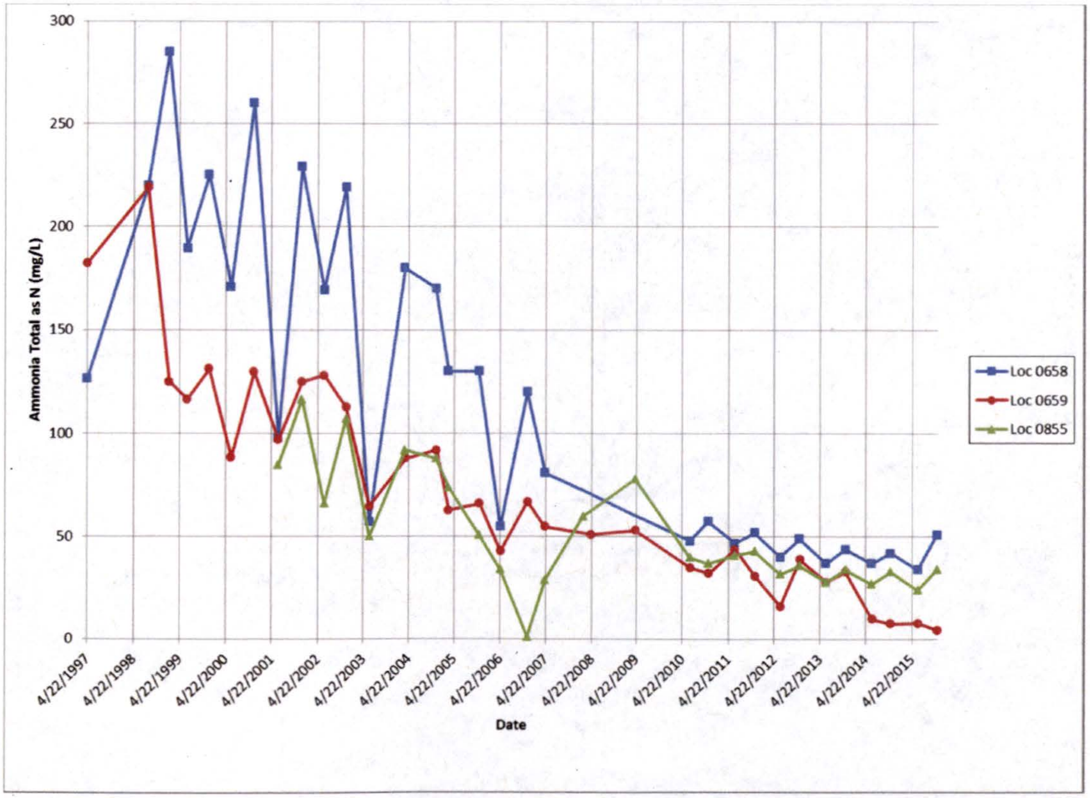


Figure B-10. Ammonia Time-Concentration Plot for Selected Wells

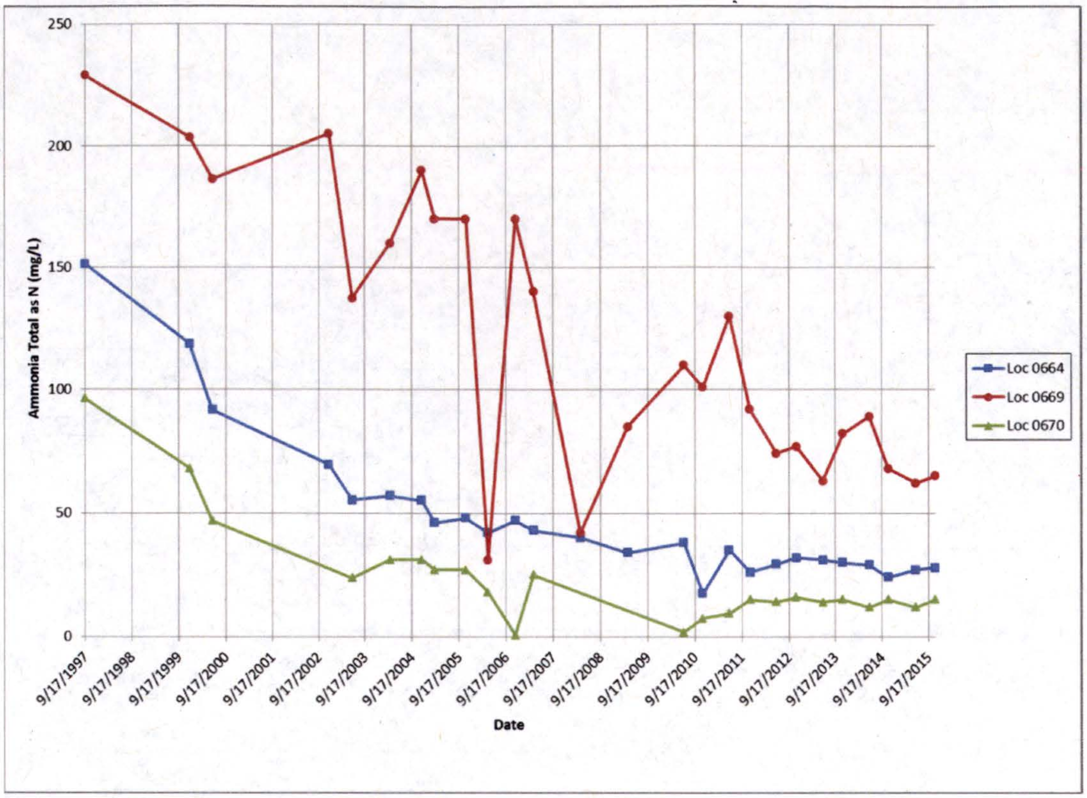


Figure B-11. Ammonia Time-Concentration Plot for Selected Wells

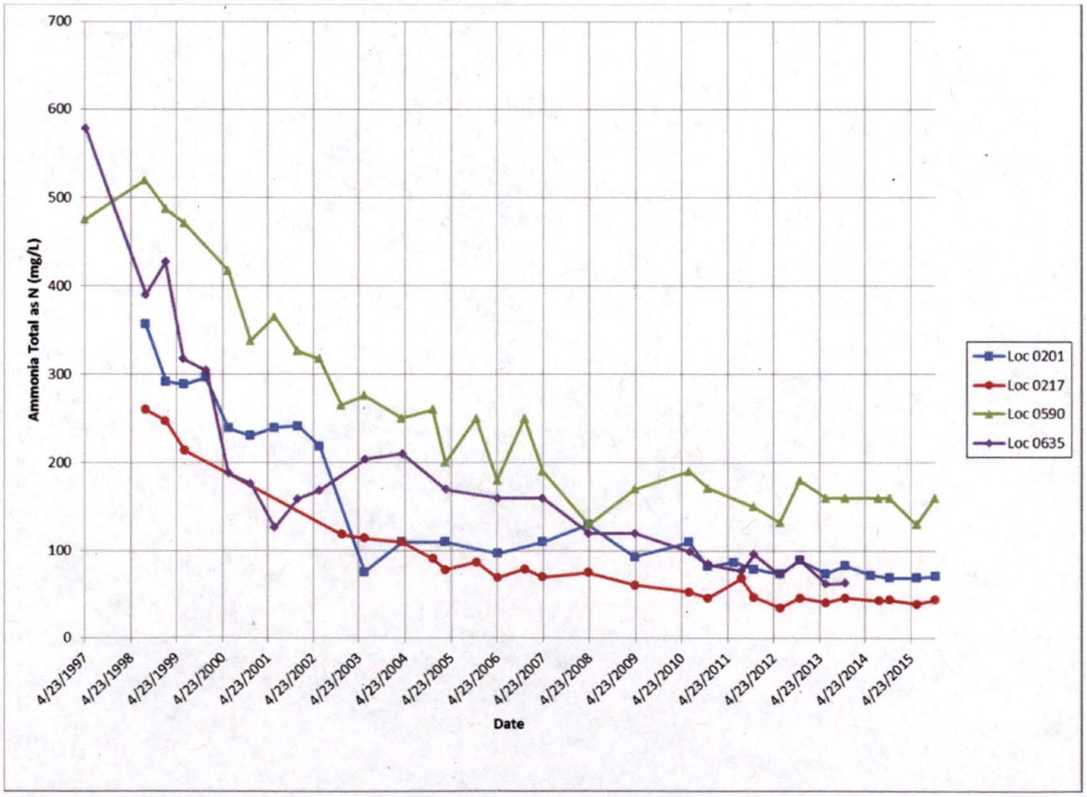


Figure B-12. Ammonia Time-Concentration Plot for Selected Wells

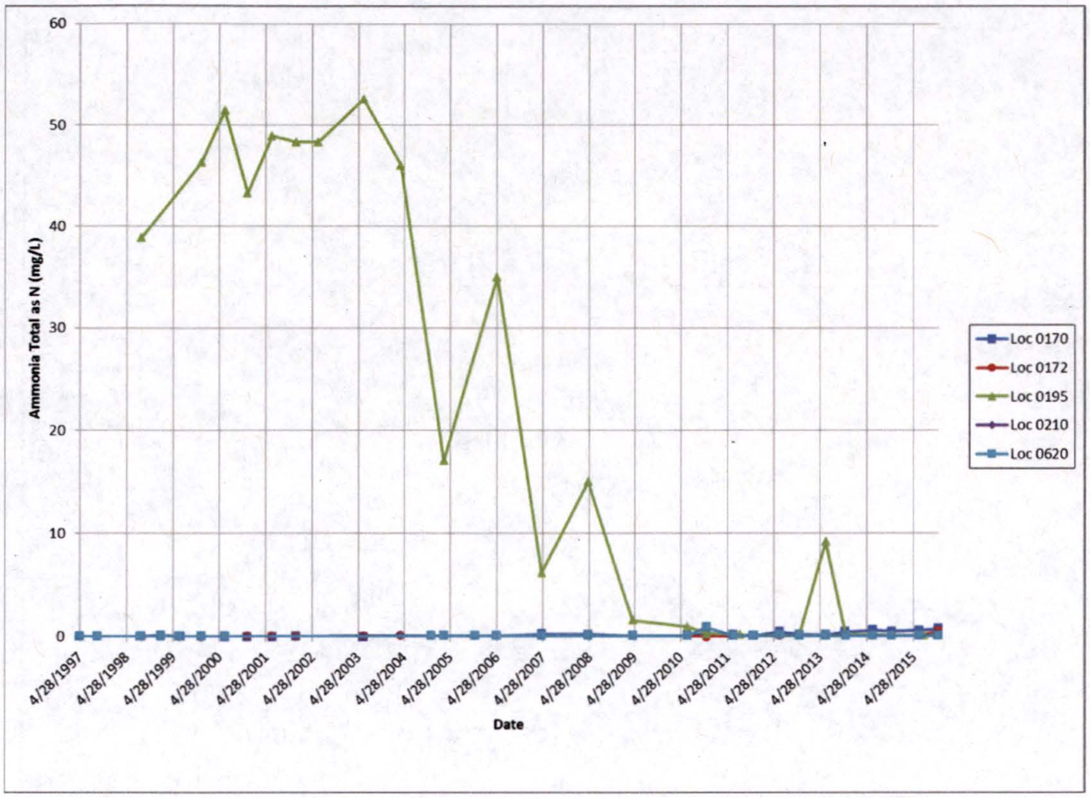


Figure B-13. Ammonia Time-Concentration Plot for Selected Wells

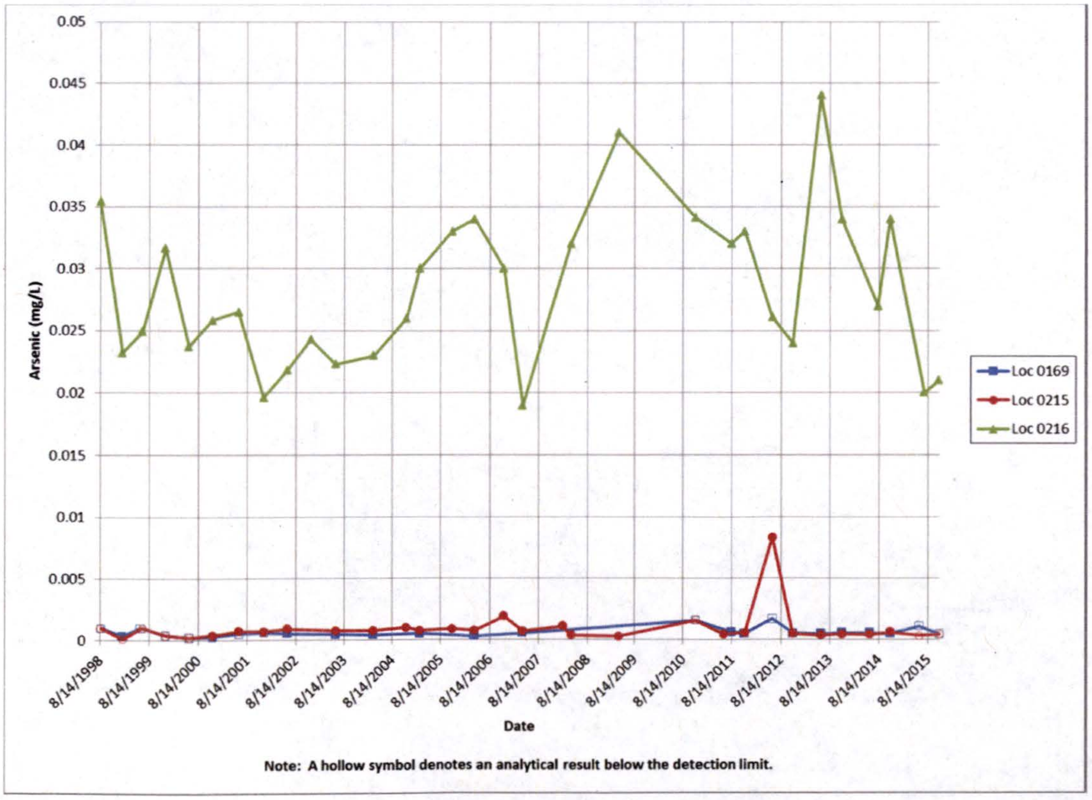


Figure B-14. Arsenic Time-Concentration Plot

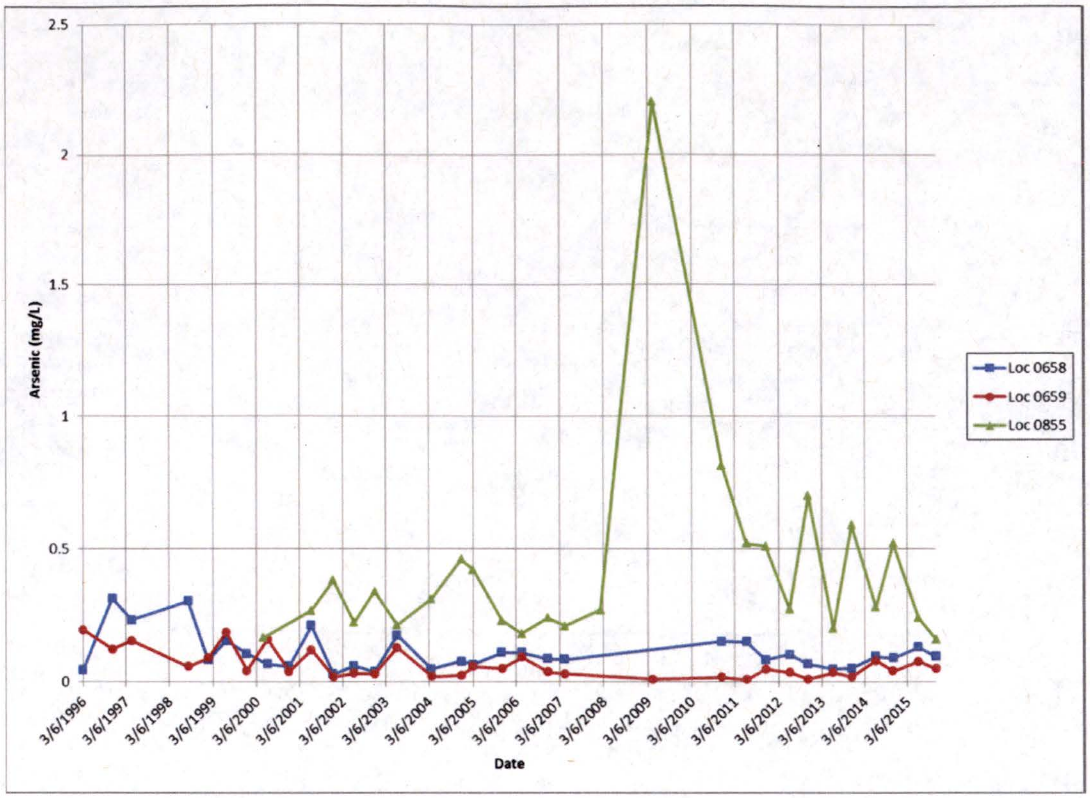


Figure B-15. Arsenic Time-Concentration Plot

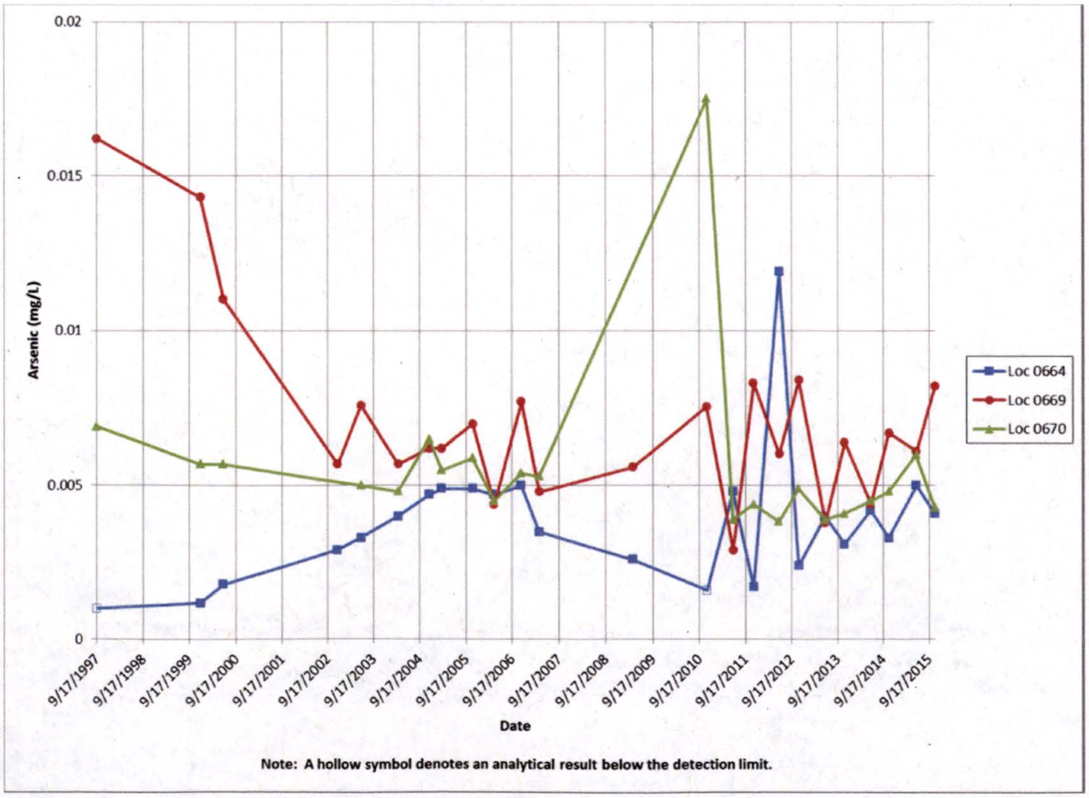


