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US Department of Energy, Office of Legacy Management
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SUBJECT: Final Groundwater Contingency Remedy Optimization Remedial Design/Remedial Action Work Plan for the Monticello Mill Tailings Site Operable Unit III, Monticello, Utah

Dear Mr. Nguyen:

Thank you for submitting the Final Groundwater Contingency Remedy Optimization Remedial Design/Remedial Action Work Plan for the Monticello Mill Tailings Site Operable Unit III, Monticello, Utah, dated May 2014.

The US Environmental Protection Agency (EPA), in consultation with the State of Utah/UDEQ-DERR, approves this document as submitted.

Should you have questions on this matter, please contact me at 303/312-6981 or at moritz.vera@epa.gov.

Sincerely,

Vera Moritz
Federal Facilities Program
Office of Ecosystems Protection and Remediation

cc. Michael Storck, UDEQ

LMS/MNT/S10629

Final Groundwater Contingency Remedy Optimization Remedial Design/Remedial Action Work Plan for the Monticello Mill Tailings Site Operable Unit III, Monticello, Utah

May 2014

U.S. DEPARTMENT OF ENERGY | Legacy Management

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LMS/MNT/S10629

Final

Groundwater Contingency Remedy Optimization Remedial Design/Remedial Action Work Plan for the Monticello Mill Tailings Site Operable Unit III, Monticello, Utah

May 2014

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Abbreviations

AOA	Area of Attainment
ARAR	applicable or relevant and appropriate requirement
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
ESD	Explanation of Significant Difference
FFA	Federal Facility Agreement
FS	Feasibility Study
ft	foot (feet)
gpm	gallons per minute
HDPE	high density polyethylene
JSA	job safety analysis
LM	Office of Legacy Management
LMS	Legacy Management Support (contractor)
MCL	(EPA) maximum contaminant level
µg/L	microgram(s) per liter
MMTS	Monticello Mill Tailings Site
NEPA	National Environmental Policy Act
OU	Operable Unit
pCi/L	picocurie(s) per liter
PRB	permeable reactive barrier
PVC	polyvinyl chloride
RA	Remedial Action
RD	Remedial Design
RI	Remedial Investigation
ROD	Record of Decision
RQs	reportable quantities
SOARS	System Operation and Analysis at Remote Sites
UDEQ	Utah Department of Environmental Quality

Executive Summary

This Remedial Design/Remedial Action work plan presents the conceptual design and implementation process to optimize the contingency groundwater remedy at Operable Unit (OU) III of the Monticello Mill Tailings Site (MMTS), located in Monticello, Utah. MMTS is a Comprehensive Environmental Response, Compensation, and Liability Act National Priorities List site that is administered by the U.S. Department of Energy (DOE) Office of Legacy Management (LM). OU III of the MMTS is comprised of surface water and groundwater that became contaminated as a result of uranium- and vanadium-ore processing at the former Monticello mill (mill site). The alluvial aquifer is classified under the Utah Safe Drinking Water Act as a potential source of drinking water Class II, Drinking Water Quality.

The OU III Record of Decision (ROD; June 2004) selected monitored natural attenuation with institutional controls as the OU III remedy. Potential risk to human health is from hypothetical domestic-use ingestion of groundwater; however, there is no current or anticipated risk to human health from exposure to contaminated groundwater because of incomplete exposure pathways: the affected aquifer has no historical record of domestic use, alternate water sources are available, and institutional controls (implemented in 1999 and administered by the Utah State Engineer's Office) are in place to restrict use of contaminated groundwater. Per EPA, institutional controls are not intended to replace permanent remedies. However, because groundwater restoration progress did not meet ROD-specified performance metrics, DOE responded with a contingency remedy to include active remediation, as documented in a March 2009 Explanation of Significant Difference.

That approach adopted an existing active remediation system, installed in 2005 as a technology demonstration project, into the remedy. This ex situ treatment system, consisting of one groundwater extraction well and two aboveground vessels containing zero-valent iron as the treatment medium, functions as designed but is not effective for remediating the defined area of attainment (AOA). This is because the extraction well does not capture the main area of contamination and the treatment capacity of the system is limited by the allowed rate of discharge of treated water to surface water (Montezuma Creek). The groundwater remedy will therefore be optimized by expanding pump-and-treat remediation in the AOA, where hydrogeologic boundaries and elevated concentrations of uranium in groundwater are both well defined. This plan focuses on (1) administrative and technical issues associated with the rationale, design, and installation of the optimized groundwater remedy and (2) basic aspects of system operation, monitoring, and reporting.

LM will optimize the groundwater remedy by installing a network of eight vertical extraction wells strategically placed in the AOA. Well placement will target the greatest saturated thickness of the aquifer and highest uranium concentrations in order to maximize uranium recovery from the AOA (located on private property). Contaminated groundwater extracted from these wells will be transmitted for evaporative treatment in a buried pipeline (to be constructed mainly on City-owned property) to an existing evaporation pond (Pond 4) located on DOE property about 1 mile south of the AOA. Pond 4 was constructed to manage leachate from the disposal cell, which encapsulates mill tailings and contaminated soil derived from the remediation of the former mill site and nearby properties. The operating capacity of Pond 4 (16 million gallons) far exceeds current and projected disposal cell leachate management needs.

The remedy optimization system is designed for year-round operation. Operation of the remedy optimization will be cyclical: the portion of the AOA that contains the bulk of the uranium contamination will be dewatered through aggressive groundwater extraction; extraction will then cease until the aquifer is recharged by ambient sources (creek loss and groundwater underflow for the west) to allow resumed pumping. This approach will enable a more accurate assessment of pore volume capture and replacement compared to a steady state pumping strategy.

The remedy optimization will be monitored frequently (every 1 million gallons of groundwater extracted) for water quality parameters and groundwater levels to assess removal of uranium mass, concentration trends, and the groundwater capture zone. Monitoring results will be reported twice yearly. This work plan does not specify metrics for assessing system performance in reducing uranium concentrations and does not propose the duration of the remedial action; however, these considerations will be addressed in separate documentation to be prepared at a later date following collection and evaluation of performance data. Progress of the remedy optimization will be evaluated in annual reports and evaluated for protectiveness to human health and the environment in CERCLA 5-year reviews. Section 9.0 of this work plan provides greater detail on remedy evaluation.

Despite the aggressive approach proposed in this work plan to remediate a well-defined area of the aquifer, DOE recognizes that restoring the aquifer to current remediation goals may not be feasible in a reasonable time (within 50 years as defined in the OU III ROD for natural attenuation). Possible limitations, described later in this work plan, include uranium concentrations tailing-off at a level in excess of the remediation goal, limited recharge of clean groundwater to the AOA, and Pond 4 infrastructure longevity. Possible future alternative remedies include applying alternate concentration limits; waiving a remediation goal or goals based on reasons of technical impracticability; and restoring natural attenuation conditions by removing the permeable reactive barrier, which presently restricts groundwater flow.

1.0 Introduction and Objective

This Remedial Design (RD)/Remedial Action (RA) work plan presents the remedy approach, conceptual design, and implementation process to optimize the groundwater contingency remedy at Operable Unit (OU) III of the Monticello Mill Tailings Site (MMTS), located in Monticello, Utah (Figure 1). MMTS is a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) National Priorities List site administered by the U.S. Department of Energy (DOE) Office of Legacy Management (LM). OU III comprises surface water and groundwater that became contaminated as a result of uranium- and vanadium-ore processing at the former Monticello mill (mill site). Groundwater remediation at OU III focuses on restoration of water quality in the shallow alluvial aquifer and in surface water. The alluvial aquifer is classified as a potential source of drinking water under the Utah Safe Drinking Water Act as Class II, Drinking Water Quality.

The groundwater remedy will be optimized by expanding the existing pump-and-treat remediation system in a well-defined area of the aquifer [AOA], as defined in Section 2.1. This plan focuses on (1) administrative and technical issues associated with the rationale, design, and installation of the optimized groundwater remedy and (2) basic aspects of system operation, monitoring, and reporting. The objective of the OU III contingency remedy optimization is to attain the maximum contaminant level (MCL)-based groundwater quality remediation goal for uranium of 30 micrograms per liter (µg/L) in the AOA. Aquifer restoration time will be projected based on monitoring results and performance evaluation during operation of the remediation system.

The contingency remedy optimization is being implemented because prior groundwater restoration progress did not meet performance metrics specified in the OU III Record of Decision (ROD; DOE 2004a). DOE therefore responded with a contingency remedy approach to include active remediation, as documented in a March 2009 Explanation of Significant Difference (ESD; DOE 2009a). Potential risk to human health is from a hypothetical scenario of domestic-use ingestion of the contaminated groundwater. However, there is no current or anticipated risk to human health from exposure to contaminated groundwater at OU III because the exposure pathway is incomplete: the affected aquifer has no historical record for use as a drinking water source, alternate water sources are available, and institutional controls (implemented in 1999 and administered by the Utah State Engineer's Office) are in place to restrict use of the contaminated groundwater. Per EPA, institutional controls are not intended to replace permanent remedies.

1.1 Site Description

MMTS comprises the 110-acre site of a former uranium- and vanadium-ore-processing mill and about 1,700 acres of surrounding private and municipal property. The mill generated approximately 2.5 million cubic yards of low-level radioactive waste (mill tailings) during its operation from 1942 to 1960. These mill tailings are the byproduct of crushing and extracting uranium and vanadium from local, naturally occurring ore deposits.

The mill tailings were impounded as slurries at four locations on the former mill site. Leaching of radioactive and other inorganic constituents in the tailings subsequently resulted in contamination of a shallow alluvial aquifer and local surface water (Montezuma Creek). Some mill tailings were transported from the former mill site by wind and surface water to contaminate adjoining, downwind, and downstream properties.

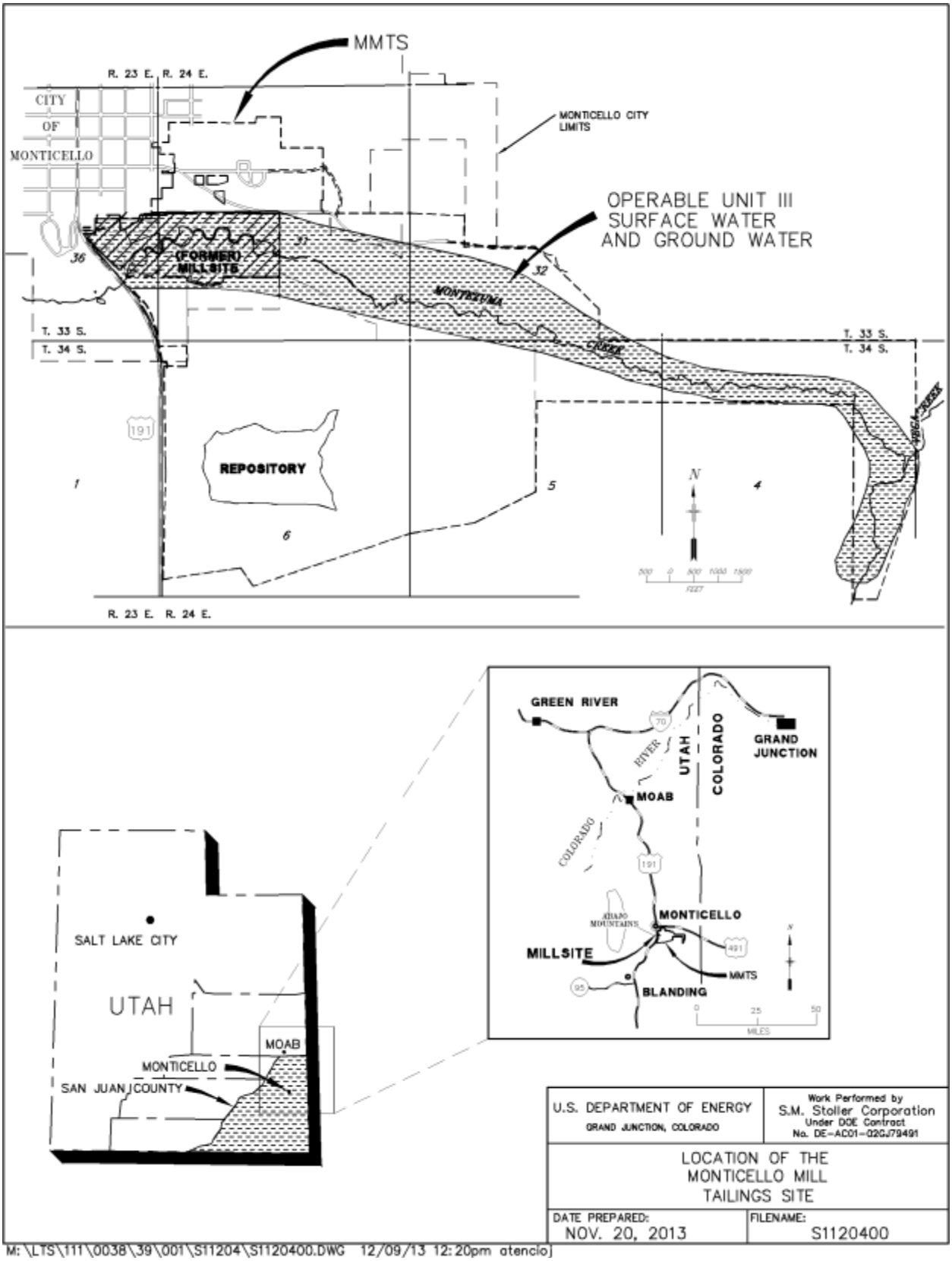

Figure 1. Location of OU III of the MMTS

Removal and disposal of the tailings and contaminated soil and sediment from the former mill site (OU I) and surrounding properties (OU II) was completed in 1999. These wastes were encapsulated in a repository that was constructed on DOE property about 1 mile south of the former mill site. Because of geographic, hydrologic, and engineered isolation of the material, wastes contained in the repository do not represent a potential continuing source of contamination to OU III groundwater.

1.2 OU III Remedial Action History

Activities to characterize environmental impacts on the OU III groundwater system began in 1982. These were followed in 1992 under a CERCLA-directed OU III Remedial Investigation (RI)/Feasibility Study (FS) (DOE 1998a). Subsequent CERCLA studies were conducted in accordance with an interim remedial action to assess environmental conditions following remedial actions completed under OU I and OU II. One component of the interim remedial action was to install an iron-based in situ permeable reactive barrier (PRB) in 1999 to evaluate the feasibility of this technology as a long-term remedy option.

Findings from these studies are documented in the OU III RI Addendum/Focused Feasibility Study (DOE 2004b). The cumulative findings led to the OU III ROD in 2004, which selected monitored natural attenuation with institutional controls as the OU III remedy; however, the PRB was not adopted as a formal remedy component because of its status as an unproven field-scale remediation techonology.

Water quality improvement did not subsequently meet ROD-established performance criteria, leading DOE, in concurrence with the U.S. Environmental Protection Agency (EPA) and the Utah Department of Environmental Quality (UDEQ), to implement a contingency remedy in March 2009 under an ESD. The ESD adopted an existing pump-and-treat remediation system (ex situ treatment system) as a contingency remedy component and identified the PRB as a groundwater containment structure.

The ex situ treatment system was installed in 2005 to complement an in situ permeable reactive barrier (PRB), installed in 1999. Both projects were conceived and implemented as technology demonstrations using zero-valent iron (ZVI) as the treatment medium. Mineral fouling and consequent loss in water transmission through the PRB provided the incentive to install the ex situ treatment system. Using a single extraction well, the ex situ treatment system targeted a groundwater mound that had developed upgradient of the PRB. An advantage of the ex situ treatment system compared to the in situ PRB was that it could be serviced from ground surface, which includes exchange of the ZVI.