Figure B-16. Arsenic Time-Concentration Plot

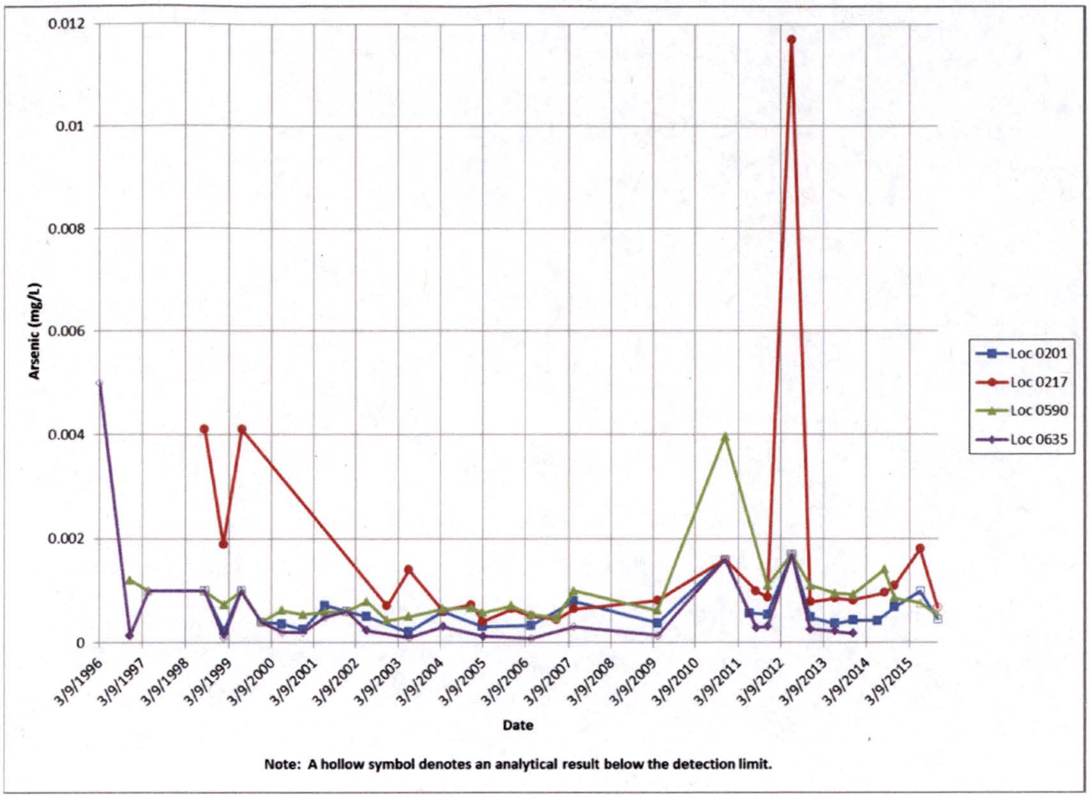


Figure B-17. Arsenic Time-Concentration Plot

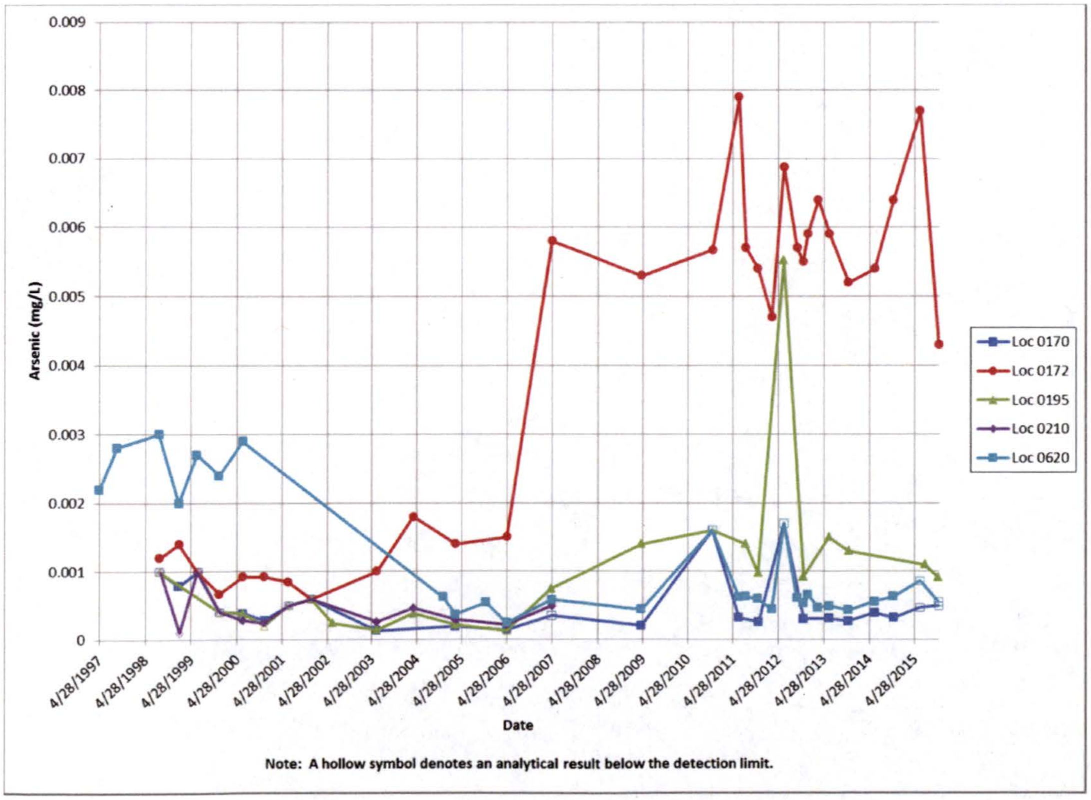


Figure B-18. Arsenic Time-Concentration Plot

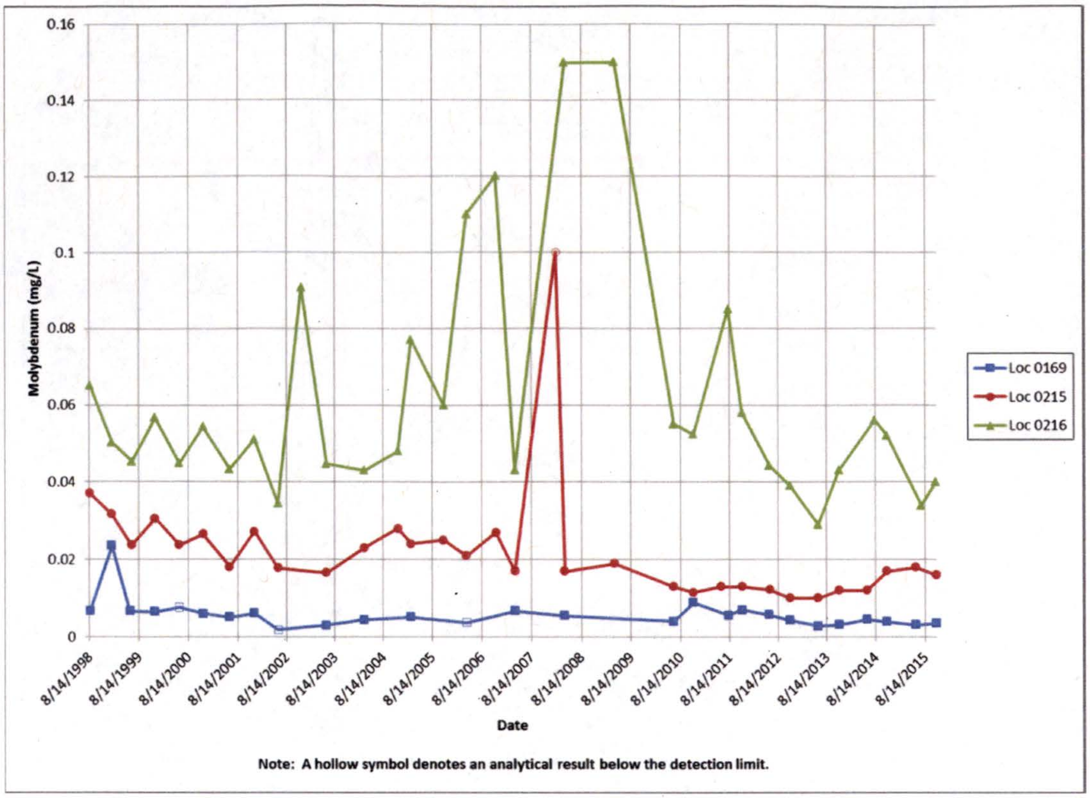


Figure B-19. Molybdenum Time-Concentration Plot

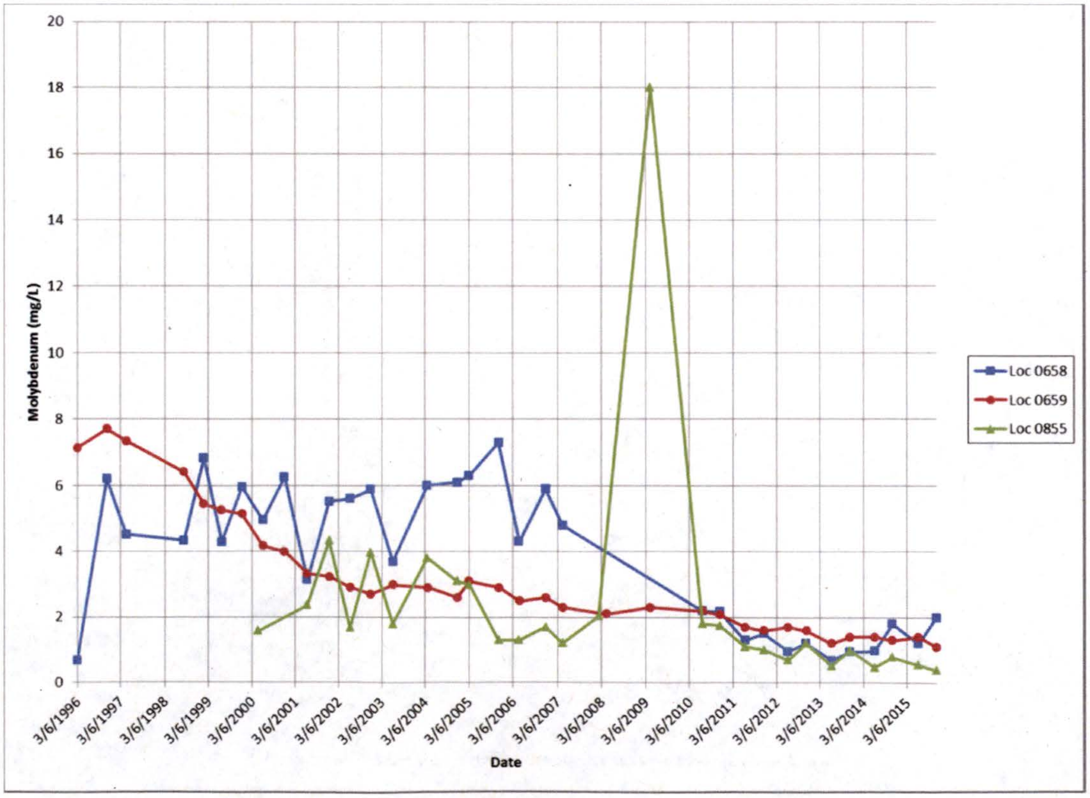


Figure B-20. Molybdenum Time-Concentration Plot

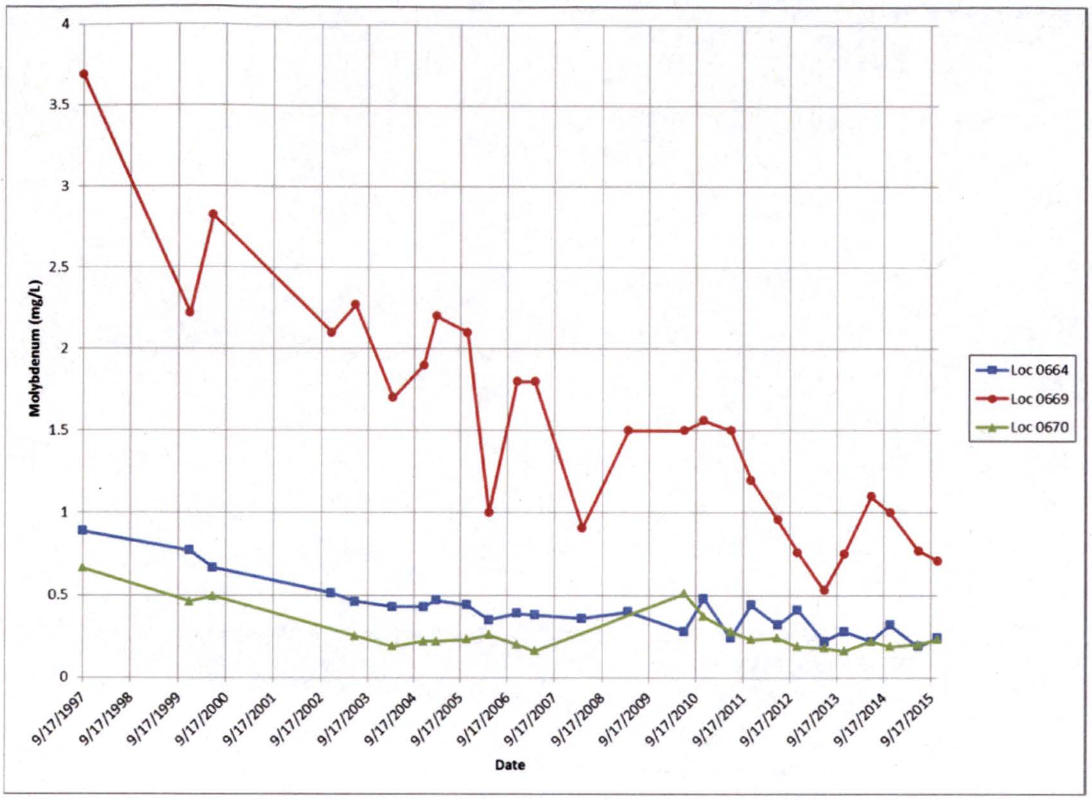


Figure B-21. Molybdenum Time-Concentration Plot

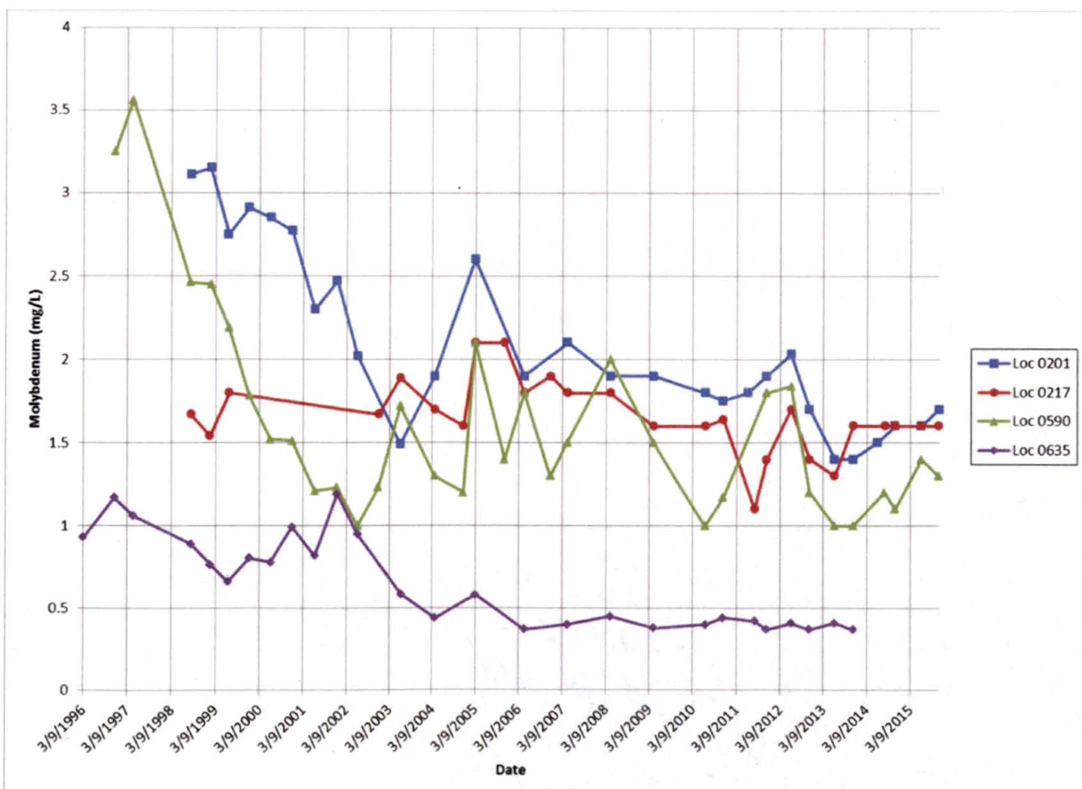


Figure B-22. Molybdenum Time-Concentration Plot

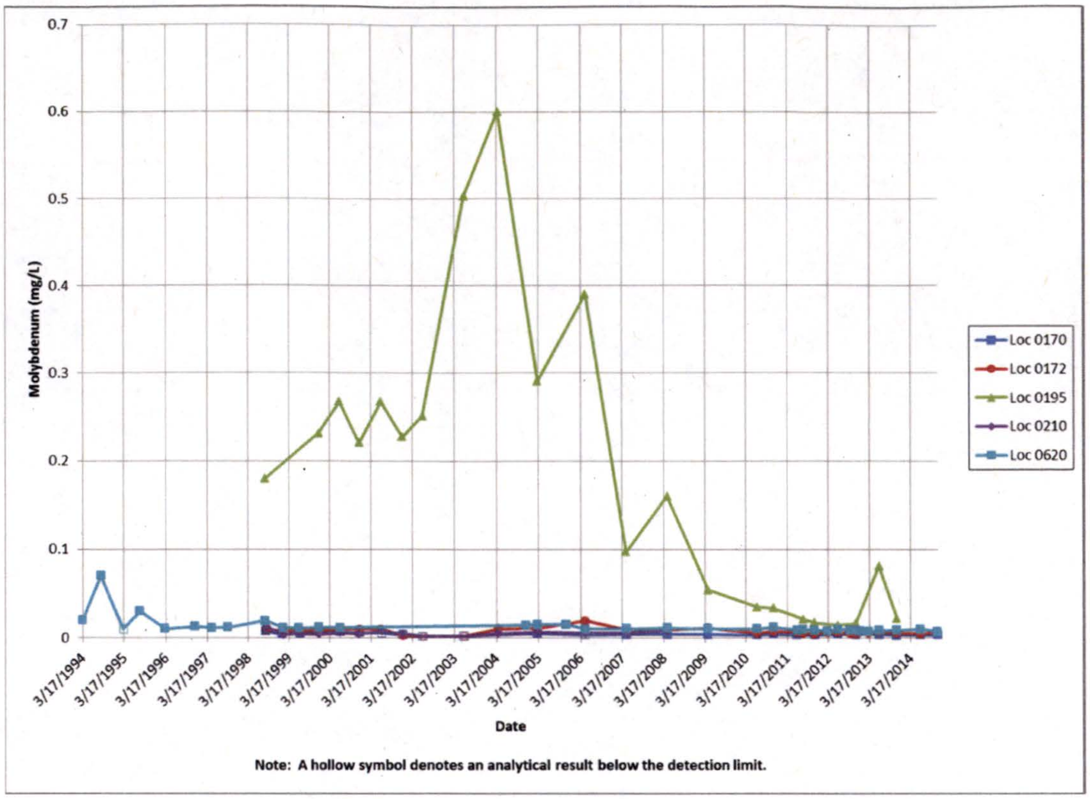


Figure B-23. Molybdenum Time-Concentration Plot

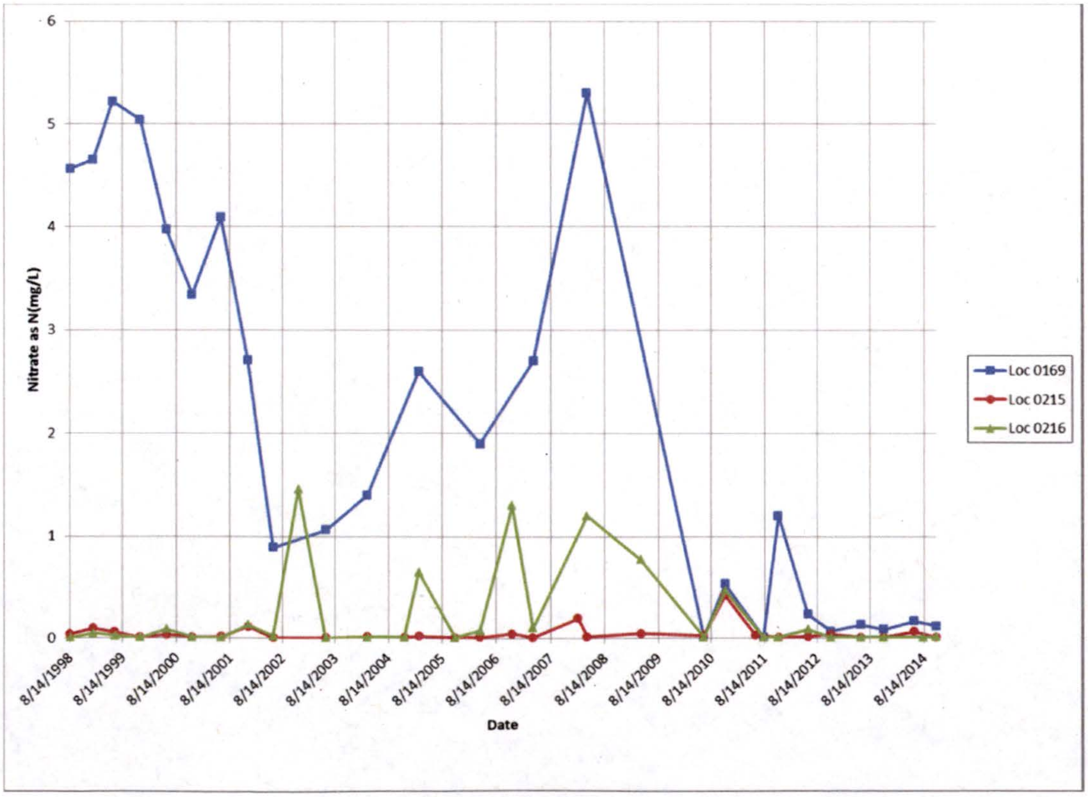


Figure B-24. Nitrate Time-Concentration Plot

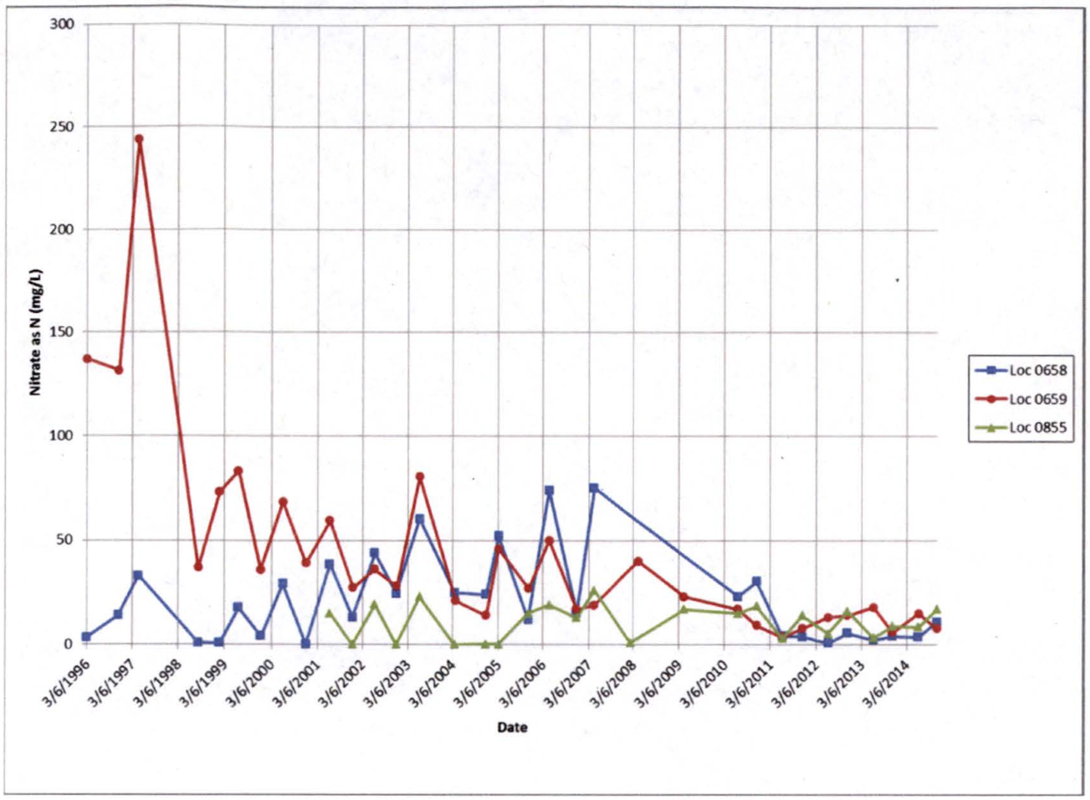


Figure B-25. Nitrate Time-Concentration Plot

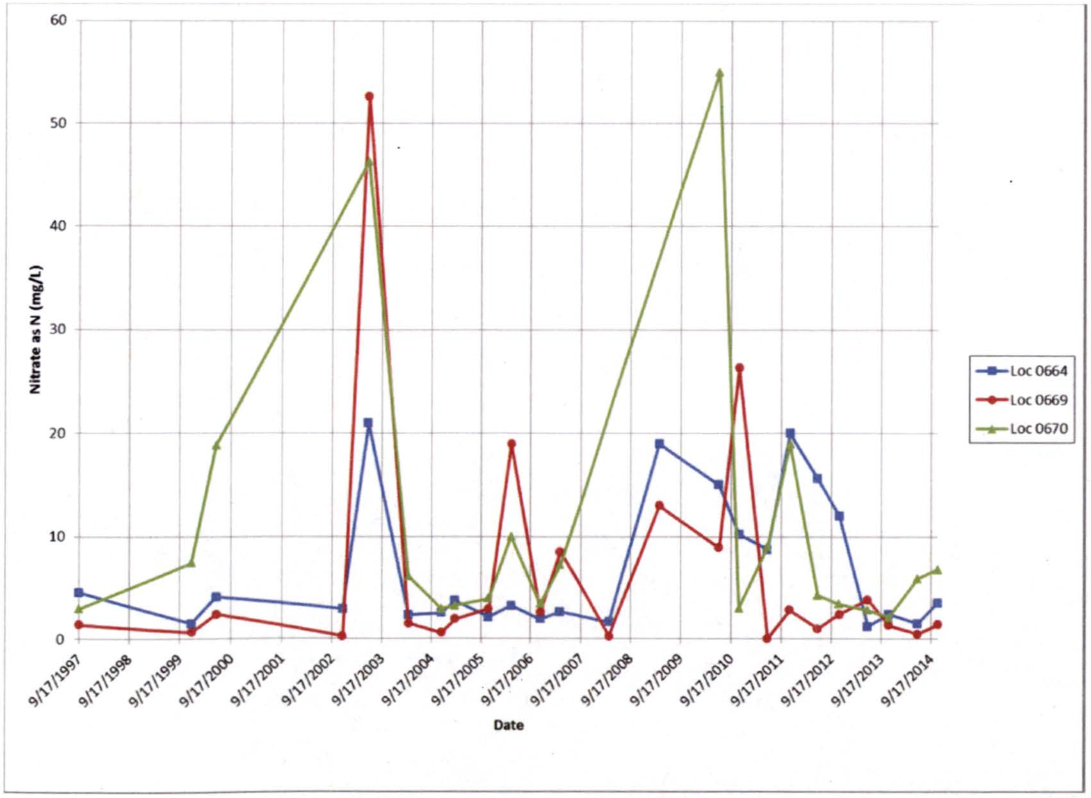


Figure B-26. Nitrate Time-Concentration Plot

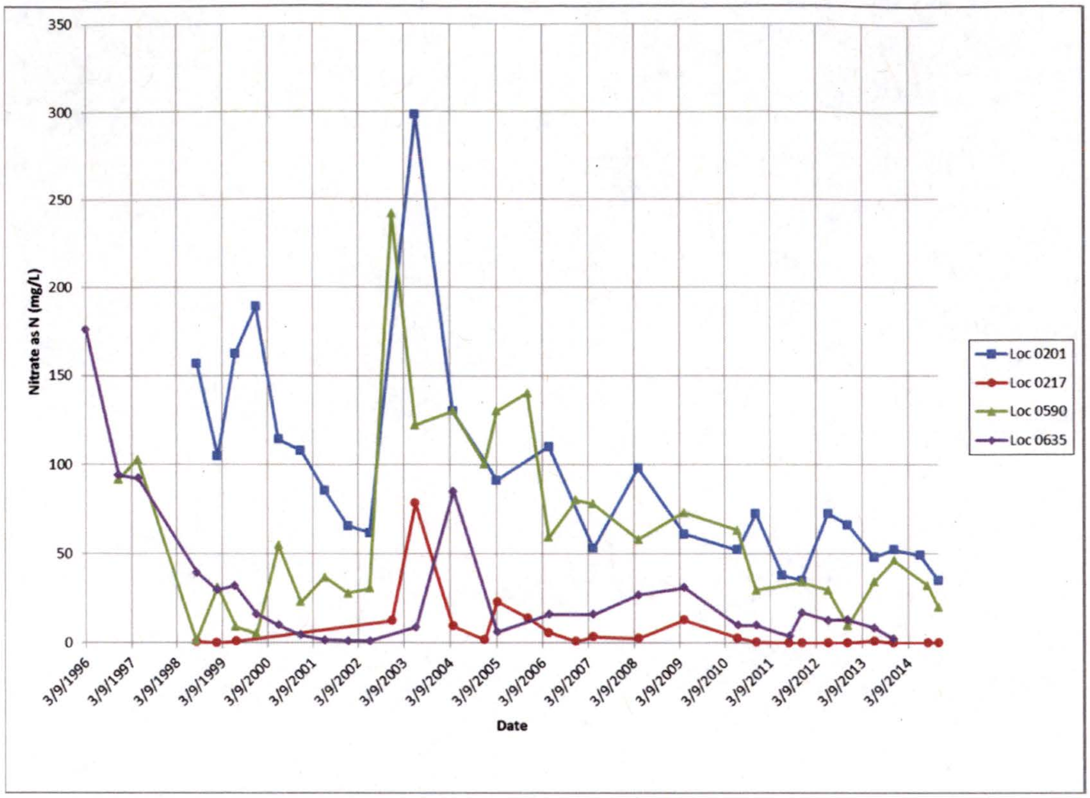


Figure B-27. Nitrate Time-Concentration Plot

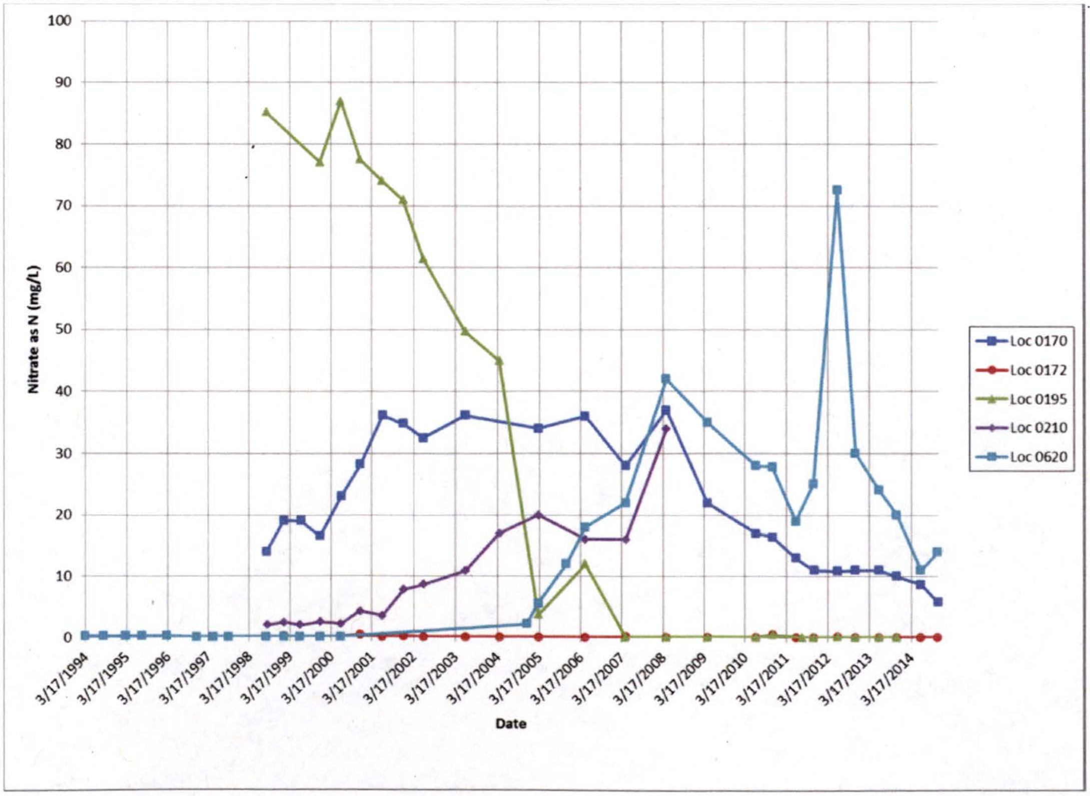


Figure B-28. Nitrate Time-Concentration Plot

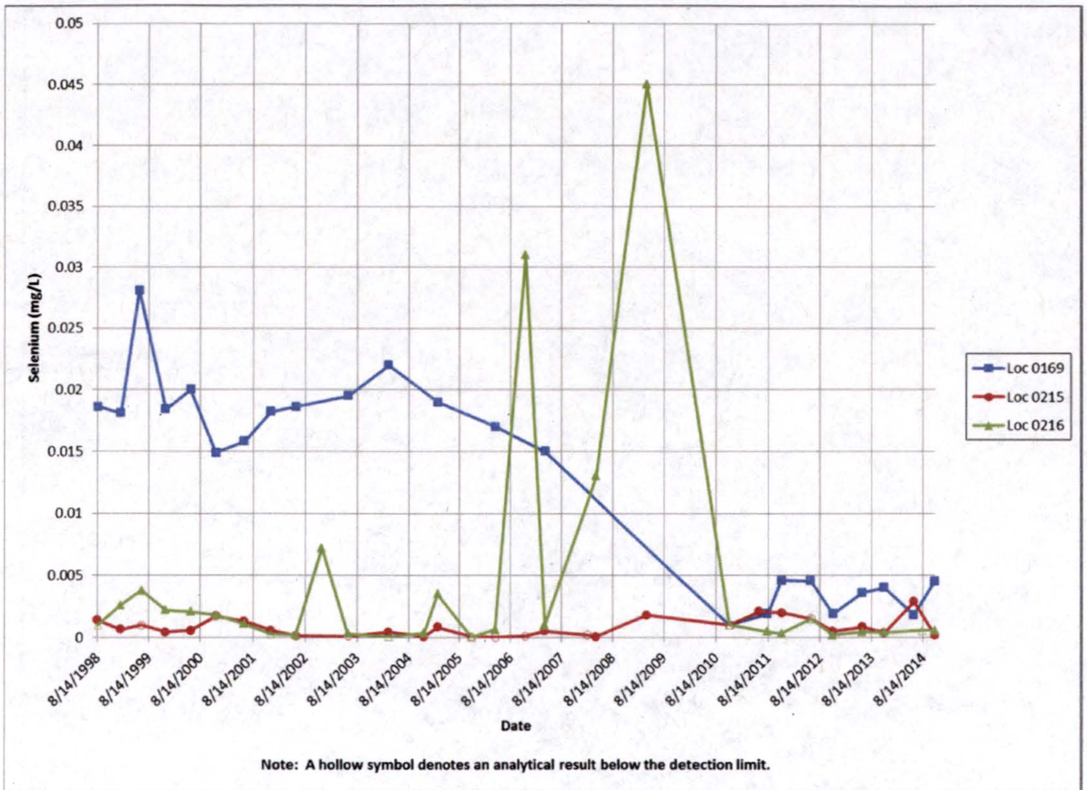
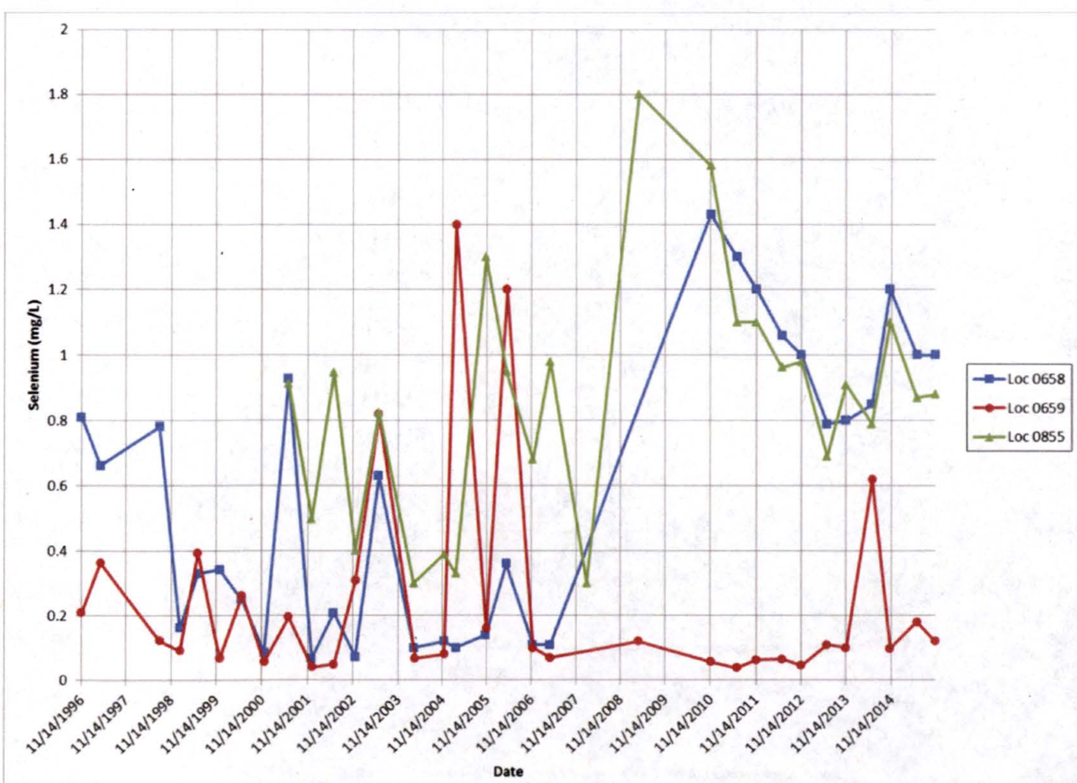


Figure B-29. Selenium Time-Concentration Plot



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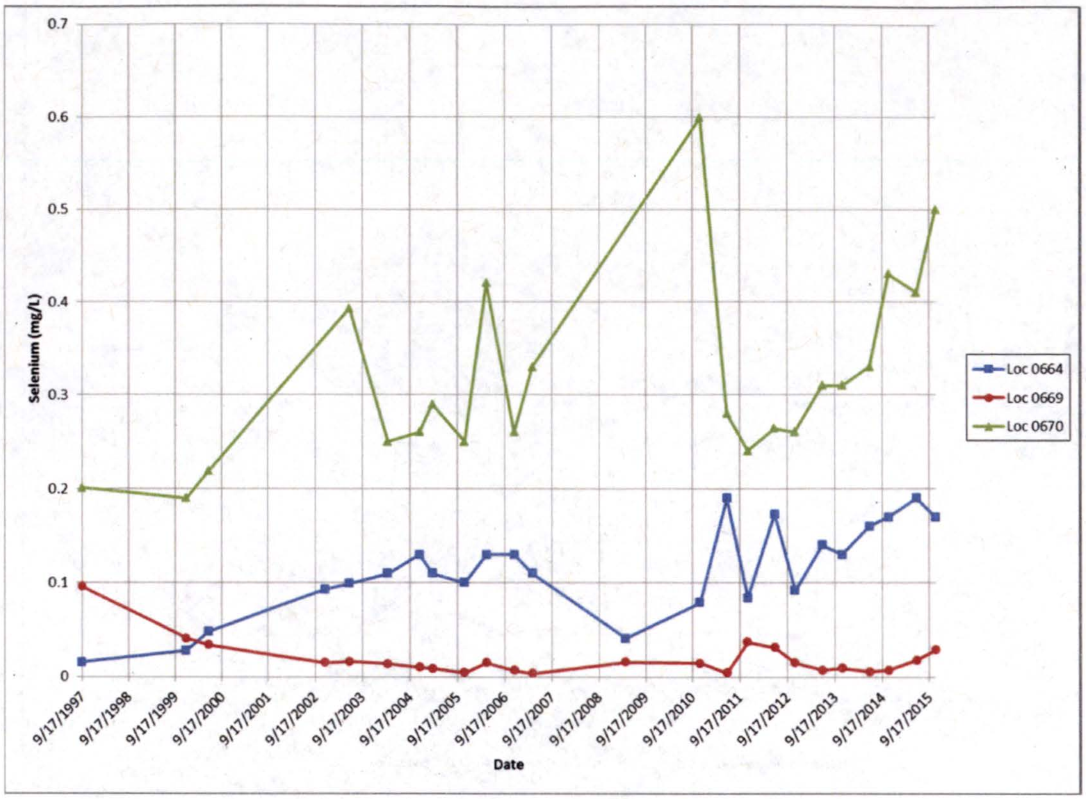