The ex situ treatment system is effective in extracting and treating limited quantities of contaminated groundwater. However, it was not designed to remediate a significant portion of the aquifer, and because concentrations of uranium (the primary contaminant of concern) have not significantly declined in the surrounding aquifer, the effect of the ex situ system is probably very local. DOE will therefore optimize the groundwater remedy in the AOA according to the scope of work identified in this work plan and as consistent in concept with the requirements of the ROD and ESD.

1.3 Objectives and Remedy Optimization Concept

The objective of optimizing the OU III contingency remedy is to achieve the remediation goal for uranium (30 µg/L) in a specified AOA through active remediation using a more aggressive pump-and-treat technology. Uranium is the main contaminant of concern in OU III because it contributes most to potential risk to human health through the primary exposure path (domestic use of contaminated groundwater as a drinking water source). Uranium concentrations in the AOA (several hundred to a maximum of about 2,000 µg/L) generally have not decreased significantly since 1999, when remedial actions were completed to remove the source of contamination to the aquifer (mill tailings and contaminated soil and debris).

The AOA, along with other pertinent site features, is identified in Figure 2. The AOA is a subset of the full extent of uranium contamination in the shallow alluvial aquifer in OU III but encompasses the greatest concentration of uranium and has well-defined hydrologic boundaries (see Section 2.1 for the boundary descriptions). These are favorable conditions for expanding and evaluating pump-and-treat technology as a remediation strategy. Under this work plan, contaminated groundwater will be extracted from the AOA using a network of vertical wells and transmitted for evaporative treatment in an underground pipeline to the engineered solar evaporation pond (Pond 4) on the DOE repository site about 1 mile south of the former mill site (see Section 3.0 for conceptual design description).

1.4 Document Organization

This work plan was prepared for LM by S.M Stoller Corporation, the Legacy Management Support (LMS) contractor. The remainder of this document is organized as follows: Section 2.0 provides physical setting, contaminant distribution, and alluvial aquifer field characterization information; Sections 3.0 and 4.0 address the remedy optimization conceptual design and engineering design, respectively; Section 5.0 addresses implementation of components of the project, including the applicable or relevant and appropriate requirements; Section 6.0 addresses protection of human health and the environment; Section 7.0 addresses monitoring and reporting requirements for the remedy optimization. Potential limitations of the remedy optimization are provided in Section 8.0. Section 9.0 presents the approach to evaluate the performance of the optimized remedy. References cited in this work plan are provided in Section 10.0.

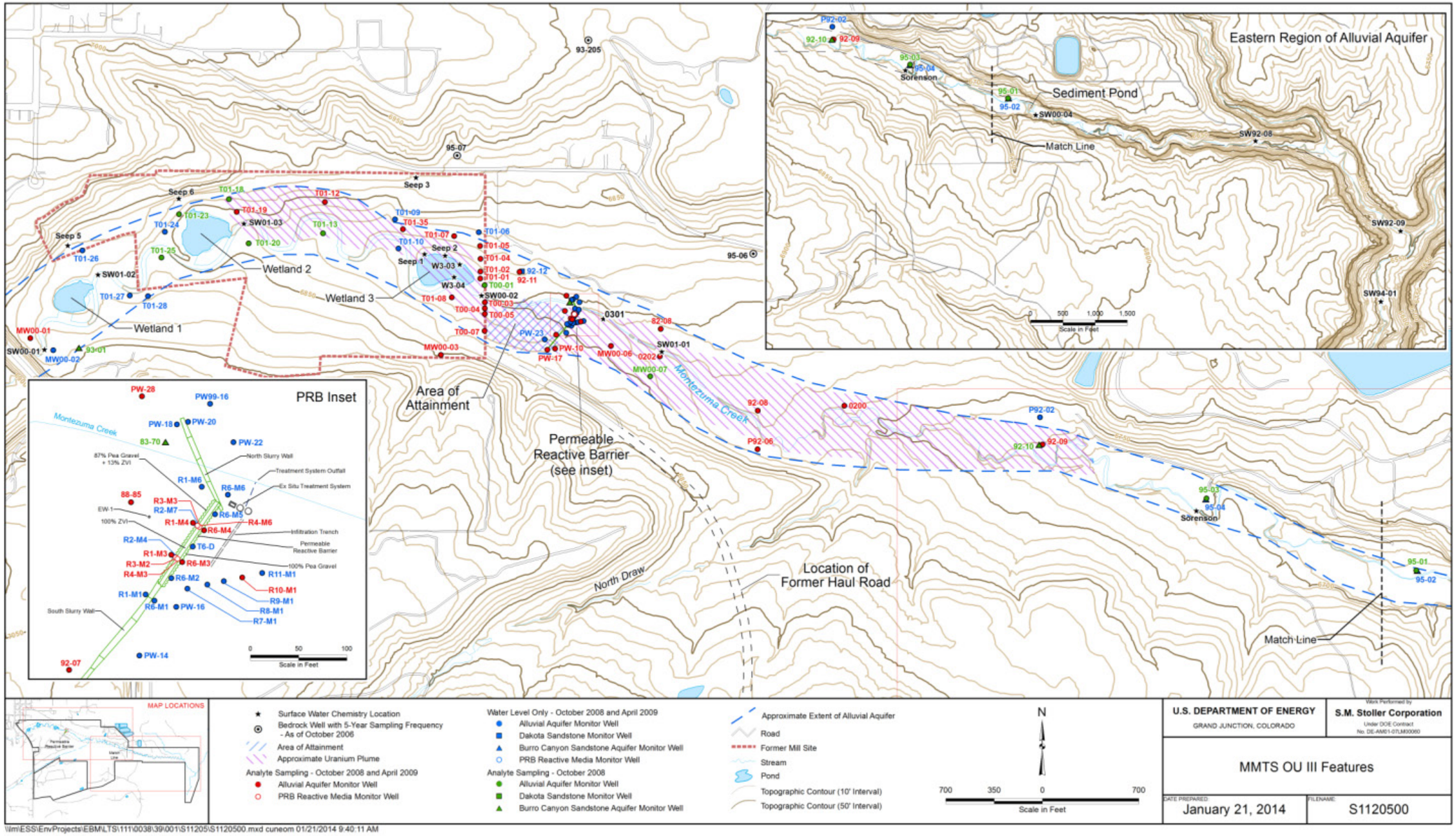

Figure 2. Features of MMTS and OU III

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2.0 Physical Setting

MMTS is located in rural southeast Utah at an elevation of approximately 7,000 feet (ft) above mean sea level. The local climate is semiarid with four distinct seasons. Average annual precipitation is about 15 inches, most of which occurs during late summer storms. Typical woody vegetation includes sagebrush, rabbitbrush, oak brush, piñon-pine, and juniper.

OU III occupies the valley of Montezuma Creek, a small, ephemeral stream that flows eastward from its origins in the Abajo Mountains, which rise to 11,000 ft about 5 miles west of the site. The valley of Montezuma Creek transitions, west to east, from a relatively broad alluvial valley (approximately 1,000 ft wide at the former mill site) to a steep-walled canyon only 100 to 200 ft wide in some locations. The former mill site is restored as an open-space public park owned by the City of Monticello. Land use within about 1 mile east of the former mill site, including the AOA, is sparse residential and agricultural (alfalfa production and livestock grazing). Farther east, the canyon (privately owned) is undeveloped.

The valley of Montezuma Creek is underlain by a shallow, thin, unconfined alluvial aquifer composed of alluvial silt, sand, and gravel, which is the subject of groundwater remediation at OU III. Both the depth to groundwater and the saturated thickness of the aquifer along the axis of the alluvial valley are generally not more than 10 ft. Groundwater flow in the alluvial aquifer is west to east following the slope of the valley. Groundwater flow across the eastern boundary of the former mill site is probably not more than several tens of gallons per minute.

Underlying the alluvial aquifer in the AOA is low-permeability bedrock of the Dakota Sandstone Formation. The remnant thickness of these sedimentary deposits (predominantly sandstone and shale) is several tens of feet, and the Dakota Sandstone forms an aquitard that prevents downward migration of contaminated alluvial groundwater to the deeper sandstone aquifer of the Burro Canyon Formation, which is a viable drinking water source.

Montezuma Creek is hydraulically connected to the alluvial aquifer. Flow in some reaches of the creek is often absent during dry seasons and during recent drought has been dry throughout OU III. In wetter times, Montezuma Creek is a gaining stream west to east on the former mill site from the discharge of alluvial groundwater and then has a losing potential through the AOA. Groundwater mounding immediately upgradient of the PRB may cause local discharge of groundwater to the creek. Uranium concentrations in Montezuma Creek in the AOA do not exceed the surface water remediation goal.

2.1 Area of Attainment

The AOA comprises approximately 6.5 acres of private property. It extends from Montezuma Creek south to the southern margin of the aquifer, and from the eastern boundary of the former mill site to the PRB. Figure 3 is a photograph that focuses on the AOA. In this figure, the AOA is viewed to the northwest from a location on the former haul road that was used for transporting contaminated material from the former mill site to the repository. The AOA encompasses the flat-lying central area of the valley, and spans from left to right (west to east) pasture (light brown area) and alfalfa crop (green area).

Subsurface characterization was conducted in and near the AOA (1) during RI/FS activities starting in 1992 (DOE 1998a and DOE 2004a); (2) to design the PRB in 1998 and 1999 (DOE 1998b and DOE 1999); (3) in 2000 to investigate the southeast corner of the former mill site for a possible residual source of groundwater contamination (DOE 2001); and (4) in April 2009 to evaluate the feasibility of optimizing groundwater remediation in that area (DOE 2009b and DOE 2010).

The hydrogeologic boundaries of the AOA correspond to (1) Montezuma Creek (northern boundary, mainly a recharge boundary), (2) underflow in the alluvial aquifer across the eastern boundary of the former mill site south of Montezuma Creek (western boundary), (3) the PRB (eastern boundary, mainly a no-flow condition), and (4) unsaturated, low-permeability bedrock of the Mancos Shale (southern boundary, no-flow condition). These boundary definitions and the monitoring locations used to define these boundaries are depicted in Figure 4. Given these boundary conditions, the AOA represents a convenient target to continue to implement and evaluate active groundwater remediation.

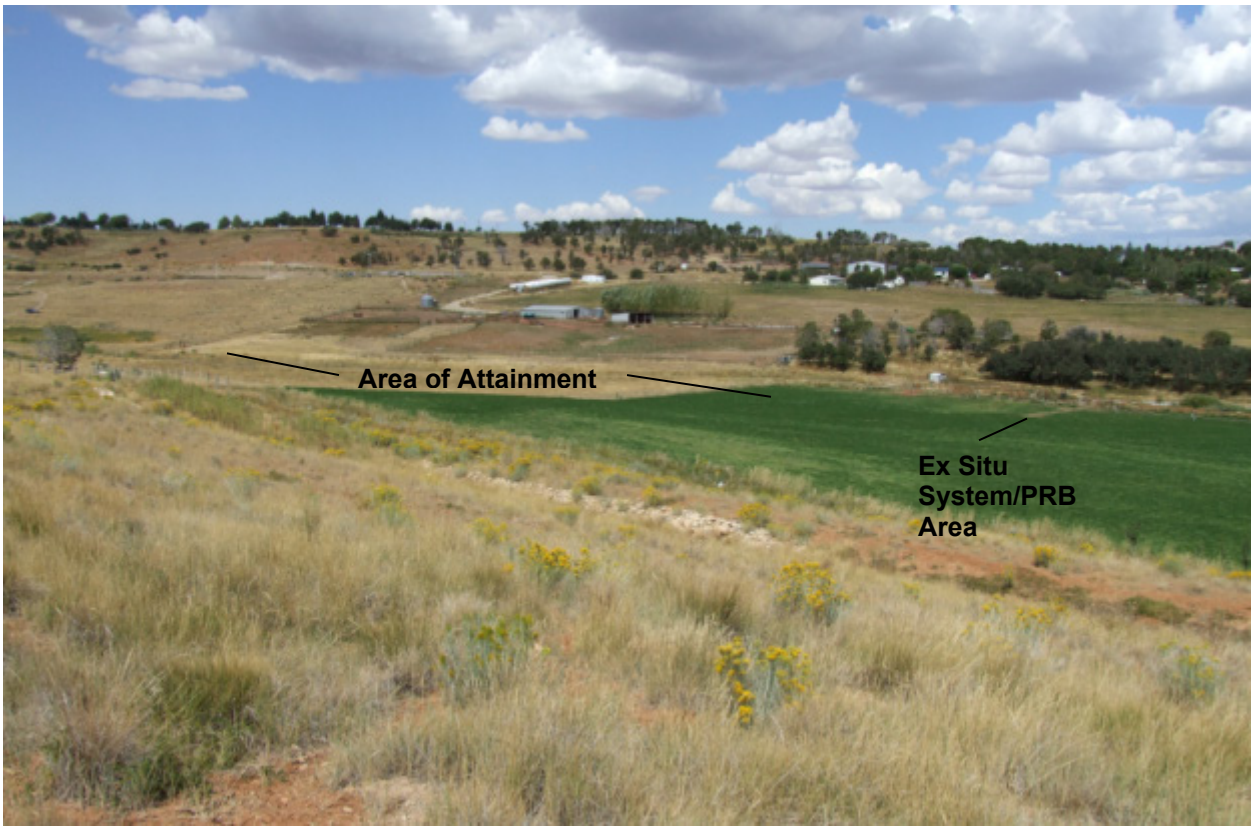

Figure 3. View Northwest Overlooking the AOA from the Former Haul Road

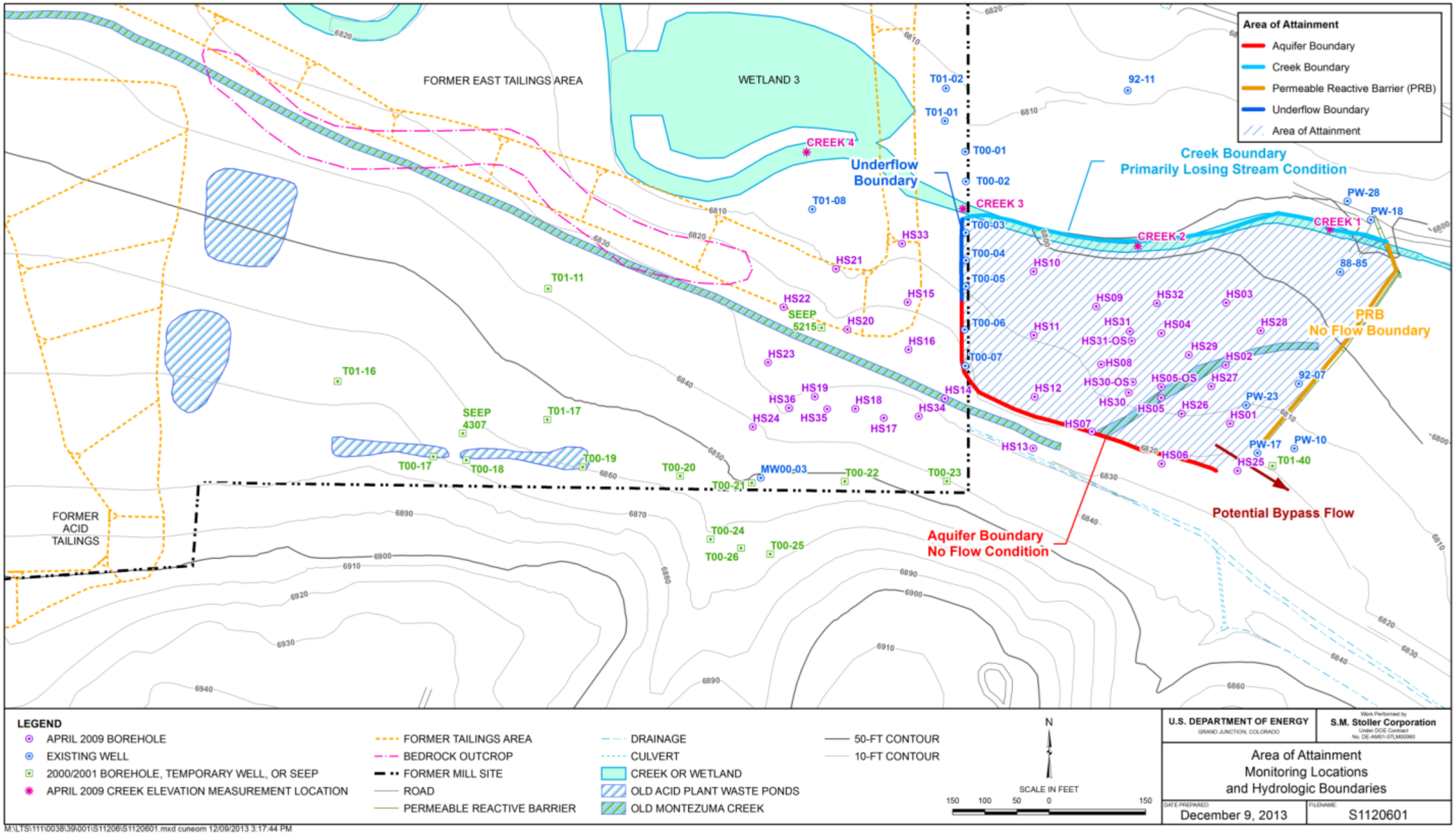

Figure 4. Monitoring Locations and Boundaries Defining the AOA

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2.1.1 Lithology

The alluvial aquifer in the AOA consists of approximately 5 to 8 ft of poorly sorted alluvial silt, sand, and gravel, with occasional cobbles and boulders. These granular deposits are overlain by about 5 to 7 ft of silt or silty clay. Groundwater saturation typically occurs within the granular material but may extend into the overlying fine-grained deposits. The subsurface setting in the AOA is depicted in cross-section view (south to north) at the PRB in Figure 5. In relation to this depiction of subsurface conditions, groundwater flow is perpendicular to the cross section view and from west to east (groundwater flow is toward the reader).