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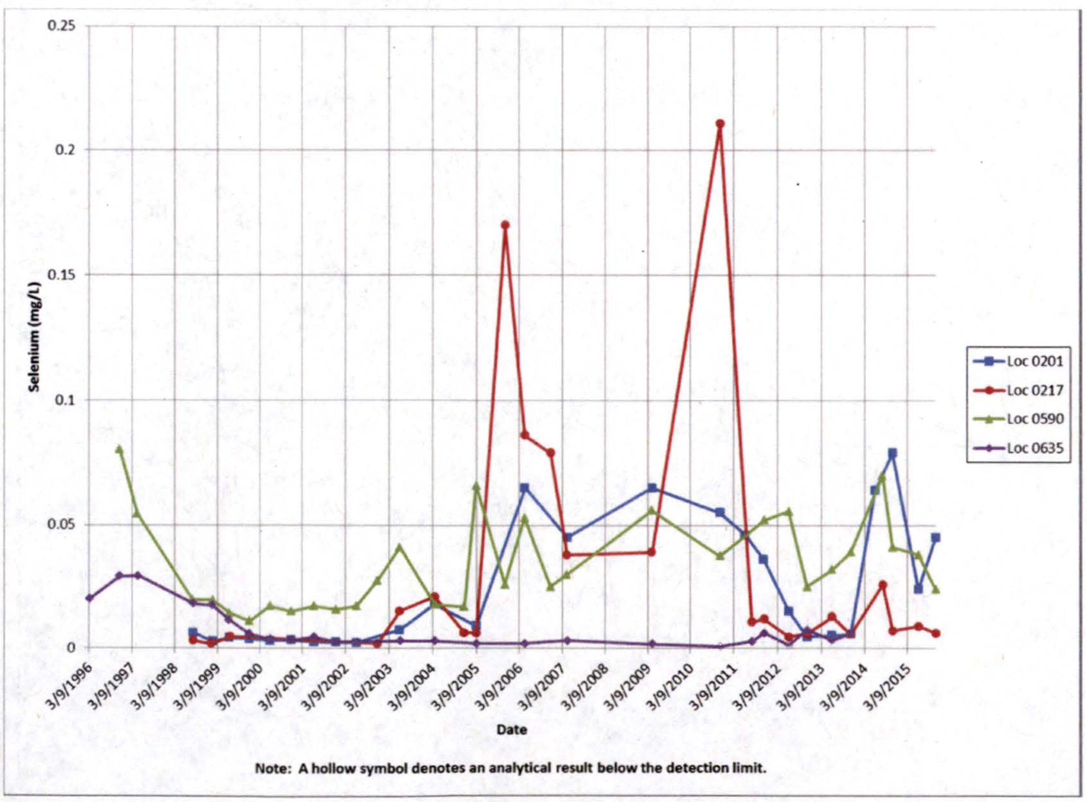


Figure B-32. Selenium Time-Concentration Plot

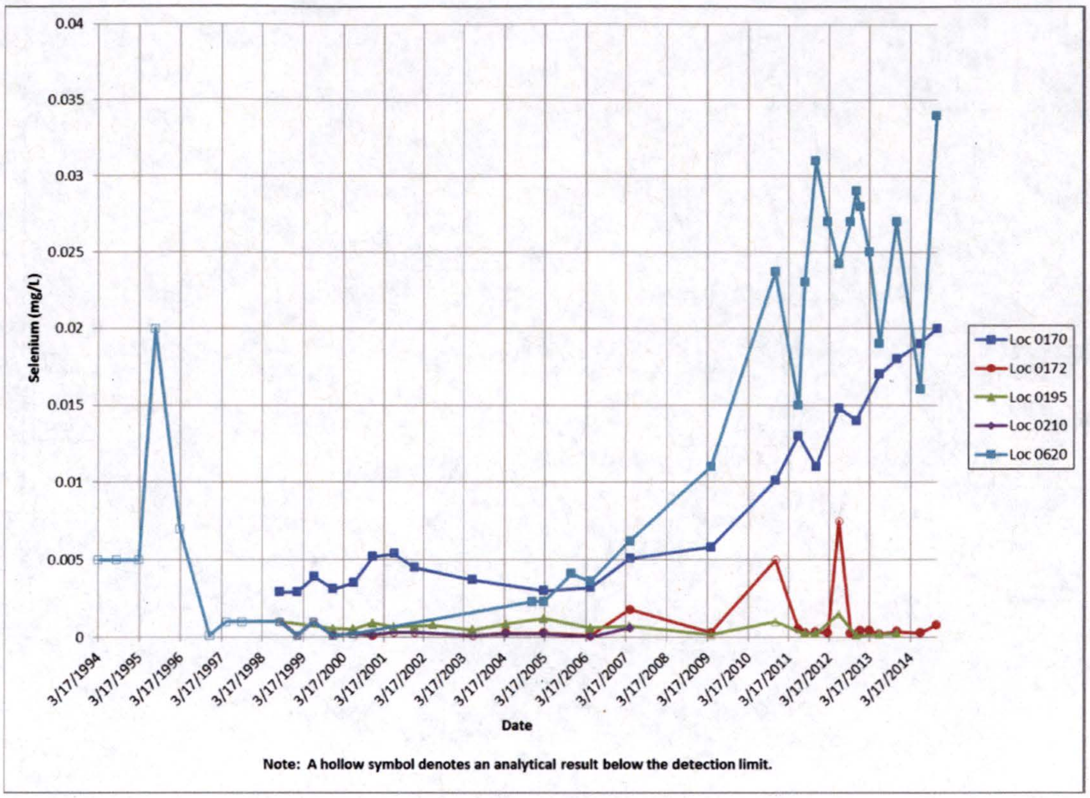


Figure B-33. Selenium Time-Concentration Plot

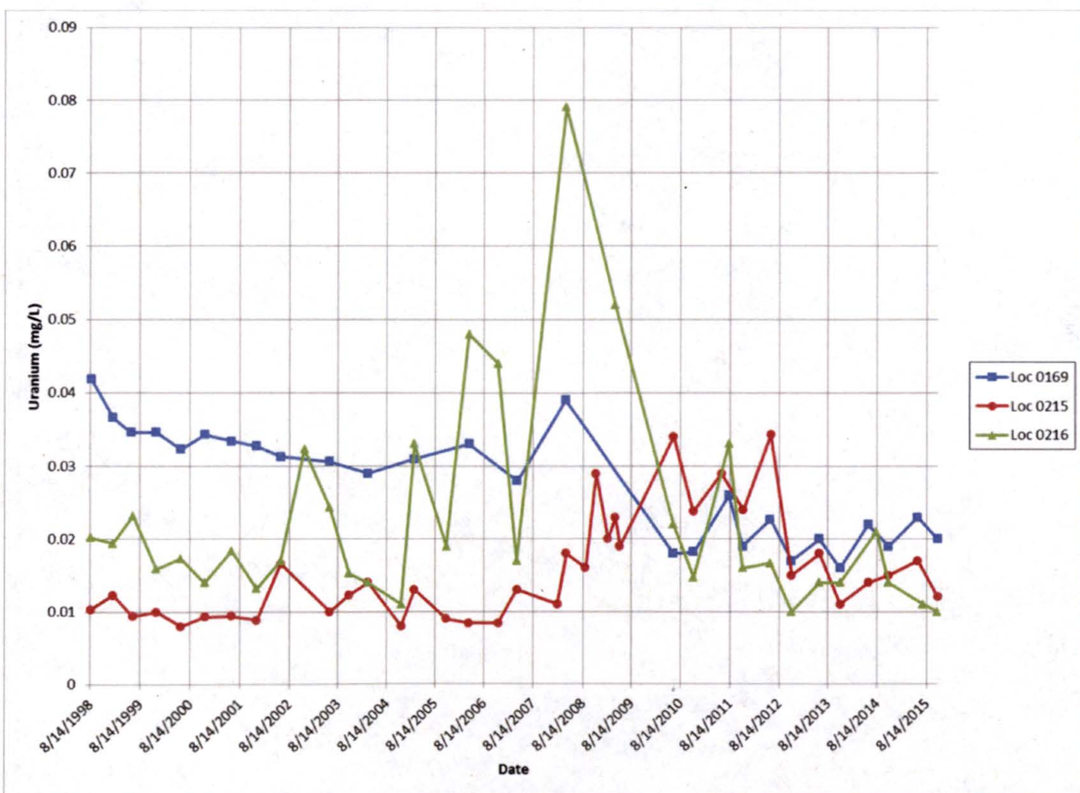
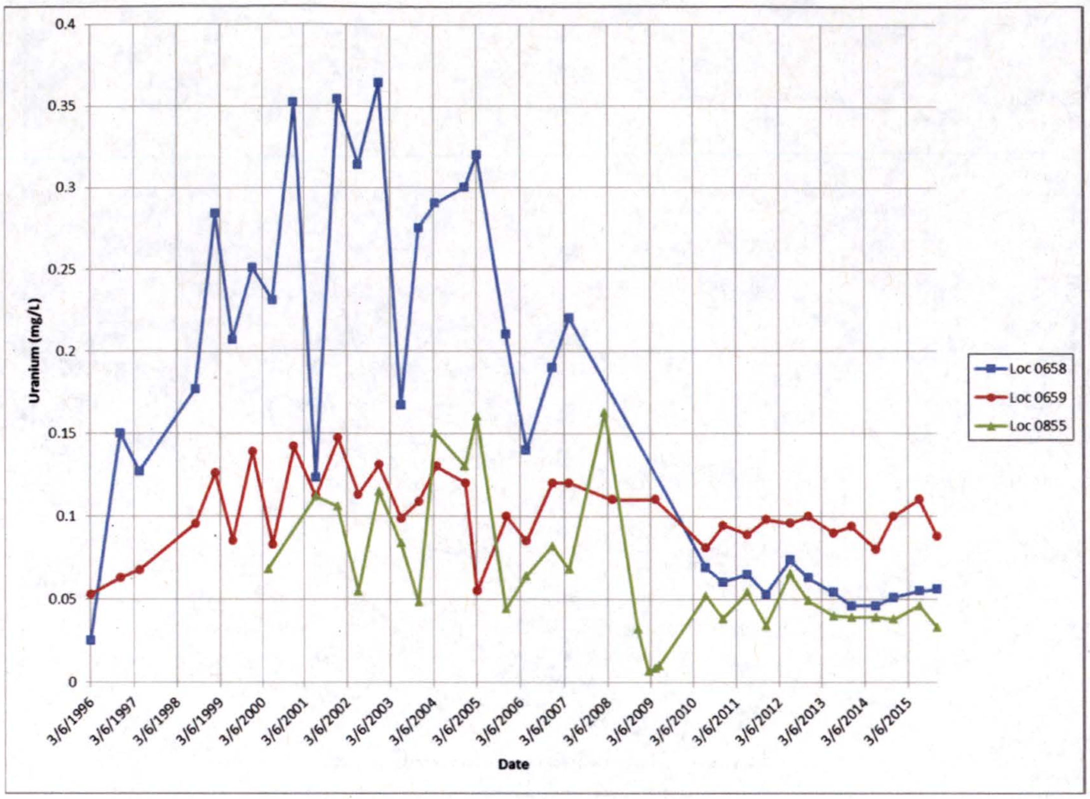


Figure B-34. Uranium Time-Concentration Plot



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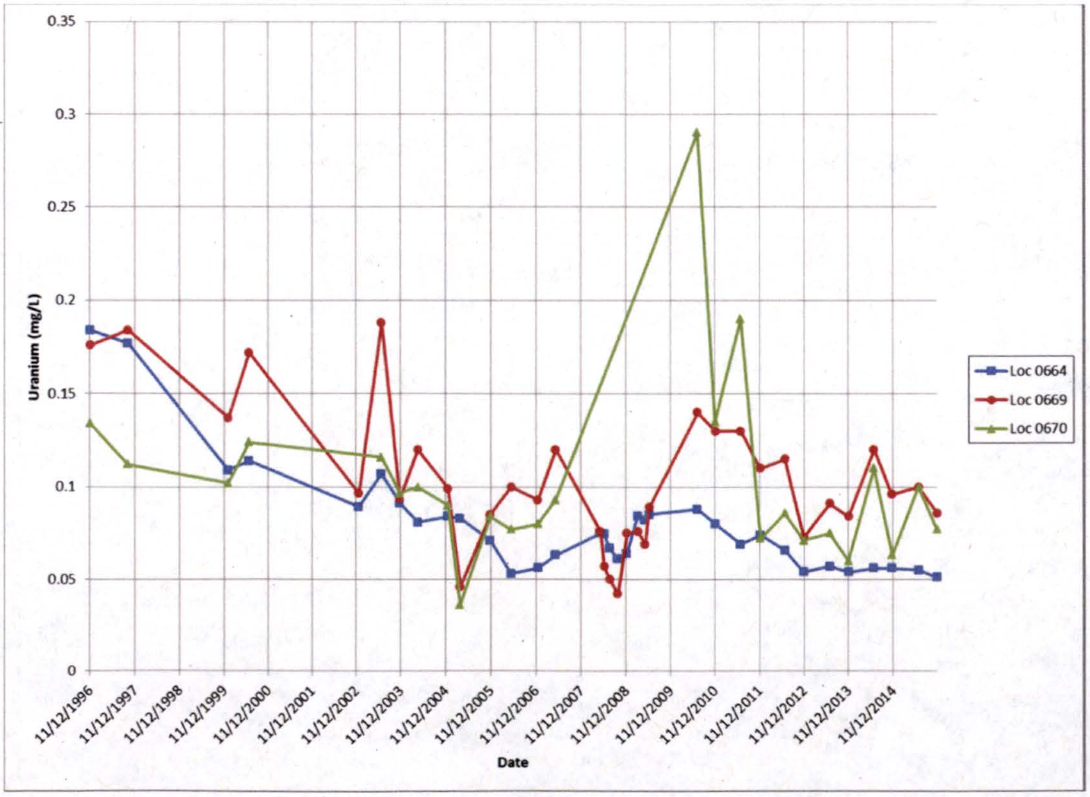


Figure B-36. Uranium Time-Concentration Plot

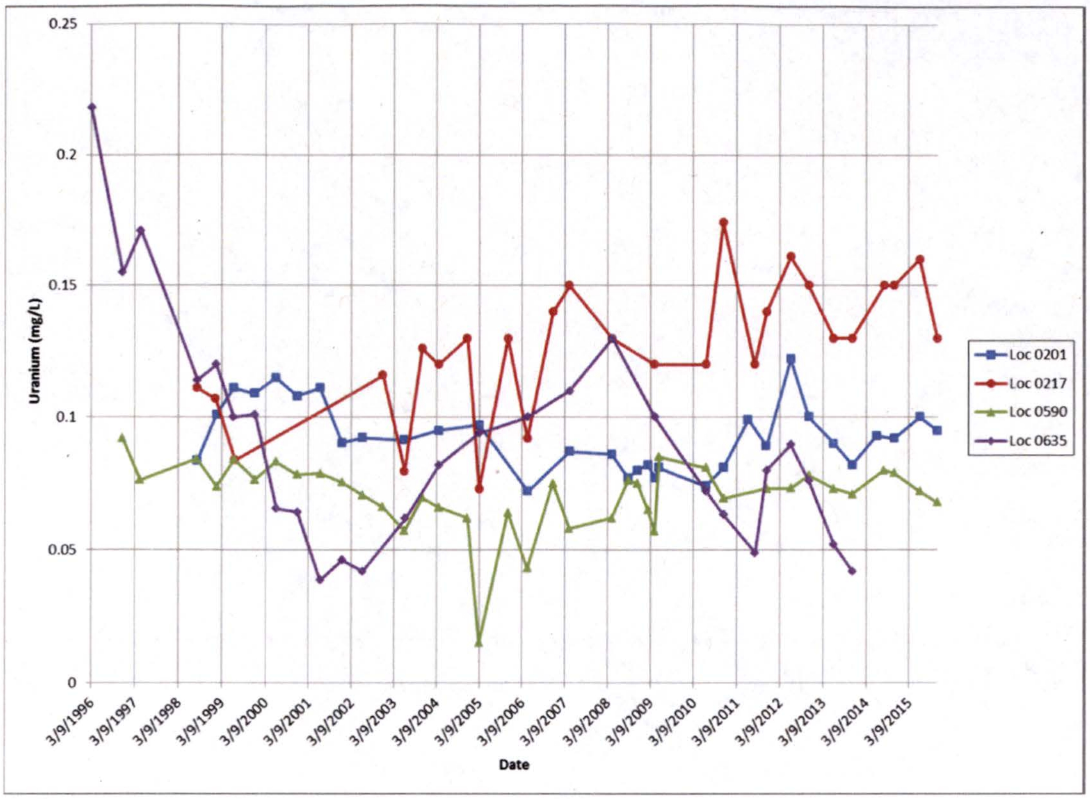


Figure B-37. Uranium Time-Concentration Plot

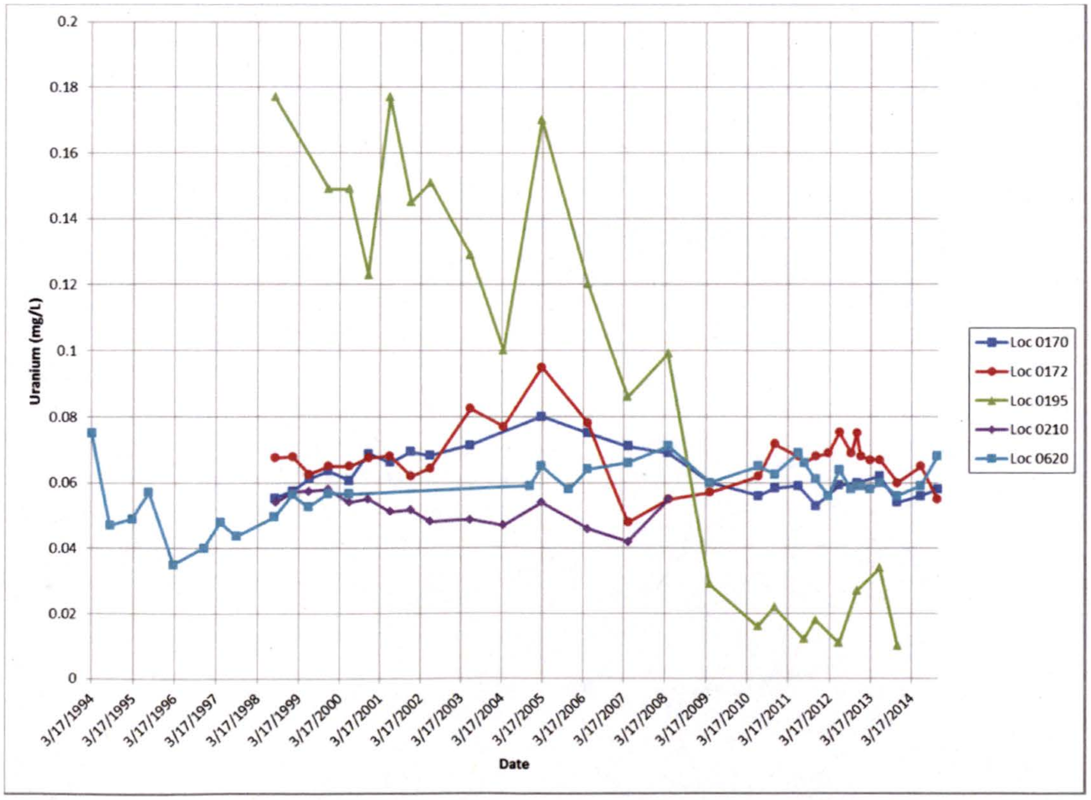


Figure B-38. Uranium Time-Concentration Plot

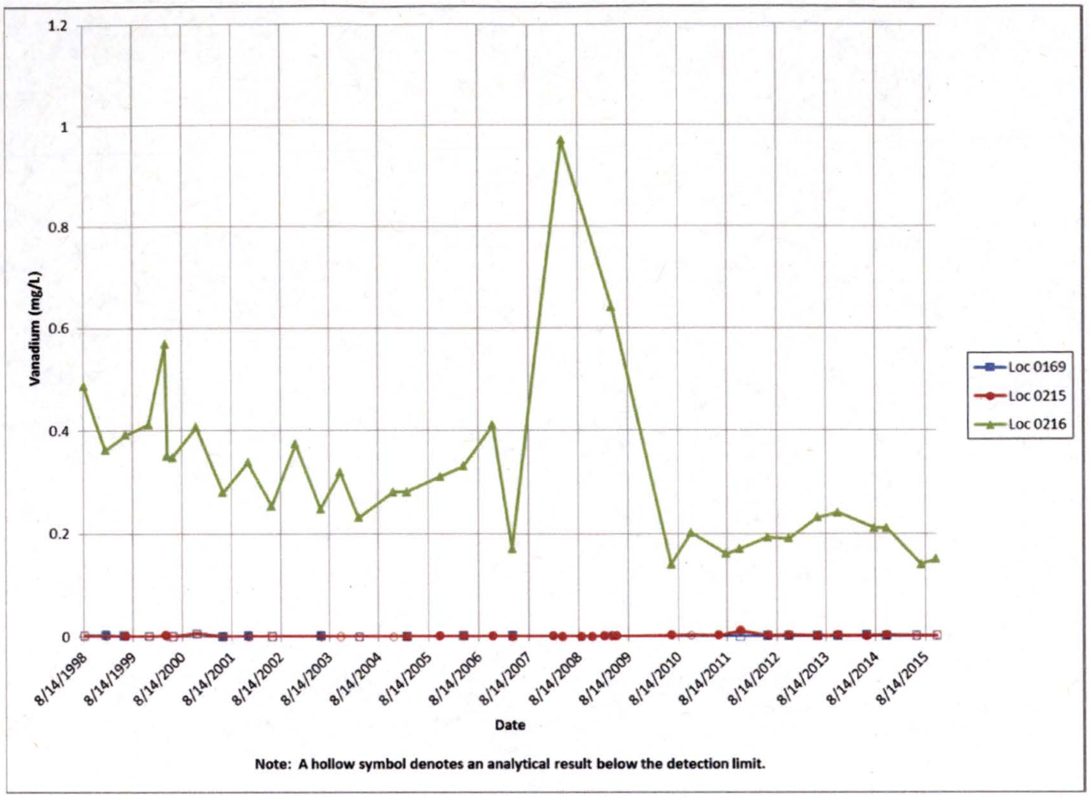


Figure B-39. Vanadium Time-Concentration Plot

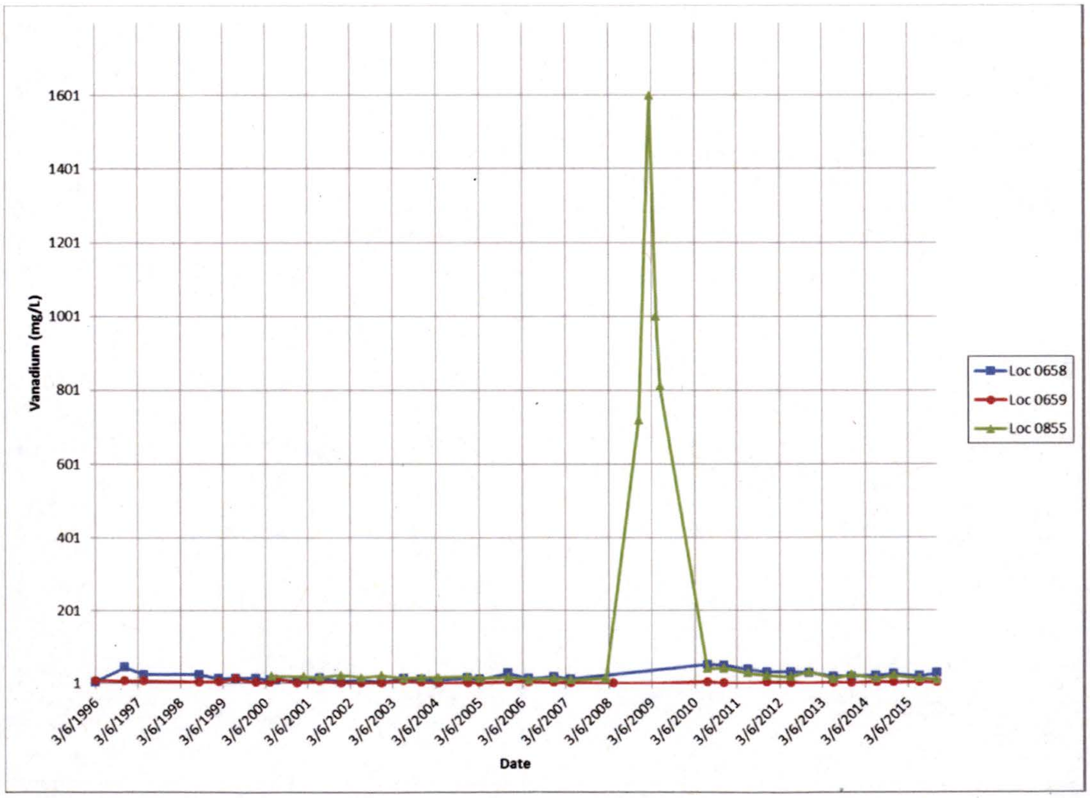
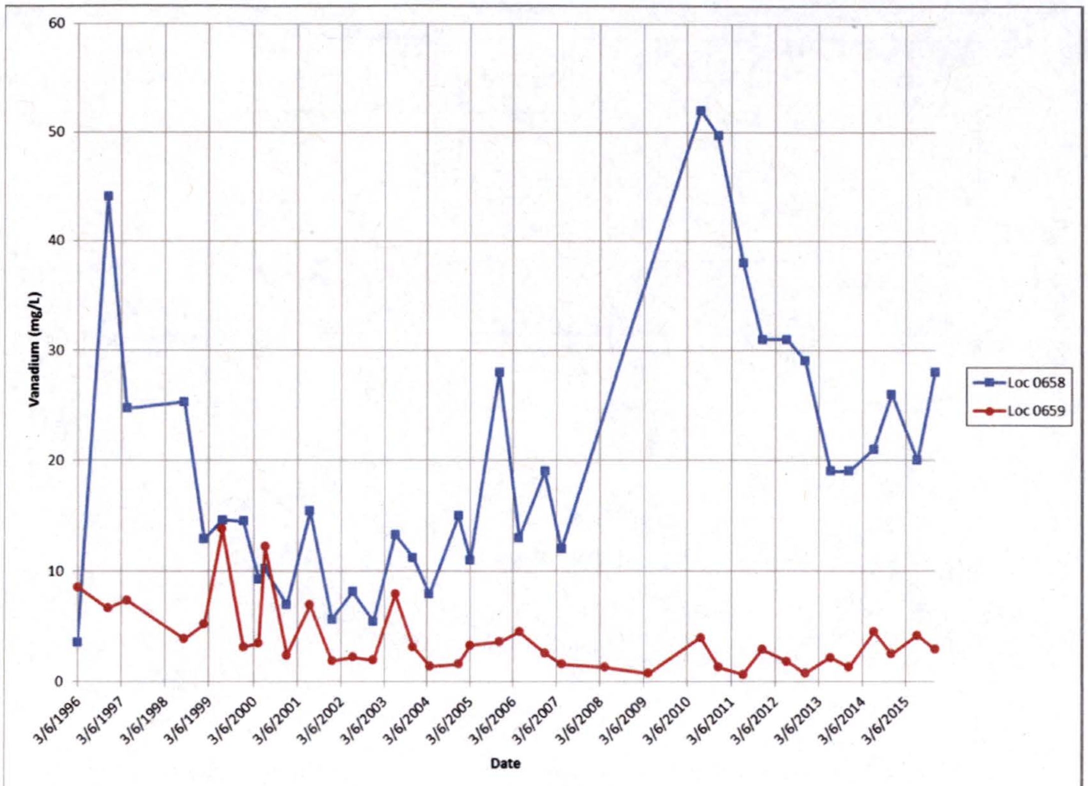


Figure B-40. Vanadium Time-Concentration Plot



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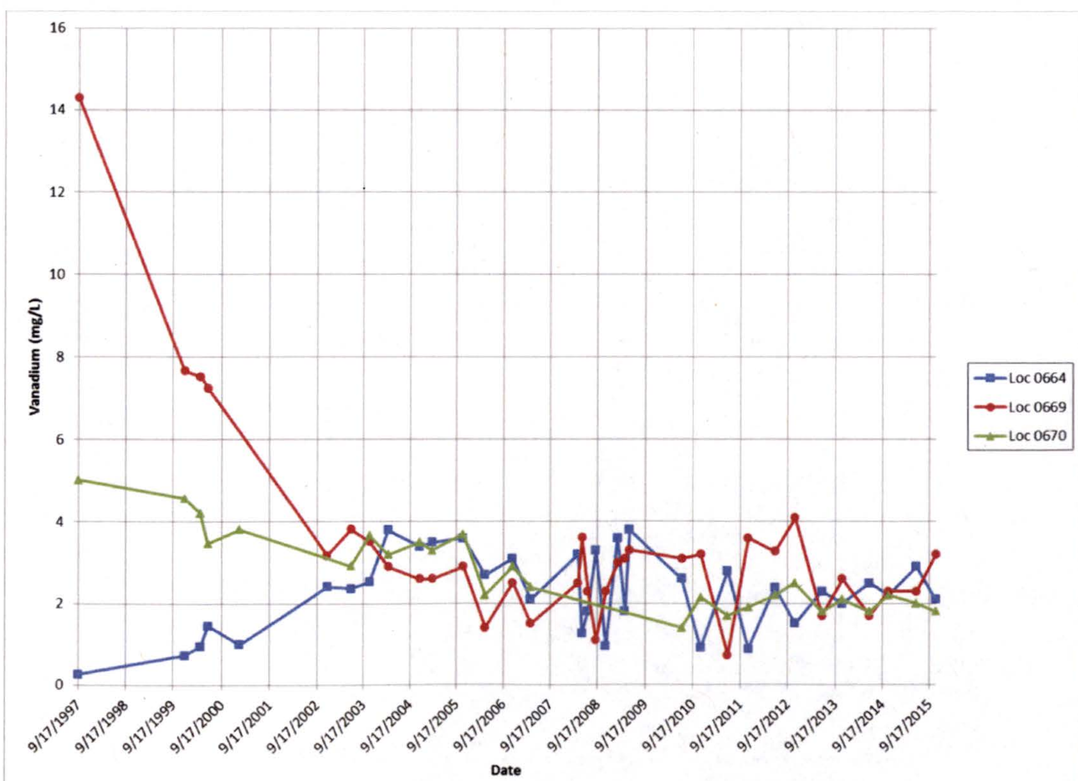