Bedrock beneath the valley floor is within 20 ft of ground surface. Similar to ground surface topography, the bedrock surface is relatively flat across the valley but steepens at the valley margins. The upper bedrock is within the middle section of the Dakota Sandstone Formation and consists of non-water-bearing gray mudstone interbedded with hard sandstone and occasional low-grade coal seams. The contact between the alluvium and Dakota Sandstone is often characterized by up to 2 ft of soft, olive/yellow, weathered mudstone.

The valley margin south of Montezuma Creek is covered by up to 30 ft of interbedded colluvium and loess. The colluvium consists of a silty clay matrix that supports sand, gravel, and cobbles. Thin (1- to 2-inch) intervals of sheetwash deposits of sorted sand, gravel, and imbricated mudstone clasts are common. The colluvium is derived from weathering of bedrock higher up the slope with subsequent downslope deposition. Significant groundwater is absent in the colluvium.

2.1.2 Depth to Groundwater and Water Table Configuration

Depth to groundwater in the AOA, as displayed in Figure 6, is generally between 6 and 11 ft below ground surface. The data displayed in this figure are from temporary boreholes and wells installed in April 2009, temporary boreholes and wells installed in 2000 and 2001, and existing OU III monitoring wells. Borehole locations where groundwater saturation is absent are labeled "dry." These data indicate that the southern margin of the aquifer trends northwest to southeast to approximately coincide with the 6,810 ft land surface contour, which closely follows the slope break where floodplain sediments adjoin the bedrock.

Water table contours depicted in Figure 7 indicate that groundwater flow south of Montezuma Creek is primarily to the southeast. The water table contours, supported by surface concurrent water-line elevation measurements in Montezuma Creek, further suggest that a losing stream potential is present through most of the AOA. A gaining stream potential (aquifer discharge) is indicated at the creek closest to the PRB, likely the result of groundwater mounding against the PRB.

In the southeast portion of the AOA, groundwater flow is directed southward along the south slurry wall. This flow pattern was evident before the PRB was installed and likely results from the bedrock surface being deepest in this portion of the aquifer. The south slurry wall of the PRB was not constructed to span the full width of the alluvial aquifer, thus allowing some groundwater to flow around the slurry wall. The geometry of this bypass zone is indicated in cross-section in Figure 5, where it is shown in the lower left of the figure that the south slurry wall does not terminate against the Dakota Formation.

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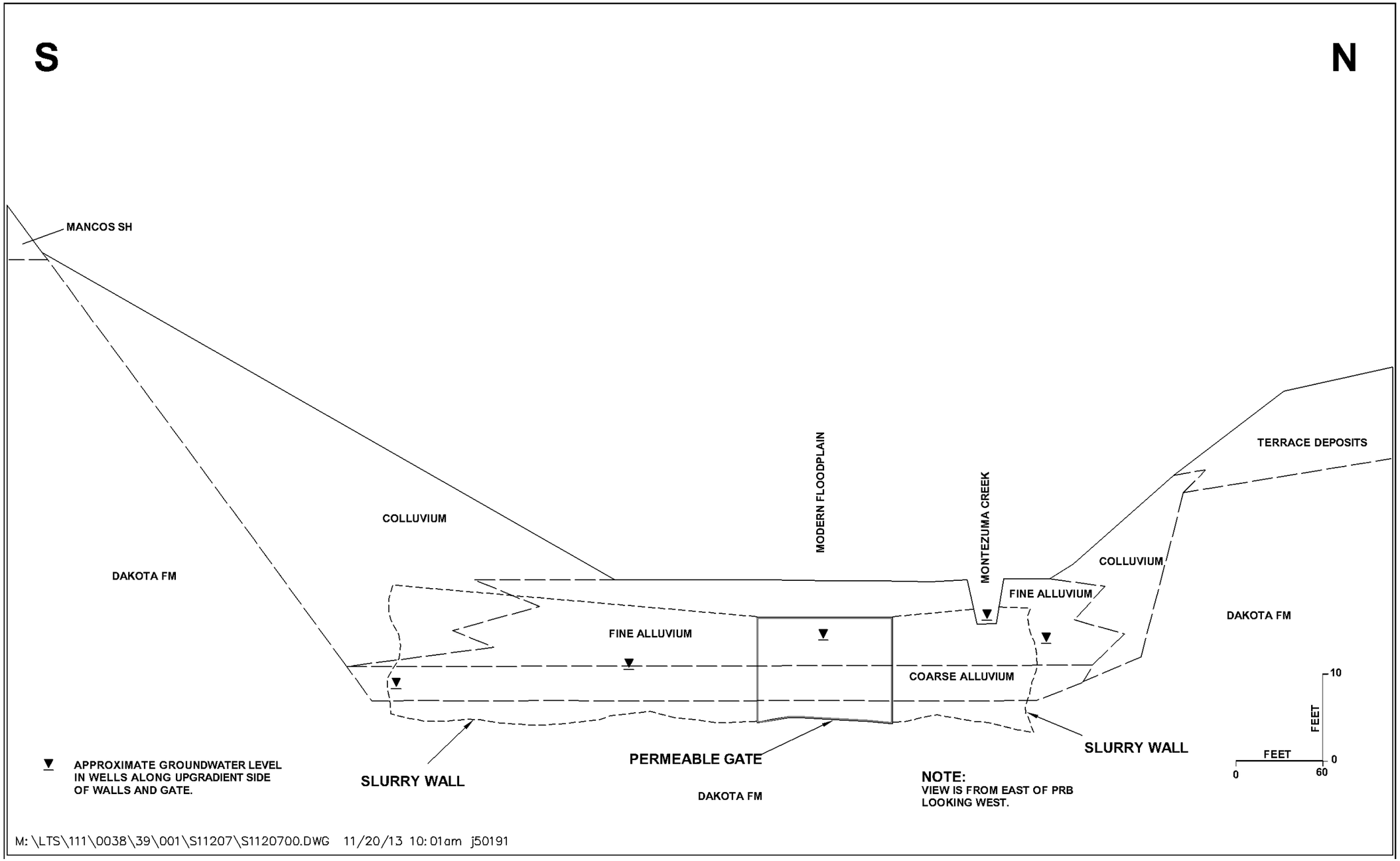

Figure 5. Cross Section of Montezuma Creek Valley at the PRB

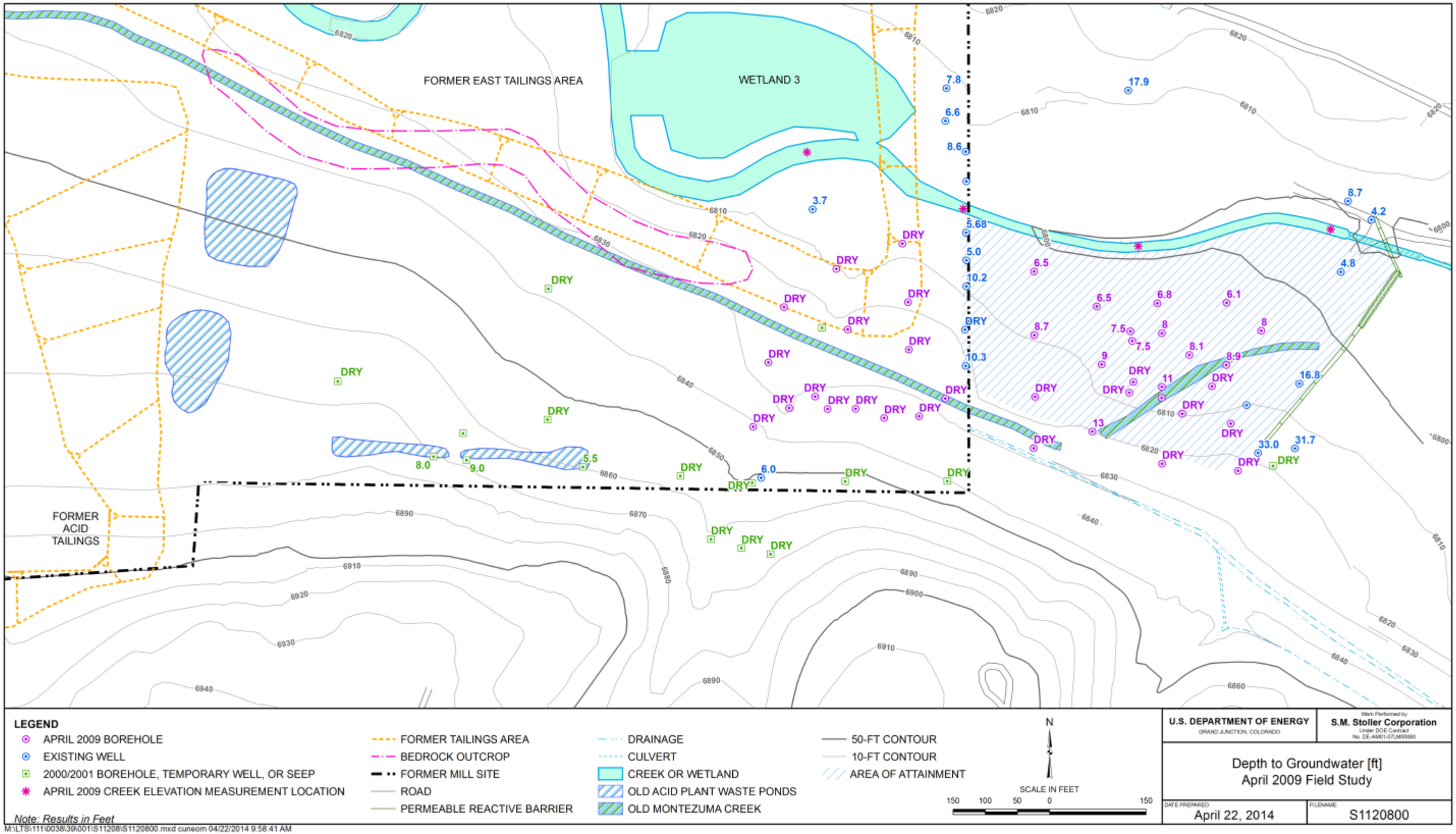

Figure 6. Depth to Groundwater (Feet) in and near the AOA

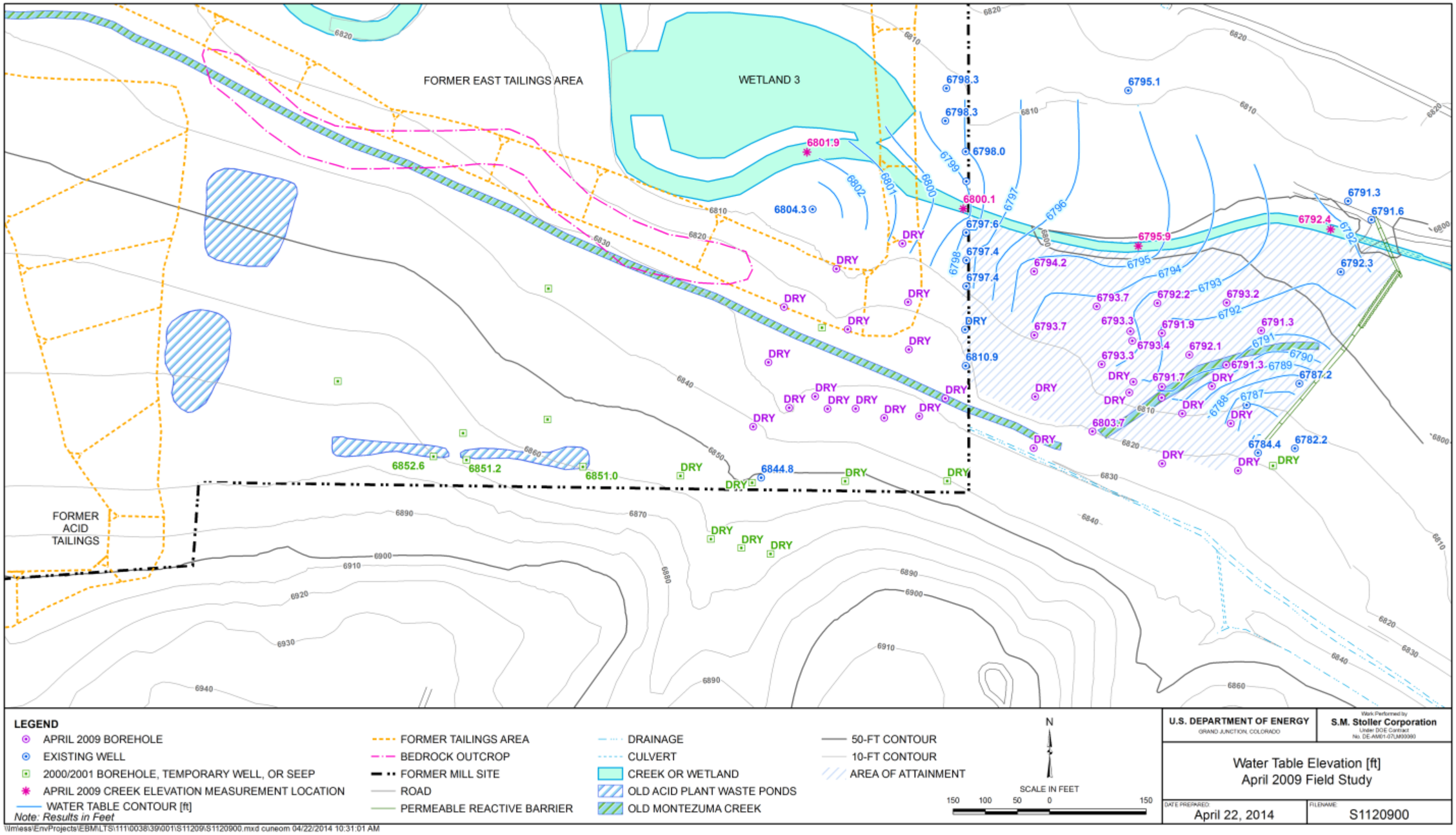

Figure 7. Water Table Elevation (Feet) in and near the AOA

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2.1.3 Bedrock Surface

Figure 8 illustrates the depth to bedrock encountered in the April 2009 boreholes, at temporary boreholes and wells installed in 2000 and 2001, and at existing OU III monitoring wells. The outcropping of a bedrock ledge that bounds the aquifer in this area is also indicated. Depth to bedrock beneath the floodplain in the AOA generally ranges between about 7 and 18 ft but is shallower in the western part of the AOA (e.g., 3 ft to bedrock at location HS-12). Depth to bedrock is locally greatest, up to 36 ft, where relatively thick colluvium and loess deposits occur on the south hillside that bounds the valley (refer also to Figure 5 showing bedrock and land surfaces in cross-section view).