Figure B-42. Vanadium Time-Concentration Plot

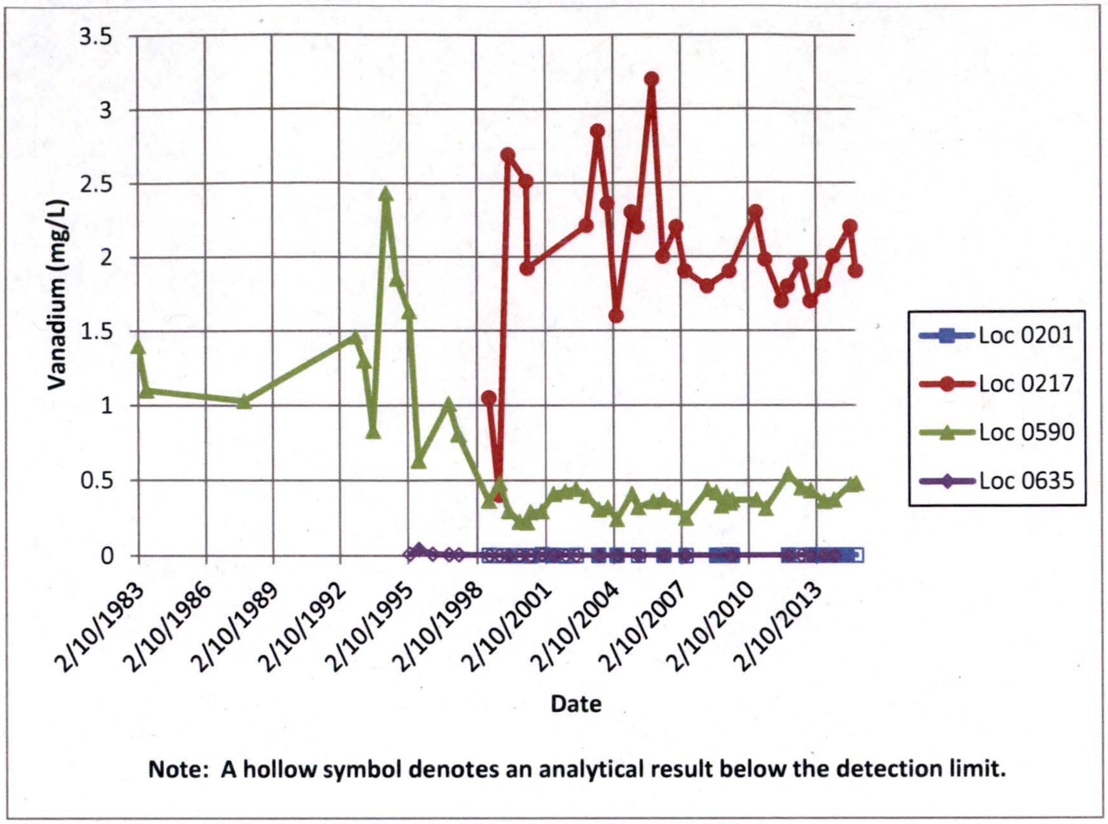

Figure B-43. Vanadium Time-Concentration Plot

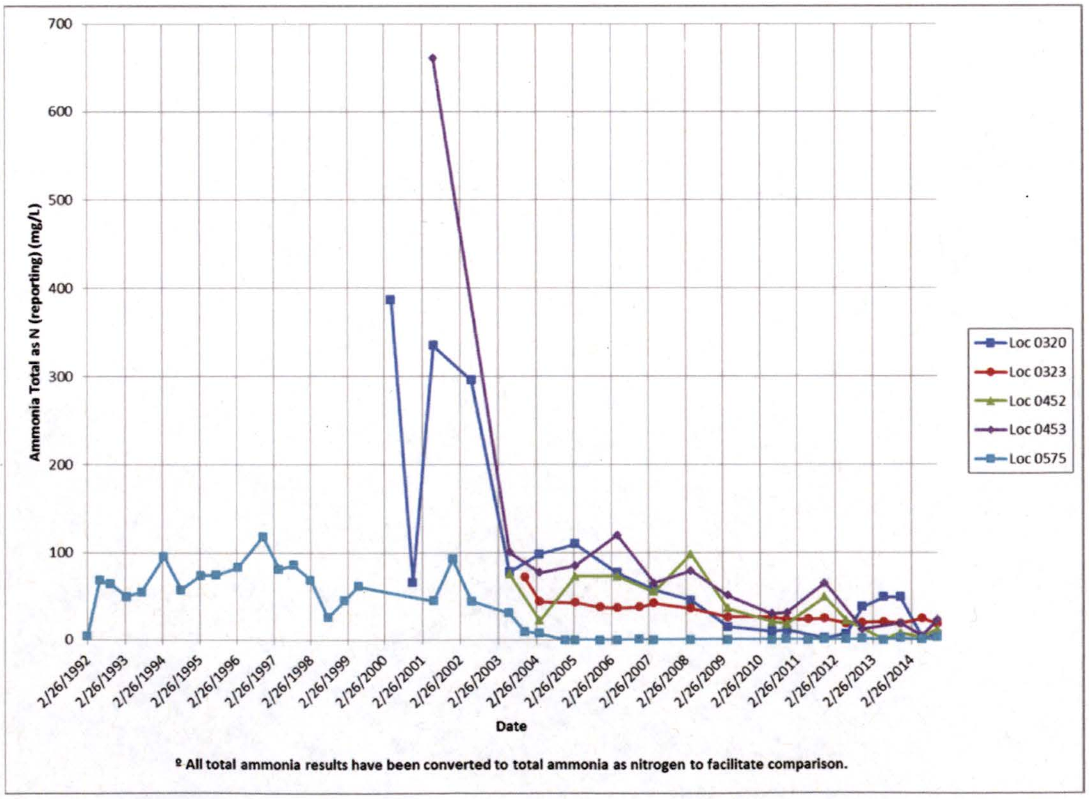

Figure B-44. Ammonia Time-Concentration Plot for Surface Water Locations

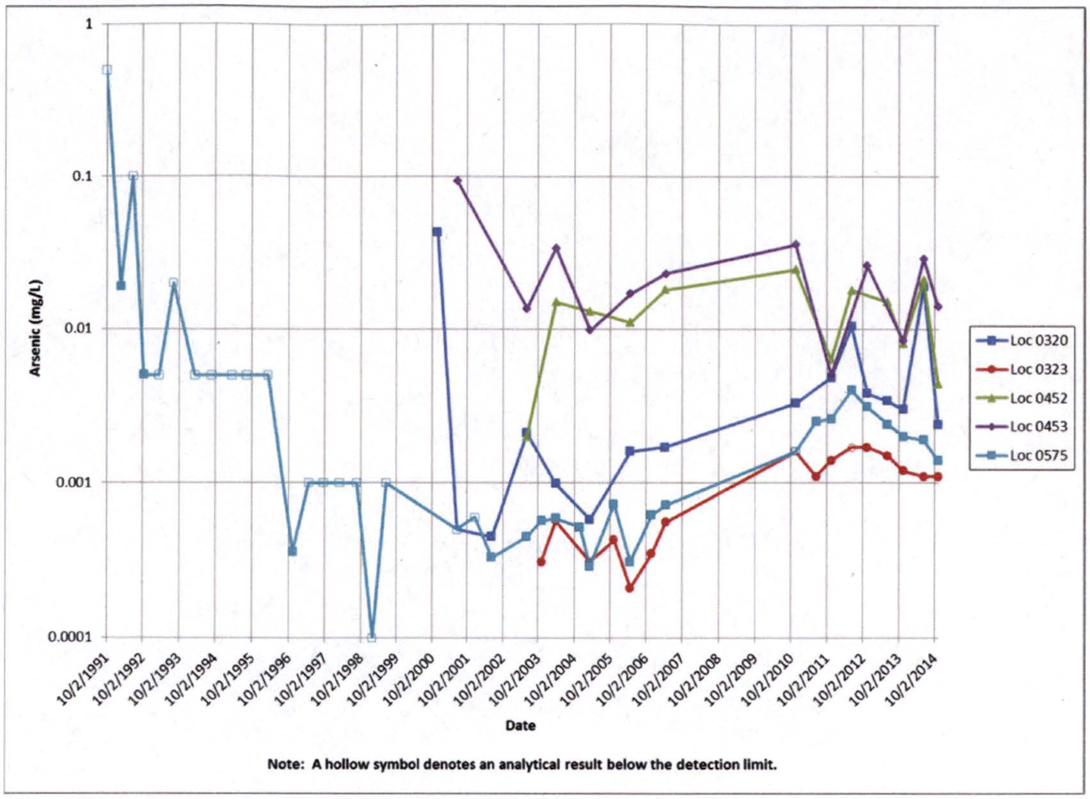

Figure B-45. Arsenic Time-Concentration Plot for Surface Water Locations

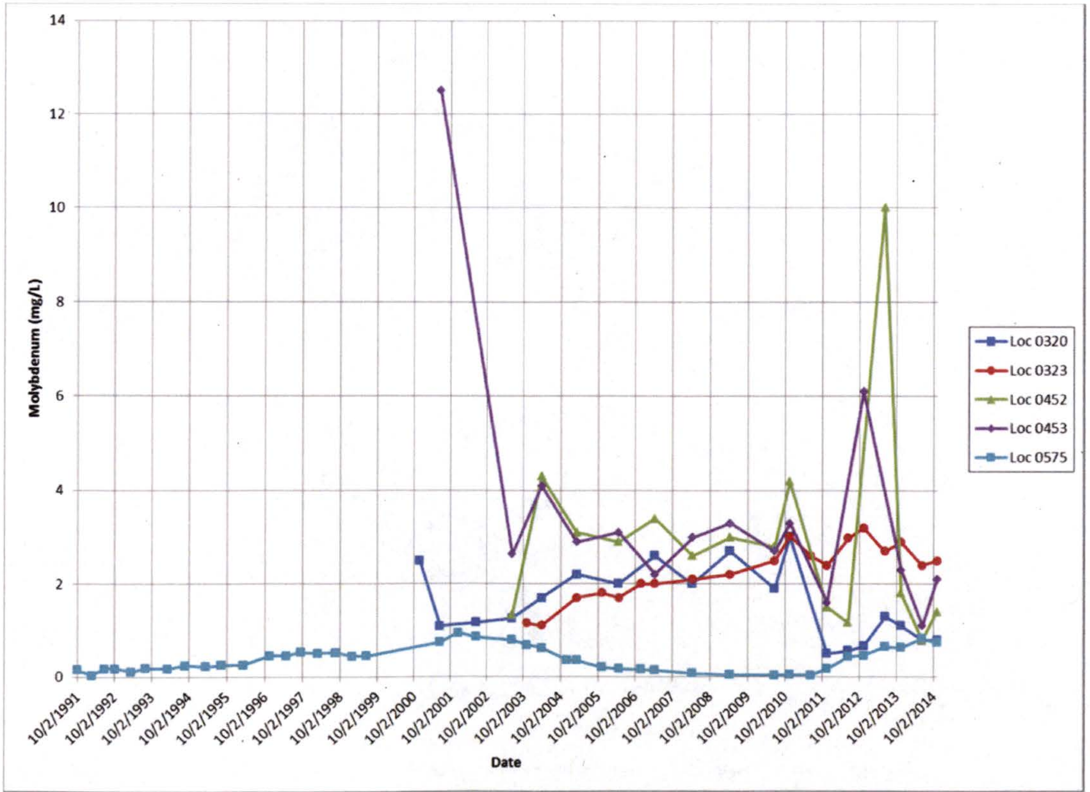

Figure B-46. Molybdenum Time-Concentration Plot for Surface Water Locations

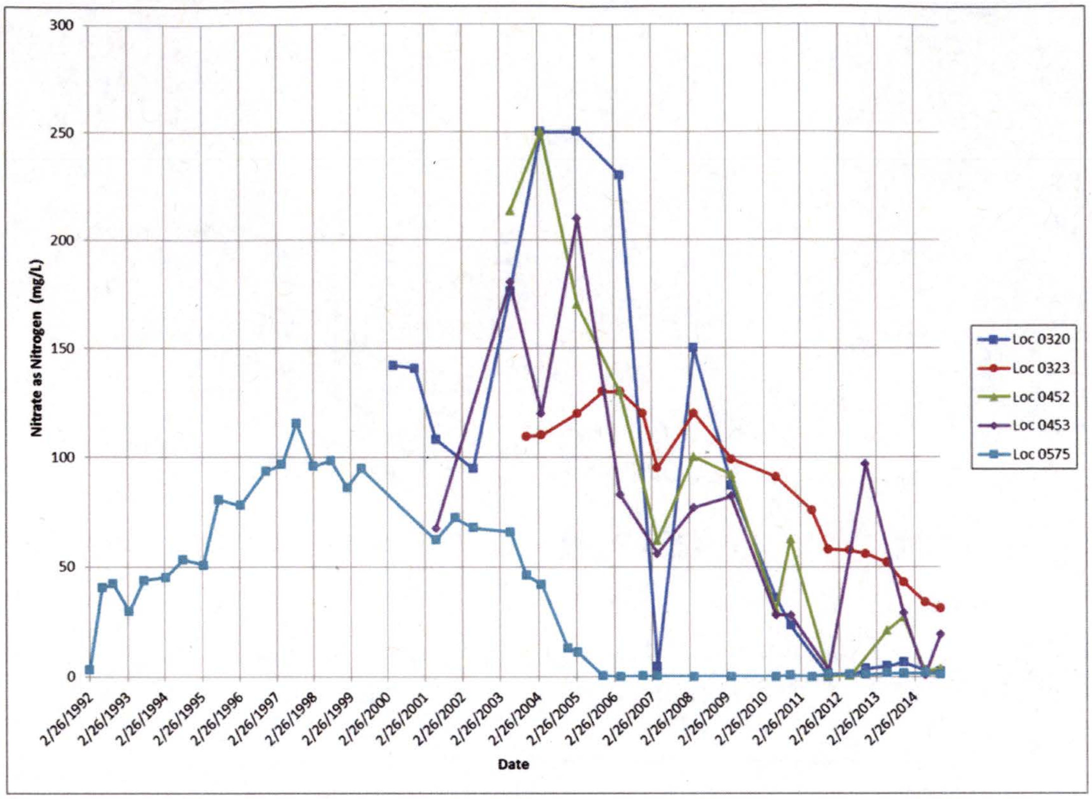

Figure B-47. Nitrate Time-Concentration Plot for Surface Water Locations

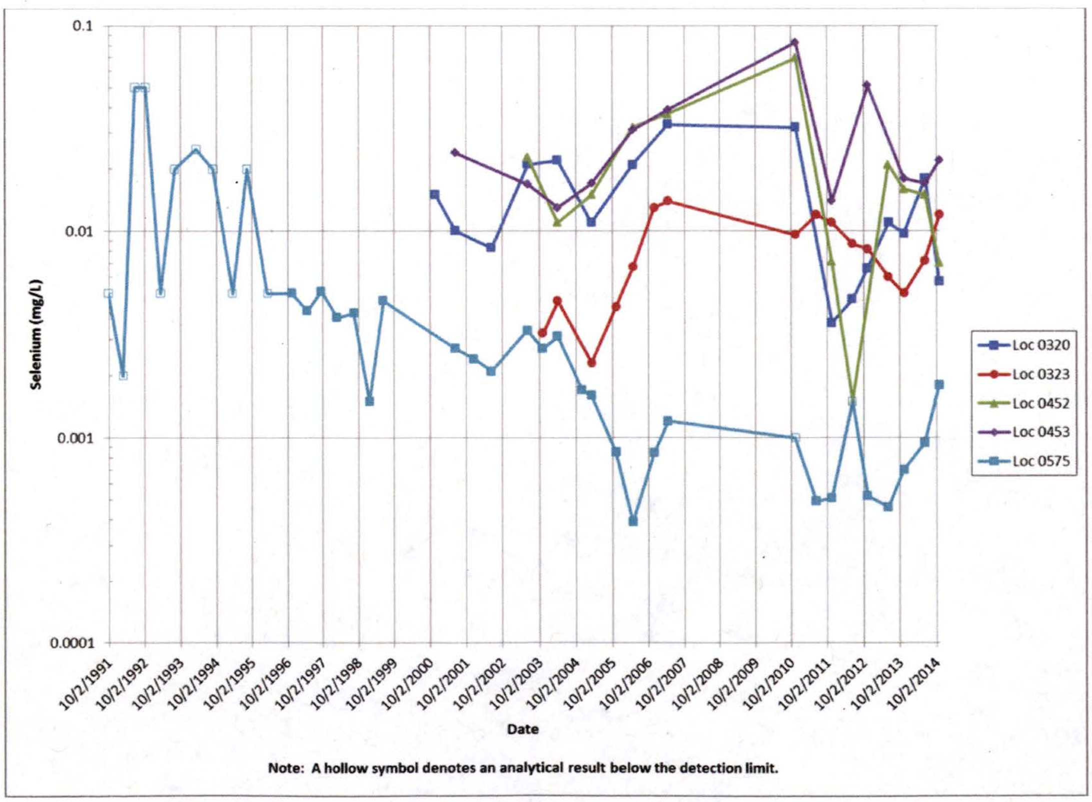

Figure B-48. Selenium Time-Concentration Plot for Surface Water Locations

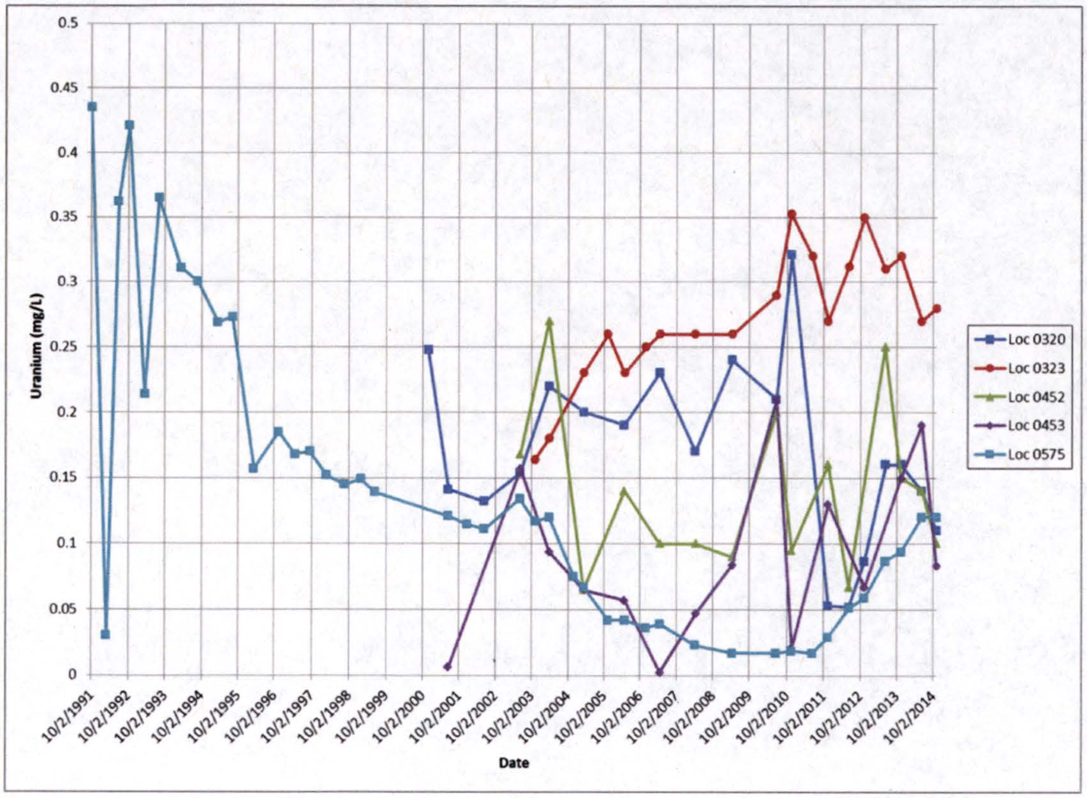

Figure B-49. Uranium Time-Concentration Plot for Surface Water Locations

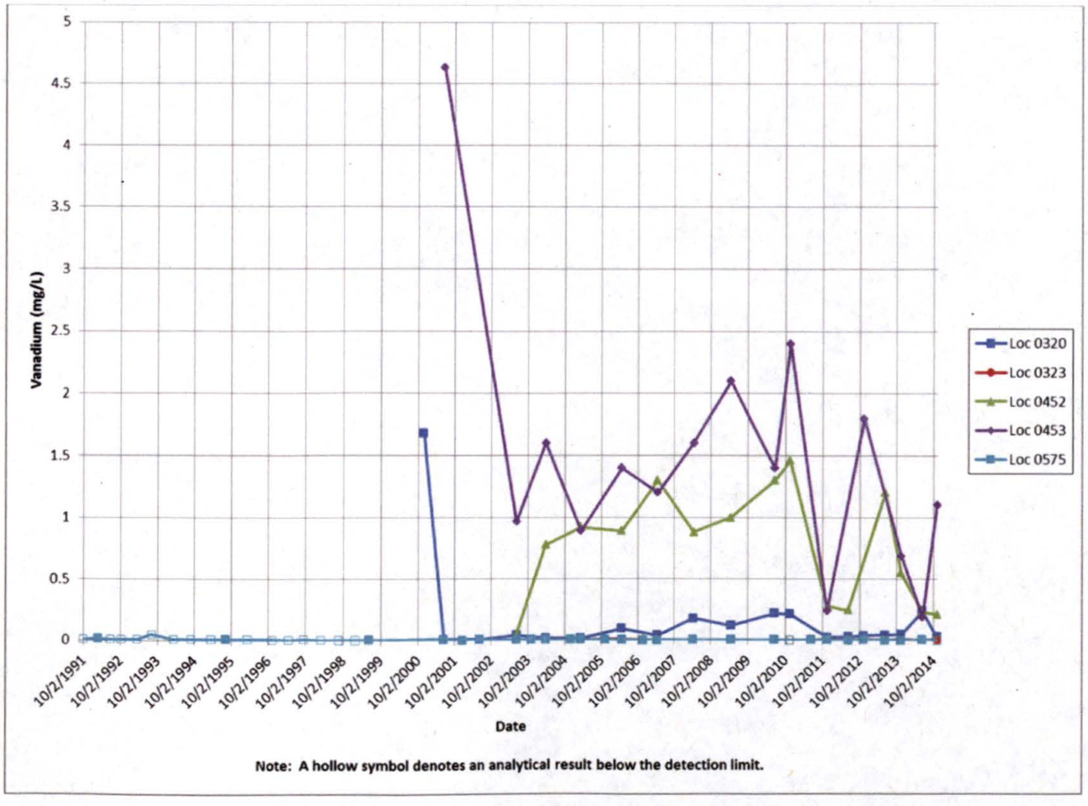

Figure B-50. Vanadium Time-Concentration Plot for Surface Water Locations

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Appendix C

Alternate Concentration Limit Application for the New Rifle, Colorado, Site

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LMS/RFN/S14424

Draft Alternate Concentration Limit Application for the New Rifle, Colorado, Site

July 2016

U.S. DEPARTMENT OF ENERGY | Legacy Management

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Abbreviations

ACL	Alternate Concentration Limit
ALARA	As Low as Reasonably Achievable
AR	activity ratio
BTV	background threshold value
CCR	*Code of Colorado Regulations*
CFR	*Code of Federal Regulations*
COC	contaminants of concern
EPA	U.S. Environmental Protection Agency
ft	feet
GCAP	groundwater compliance action plan
IC	institutional control
IRIS	Integrated Risk Information System
MCL	maximum concentration limit
NRC	U.S. Nuclear Regulatory Commission
POC	point of compliance
POE	point of exposure
µmho/cm	micromhos per centimeter
mg/L	milligram per liter
RBC	risk-based concentration
SOWP	*Final Site Observational Work Plan for the UMTRA Project New Rifle Site*
UMTRCA	Uranium Mill Tailings Radiation Control Act
Union Carbide	Union Carbide and Carbon Corporation
USL	upper simultaneous limit
UPL	upper prediction limit
UTL	upper tolerance limit

1.0 General Information

1.1 Introduction

This Alternate Concentration Limit (ACL) application for the New Rifle, Colorado, Uranium Mill Tailings Radiation Control Act (UMTRCA) Title I Disposal Site proposes alternative cleanup standards for site groundwater. This document follows the standard ACL application format provided in the U.S. Nuclear Regulatory Commission's (NRC) standard review plan for ACLs (NRC 1996; Table 2). Although the NRC guidance was prepared for Title II sites, it indicates that the same approach may be used at Title I sites, with modification to reflect the difference between the two programs (NRC 1996). Section 1.0 of the application includes general site information, and Section 2.0 provides the hazard assessment for the site. Section 3.0 lists the factors considered in making present and potential future hazard findings (Table 1 of NRC guidance). Section 4.0 provides the corrective action assessment, and proposed ACLs are discussed in Section 5.0. ACLs are being considered at this time because monitoring data and pilot study results indicate that maximum concentration limits (MCLs) cannot be met at this site, and the current groundwater concentrations are as low as reasonably achievable.

1.2 Facility Description

Historically, vanadium and uranium ores were processed at two different mills located near the city of Rifle, Colorado. The U.S. Vanadium Company constructed the first mill in 1924 for the production of vanadium (Merritt 1971). That plant was located approximately 0.3 mile east of the city and is referred to as the Old Rifle site. Union Carbide and Carbon Corporation (Union Carbide) purchased the assets of the U.S. Vanadium Company in 1926 and established U.S. Vanadium Corporation as a subsidiary (Chenoweth 1982). The subsidiary operated the former Old Rifle plant intermittently until 1946, when it was modified to include the recovery of uranium as well as vanadium. Production continued until 1958 when the old plant was replaced with a new mill located approximately 2.3 miles west of the Old Rifle site. The former location of the new mill is referred to as the New Rifle site (Figure 1).

Uranium and vanadium production at the New Rifle mill lasted from 1958 to 1984. Concentrated ore was shipped to the New Rifle mill from 1958 to the early 1960s from a variety of locations in the region. From 1964 to 1967, the New Rifle mill also processed lignite ash. From 1973 to 1984, part of the mill was used to produce vanadium; this operation, which did not produce tailings, involved processing vanadium-bearing solutions.

U.S. Atomic Energy Commission records document that 2,259,000 cubic yards of Old Rifle site tailings and 1,802,019 tons of ore were processed. The west-central portion of the New Rifle mill site contained 33 acres of tailings in two distinct piles. The combined piles measured approximately 1,600 feet (ft) in the north-south direction and approximately 1,150 ft in the east-west direction. Former holding ponds that held processing wastes (including vanadium and gypsum) were located east of the piles. The locations of tailing piles, evaporation ponds, ore storage area, and mill buildings as they existed in 1974 are shown in Figure 2.

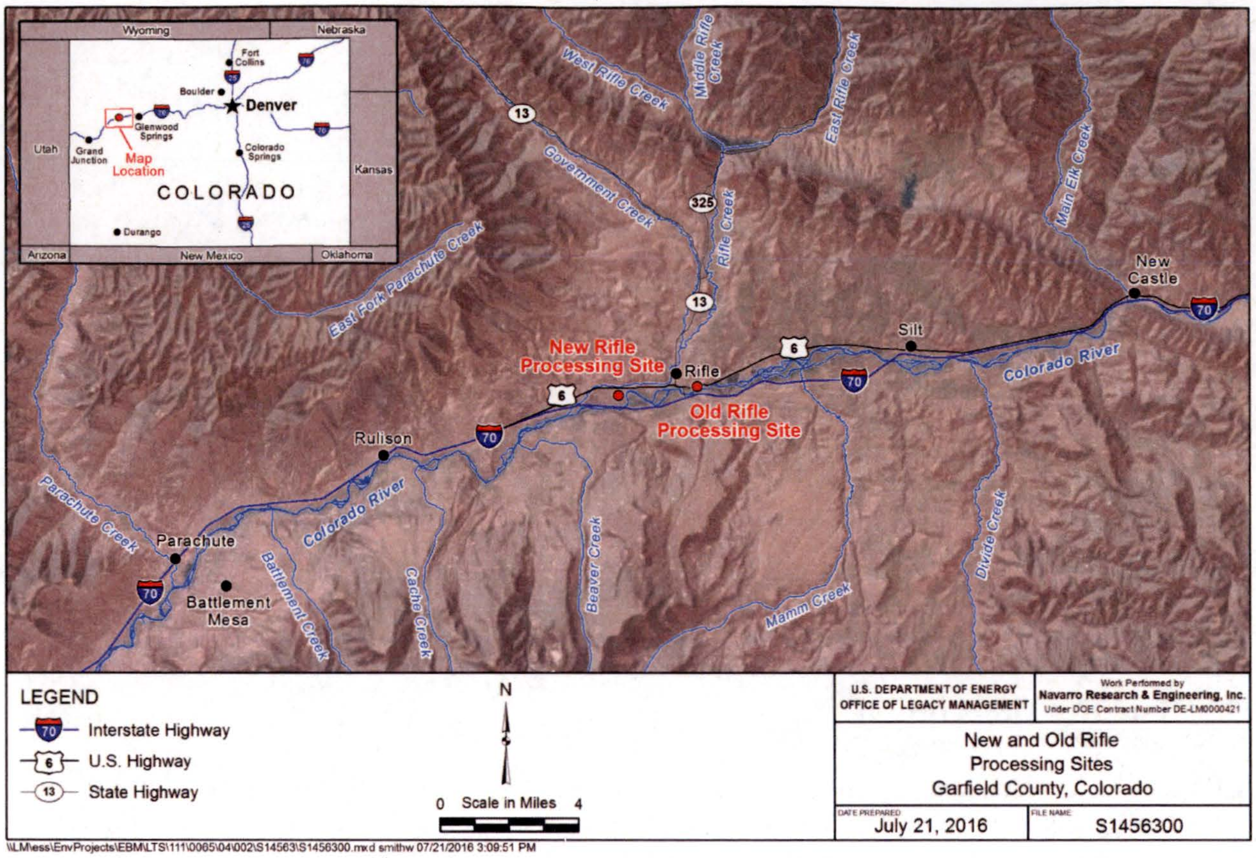

Figure 1. Location of the New Rifle Site

The tailing piles were partially stabilized by Union Carbide with the application of mulch and fertilizer. An irrigation system was installed to promote growth of native grasses that were planted. However, much of the pile did not revegetate, and wind and water eroded some of the tailings. The tailings pile at the beginning phase of surface remediation in 1989 is shown in Figure 3. All tailings, contaminated materials, and associated process buildings and structures were removed from the site during the surface remedial action completed in 1996.

1.3 Extent of Groundwater Contamination

See Section 2.4.2 of the GCAP.

Summary

Although preliminary, results of evaluating chemical and isotopic signatures in New Rifle site groundwater samples indicate that the groundwater chemistry in westernmost site wells may be influenced by water derived from sources different from those that impact the former mill site. It does appear that some site-related contamination has made it as far downgradient as well RFN-0620 but that most of the contamination downgradient of well RFN-0195 has dissipated to the point that it is not discernible from background or other anthropogenic sources. Therefore, alternate standards need only apply from the eastern boundary of the mill site to approximately the location of well RFN-0195.

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Figure 2. New Rifle Mill Site Showing the Location of the Northwest and Southwest Tailings Piles, Holding Ponds, Mill Buildings, and the Ore Storage Area—August 1974

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Figure 3. View of the New Rifle Site Looking West During the Early Stages of Surface Remedial Action—August 1989

1.4 Current Groundwater Cleanup Standards

Table 1 lists the current groundwater standards that apply to the New Rifle site. Also provided are the maximum concentrations and associated wells based on most recent sampling data (DOE 2015).

Table 1. Comparison of Groundwater Standards with Recent Sampling Results

Contaminant	UMTRCA Groundwater Standard (mg/L)	Maximum Observed in Groundwater in 2015 (mg/L)	Well with Maximum 2015
Arsenic	0.05	0.24	RFN-0855
Molybdenum	0.1	1.6	RFN-0201, RFN-0217
Nitrate (as N)	10	22	RFN-0201
Selenium	0.01	1.0	RFN-0658
Uranium	0.044	0.16	RFN-0217
Vanadium	NA	20	RFN-0658

Abbreviation:
NA = not applicable

1.5 Proposed Alternate Concentration Limits

Table 2 provides the proposed ACLs for the New Rifle site. Wells RFN-0217, RFN-0659, RFN-0664, and RFN-0669 are proposed as point of compliance (POC) wells where the ACLs must be met. Section 5.1 describes how these proposed values were determined. Section 5.2 describes implementation measures.

Table 2. Proposed ACLs for New Rifle Site

Contaminant	Proposed ACL (mg/L)
Arsenic	0.313
Molybdenum	7.3
Nitrate (as N)	75
Selenium	1.43
Uranium	0.364
Vanadium	52

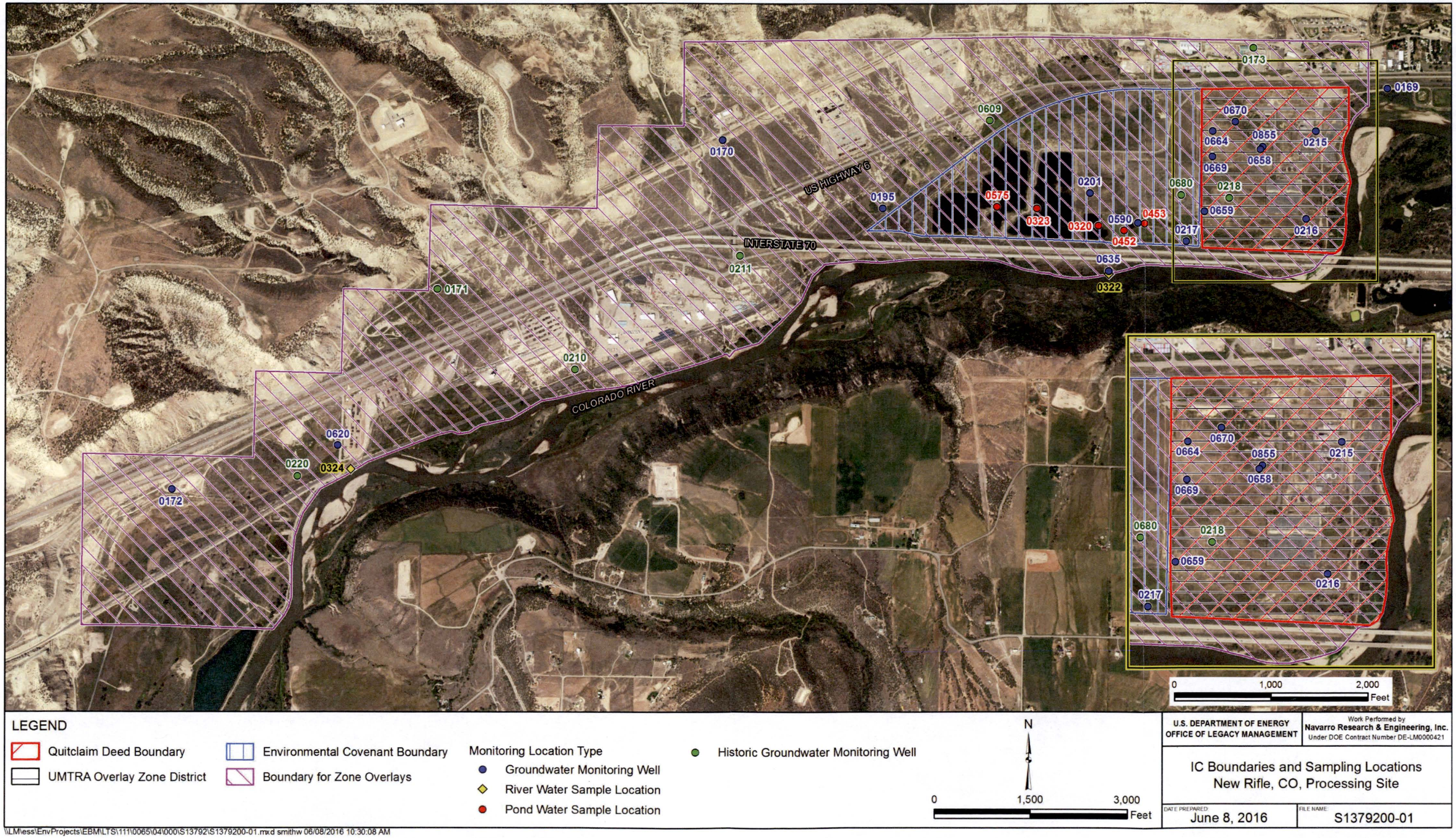

Figure 4. IC Boundaries and Sampling Locations at the New Rifle Site

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2.0 Hazard Assessment

2.1 Source and Contamination Characterization

Surface remediation removed the primary source of contamination at the site—the tailings and materials from the various onsite ponds. Surface cleanup was completed in 1996. However, cleanup was based only on meeting the Ra-226 standard in soils. Sampling of subpile soils completed during preparation of the SOWP (DOE 1999) and the vanadium pilot study (DOE 2001) indicated that significant secondary contamination remains in these soils. Construction activities conducted on the mill site in 2009 by the City of Rifle resulted in the mobilization of some of this residual contamination and caused large spikes in concentrations of some site-related constituents (e.g., arsenic, selenium, molybdenum, and vanadium). Based on pilot study results, which focused on vanadium, it was concluded that the aquifer restoration potential was limited due to the relatively high adsorption of vanadium to the aquifer matrix (DOE 2001). It is important to take this secondary source into consideration in the establishment of site ACLs.

2.2 Transport Assessment

See Section 2.3.3 of the GCAP.

2.3 Exposure Assessment

See Section 2.5 of the GCAP.

3.0 Factors Considered in Making Present and Potential Hazard Findings

UMTRCA Title I regulations (40 *Code of Federal Regulations* [CFR] 192.02[c][3][ii][B][1] and [2]) require that a number of factors must be considered in evaluating the applicability of ACLs. These factors differ slightly from those provided in the NRC Title II guidance (NRC 1996) and include an additional factor for the groundwater-quality evaluation. A discussion of these factors as they relate to the New Rifle site is provided in this section.

3.1 Potential Adverse Effects on Groundwater Quality

The physical and chemical characteristics of constituents in the residual radioactive material at the site, including their potential for migration. No disposal cell is present at the site. Surface remediation was completed in 1996. Subpile soil analysis indicates that residual soil contamination remains in place that could cause groundwater contamination to persist at the site for certain constituents, e.g., vanadium (DOE 2001). For the less mobile constituents such as vanadium and selenium, the contaminant plumes associated appear to be relatively stable and confined to the immediate vicinity of the site. For the more mobile constituents such as nitrate and molybdenum, plumes have been more widespread, but are diminishing over time.

The hydrogeological characteristics of the site and surrounding land. The hydrogeology of the site was characterized for input to the flow and transport model (see the SOWP, Sections 5.1 "Geology," and 5.2 "Hydrologic System"). Groundwater flows in a west to southwesterly direction. Contamination has migrated downgradient of the site, though the worst contamination is confined to the site. Modeling predicts that contaminated groundwater will eventually discharge to the Colorado River, where it will be diluted. An artificially constructed mitigation wetland is on the site. Groundwater discharges to this wetland, though the area is typically dry during periods of low river flow.

The quantity of contaminated groundwater and the direction of groundwater flow. Groundwater flow is generally west-southwest at an average rate of 0.8 to 1.7 ft/day. The total volume of contaminated groundwater is estimated at approximately 600 million gallons (DOE 1996).

The proximity and withdrawal rates of groundwater users. There are currently no users of alluvial groundwater downgradient of the site. Wells that were formerly used for domestic purposes are out of service. Former well users have been hooked up to the municipal water supply system.

The current and future uses of groundwater in the region surrounding the site. Both alluvial and bedrock aquifers are utilized for fresh water supply in the region surrounding the site. The alluvial aquifers are limited in extent and typically occur only locally in stream valleys. Wells that are completed in the alluvium primarily are adjacent to the Colorado River; only a few alluvial wells are present in the tributary drainages in the region (e.g., Mamm Creek, Dry Hollow Creek, and West Divide Creek). The large majority of water supply wells are completed in the Lower Tertiary Wasatch Formation. The Wasatch Formation is present at the ground surface over much of the area surrounding the site (S.S. Papadopulos & Associates 2008). Institutional controls prevent the use of untreated groundwater for domestic use at and downgradient of the site.

The existing quality of groundwater, including other sources of contamination and their cumulative impact on groundwater quality. Groundwater quality at the site is generally poor, as is most of the groundwater in the Rifle vicinity. Historically, background concentrations of molybdenum, selenium, and uranium have exceeded EPA standards. Fluoride, iron, manganese, and sulfate concentrations in groundwater in background areas all exceed EPA's applicable drinking water standards. Water at the site also has elevated concentrations of arsenic, ammonia, selenium, uranium, and vanadium as a result of milling activities. There is some evidence of alluvial groundwater contamination due to drilling activities downgradient of the site. Several studies have been undertaken to better understand the potential impacts of oil and gas drilling in the region. Regionally, elevated levels of selenium, nitrate, and fluoride have been identified (S.S. Papadopulos & Associates 2008).

The potential for health risks caused by human exposure to constituents. The only potentially unacceptable risks to humans would occur through regular use of untreated groundwater as drinking water in a residential scenario, which currently does not exist. Incidental use would not result in any unacceptable risks. Institutional controls imposed by Garfield County require residents to prove a source of potable water to develop a property. Any property located within the Rifle city limits is required to tap into the city's municipal water system. Therefore, institutional controls and the designation of the site as agricultural/industrial ensure that groundwater will not be used in any manner that would result in unacceptable human health risks.

The potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to constituents. Ecological risks are discussed in Section 2.3.2 of this document. No adverse effects are expected for wildlife or vegetation. Residual groundwater contamination is not expected to cause damage to physical structures; e.g., there are no volatile constituents that could seep into buildings.

The persistence and permanence of the potential adverse effects. It is possible that groundwater contamination could remain at levels that are unacceptable for drinking water for an extended period of time. However, during that period of time institutional controls will ensure that no improper use of water that could produce adverse effects occurs.

The presence of underground sources of drinking water and exempted aquifers identified under Section 144.7 of this chapter [40 CFR 144.7]. There once were downgradient drinking water wells installed into the contaminant plume. However, those wells have since been removed from service, and the former well users now obtain domestic water from the municipal water supply system.

3.2 Potential Adverse Effects on Hydraulically Connected Surface Water Quality

The volume and physical and chemical characteristics of the residual radioactive material at the site. No disposal cell is present at the site and the surface of the site has been remediated. Subpile soil analysis indicates residual soil contamination could represent an ongoing source of contamination to groundwater (DOE 2001).

The hydrogeological characteristics of the site and surrounding land. Only the surficial aquifer at the site is contaminated. It is composed of unconsolidated alluvial material deposited by the Colorado River, and the material ranges in size from clay to cobbles. The alluvial material is approximately 20–30 ft thick over most of the site. The saturated thickness of the aquifer ranges from 5 to 15 ft. Groundwater movement is generally west-southwest. Groundwater from the site moves through the mitigation wetland and the gravel ponds and discharges to the Colorado River (Sections 5.1 and 5.2 of the SOWP describe the geology and hydrology of the site, respectively).

The quantity and quality of groundwater and the direction of groundwater flow. Groundwater flow is generally west-southwest at an average rate of 0.8 to 1.70 ft/day. Water quality is poor; concentrations of several constituents exceed groundwater standards. For a detailed discussion of groundwater quality, see Section 5.3.3 of the SOWP. The quantity of contaminated groundwater is estimated at approximately 600 million gallons (DOE 1996).

The patterns of rainfall in the region. The site receives on average approximately 11 inches of precipitation per year. Rainfall occurs during the summer in high-intensity, short-duration, late afternoon thunderstorms that are conducive to runoff. Precipitation occurs in the winter as snowfall. In regards to the effects of site contamination, precipitation events have no measurable effect on the quality of water in the Colorado River.

The proximity of the site to surface waters. The Colorado River forms the eastern and southern boundaries of the site. The mitigation wetland is on and downgradient of the site. Ponds are located on the property adjacent to and downgradient from the site as the result of a former gravel mining operation, and they are within the plume boundary.

The current and future uses of surface waters in the region surrounding the site and any water-quality standards established for those surface waters. The Colorado River in the site vicinity is classified for use as recreation, water supply (i.e., source of drinking water for a community), and agriculture. Water-quality standards for the river are established in Regulation No. 37 of the Colorado Department of Public Health and Environment's Water Quality Control Commission (5 *Code of Colorado Regulations* [CCR]1002-37). Concentrations of constituents in the river water in the site vicinity do not exceed any of these standards or any of the Colorado State standards established for agricultural water use. No water-quality criteria have been established for the mitigation wetland. State surface water standards generally do not apply to constructed wetlands. For details about surface water quality, see Section 5.3.2 of the SOWP and Section 2.3.2 of this document.

The existing quality of surface water, including other sources of contamination and the cumulative impact on surface water quality. Water in the Colorado River in the vicinity of the site is designated high quality by the State of Colorado. The site has no measurable impact on the river water quality. Water in the vicinity of the site is indistinguishable from background Colorado River water. Water quality in the mitigation wetland and the former gravel ponds is currently of poor quality but will improve over time as natural attenuation decreases contaminant concentrations in the groundwater.

The potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to constituents. The ecological risk assessment (Section 2.3.2 of this document) indicates that risks to wildlife from exposure to contaminated water at the wetland area and the gravel ponds are low. There is no potential damage associated with the Colorado River because site contamination has no measureable impact on the Colorado River water quality. Vegetation in the mitigation wetland is currently of limited diversity but will become more diverse as water quality improves through natural attenuation process. ICs are in place to prevent use of the ponds for agricultural purposes. Surface water contamination should not damage any physical structures that may contact it.

The persistence and permanence of potential adverse effects. No adverse effects are currently present, and none are expected in the future. Pond water quality should improve as more mobile constituents continue to attenuate.

4.0 Corrective Action Assessment

A detailed corrective action assessment was included in Section 8.4.3 of the SOWP.

4.1 Results of Corrective Action Program

The primary corrective action taken at the New Rifle site was source removal. Residual soil and groundwater contamination at the New Rifle site was addressed by a pilot study to examine the feasibility of extracting and treating vanadium-contaminated groundwater. Monitoring conducted during the pilot study showed no decrease in vanadium concentration in groundwater after the extraction of nearly 3 million gallons of groundwater. There were no problems in extracting the target volumes of water, and the water could be effectively treated. However, the lack of any reduction in concentration indicates that continued extraction would not be likely to meet target cleanup goals in onsite areas or could require an extraordinary effort.

4.2 Feasibility of Alternate Corrective Actions

Alternate actions focused on groundwater extraction technology would not be likely to remove vanadium to the extent needed to restore groundwater. At least in the vicinity of the mill site, the existence of secondary source material makes any groundwater treatment option unlikely to succeed.

4.3 Corrective Action Costs

Costs to operate the pilot study were estimated based on one year of operation. Pilot study results indicated that costs over time would drop and level off at around $100/1000 gallons (in 2001 dollars). Costs include zero-valent iron, chemicals, waste disposal, labor, and utilities. On the basis of results at other similar sites, a system would need to operate indefinitely, and treatment goals may never be achieved.

4.4 Corrective Action Benefits

Background water quality is elevated above standards in sulfate, uranium, manganese, and iron. Therefore, in light of already somewhat poor water quality, the removal of site-related contamination is unlikely to provide significant benefit. If a landowner wishes to use groundwater, some type of treatment would be likely needed even in the absence of site-related contamination. Site-related contaminants could also be removed in the same manner. Currently the city requires homeowners and businesses to connect to the municipal water supply system.

4.5 As Low as Reasonably Achievable (ALARA) Demonstration

Source removal resulted in significant reductions in groundwater contamination. Table 3 provides a comparison of historic and recent results from sampling of wells downgradient of the site. Maximum concentrations of contaminants observed downgradient of the site are all currently lower than observed prior to surface remediation. Time–concentration plots (Attachment 1) show significant declines in concentration for most onsite and immediately downgradient wells. The pilot study results for vanadium indicate that the ability to further decrease concentrations of the more immobile constituents in limited. The more mobile constituents have declined naturally over time and will continue to do so in the future. It can be concluded that current constituent concentrations are as low as reasonably achievable, given the limited beneficial use of the groundwater.

Table 3. Comparison of Historic and Recent Monitoring Results for Wells Downgradient of the New Rifle Site

Contaminant	UMTRCA Groundwater Standard (mg/L)	Maximum Historic Downgradient Concentration (mg/L)[a]	Maximum Observed in Downgradient Groundwater in 2015[b] (mg/L)
Arsenic	0.05	2.39	0.0018
Molybdenum	0.1	8.38	1.7
Nitrate (as N)	10	231[c]	22
Selenium	0.01	0.809	0.045
Uranium	0.044	0.447	0.16
Vanadium	NA	9.86	2.3

Notes:
[a] Data from the Remedial Action Plan (DOE 1992).
[b] Includes wells RFN-0201, RFN-0217, RFN-0590, and RFN-0635.
[c] Assumes nitrate in RAP reported as NO_3.

Abbreviation:
NA = not applicable

5.0 Proposed Alternate Concentration Limits

5.1 Proposed Alternate Concentration Limits

There is no guidance that specifically addresses the development of ACLs for UMTRCA Title I sites. In the final rule for the UMTRCA groundwater standards (60 *Federal Register* [FR] 2854), EPA refers to existing ACL guidance for NRC Title II sites (NRC 1996) as well as EPA guidance developed for RCRA sites (EPA 1987). Those guidance documents were used to the extent that they apply to conditions at the New Rifle site.

5.1.1 Area Requiring Alternate Concentration Limits

In general, the concept of ACLs was developed for application at a POC located at the downgradient edge of a "waste management unit" (e.g., a tailings disposal cell) where releases have resulted, or are expected to result, in groundwater contamination. In accordance with NRC regulations (10 CFR 40, Appendix A),

> The objective in selecting the point of compliance is to provide the earliest practicable warning that the impoundment is releasing hazardous constituents to the groundwater. The point of compliance must be selected to provide prompt indication of groundwater contamination on the hydraulically downgradient edge of the disposal area.

Concentrations above otherwise applicable standards are established for the POC that will be protective at some downgradient POE where access to contaminated groundwater is possible (often this is considered to be the facility boundary). Groundwater contamination attenuates between the POC and the POE such that likely exposures at the POE are protective. The type and degree of exposure at the POE is dependent on site-specific factors such as local land and water use, ambient water quality, etc. Institutional controls are generally required for the area from the waste management unit downgradient to the POE. In theory, as long as ACLs are not exceeded at the POC, groundwater concentrations at the POE will remain protective.

At the New Rifle site there is no formal waste management unit. Tailings, sludges, and other materials with concentrations above the radium-226 cleanup standard were removed from the site for offsite disposal. However, an investigation of residual soil contamination in the former gypsum and vanadium pond areas (Figure 2) indicated that considerable residual contamination remains in site soils (DOE 2000). Soil contamination also remains in the footprint of the former tailings pile, ore storage area, and evaporation pond (DOE 1999; Figure 2 and Figure 3). Wells RFN-0855 and RFN-0658, which are located in the footprint of the vanadium pond, have exhibited the most highly elevated groundwater concentrations over the years. POC wells should be located downgradient of these source areas. Wells 0664, 0669, 0659, and 0217 are located just outside and downgradient of the secondary source areas and are proposed as POC wells for the site.

Wells upgradient of the POC locations in the source areas may have concentrations above the established ACLs, but these concentrations should decline to the ACLs by the time groundwater reaches the POCs. Groundwater concentrations downgradient of the POC wells should be less than the established ACLs, but may be elevated above otherwise applicable standards (e.g., MCLs). Because institutional controls prevent the use of untreated groundwater at all downgradient locations, there are no actual groundwater POEs at the New Rifle site. However, it is proposed that the area requiring alternate standards extend only as far downgradient as well RFN-0195; MCLs or background will be met beyond this location. As demonstrated above, there is no indication that significant site-related contamination currently occurs downgradient of this location. The proposed POEs are where groundwater discharges to surface water—in the former gravel pits and the Colorado River.

5.1.2 Determining Numerical Values for ACLs

See Section 3.3 of the GCAP.

5.2 Proposed Implementation Measures

DOE proposes to continue to monitor site groundwater and institutional controls to ensure the remedy remains protective. Figure 4 shows the groundwater and surface water locations included in the New Rifle site monitoring network. Wells RFN-0664, RFN-0669, RFN-0659, and RFN-0217 have been designated as POC wells that must maintain compliance with ACLs. Sampling and analysis is conducted according to procedures in the *Sampling and Analysis Plan for U.S. Department of Energy Office of Legacy Management Sites* (LMS/PRO/S04351).

Background locations have been sampled in the past to determine the degree of natural variability of COCs. Background locations have included well 0169 and Old Rifle wells RFO-0292A and RFO-0658. Seep location RFO-0395 at the Old Rifle site is also considered a background location. The background data set is believed to be adequate at present. It is proposed that background monitoring be discontinued for the time being; however, background wells 0169, RFO-0292A, and RFO-0658 will be retained in the event that additional background data are deemed necessary in the future.