The shape of the bedrock surface, depicted in Figure 9, has an influence on the direction of local groundwater flow. For example, the east to southeasterly flow of groundwater implied in Figure 7 mimics the contours of the bedrock valley. Also, the predominantly southward flow of groundwater near the south slurry wall of the PRB corresponds to a slight deepening of the bedrock channel along the southern margin of the aquifer. The aquifer boundary in this area coincides with the termination of alluvial deposits against bedrock or colluvium.

2.1.4 Saturated Thickness

Figure 10 shows the saturated thickness of the alluvial aquifer in and near the AOA, computed as the difference between the water table and the top of the bedrock elevations (saturated thickness posted in Figure 10 is rounded to the nearest foot). The data displayed in this figure are from temporary boreholes and wells installed in April 2009, temporary boreholes and wells installed in 2000 and 2001, and existing OU III monitoring wells.

The saturated thickness is greatest in the central area of the floodplain between the PRB and former mill site, where it reaches 8 to 10 ft in thickness. The 2009 saturated thickness is 2 to 3 ft greater than that observed in June and July 1998, before the PRB was constructed. This may be in response to progressive loss of hydraulic conductivity in the PRB and subsequent groundwater mounding.

Between the former mill site and PRB, groundwater saturation becomes much thinner toward the former mill site (see Figure 10). For example, at locations HS-10 and T00-03 (see Figure 4 for monitoring locations), only 1 ft of saturation is present. This is due to locally higher bedrock elevation, limited groundwater underflow from the west, and greater distance from the PRB and its associated mounding effect.

Groundwater saturation is generally absent in the area east of the former channel of Montezuma Creek near the PRB (Figure 10). This former channel, which trends southwest to northeast, was 10 to 20 ft deep and extended to or very near the bedrock surface. OU II remedial actions removed tailings-contaminated sediment and soil from the channel, which was subsequently backfilled with common fill. The backfill material is presumably less conductive to groundwater flow than the native alluvium and acts as a vertical barrier to groundwater flow.

This effect could isolate the area southeast of the former channel from groundwater flow and could account for groundwater mounding on the upgradient side of the channel fill. For example, the water table elevation at bores HS-05OS and HS-29 (approximately 6,792 ft, and 5 to 10 ft of

saturated thickness; see Figure 4 for monitoring locations), both on the northwest side of the former channel, is higher than the bedrock surface on the opposite side at dry locations HS-26 and HS-27 (6,784 and 6,779 ft, respectively).

2.1.5 Uranium Distribution in Groundwater

Figure 11 shows the distribution of uranium as measured in groundwater samples collected from temporary borings installed in April 2009, at nearby OU III monitoring wells sampled at that time, and at seeps and temporary borings that were sampled in 2000 or 2001. In the AOA, the central portion of the floodplain contains the greatest concentrations of uranium, ranging from approximately 450 to between about 1,000 and 2,000 µg/L and averaging about 1,000 µg/L.

Uranium concentrations tend to decrease toward Montezuma Creek, likely the result of a losing stream condition with subsequent dilution (uranium concentration in Montezuma Creek in this reach is about 20 µg/L since the former mill site was remediated). Former dilution of the uranium plume by creek water infiltration may also account for lower uranium concentrations detected in groundwater nearest the former channel of the creek.

2.1.6 Optimized Groundwater Remedy Target Area

The optimized groundwater remedy will target the portion of the aquifer containing the greatest mass of uranium in the AOA. Optimizing the remedy therefore focuses on the portion of the aquifer with the greatest volume of groundwater and the greatest concentration of uranium (uranium distribution is addressed in Section 2.1.5).

The area of highest uranium concentrations (averaging approximately 1,000 µg/L) generally coincides with the greatest saturated thickness of the aquifer (5 to 10 ft). This area is centered in the AOA and to the northwest of the former channel of Montezuma Creek. The coincidence of high uranium concentrations and maximum saturated thickness within a well-bounded groundwater setting provides conditions convenient for targeting, implementing, and evaluating groundwater remediation by the optimized pump-and-treat remedy.

2.1.7 Determination of Noncontinuing Source of Groundwater Contamination

One objective of the April 2009 study was to confirm that there is no continuing source of groundwater contamination to the AOA from the southeast portion of the former mill site. This study was focused because (1) locally high concentrations of uranium were detected in seeps and groundwater in earlier studies (DOE 2001), and (2) if identified, a continuing source of contamination to the AOA would compromise the ability to evaluate remedy progression toward meeting the remediation goal.

The preponderance of dry holes installed in April 2009 in this area of the former mill site (see Figure 11) suggests that the uranium contamination detected in earlier studies (2000/2001) at seep 4307 (no longer present), at temporary wells T00-17, T00-18, and T00-19, and at MW00-03, is isolated from the alluvial aquifer by lack of hydraulic connection (see Figure 4 for monitoring locations). It was concluded that groundwater contamination at these locations is (1) remnant from the storage of process liquids in temporary impoundments during a phase of mill operation, and (2) not a continuing source of contamination to groundwater in the AOA (DOE 2001, DOE 2009b).