Surface water locations to be monitored include pond and wetland locations RFN-0320, RFN-0322, RFN-0323, RFN-0324, RFN-0452, RFN-0453, and RFN-0575. These are considered to be point-of-exposure locations. Water quality will also be monitored in the Colorado River at upstream location RFO-0538 and at downstream locations RFN-0322 and RFN-0324. All COCs are analyzed at surface locations with the same regularity as POC wells to verify that groundwater concentrations are protective where it discharges to surface water.

Sampling of each well and surface location will take place annually for the first 5 years following regulators' concurrence with the GCAP. After the first 5 years of monitoring, DOE will evaluate the monitoring results and adjust the monitoring strategy as appropriate. It is expected that a reduction in further monitoring may be justified, with the possible exception of POC wells and surface locations. A frequency of once every 3–5 years for a period of 30 years may be adequate. Downgradient wells will be analyzed for ammonia, nitrate, molybdenum, and uranium only, as the other COCs, arsenic, selenium and vanadium, have never been detected in these wells. Far-downgradient wells RFN-0172 and RFN-0620 may be eliminated or monitored less frequently. If future monitoring results indicate that contaminants have begun to spread beyond the current plume boundaries, or if some other unexpected changes in contaminant trends are noted, the sampling plan will also be reevaluated and adjusted at that time. As part of the monitoring program, DOE will also evaluate the effectiveness of the ICs on a regular basis (see Section 3.0). Monitoring requirements are summarized in Table 4 along with the rationales for the monitoring locations.

Table 4. Summary of Monitoring Requirements

Locations	Monitoring Purpose	Analytes	Frequency
RFN-0215, RFN-0216, RFN-0658, RFN-0659, RFN-0664, RFN-0669, RFN-0670, RFN-0855	**Onsite wells**: monitor COCs flushing in main body of site.	Ammonia, molybdenum, nitrate (as N), uranium, vanadium, selenium, and arsenic	All wells and locations, annually for first 5 years after GCAP accepted. Monitoring requirements will be reevaluated at that time.
RFN-0201, RFN-0217, RFN-0590, RFN-0635	**Adjacent to site wells**: monitor COCs flushing downgradient of main site.	Ammonia, molybdenum, nitrate (as N), uranium, vanadium, selenium, and arsenic	
RFN-0170, RFN-0172, RFN-0195, RFN-620	**Downgradient wells**: monitor COCs that have traveled farthest offsite.	Ammonia, molybdenum, nitrate (as N), and uranium	
RFN-0320, RFN-0322, RFN-0323, RFN-0324, RFN-0452, RFN-0453, RFO-538, RFN-0575	**Surface water:** monitor surface water to determine impact of groundwater discharge to surface water and ecological receptors; RFO-538 is an upgradient river location at the Old Rifle site.	Ammonia, molybdenum, nitrate (as N), uranium, vanadium, selenium, and arsenic	

6.0 References

5 CCR 1002-31. Colorado Department of Public Health and Environment Water Quality Control Commission, Regulation No. 31, "The Basic Standards and Methodologies for Surface Water," *Code of Colorado Regulations.*

5 CCR 1002-37. Colorado Department of Public Health and Environment Water Quality Control Commission, Regulation No. 37, "Classifications and Numeric Standards for Lower Colorado River Basin," *Code of Colorado Regulations.*

5 CCR 1002-41. Colorado Department of Public Health and Environment Water Quality Control Commission, Regulation No. 41, "The Basic Standards for Ground Water," *Code of Colorado Regulations.*

10 CFR 40. U.S. Nuclear Regulatory Commission, "Domestic Licensing of Source Material," *Code of Federal Regulations*, January 1, 2008.

40 CFR 192. U.S. Environmental Protection Agency, "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings," *Code of Federal Regulations*, July 1, 2008.

60 FR 2854, 1995. U.S. Environmental Protection Agency, "Groundwater Standards for Remedial Actions at Inactive Uranium Processing Sites," *Federal Register,* January 11, 1995.

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Appendix D

ProUCL Statistical Results

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Background Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	6/6/2016 11:50
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Coverage	95%
New or Future K Observations	1
Number of Bootstrap Operations	2000

658-Nitrate-N

General Statistics			
Total Number of Observations	33	Number of Distinct Observations	32
Minimum	0.31	First Quartile	3.7
Second Largest	74	Median	13.17
Maximum	75	Third Quartile	29.14
Mean	19.84	SD	21.19
Coefficient of Variation	1.068	Skewness	1.322
Mean of logged Data	2.229	SD of logged Data	1.459
Critical Values for Background Threshold Values (BTVs)			
Tolerance Factor K (For UTL)	2.176	d2max (for USL)	2.787
Normal GOF Test			
Shapiro Wilk Test Statistic	0.824	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.931	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.178	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.154	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Background Statistics Assuming Normal Distribution			
95% UTL with 95% Coverage	65.95	90% Percentile (z)	47
95% UPL (t)	56.27	95% Percentile (z)	54.7
95% USL	78.89	99% Percentile (z)	69.14
Gamma GOF Test			
A-D Test Statistic	0.41	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.786	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.152	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.159	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	0.784	k star (bias corrected MLE)	0.733
Theta hat (MLE)	25.3	Theta star (bias corrected MLE)	27.06
nu hat (MLE)	51.76	nu star (bias corrected)	48.39
MLE Mean (bias corrected)	19.84	MLE Sd (bias corrected)	23.17
Background Statistics Assuming Gamma Distribution			
95% Wilson Hilferty (WH) Approx. Gamma UPL	67.46	90% Percentile	49.26
95% Hawkins Wixley (HW) Approx. Gamma UPL	72.63	95% Percentile	66.41
95% WH Approx. Gamma UTL with 95% Coverage	93.09	99% Percentile	107.2
95% HW Approx. Gamma UTL with 95% Coverage	105.1		
95% WH USL	136.5	95% HW USL	164.3
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.943	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.931	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.127	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.154	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Background Statistics assuming Lognormal Distribution			
95% UTL with 95% Coverage	222.2	90% Percentile (z)	60.25
95% UPL (t)	114.1	95% Percentile (z)	102.4
95% USL	541.4	99% Percentile (z)	276.6
Nonparametric Distribution Free Background Statistics			
Data appear Gamma Distributed at 5% Significance Level			
Nonparametric Upper Limits for Background Threshold Values			
Order of Statistic, r	33	95% UTL with 95% Coverage	75
Approximate f	1.737	Confidence Coefficient (CC) achieved by UTL	0.816
95% Percentile Bootstrap UTL with 95% Coverage	75	95% BCA Bootstrap UTL with 95% Coverage	75
95% UPL	74.3	90% Percentile	50.36
90% Chebyshev UPL	84.37	95% Percentile	65.79
95% Chebyshev UPL	113.6	99% Percentile	74.68
95% USL	75		

Note: The use of USL to estimate a BTV is recommended only when the data set represents a background data set free of outliers and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data represents a background data set and when many onsite observations need to be compared with the BTV.

658-Uranium

General Statistics			
Total Number of Observations	34	Number of Distinct Observations	33
Minimum	0.025	First Quartile	0.0611
Second Largest	0.354	Median	0.159
Maximum	0.364	Third Quartile	0.269
Mean	0.169	SD	0.109
Coefficient of Variation	0.647	Skewness	0.327
Mean of logged Data	-2.034	SD of logged Data	0.779
Critical Values for Background Threshold Values (BTVs)			
Tolerance Factor K (For UTL)	2.166	d2max (for USL)	2.799
Normal GOF Test			
Shapiro Wilk Test Statistic	0.894	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.933	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.191	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.152	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Background Statistics Assuming Normal Distribution			
95% UTL with 95% Coverage	0.406	90% Percentile (z)	0.31
95% UPL (t)	0.357	95% Percentile (z)	0.349
95% USL	0.476	99% Percentile (z)	0.424
Gamma GOF Test			
A-D Test Statistic	1.141	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.759	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.174	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.153	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	2.091	k star (bias corrected MLE)	1.926
Theta hat (MLE)	0.0809	Theta star (bias corrected MLE)	0.0879
nu hat (MLE)	142.2	nu star (bias corrected)	131
MLE Mean (bias corrected)	0.169	MLE Sd (bias corrected)	0.122
Background Statistics Assuming Gamma Distribution			
95% Wilson Hilferty (WH) Approx. Gamma UPL	0.416	90% Percentile	0.332
95% Hawkins Wixley (HW) Approx. Gamma UPL	0.43	95% Percentile	0.406
95% WH Approx. Gamma UTL with 95% Coverage	0.521	99% Percentile	0.571
95% HW Approx. Gamma UTL with 95% Coverage	0.551		
95% WH USL	0.697	95% HW USL	0.763
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.9	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.933	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.152	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.152	Data Not Lognormal at 5% Significance Level	
Data Not Lognormal at 5% Significance Level			
Background Statistics assuming Lognormal Distribution			
95% UTL with 95% Coverage	0.707	90% Percentile (z)	0.355
95% UPL (t)	0.498	95% Percentile (z)	0.471
95% USL	1.158	99% Percentile (z)	0.801
Nonparametric Distribution Free Background Statistics			
Data do not follow a Discernible Distribution (0.05)			
Nonparametric Upper Limits for Background Threshold Values			
Order of Statistic, r	34	95% UTL with 95% Coverage	0.364
Approximate f	1.789	Confidence Coefficient (CC) achieved by UTL	0.825
95% Percentile Bootstrap UTL with 95% Coverage	0.364	95% BCA Bootstrap UTL with 95% Coverage	0.364
95% UPL	0.357	90% Percentile	0.316
90% Chebyshev UPL	0.502	95% Percentile	0.353
95% Chebyshev UPL	0.653	99% Percentile	0.361
95% USL	0.364		

Note: The use of USL to estimate a BTV is recommended only when the data set represents a background data set free of outliers and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data represents a background data set and when many onsite observations need to be compared with the BTV.

658-Arsenic

General Statistics			
Total Number of Observations	32	Number of Distinct Observations	30
Minimum	0.0292	First Quartile	0.0634
Second Largest	0.304	Median	0.088
Maximum	0.313	Third Quartile	0.135
Mean	0.11	SD	0.0712
Coefficient of Variation	0.649	Skewness	1.577
Mean of logged Data	-2.381	SD of logged Data	0.585
Critical Values for Background Threshold Values (BTVs)			
Tolerance Factor K (For UTL)	2.186	d2max (for USL)	2.773
Normal GOF Test			
Shapiro Wilk Test Statistic	0.832	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.93	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.217	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.157	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Background Statistics Assuming Normal Distribution			
95% UTL with 95% Coverage	0.266	90% Percentile (z)	0.201
95% UPL (t)	0.232	95% Percentile (z)	0.227
95% USL	0.307	99% Percentile (z)	0.276
Gamma GOF Test			
A-D Test Statistic	0.523	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.753	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.141	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.157	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	3.062	k star (bias corrected MLE)	2.796
Theta hat (MLE)	0.0358	Theta star (bias corrected MLE)	0.0393
nu hat (MLE)	196	nu star (bias corrected)	179
MLE Mean (bias corrected)	0.11	MLE Sd (bias corrected)	0.0656
Background Statistics Assuming Gamma Distribution			
95% Wilson Hilferty (WH) Approx. Gamma UPL	0.238	90% Percentile	0.198
95% Hawkins Wixley (HW) Approx. Gamma UPL	0.241	95% Percentile	0.235
95% WH Approx. Gamma UTL with 95% Coverage	0.292	99% Percentile	0.316
95% HW Approx. Gamma UTL with 95% Coverage	0.299		
95% WH USL	0.369	95% HW USL	0.386
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.978	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.93	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.102	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.157	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Background Statistics assuming Lognormal Distribution			
95% UTL with 95% Coverage	0.332	90% Percentile (z)	0.196
95% UPL (t)	0.253	95% Percentile (z)	0.242
95% USL	0.468	99% Percentile (z)	0.36
Nonparametric Distribution Free Background Statistics			
Data appear Gamma Distributed at 5% Significance Level			
Nonparametric Upper Limits for Background Threshold Values			
Order of Statistic, r	32	95% UTL with 95% Coverage	0.313
Approximate f	1.684	Confidence Coefficient (CC) achieved by UTL	0.806
95% Percentile Bootstrap UTL with 95% Coverage	0.313	95% BCA Bootstrap UTL with 95% Coverage	0.313
95% UPL	0.307	90% Percentile	0.207
90% Chebyshev UPL	0.327	95% Percentile	0.264
95% Chebyshev UPL	0.425	99% Percentile	0.31
95% USL	0.313		

Note: The use of USL to estimate a BTV is recommended only when the data set represents a background data set free of outliers and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data represents a background data set and when many onsite observations need to be compared with the BTV.

658-Selenium

General Statistics			
Total Number of Observations	30	Number of Distinct Observations	26
Minimum	0.0671	First Quartile	0.125
Second Largest	1.3	Median	0.496
Maximum	1.43	Third Quartile	0.909
Mean	0.567	SD	0.441
Coefficient of Variation	0.778	Skewness	0.367
Mean of logged Data	-0.995	SD of logged Data	1.038
Critical Values for Background Threshold Values (BTVs)			
Tolerance Factor K (For UTL)	2.22	d2max (for USL)	2.745
Normal GOF Test			
Shapiro Wilk Test Statistic	0.882	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.927	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.18	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.162	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Background Statistics Assuming Normal Distribution			
95% UTL with 95% Coverage	1.546	90% Percentile (z)	1.132
95% UPL (t)	1.329	95% Percentile (z)	1.292
95% USL	1.777	99% Percentile (z)	1.593
Gamma GOF Test			
A-D Test Statistic	1.233	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.768	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.184	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.164	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	1.312	k star (bias corrected MLE)	1.203
Theta hat (MLE)	0.432	Theta star (bias corrected MLE)	0.471
nu hat (MLE)	78.73	nu star (bias corrected)	72.19
MLE Mean (bias corrected)	0.567	MLE Sd (bias corrected)	0.517
Background Statistics Assuming Gamma Distribution			
95% Wilson Hilferty (WH) Approx. Gamma UPL	1.646	90% Percentile	1.247
95% Hawkins Wixley (HW) Approx. Gamma UPL	1.737	95% Percentile	1.592
95% WH Approx. Gamma UTL with 95% Coverage	2.203	99% Percentile	2.382
95% HW Approx. Gamma UTL with 95% Coverage	2.41		
95% WH USL	2.922	95% HW USL	3.325
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.878	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.927	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.198	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.162	Data Not Lognormal at 5% Significance Level	
Data Not Lognormal at 5% Significance Level			
Background Statistics assuming Lognormal Distribution			
95% UTL with 95% Coverage	3.705	90% Percentile (z)	1.399
95% UPL (t)	2.221	95% Percentile (z)	2.039
95% USL	6.39	99% Percentile (z)	4.137
Nonparametric Distribution Free Background Statistics			
Data do not follow a Discernible Distribution (0.05)			
Nonparametric Upper Limits for Background Threshold Values			
Order of Statistic, r	30	95% UTL with 95% Coverage	1.43
Approximate f	1.579	Confidence Coefficient (CC) achieved by UTL	0.785
95% Percentile Bootstrap UTL with 95% Coverage	1.43	95% BCA Bootstrap UTL with 95% Coverage	1.372
95% UPL	1.359	90% Percentile	1.2
90% Chebyshev UPL	1.912	95% Percentile	1.255
95% Chebyshev UPL	2.521	99% Percentile	1.392
95% USL	1.43		

Note: The use of USL to estimate a BTV is recommended only when the data set represents a background data set free of outliers and consists of observations collected from clean unimpacted locations.
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658-Vanadium

General Statistics			
Total Number of Observations	35	Number of Distinct Observations	31
Minimum	3.55	First Quartile	11.1
Second Largest	49.7	Median	15.4
Maximum	52	Third Quartile	27
Mean	19.85	SD	12.35
Coefficient of Variation	0.622	Skewness	1.064
Mean of logged Data	2.797	SD of logged Data	0.649
Critical Values for Background Threshold Values (BTVs)			
Tolerance Factor K (For UTL)	2.157	d2max (for USL)	2.812
Normal GOF Test			
Shapiro Wilk Test Statistic	0.903	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.934	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.155	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.15	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Background Statistics Assuming Normal Distribution			
95% UTL with 95% Coverage	46.48	90% Percentile (z)	35.67
95% UPL (t)	41.02	95% Percentile (z)	40.16
95% USL	54.56	99% Percentile (z)	48.57
Gamma GOF Test			
A-D Test Statistic	0.196	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.755	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.0934	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.15	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	2.769	k star (bias corrected MLE)	2.551
Theta hat (MLE)	7.168	Theta star (bias corrected MLE)	7.781
nu hat (MLE)	193.8	nu star (bias corrected)	178.6
MLE Mean (bias corrected)	19.85	MLE Sd (bias corrected)	12.43
Background Statistics Assuming Gamma Distribution			
95% Wilson Hilferty (WH) Approx. Gamma UPL	44.38	90% Percentile	36.5
95% Hawkins Wixley (HW) Approx. Gamma UPL	45.34	95% Percentile	43.68
95% WH Approx. Gamma UTL with 95% Coverage	54.16	99% Percentile	59.39
95% HW Approx. Gamma UTL with 95% Coverage	56.25		
95% WH USL	71.14	95% HW USL	75.87
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.981	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.934	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0792	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.15	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Background Statistics assuming Lognormal Distribution			
95% UTL with 95% Coverage	66.43	90% Percentile (z)	37.64
95% UPL (t)	49.86	95% Percentile (z)	47.65
95% USL	101.6	99% Percentile (z)	74.13
Nonparametric Distribution Free Background Statistics			
Data appear Gamma Distributed at 5% Significance Level			
Nonparametric Upper Limits for Background Threshold Values			
Order of Statistic, r	35	95% UTL with 95% Coverage	52
Approximate f	1.842	Confidence Coefficient (CC) achieved by UTL	0.834
95% Percentile Bootstrap UTL with 95% Coverage	52	95% BCA Bootstrap UTL with 95% Coverage	52
95% UPL	50.16	90% Percentile	35.2
90% Chebyshev UPL	57.41	95% Percentile	45.78
95% Chebyshev UPL	74.43	99% Percentile	51.22
95% USL	52		

Note: The use of USL to estimate a BTV is recommended only when the data set represents a background data set free of outliers and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data represents a background data set and when many onsite observations need to be compared with the BTV.

658-Molybdenum

General Statistics			
Total Number of Observations	33	Number of Distinct Observations	32
Minimum	0.67	First Quartile	1.5
Second Largest	6.84	Median	4.3
Maximum	7.3	Third Quartile	5.9
Mean	3.798	SD	2.195
Coefficient of Variation	0.578	Skewness	-0.11
Mean of logged Data	1.097	SD of logged Data	0.773
Critical Values for Background Threshold Values (BTVs)			
Tolerance Factor K (For UTL)	2.176	d2max (for USL)	2.787
Normal GOF Test			
Shapiro Wilk Test Statistic	0.887	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.931	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.161	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.154	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Background Statistics Assuming Normal Distribution			
95% UTL with 95% Coverage	8.574	90% Percentile (z)	6.611
95% UPL (t)	7.572	95% Percentile (z)	7.409
95% USL	9.915	99% Percentile (z)	8.904
Gamma GOF Test			
A-D Test Statistic	1.585	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.758	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.204	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.155	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	2.262	k star (bias corrected MLE)	2.077
Theta hat (MLE)	1.679	Theta star (bias corrected MLE)	1.829
nu hat (MLE)	149.3	nu star (bias corrected)	137.1
MLE Mean (bias corrected)	3.798	MLE Sd (bias corrected)	2.636
Background Statistics Assuming Gamma Distribution			
95% Wilson Hilferty (WH) Approx. Gamma UPL	9.128	90% Percentile	7.322
95% Hawkins Wixley (HW) Approx. Gamma UPL	9.512	95% Percentile	8.903
95% WH Approx. Gamma UTL with 95% Coverage	11.4	99% Percentile	12.4
95% HW Approx. Gamma UTL with 95% Coverage	12.15		
95% WH USL	14.97	95% HW USL	16.5
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.858	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.931	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.224	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.154	Data Not Lognormal at 5% Significance Level	
Data Not Lognormal at 5% Significance Level			
Background Statistics assuming Lognormal Distribution			
95% UTL with 95% Coverage	16.1	90% Percentile (z)	8.066
95% UPL (t)	11.31	95% Percentile (z)	10.68
95% USL	25.8	99% Percentile (z)	18.08
Nonparametric Distribution Free Background Statistics			
Data do not follow a Discernible Distribution (0.05)			
Nonparametric Upper Limits for Background Threshold Values			
Order of Statistic, r	33	95% UTL with 95% Coverage	7.3
Approximate f	1.737	Confidence Coefficient (CC) achieved by UTL	0.816
95% Percentile Bootstrap UTL with 95% Coverage	7.3	95% BCA Bootstrap UTL with 95% Coverage	7.3
95% UPL	6.978	90% Percentile	6.248
90% Chebyshev UPL	10.48	95% Percentile	6.516
95% Chebyshev UPL	13.51	99% Percentile	7.153
95% USL	7.3		

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