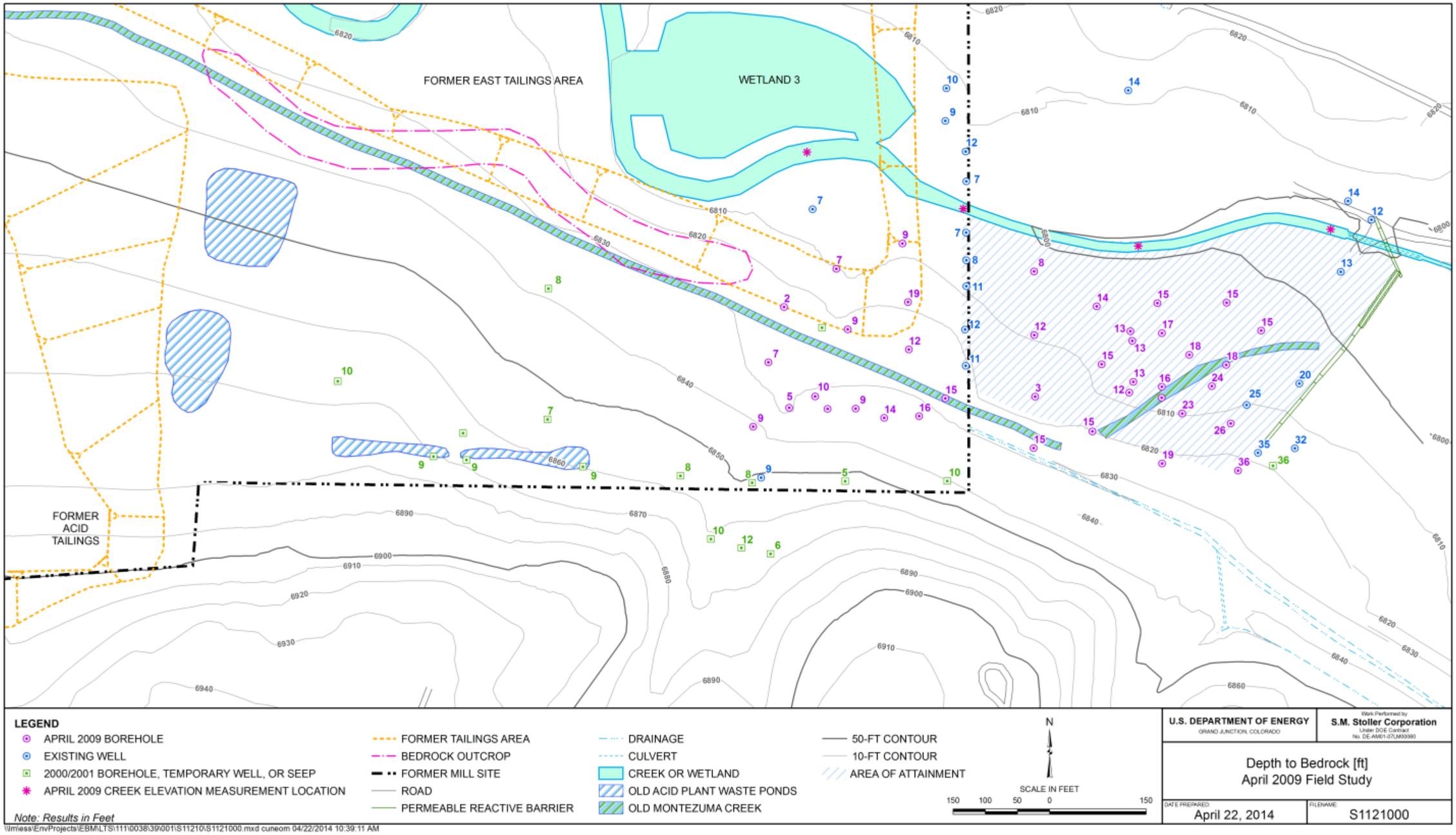

Figure 8. Depth to Bedrock (Feet) in and near AOA

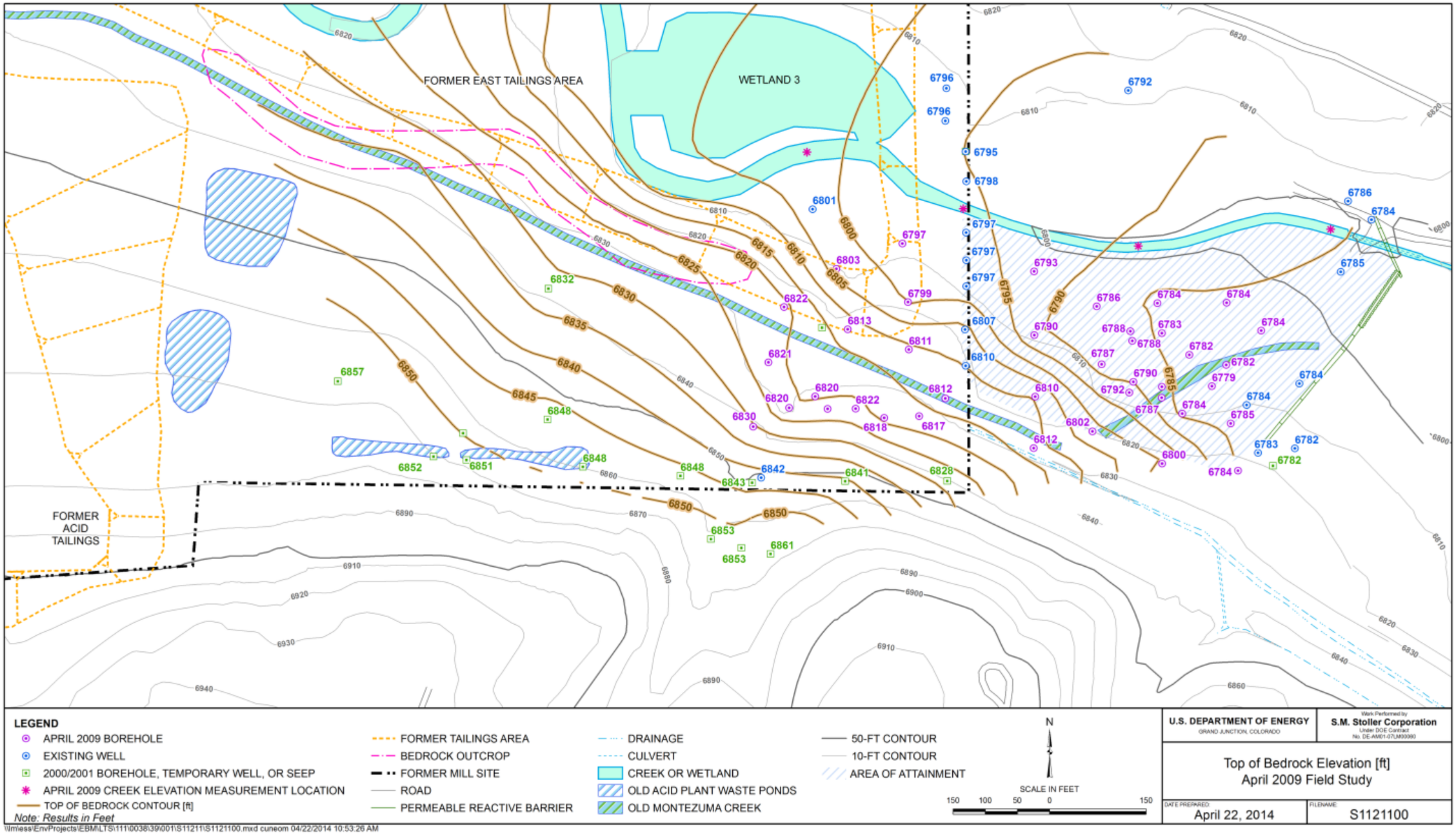

Figure 9. Top of Bedrock Elevation (Feet) in and near AOA

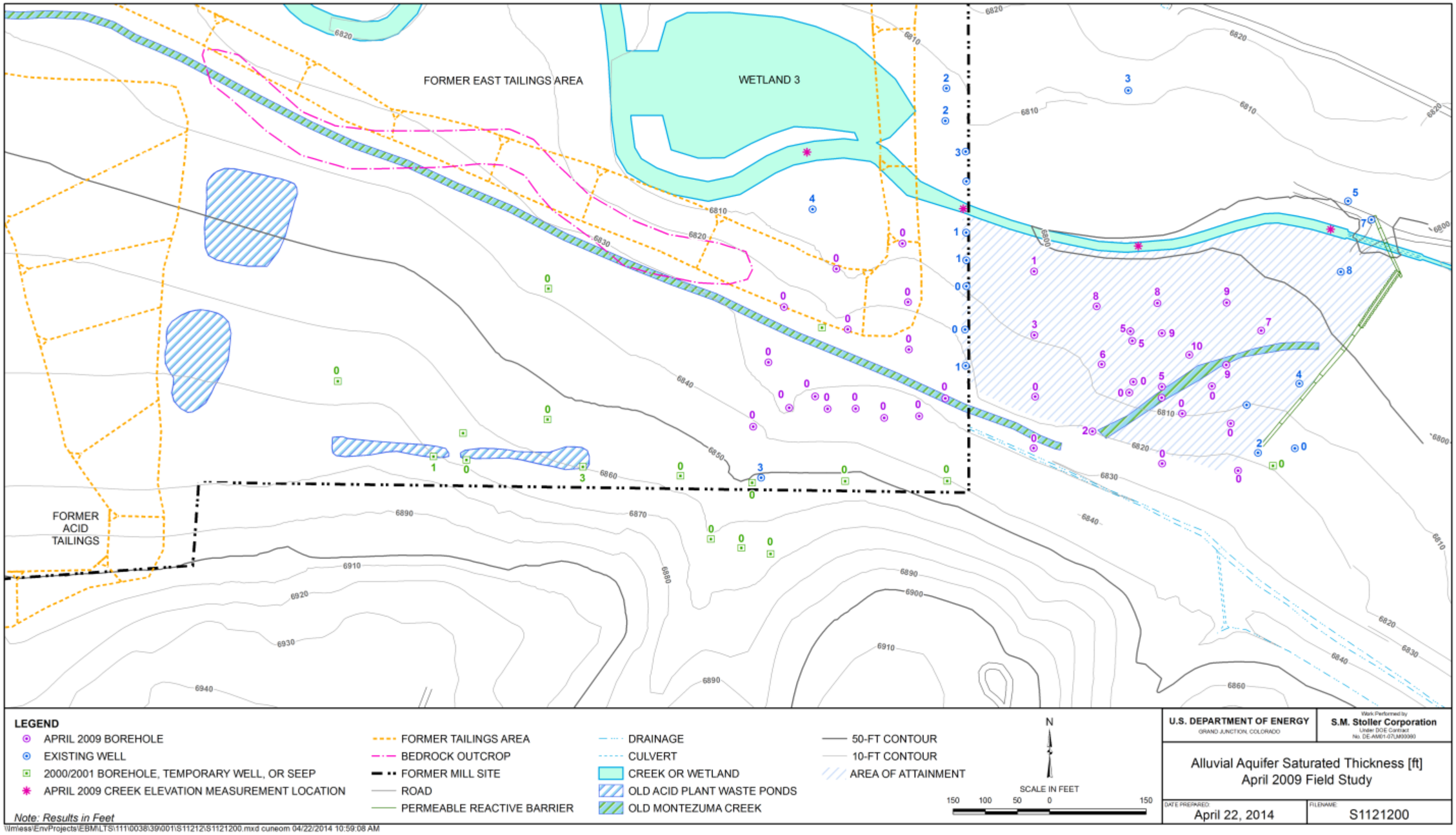

Figure 10. Alluvial Aquifer Saturated Thickness (Feet) in and near AOA

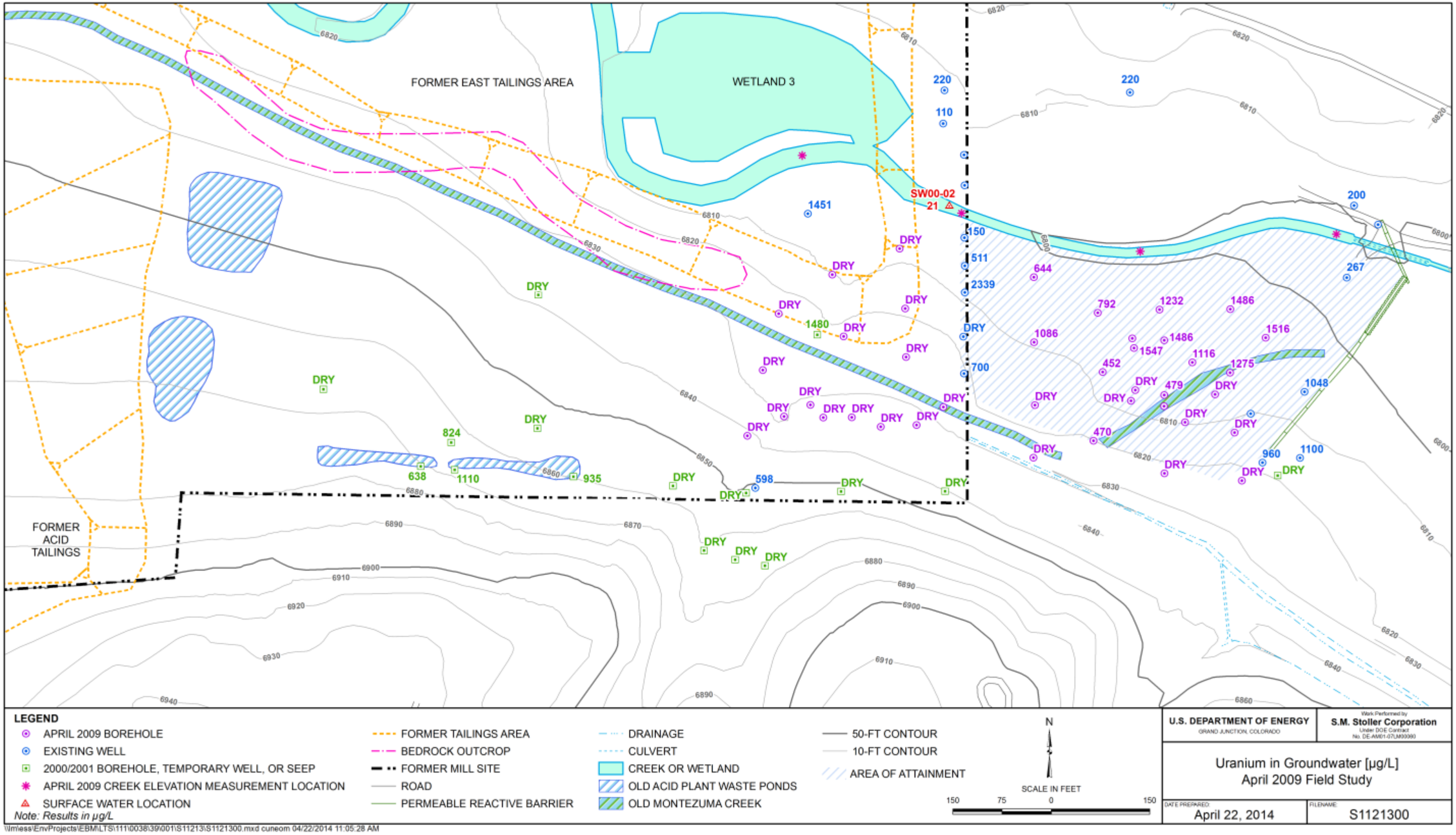

Figure 11. Uranium in Groundwater (µg/L) in and near AOA

The occurrence of elevated uranium concentration at the former location of Seep 5215 (see Figure 4 for seep location and Figure 11 for uranium concentration) represents seepage from groundwater discharge from remnant alluvium adjacent to the southeast toe of the former East Tailings Pile. The area encompassing the location of former Seep 5215 is now dry because of creek realignment and aquifer reconstruction during site restoration.

2.1.8 Alluvial Aquifer Field Characterization Summary

- The AOA is a region of the shallow alluvial aquifer encompassed by well-defined hydrogeologic boundaries.
- Depth to groundwater in the target area is within 10 ft of land surface.
- Depth to bedrock in the target area is within 20 ft of land surface.
- Sedimentary deposits comprising the alluvial aquifer in the AOA consist of poorly sorted alluvial silt, sand, and gravel.
- There is no evidence for a continuing source of groundwater contamination to the AOA from the southeast portion of the former mill site.
- Groundwater flow from the west is not expected to contribute significant contamination to the AOA because concentrations of uranium in the inflowing groundwater are much lower than in the AOA.
- Montezuma Creek is not contaminated through the AOA, and therefore leakage from the creek does not represent a potential source of contamination to the aquifer but may instead serve as a flushing/recharge mechanism.
- The PRB has the effect of a hydraulic flow barrier to form the downgradient boundary of the AOA. Some groundwater flow through the PRB is expected, as is bypass flow around the ends of the slurry walls.
- Low-permeability bedrock comprises the southern no-flow boundary and the lower boundary of the aquifer in the AOA.
- The target area for optimizing the groundwater remedy is the center of the AOA, having the greatest saturated thickness (5 to 10 ft) and highest concentrations of uranium in groundwater (averaging approximately 1,000 µg/L).
- Conditions for optimizing the groundwater remedy are less optimal (1) toward the creek (lower uranium concentrations and greater potential to capture uncontaminated creek water); (2) toward the former mill site (less saturated thickness); and, (3) southeast of the former creek channel (hydraulic flow barrier).
- The well-defined boundaries of the AOA are favorable for evaluating the progress of water quality restoration once the remedy optimization is implemented.
- The AOA may receive only minimal recharge from creek discharge or from underflow from the west. These recharge conditions are recognized as potential limiting factors of the remedy optimization.

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3.0 Conceptual Design and Remedy Approach

3.1 Overview

The contingency remedy optimization is being designed for all-season operation. DOE will optimize the groundwater remedy by installing a network of vertical extraction wells in the central portion of the AOA. Contaminated groundwater that is extracted from these wells will be transmitted in a buried pipeline (to be constructed) to an existing evaporation pond (Pond 4). The pipeline will be constructed on City- and DOE-owned property in the corridor of the former haul road that was used to transfer mill tailings from the former mill site to the disposal cell. Pond 4 is located on DOE property about 1 mile south of the AOA and was constructed to manage leachate from the disposal cell, which encapsulates solid wastes from OU I and OU II remedial actions. The operating capacity of Pond 4 (16 million gallons) far exceeds current and projected leachate management needs for the disposal cell. The main components of the remedy optimization project are identified in Figure 12.

Groundwater extraction will be conducted cyclically, whereby the aquifer is dewatered to the extent possible and then allowed to recharge during a period when the pumps are not active. This approach may enable a more accurate assessment of the remedy optimization progress in terms of actual pore volume removal than if a steady state pumping regime were implemented.

Upon extraction, contaminated groundwater will be transmitted to an operational control building (groundwater transfer building) that will be constructed on City-owned property. At that location, the extracted groundwater will be collected in an aboveground water transfer tank in the building for subsequent transmission in a buried pipeline to Pond 4 for evaporative treatment. The effectiveness of using mechanically enhanced evaporation will be separately assessed and implemented, if necessary.

A network of groundwater monitoring wells will be installed within and surrounding the proposed extraction well network. The monitoring wells will be used to track the progress of water quality improvement and to measure water levels within the target area in order to assess the groundwater capture zone of the extraction wells.

The extraction and monitoring well networks, transfer tank, and pipeline will be equipped for remote monitoring and operation through the LM SOARS (System Operation and Analysis at Remote Sites) program. Remote monitoring, data collection, and data transmission to a central LM database is commonly referred to as the “telemetry” system.

Figure 12. Conceptual Plan of the OU III Remedy Optimization

3.2 Strategic Placement of Extraction and Monitoring Wells

Figure 13 identifies the planned locations of the 8 extraction wells and 16 monitoring wells in relation to uranium concentration and saturated thickness in the AOA, as presented in Section 2.1. This figure is provided to indicate that the extraction wells target the portion of the aquifer that has the greatest potential to reduce contaminant mass and elevated uranium concentrations in the AOA. Monitoring well locations were selected to evaluate water quality and water table response to pumping within and surrounding the extraction wells.

Flexibility will be allowed in the field to relocate a given extraction or monitoring well if the planned location is dry or nearly so. The point of relocation will be discretionary by the project hydrologist or designee based on historical knowledge of the AOA and site conditions during well drilling. Off-set locations are generally expected to be within 50 ft of the planned location.

3.3 Remedy Approach

Attaining the remediation goal for uranium in the AOA, if feasible, will require the removal of multiple pore volumes of contaminated groundwater from the alluvial aquifer in that area. This is because uranium exists in the aquifer both in the dissolved state and in less mobile forms that are bound to the aquifer substrate. Dissolved and sorbed uranium is also likely to be distributed in low-permeability sediments comprising the aquifer matrix as well as in the higher-permeability sediments. Slow release of uranium from the sorbed phase and from the lower-permeability sediments will necessitate removal of multiple pore volumes from the contaminated region of the aquifer. Uranium present in the aquifer, whether in the dissolved or sorbed phase, is not indicative of the presence of mill tailings in the subsurface but rather is the result of the contaminant plume originating and migrating from the former mill site.

The approach in attaining the remediation goal will be to extract the groundwater based on cyclic operation of the extraction wells. The wells will be operated at rates that maximize drawdown in the AOA until the affected area is dewatered such that additional pumping cannot be sustained. Individual well pumps will have the ability to be controlled at different extraction rates. The extraction well pumps will then be deactivated to allow the pore volume in the affected portion of the aquifer to refill with new groundwater before pumping is resumed.

It is anticipated that during the inactive period (aquifer recovery period), uranium will partition from the sorbed phase into the dissolved phase in the fresh groundwater. This water will then be extracted until the affected area is again dewatered. This cycling process will be repeated as needed. An advantage of this approach over steady state pumping is to minimize the effect of preferential flow paths, and to facilitate removal and recharge of actual pore volumes.

The initial dewatering of the aquifer may require more time than in subsequent extraction/recharge cycles due to the excess volume of groundwater comprising the groundwater mound. Individual periods of extraction and recharge are expected to require months, depending on the availability of water during the recharge period. Extraction rates are also likely to require adjustment based on seasonal evaporation rates from Pond 4.

The temporal reference frame for well-field cyclic operation (months) is based on general observation of aquifer responses to transient stresses such as aquifer dewatering during mill site remediation, groundwater mound development following installation of the PRB, and seasonal variability of aquifer recharge from Montezuma Creek and percolation of precipitation to the shallow water table.

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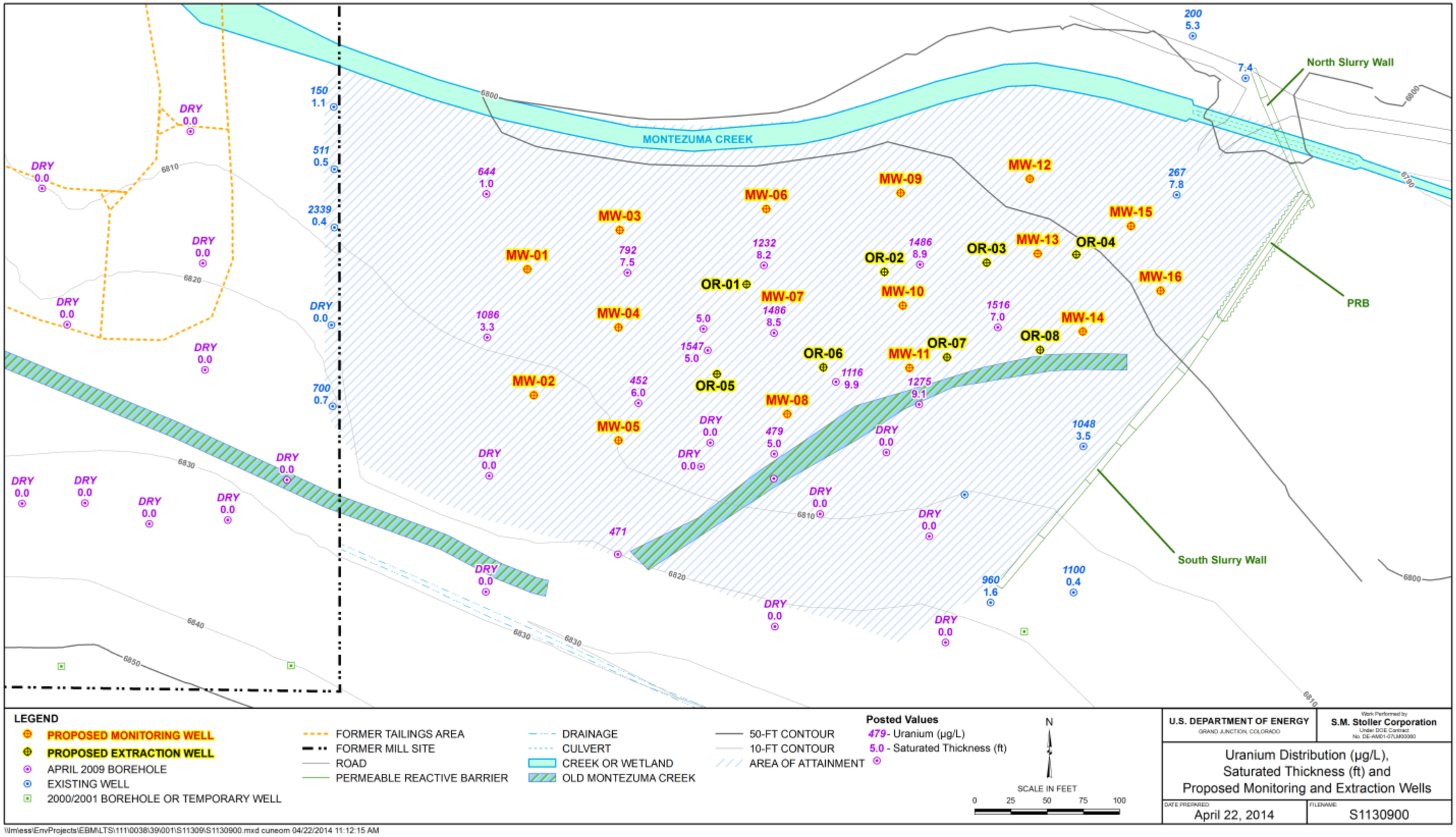

Figure 13. Uranium Distribution, Saturated Thickness and Proposed Monitoring and Extraction Wells

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3.4 Role of the Ex Situ Treatment System

Remedy optimization does not include continued operation of the existing ex situ treatment system (extraction well EW-1 and treatment vessels) because it (1) has not been very effective in reducing uranium concentrations or groundwater mounding, (2) poses separate operating, monitoring, and maintenance requirements, and (3) poses separate performance and compliance issues, such as media exchange and monitoring of discharge allowances to Montezuma Creek. Discontinuing the ex situ treatment system operation will allow for a more accurate evaluation of the progress of the optimized remedy. The ex situ treatment system will remain operational until baseline monitoring of the remedy optimization begins, which will precede the remedy optimization system start-up. The eventual decommissioning and clean closure of the ex situ treatment system will be addressed in a separate plan which will be prepared at a later date in consultation with EPA and UDEQ.

3.5 Role of the PRB in the OU III Remedy Optimization

DOE does not intend to decommission the PRB until performance of the remedy optimization is assessed. Retaining the PRB as a groundwater containment structure, as identified in the ESD (DOE 2009a) is integral to the success of the proposed remedy optimization. This is because the groundwater that is currently contained by the PRB, which restricts groundwater flow, is the primary target for extraction and treatment under this optimization plan. Premature removal of the PRB would lower the water table and release groundwater otherwise available for capture and treatment, thereby reducing the effectiveness of the remedy optimization. The eventual decommissioning and clean closure of the PRB will be addressed in a separate plan which will be prepared at a later date in consultation with EPA and UDEQ.

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4.0 Engineering Design

The engineering design described in this section references Figure 12 and Figure 13 for plan views of the conceptual design components and target areas for groundwater extraction and monitoring.

4.1 Construction Access and Staging Areas

Construction access for work performed in the AOA, including well installation and trenching, will be from Clay Hill Drive, a paved municipal road, then through an unimproved gravel road on private property to the construction area. The private access road and the construction area are on ranchland belonging to the same owner. The access road through the private property is about one-third of a mile in length. DOE has used this route and the affected property for many years to conduct remedial actions associated with groundwater monitoring and installing and operating the PRB and ex situ treatment system. Improvements will be made to the private access road to support construction activities in this area.

The primary area for temporary storage of constructions materials and equipment for work in the AOA will be on the private property at the construction area. A secondary staging area will be located on City-owned property in the northeast corner of the former mill site off of Clay Hill Drive to support construction activities occurring in the northern portion of the remedy optimization project area. This secondary staging area was formerly used for staging equipment and materials during MMTS remedial actions and remains suitable for this purpose.

Construction access to install the pipeline and the groundwater transfer building will mainly be from State Highway 191 then through DOE property that contains the repository. Access to the pipeline route will use a portion of the perimeter road on the disposal cell. This road (compacted road-base) does not overlie the encapsulated wastes; it is suitable for construction traffic and its use will not damage the disposal cell. Some improvement to the former haul road will be required to accommodate construction traffic. Access to and from the pipeline and groundwater transfer building will also occur through the private access road off of Clay Hill Drive.

The primary equipment and materials staging area for construction of the pipeline, the groundwater transfer building, and the Pond 4 control vault will be located near the northwest corner of Pond 4. The graveled parking area at the LM field office at the repository is also available for equipment and materials staging.

4.2 Electric Power Supply

Electric power for the extraction well pumps, the transfer pump, and the control system housed in the groundwater transfer building will be supplied from an existing power line that crosses the former haul road, north to south, approximately 1,100 ft east of the groundwater transfer building. Connection, routing, and metering of electrical power to the LM control station adjacent to the groundwater transfer building will be on City property south of the AOA. The placement of additional power utility poles for the overhead power line will be required.

4.3 Groundwater Extraction Wells

Vertically oriented wells were selected as the method to extract groundwater, as opposed to horizontal wells or a collection trench. A network of conventional vertical wells (1) will provide greater flexibility in controlling the groundwater capture zone through manipulation of the pumping rate at individual wells, (2) may provide greater flexibility to modify (add to or reduce) the collection network, and (3) will have less impact on private property during installation.

The locations of the eight planned remedy optimization extraction wells are shown in Figure 13. The wells are identified as OR-01 through OR-08. The extraction wells will be installed to match the design and construction of existing well EW-1, which supplies groundwater to the ex situ treatment system. Extraction well EW-1 has proven reliable in sustaining 10 to 12 gpm since its installation in 2005. This is the target rate for the planned extraction wells in order to draw down the groundwater mound.

Extraction wells will be drilled and installed by a qualified, licensed, subcontracted drilling service using hollow stem auger (preferred), air-rotary, or cable-tool drilling technology with a 10 inch borehole diameter. Extraction wells will be drilled and installed to approximately 0.5 to 1 ft into the bedrock. Well materials will consist of 6-inch-diameter, schedule 40 polyvinyl chloride (PVC), flush-threaded casing and vee-wrapped slotted screen (0.02 inch slot size [or #20 slot]). Screen lengths will be 5 ft. A section of blank casing (well sump), 0.5 or 1 ft in length, will be set at the base of the well screen and extend 0.5 to 1 ft into the bedrock.

A filter pack consisting of well-rounded #10–20 sand will be placed in the annulus between the well casing and borehole wall to 2 ft above the top of the screen (#10–20 sand is a factory sieved silica sand consisting of grains that pass a 10-mesh sieve (approximate opening of 0.08 inch) and is retained on a number 20 mesh sieve (approximate opening of 0.03 inch). A 1 ft layer of finer sand (#100 mesh) will be placed above the coarse-grained filter sand pack. The annular space will then be filled with bentonite pellets or chips to 1 ft below land surface. At the time of well installation, the well will be temporarily completed with a 2 or 3 ft stick-up and capped until electrical and water line connections are constructed and downhole equipment (pump and water level sensor) is installed. Figure 14 provides a schematic, cross section view of a planned extraction well at the completion of drilling and well installation.

Prior to equipment installation and construction of piping and electrical connections, each extraction well will be developed by cyclic surging and pumping to ensure hydraulic connection between the well intake (screen and filter pack) and surrounding aquifer and to remove sediment that could interfere with pump operation. Well development will be conducted by the subcontracted drilling service or using LMS contractor resources. Water produced during extraction well development will be dispersed over a broad area on the land surface near each well. Contaminant concentrations in the groundwater and the associated volumes of development water have no potential to contaminate the soil, or directly reach the aquifer, where the water is dispersed.

The final surface completion will consist of embedding a flush-mounted vault that is rated for traffic loading. Aboveground well completion structures are not acceptable to the landowner. Specifications for extraction well downhole equipment, electrical and water line connections, and surface completion are included in the project engineering design plans, which will be available to EPA and UDEQ at a later date.

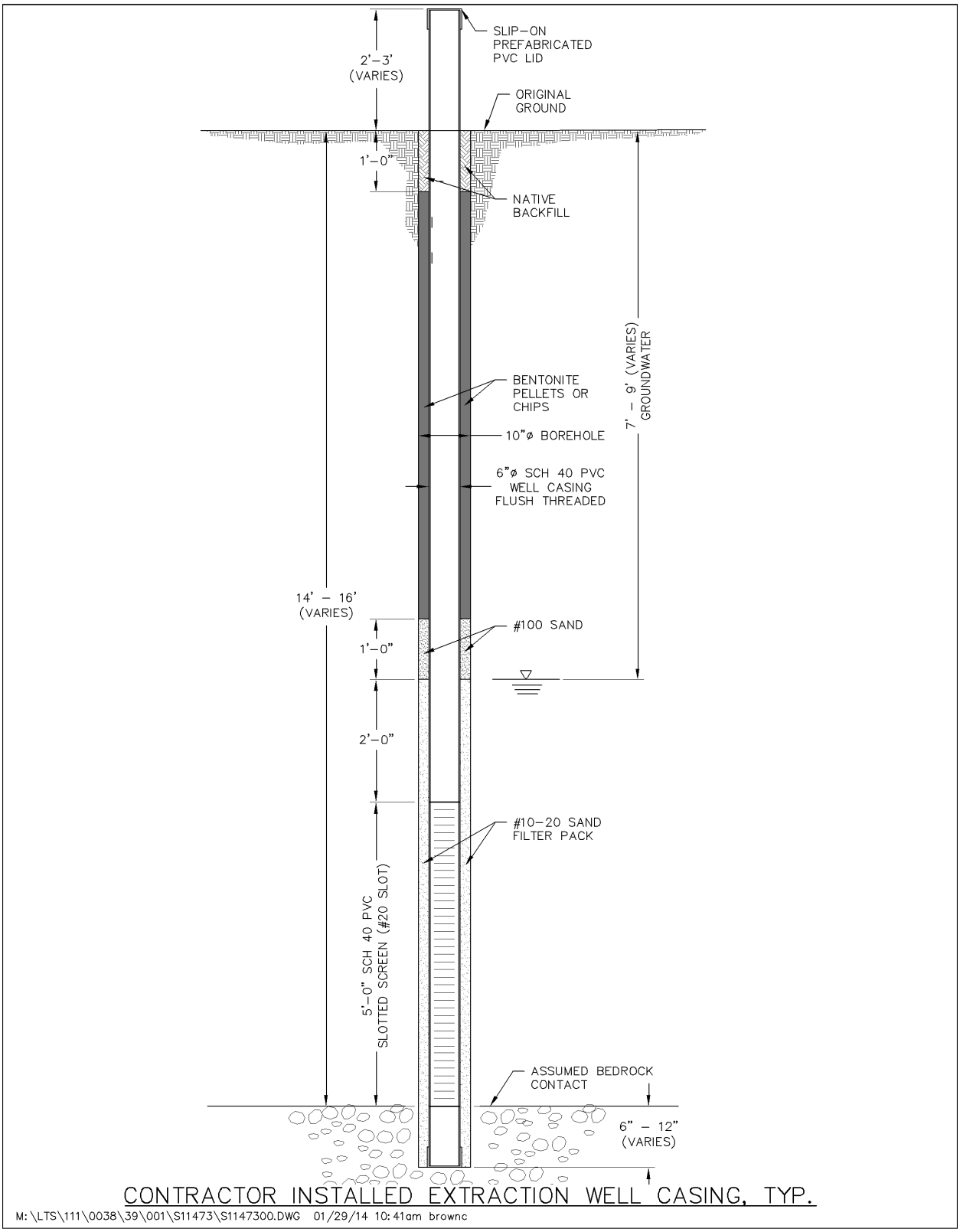

Figure 14. Contractor Installed Extraction Well Casing, Typical

4.3.1 Extraction Well Routing to Groundwater Transfer Building

Electrical conduits (power and control wiring) and water transmission piping will be supplied individually to/from each extraction well. The conduits and the piping will be routed between the extraction wells and the groundwater transfer building in a common trench. Transmission of groundwater from each extraction well to the groundwater transfer building will use individual small-diameter (≤ 2 in) piping composed of high-density polyethylene (HDPE).The water transmission pipe will be placed below the frost depth at approximately 4-ft below ground surface.

4.3.2 Extraction Well Pumps

Each extraction well will be equipped with a submersible pump designed to operate at flow rates up to 15 gallons per minute (gpm). This design criterion meets the specification for the pump in existing well EW-1, which services the ex situ treatment system. Each extraction well pump will be separately controlled to allow for maximum hydraulic control of the aquifer.

4.4 Monitoring Well Network

Sixteen monitoring wells will be installed in the AOA to monitor water quality and water table elevations during the remedy optimization (see Section 7.2 for monitoring frequency and objectives). Monitoring well locations are shown in Figure 13. The wells are identified as MW-01 through MW-16.

The LMS contractor will install the monitoring wells using direct-push technology, which has been successfully employed to install more than 100 borings and wells at OU III. The new monitoring wells will be constructed using methods, designs, and materials similar to those of many of the existing monitoring wells in the AOA. The monitoring wells will be constructed of 1- or 1.5-inch-diameter PVC casing and slotted screen (#10 or #20 slot). Screen lengths will be 5 ft. The screen will be encased in a coarse sand filter pack (#10–20 sand) to 1 ft above the slotted section followed by a 1 ft thickness of fine sand (#100 mesh); the remainder of the annulus between casing and borehole wall will be filled with bentonite pellets or chips to about 1 ft below ground surface. Surface completion will consist of a steel, flush-mount well vault (6- or 8-inch diameter) embedded in a concrete surface seal. Aboveground well completion structures are not acceptable to the landowner. Figure 15 provides a cross section schematic view of a planned monitoring well at final completion (excluding the water level pressure transducer assembly and connection).

4.5 Groundwater Transfer Building

The groundwater transfer building will be built on City property immediately south of the extraction well field. The building will be a heated, insulated, aboveground, framed structure. Approximate dimensions are 20 ft by 30 ft. The structure will contain piping, pump and telemetry controls, electrical panels, and the aboveground groundwater transfer tank (see additional control descriptions in Sections 4.8–4.10).

Groundwater from the extraction wells will be pumped to the transfer tank (approximately 5,025 gallon capacity) for subsequent transfer to Pond 4 via a buried pipeline. Water collected in the tank will be transferred to Pond 4 using a centrifugal pump suitably designed to maintain sufficient velocity and flow rate in the pipeline given the projected elevation lift and head loss in the pipeline.

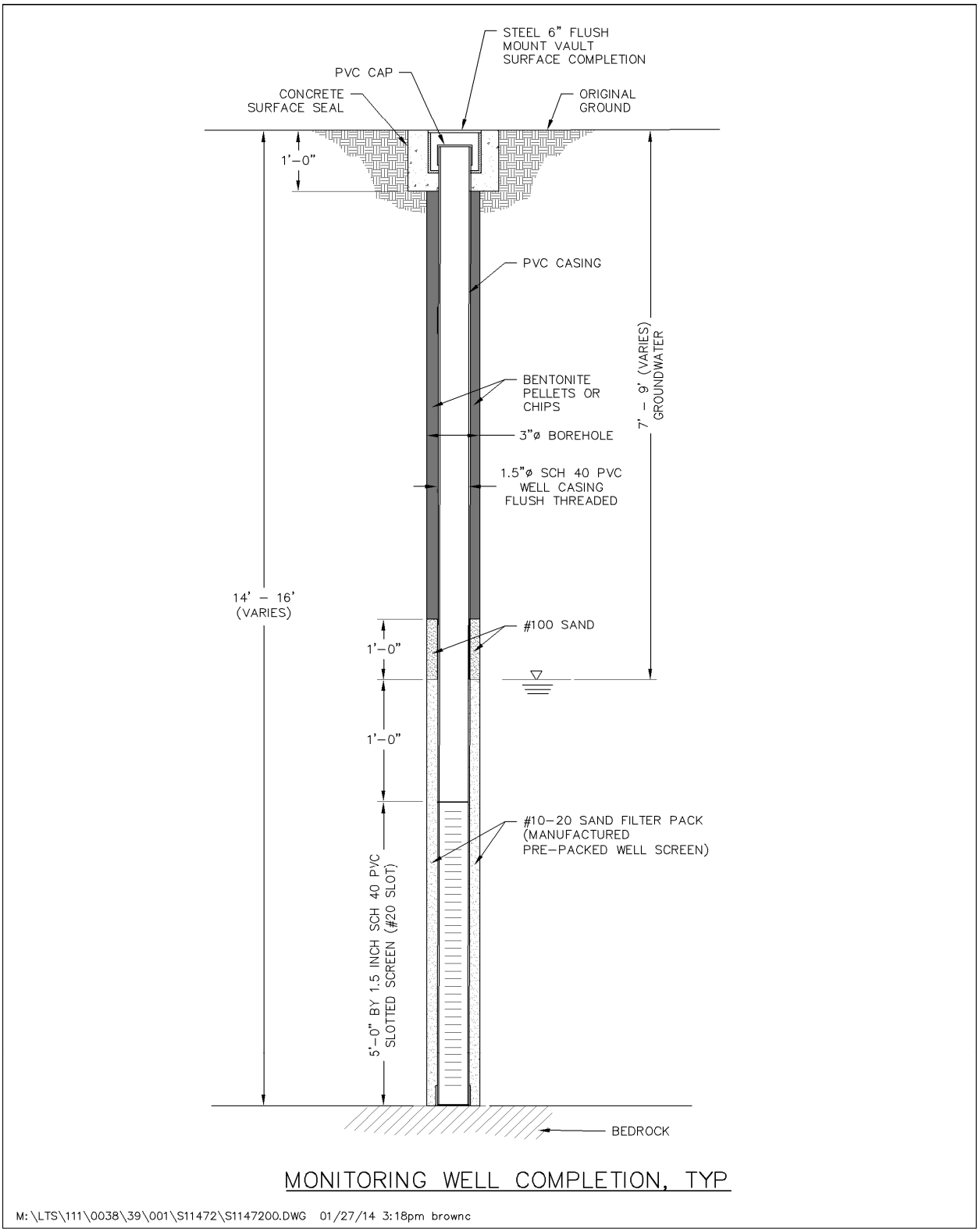

Figure 15. Monitoring Well Completion, Typical

The transfer tank will be equipped for automated monitoring and operation of the transfer pump at specified high and low water levels in the tank. The capacity of the tank and high-water operating level will allow water in the pipeline to be drained into the tank if needed for pipeline maintenance or repair. The concrete floor of the groundwater transfer building will have a sump collection system for leak detection. Although the transfer tank will not have a secondary containment system (because it is not required), overflow protection devices will be installed (floor sump and in-tank water level sensors) and programmed to deactivate the extraction well pumps at high-level trigger points.

4.6 Pipeline Routing and Construction

Transmission of groundwater from the transfer tank to Pond 4 is anticipated to use a buried 3-inch-diameter, single wall, HDPE pipe, in spools of approximately 500 ft lengths that can accommodate a working pressure of at least 125 pounds per square inch for 120 gpm. Approximately 5,000 linear feet of pipe will be required from the groundwater transfer building to Pond 4. The pipeline will follow the approximate alignment of the former haul route from the groundwater transfer building to Pond 4.

The pipeline will be on a continuous positive slope except for one low point at the crossing of North Draw (see Figure 2 and Figure 12 for location). Intermittent surface water flow in North Draw is typically limited to surface runoff following spring snowmelt and late summer monsoon storms. The pipeline will be buried across the draw and the backfill covered by riprap armoring to protect against erosion from storm flows and vehicle traffic.

A trenching machine, backhoe, or trackhoe will be used to install the trench in which the pipeline will be buried. The trench width between the groundwater transfer building and Pond 4 is not expected to exceed 2 ft. The trench depth will be a minimum of 3.5 ft (below frost depth). A qualified subcontractor will heat-fuse the HDPE pipe and fitting connections.

Air release valves will be installed at high points along the pipeline, and drain valves will be installed at low points. After the pipeline has been pressure tested using clean water, bedding material will be backfilled around the pipe, and the trench will then be backfilled with the excavation spoils to the original ground surface.

After construction is complete, the entire pipeline route will be revegetated; however, the restored route will allow for future maintenance and access to the groundwater transfer building and the pipeline along a gravel road. A separate plan will be prepared to address revegetation of affected areas of the pipeline corridor with native plant species. The plan will be based on revegetation programs that have been implemented during previous restoration activities at the site.

4.7 Evaporation Pond

Pond 4 was installed to evaporate leachate collected from the mill tailings disposal cell as it drained after tailings encapsulation. Pond 4 is approximately 1 mile from the AOA along the former haul route. The projected discharge point to Pond 4 is approximately 120 ft higher in elevation than the groundwater transfer building. The capacity of Pond 4 (16 million gallons) is underutilized because leachate production is minimal. The location of the repository and Pond 4 was selected in part because of its relative isolation from a groundwater resource. Pond 4 is constructed with a triple liner system to prevent leachate release to the environment. The liner system was designed for a 20-year duration from its installation in 1999.

The upper and second liners (HDPE) are separated to collect leachate and circulate the water back to Pond 4. The second and third liners are also separated to collect and recirculate water that has leaked through the second liner. Maintenance was completed in August 2013, at which time the integrity of the upper liner side slopes were visually inspected and identified leaks were repaired. Leakage through the upper liner has been minimal (reported in Federal Facility Agreement [FFA] quarterly reports). The lower collection system has not received water (reported in FFA quarterly reports). Inspection, maintenance, and operation of the Pond 4 leachate management system is a primary function of the long-term surveillance and maintenance activities at the Monticello site.

The pipeline from the groundwater transfer building will slope upward to terminate at Pond 4 through the existing overfill prevention pipe on the north side of the pond. The overfill pipe is constructed through the liner system at a distance of several feet below the top of the Pond 4 liner. It was designed and installed to prevent overflow that could damage the pond berms and liner system. To sleeve the water transmission pipe through the overfill outlet will not compromise the Pond 4 overfill prevention feature. The overfill prevention will continue to be functional because the transmission pipe will be of a lesser diameter than the overfill pipe, and a high-water control (water level pressure transducer) in Pond 4 will be in place to deactivate the extraction well pumps and transfer tank pump before the overfill level is reached.

4.7.1 Pond 4 Water Budget

The annual net evaporation rate from Pond 4 is estimated to be approximately 5 gpm. This estimate is based on the following water budget values: 42 inches of annual pan evaporation, 15 inches of annual precipitation, and a maximum pond area of 3.78 acres (the top of the pond has a greater area than the base of the pond). The estimated volume of groundwater in the AOA is 2 million gallons. This volume is based on areal dimensions of 700 ft by 250 ft, an average saturated thickness of 6 ft, and porosity of 25 percent. Inflow of water from the disposal cell is insignificant compared to the much greater inflow that is anticipated from the extraction wells.

At an assumed continuous inflow rate of 15 gpm, and accounting for 5 gpm of evaporation, the capacity of Pond 4 (approximately 16,000,000 gallons) would be reached in a minimum of 3 years. Filling the pond under these conditions would remove an estimated eight pore volumes of groundwater from the AOA. However, the fill rate will ultimately depend on the periodicity of extraction cycling (unknown) and on the seasonal variability of the evaporation rate.

This seasonal variation may require the rate of groundwater extraction to be reduced in winter to prevent overfilling Pond 4. Pond 4 water balance estimates are summarized in Table 1.

Table 1. Pond 4 Water Balance

Inflow		
Precipitation[1]	15 in/yr	3 gpm
Extraction wells	15 gpm	
Outflow		
Evaporation[1]	42 in/yr	8 gpm
Net fill rate	10 gpm (calculated)	
Pond 4 fill time	3 yr (calculated)	

[1] From DOE 2004b (Andrews, D., 1994).

4.7.1.1 Mechanically Enhanced Evaporation

The need to mechanically enhance evaporation at Pond 4 will be evaluated in a separate engineering assessment which will consider the actual rate of pond filling once the system becomes operational. If required, the evaporation enhancement will be designed and constructed at a later date when water levels in the pond will better facilitate system placement.

4.8 Operational Controls: Extraction and Monitoring Wells

Extraction wells will be equipped with instruments to measure, record, and transfer water level and extraction rate information to a central database on a real-time basis. This information will be collected, relayed, and managed through SOARS. An objective of the telemetry system is to enable remote pump operation at each extraction well. At a minimum, each extraction well pump will be programmed to cease operation if the water level in the well reaches a specified minimum operating level. Pump reactivation would then occur after a specified time or amount of water level recovery. Similarly, the extraction well pumps will be programmed to cease operation if the water level in the transfer tank or Pond 4 exceed a maximum level.

The monitoring wells will also be equipped with water level measurement and recording devices (data loggers), and most or all will be connected to SOARS. Water level measurement in the monitoring wells will have no mechanism to modify or control pumping rates at the extraction wells. This is because it is within an extraction well, not in the surrounding monitoring wells, where pump activation and deactivation is best controlled by water level sensing. Water level sensing in a given extraction well will deactivate the pump when the water level approaches the pump intake (pump intakes will be placed near the base of the well). Pump activation will resume when a specified water level recovery occurs. It would be undesirable to deactivate an extraction well pump if a monitoring well goes dry while pumping can be sustained at an extraction well.

4.9 Operational Controls: Groundwater Transfer Pump

Operation of the transfer tank pump in the groundwater transfer building will be regulated by pressure transducers programmed to maintain the water level in the tank between high and low levels. The system will activate the pump at a high water level and deactivate the pump at a low

water level. The system will also be programmed to deactivate the extraction well pumps if the transfer pump fails or if water is detected in the floor sump system, as monitored by pressure transducers. Pumping information and control of the transfer pump will be available using SOARS. An in-line totalizing flow meter will be installed at the outlet of the transfer tank to measure and record the instantaneous and cumulative volumes of water collected and transferred to Pond 4.

4.10 Operational Controls: Pond 4

At the point of discharge to Pond 4, the pipeline will route through a subsurface vault to be constructed on DOE property adjacent to the north side of Pond 4. The vault will contain appurtenances to monitor system pressure and flow rate.

The existing telemetry installation at the northeast corner of Pond 4, which services the repository and Pond 4 leachate management systems, will be modified to accommodate the pipeline data collection and transmission needs. The telemetry system at Pond 4 will be automated to prevent overfilling of Pond 4 at the high-water mark recommended in the as-built design specifications for Pond 4 (DOE 1998c). This will require installation of a pressure transducer in the pond, which, at the specified high-water level, will deactivate the extraction wells and the transfer pump. In addition to the telemetry system, a manual over-ride system will be installed at Pond 4 to allow for the field deactivation of the extraction well pumps and transfer pump to prevent overfilling the pond in the event of telemetry system failure.

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5.0 Implementation

This section addresses aspects of implementing the groundwater contingency remedy optimization from engineering, construction, and administrative perspectives. Assumptions of fully implementing the remedy optimization are that a binding agreement is achieved between DOE and the affected private landowner for timely site access during planning, construction, and operation.

5.1 Engineering Design

The engineering design will consist of two major components: electrical design and complete design. Both components are discussed in greater detail below.

5.1.1 Electrical Design

Electrical design services will be acquired from an electrical engineer to determine the power needs and evaluate the available power. The electrical engineer will use this information to develop an electrical design to provide electrical power to the extraction well pumps, transfer pump, and pump control and monitoring system.

5.1.2 Complete Design

The complete design includes the extraction and monitoring well plan, groundwater transfer building, piping plan and profile, electrical design, construction details, and the construction specifications. The complete design will be developed in three main phases: preliminary design, 90 percent design, and final design. Intermediate design phases of 30 percent and 60 percent lead to the 90 percent design; however, these evolutions represent refinement of design details without significant modification of the original design concept. Through informal regulator status and input opportunities (monthly teleconferences), DOE, EPA, and UDEQ have agreed in concept to the preliminary design, upon which the subsequent phases are developed. DOE will apprise EPA and UDEQ of the progress of the design phases; however, only the final design is considered a formal document.

5.1.2.1 Preliminary Design

Existing topographical survey data and a preliminary electrical power analysis were used to develop the preliminary design. The preliminary design includes relevant site features from site survey data and a plan for providing electrical power to the system. The preliminary design identified the major components of the remedy infrastructure and the spatial relationships and interconnection among those components. DOE also initiated, at that time, development of an easement agreement with the property owner regarding site access, allowed areas of disturbance, and construction schedule preferences during this stage of the design.

5.1.2.2 90 Percent Design

The 90 percent design includes detailed engineering drawings for all aspects of the project (electrical, mechanical, construction, etc.), construction specifications, and construction cost estimate. A constructability meeting will be held to review the 90 percent design. Reviewers will

include representatives of LMS contractor Health and Safety, Quality Assurance, Environmental Compliance, Construction Management, Site Management, Procurement, and other technical support organizations. See Section 5.7 for a further discussion on key project personnel.

Review of the 90 percent design is the final step toward completing a final design and is detail oriented rather than concept oriented. DOE will provide EPA and UDEQ the opportunity to review the 90 percent design and will solicit comments for inclusion in the final design.

5.1.2.3 Final Design

Final design will include addressing any comments from the 90 percent design review meeting. DOE acknowledges that EPA and UDEQ are not required to grant approval of the final design prior to proceeding with construction and operation of the system. DOE therefore assumes the primary responsibility for designing and implementing an effective groundwater remedy optimization system that is consistent with the conceptual design presented in this work plan. The plans and specifications will be completed to a level that is sufficient for procurement of a prime construction subcontractor and to then proceed with construction.

5.2 Access to Non-DOE Property

Construction and operation of the groundwater extraction system will occur on private property. A significant portion of the affected area will be beyond the extent of the current easement agreement with the property owner to operate the PRB and ex situ treatment system. DOE modified the easement agreement with the property owner, in April 2014, to include remedy optimization activities, including construction and operation. The remedy optimization will not affect any other private property owners.

Construction and operation of the groundwater transfer building and the transmission pipeline will be on City-owned property and will be primarily accessed through DOE property. The affected City property includes the corridor of the former haul road, which was restored to native conditions after OU I and OU II remedial actions but remains as a convenient corridor for pipeline construction.

DOE access to the City property to conduct remedial actions is granted under a land transfer agreement by which the City accepted ownership of former DOE property (in *CERCLA Covenant Deferral for Transfer of Federal Property in Monticello, Utah* [DOE 2000]). DOE will maintain communication with City officials to inform them of plans and pending actions associated with the remedy optimization.

5.3 Construction

Construction of the extraction well vaults, the groundwater transfer building, transfer tank and pump, electrical power and control systems, and groundwater pipelines will be completed by a prime construction subcontractor that is selected through the LM procurement process. The prime construction subcontractor will be responsible for managing all construction aspects of the project and in meeting design specifications and schedule. The subcontractor may allow qualified, specialty lower-tier subcontractors to perform specific tasks, such as electrical work and heat fusing connections of the water transmission pipeline.

Construction will commence following a pre-construction meeting between the LMS contractor and the awarded prime construction subcontractor. This meeting will confirm contractual obligations, work scope and schedule, worker safety, and field documentation requirements. The LMS contractor will appoint a full-time field supervisor to ensure subcontractor compliance with construction specifications, environmental requirements, field documentation, and health and safety requirements.

The completion of the project will include a final inspection, the startup of the system, and system testing. A complete set of as-built drawings of the project will be developed to document any changes that occurred during construction and to present a complete set of drawings of the completed project. DOE will include the as-built engineering drawings in an interim remedial action report that will be prepared and provided to EPA and UDEQ once it is determined that the remedy optimization system is operational and functional.

5.3.1 Extraction Well and Monitoring Well Installation

A qualified well-drilling service will install the extraction wells. LM will procure the well-drilling service under a subcontract that is separate from the prime construction contract. The LMS contractor will install the monitoring wells.

5.4 Environmental Compliance

As a CERCLA National Priorities List site, the MMTS is exempt from the requirement to obtain formal Federal, State, or local environmental permits for onsite remedial actions (CERCLA Section 121[e][1]). Examples of such permits are drilling permits and stormwater discharge permits for construction activities. Though formal permits may not be required, where applicable, the substantive requirements of such permits will be implemented during the groundwater remedy optimization to ensure regulatory compliance and adequate protection of human health and environment.

The remedy optimization will be implemented to comply with applicable or relevant and appropriate requirements (ARARs) to ensure regulatory compliance and protection of environmental and cultural resources during construction and operations activities. The chemical-, location-, and action-specific ARARs for the remedy optimization are listed below with a brief explanation of applicability, or relevance and appropriateness. Each ARAR was identified in the OU III ROD except that which addresses appropriation of groundwater for consumptive use.

- Federal Safe Drinking Water Act, National Primary and Secondary Drinking Water Standards—Relevant and appropriate chemical-specific requirement that governs drinking water quality. This requirement is pertinent for establishing OU III groundwater remediation goals because the alluvial aquifer is classified as a potential source of drinking water.
- Utah Safe Drinking Water Act—The State of Utah's implementation of the federal Safe Drinking Water Act, National Primary and Secondary Drinking Water Standards. This is a relevant and appropriate chemical-specific requirement that governs drinking water quality. This requirement is pertinent for establishing OU III groundwater remediation goals because the alluvial aquifer is classified as a potential source of drinking water (Class II, Drinking Water Quality).

- Utah Groundwater Quality Protection—Applicable chemical-, location-, and action-specific requirement that establishes groundwater-use categories and protection standards for those categories.
- Utah Standards of Quality for Waters of the State—Applicable chemical-, location-, and action-specific requirement that establishes surface water quality protection standards. This requirement is pertinent for establishing OU III surface water remediation goals and discharge allowances to Montezuma Creek. There are no planned surface water discharges associated with this remedy optimization project.
- Utah Well Drilling Standards—Applicable location- and action-specific requirement that governs the installation of wells with depths that are greater than 30 ft, and well abandonment. The groundwater extraction wells (which qualify as production wells) and monitoring wells that will be installed for this project will be shallower than 30 ft. The standards may apply to the eventual decommissioning of the wells.
- Utah Water Rights—Applicable location- and action-requirement that governs the appropriation and beneficial use of waters of the state. This requirement is pertinent because groundwater will be removed from the OU III hydrologic system by way of evaporation at Pond 4. Water rights have been obtained through a fixed time appropriation for the consumptive use of water associated with the remedy optimization. However, modifications to the water right, such as the identified points of diversion, are still required and must be completed before any consumptive use of water occurs.
- Utah Pollutant Discharge Elimination System—Applicable location- and action-specific requirement that governs pollutant discharges to surface waters of the state, including storm water runoff from construction sites. This requirement is pertinent because construction activities (installation of groundwater extraction wells, a buried pipeline, and associated infrastructure) may generate storm water runoff in the vicinity of Montezuma Creek, which qualifies as a water of the State. Storm water management controls will be put in place, as applicable, and maintained to ensure that sediment is not transported offsite or to any wetland areas or to Montezuma Creek.
- Utah Air Conservation Act—Applicable chemical-, location-, and action-specific requirement to govern air emissions, including fugitive dust emissions from construction activities. This requirement is pertinent because construction activities may generate fugitive dust. Dust suppression measures will be taken when necessary through the application of water to dry soils. Vehicle travel speeds will also be reduced to minimize dust generation.
- Utah Radioactive Material Management—Applicable chemical- and action-specific requirement that governs the management of radioactive material, including radioactive waste. This requirement is pertinent because groundwater treatment may generate radioactive waste such as residual radioactive waste that accumulates in Pond 4 from the evaporation of contaminated groundwater. Pond 4 is a radiologically controlled area, which will be clean closed when the use of the pond is no longer required.

- Uranium Mill Tailings Radiation Control Act—Relevant and appropriate chemical- and action-specific requirement that governs the cleanup and control of radioactive materials, including contaminated groundwater, from inactive uranium-processing sites. This requirement is pertinent for establishing OU III groundwater remediation (specifically for molybdenum and the uranium radiological dose limit) goals because uranium and vanadium were processed at the MMTS. Additionally, the radium-226 clean up standards would apply should any unanticipated uranium mill tailings be encountered (i.e., should a power pole need to be installed in a supplemental standards area on the City property).
- Clean Water Act, Dredge or Fill Requirements—Applicable location- and action-specific requirements that govern the discharge of dredge or fill materials into navigable waters and wetlands. This requirement is pertinent because construction activities will occur near Montezuma Creek and near a jurisdictional wetland in North Draw. Best management controls and practices will be put in place to ensure that these wetlands are not inadvertently disturbed during the construction activities, and that no sediment is transported into these areas. An example of a control will be to disallow the temporary stock piling of excavated soil in the vicinity of the North Draw work area while the pipeline is being constructed.
- Floodplain/Wetlands Requirements—Applicable location- and action-specific requirements that govern the management of floodplains and protection of wetlands. This requirement is pertinent because construction activities will be located on the floodplain of Montezuma Creek. The affected area will be restored to pre-remediation conditions.
- Utah Underground Injection Control—Applicable chemical- and action-specific requirement that governs the subsurface injection of fluids do not apply to the remedy optimization because subsurface injections will not occur.
- National Environmental Policy Act (NEPA)—Relevant and appropriate location- and action-specific requirement that governs the assessment of federal actions for potential environmental impacts. The actions associated with the contingency remedy have been adequately addressed through previous NEPA determinations for MMTS remedial actions and because the OU III contingency remedy is an ongoing remedial action consistent with the scope identified in the OU III ROD and ESD. No potential environmental impacts are identified that have not been addressed in previous MMTS remedial actions.
- Protection of Archeological, Anthropological, Paleontological, Historical, and Cultural Resources (cumulatively Cultural Resources)—Applicable location-specific requirement that governs the preservation of cultural resources. Impacts to cultural resources were previously evaluated for the selected remedy for OUs I and II (removal of contaminated soils, sediments, and other byproducts of the previous former mill site and surrounding peripheral properties, and their permanent disposal in the Monticello disposal cell). The actions planned for the remedy optimization will occur on the same land. Should any suspected cultural resources inadvertently be discovered during the implementation of this project, work in the area of discovery will stop and the Utah State Historic Preservation Officer will be consulted to determine required follow-up actions.
- Migratory Bird Treaty Act—Applicable location- and action-specific requirements that prohibit the taking of migratory birds and their parts, including nests and eggs. Construction activities are not planned in habitat areas of migratory birds. However, migratory bird species may come into contact with contaminated water in the evaporation pond.

5.5 Worker Health and Safety

LM administers a comprehensive health and safety and work control process, implemented through several manuals and written to meet the requirements of various laws and DOE orders. In particular, the *Health and Safety Manual* (LMS/POL/S04321), which implements Title 10 *Code of Federal Regulations* Part 851 (10 CFR 851), requires thorough work planning, task hazard analysis, and safety controls, and the *Project Management Control Systems Manual* (LMS/POL/S04330) specifies how to plan work, ensure that subject matter experts are involved, and ensure that only authorized work is performed, in accordance with the safety controls.

A designated LMS contractor remedial action manager, working at the direction of the LMS contractor site manager, will manage this project. A construction site superintendent will support the project manager and act as the site safety supervisor. Professional staff members from the LM Grand Junction office will also provide Health and Safety supervision at key points during the work.

Prior to any construction activities, all work activities will be segregated into discrete tasks during the job safety analysis (JSA) process. Multiple JSAs will be required for this project. All workers, including subcontractors, will have the opportunity to provide input to the JSAs prior to the start of work. A JSA identifies the safety and environmental hazards for a given task and identifies the associated hazard mitigation and controls. Before any work begins, all workers will participate in a pre-job meeting conducted by the construction site supervisor or a designee. During the meeting, the following topics will be discussed:

- The authorized scope of work and planned work sequence, as detailed in the Plan of the Day. The Plan of the Day identifies daily scheduled work activities to ensure that health and safety protections are in place for the planned work and that unplanned work is not implemented without proper hazard analysis and authorization.
- The lines of authority for the project.
- Emergency response information, such as the location of the nearest medical facility, the first aid kit, and fire extinguishers; and, the spill response process.
- Site access control and safety postings.
- Hazard controls, such as required training and personal protective equipment.
- The contents of the JSA.

A safety meeting will be held prior to the start of activities on each day of construction work. During both the pre-job meeting and the daily meetings, workers will be asked to provide input on the safety and environmental controls. The JSAs will be updated as needed based on that input.

The planned work activities are those related to basic construction and drilling operations and do not pose unusual hazards to personnel. No confined spaces will be entered or constructed. Worker exposure to contaminants in the groundwater encountered during well drilling is insignificant because concentrations in the water are too low to present significant risk.

The entire work area has been remediated to applicable radiological cleanup standards for surface and subsurface soils specified in 40 CFR 192.12. Radiological contamination is therefore not expected to be encountered; however, as a best management practice, excavation spoils may be scanned for radiologic contamination by a qualified radiological control technician. If radiological contamination is detected, the technician will ensure that adequate protections and management practices are implemented in accordance with standard operating procedures as prescribed in the Long-Term Surveillance and Maintenance Plan for the MMTS (DOE 2007).

5.6 Project Schedule

The primary tasks to complete the remedy optimization project and the expected schedule for those tasks are presented below. The assumed schedule is contingent upon EPA and UDEQ concurrence with the concept and scope of work identified in this work plan and access to the affected private property.

- Binding compensation/easement agreement finalized between DOE and the affected private property owner for construction access, disturbance, and operation and maintenance of the remedy optimization—late February 2014 (completed in April 2014).
- Final RD/RA Work Plan completed (with regulator approval)—mid-April 2014.
- 90 percent Engineering and Electrical Design submitted for regulator approval—late March 2014.
- Begin prime construction subcontract bid solicitation—April 2014.
- Install extraction and monitoring wells—May/June 2014.
- Prime construction subcontract awarded—early-June 2014.
- Construction—Begin July 2014. Assume a 5-month construction period including mobilization, site preparation, and demobilization.
- System operations testing and start up—October 2014.
- Evaluate need for enhanced evaporation at Pond 4—winter 2015.
- Site restoration (haul road and private property)—spring 2015.
- Construct enhanced evaporation system at Pond 4, if necessary—spring/summer 2015.
- Project close-out (as-built drawing set)—summer/fall 2015.

5.7 Project Organization

Table 2 provides a list of the names, titles, organization affiliations, and telephone numbers of key personnel associated with this project.

Table 2. Key Project Personnel

Key Project Personnel	Organization and Title	Contact Information
Jason Nguyen	DOE-LM Site Manager	(970) 248-6707
Ann Houska	LMS Contractor Site Manager; Remedial Project Manager	(970) 248-6579
Timothy Bartlett	LMS Contractor Site Hydrologist	(970) 248-7741

Table 2 (continued). Key Project Personnel

Key Project Personnel	Organization and Title	Contact Information
Fred Smith	LMS Contractor Site Operations Manager	(435) 587-3115
James Garcia	LMS Construction Safety Supervisor; Subcontractor Field Supervisor and Oversight	(970) 248-6388
Benjamin Gonzales	LMS Contractor Lead Design Engineer	(303) 410-4814
Melvin Madril	LMS Contractor Engineering Manager	(970) 248-6487
Craig Reese	LMS Contractor Engineering Quality Control	(208) 227-9046
Vicki Price	LMS Contractor Site Quality Performance and Assurance Specialist	(970) 248-6491
Paul Wetherstein	LMS Contractor Site Environmental Compliance Specialist	(970) 248-6645
Thomas Maveal	LMS Contractor Site Health and Safety Specialist; Radiologic Control Technician	(970) 248-6150
Sam Campbell	LMS Contractor Environmental Monitoring Lead	(970) 248-6654
Judy Miller	LMS Contractor Public Affairs Specialist	(970) 248-6363
Rex Sellers	LMS Contractor Contracts Services Manager	(970) 248-6614
Julie Hendricks	LMS Contractor Subcontractor Technical Interface	(970) 248-6684
Roxeen Kanka	LMS Contractor Project Analyst	(970) 248-6683
To Be Determined	Prime Construction Subcontractor Manager	To Be Determined

6.0 Protection of Human Health and the Environment

The latest CERCLA Five-Year Review (DOE 2012) of the MMTS concluded that the remedy documented in the OU III ROD (monitored natural attenuation with institutional controls), and as modified by the ESD, remains protective of human health. The protectiveness of the remedy is expected to continue mainly because there is no current or expected exposure pathway to the contaminated groundwater nor will there be through the construction and implementation of the remedy optimization. Although the affected aquifer is classified as a potential source of drinking water Class II, Drinking Water Quality, it has no historical record of use as a drinking water source. The aquifer is shallow, thin, and underlies agricultural land (livestock grazing and fodder production). Other sources of domestic-use water are readily available to nearby residents (municipal water and groundwater in a deeper bedrock aquifer).

Furthermore, the institutional control that was implemented in 1999 to prohibit domestic use of the contaminated groundwater represents an added measure of protectiveness. The institutional control, administered through the Utah State Engineer's Office, prevents groundwater use through the well permitting process within a defined groundwater restricted area. Documentation of this groundwater management policy is provided in DOE 2004b. Per EPA, institutional controls are not intended to replace permanent remedies.

For a brief comparison, the potential risk of groundwater use in a residential setting as tap water was estimated for three uranium concentrations associated with different phases of the groundwater remedy. These estimates, summarized in Table 3, represent order-of-magnitude approximations for evaluating potential human health risk reduction. Risk estimates are for (1) current uranium concentrations in the AOA, (2) a concentration representing a hypothetical tailing-off period (see Section 8.0 for a description of the concentration tailing effect), and (3) potential risk associated with the OU III remediation goal for uranium (30 µg/L based on the MCL). Risks were estimated from EPA's radionuclide preliminary remediation goals for tap water[1] and EPA's Regional Screening Level Table[2].

Uranium concentrations in OU III groundwater are currently based on laboratory analysis for uranium in µg/L. Carcinogenic risks based on uranium in picocuries per liter (pCi/L) are estimated by converting from µg/L to pCi/L using a conversion factor of 1 µg equivalence to 0.68 pCi (established for OU III during the RI). Carcinogenic risks were calculated based on toxicity data for uranium-238, the most toxic of the uranium radioisotopes present, and its daughter products. This is a conservative approach that likely overestimates risks. In addition, the risks are hypothetical since a complete exposure pathway for drinking water does not exist and institutional controls are in place to further prevent exposure.

[1] Radionuclide Toxicity and Preliminary Remediation Goals for Superfund (August 2010), http://epa-prgs.ornl.gov/radionuclides/ (last accessed December 4, 2013).
[2] Risk-Based Concentration Table, Mid-Atlantic Risk Assessment (November 2013), http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm (last accessed December 4, 2013).

The results in Table 3 show that carcinogenic risks associated with the present-day uranium concentration and those expected during the tailing period exceed the high end of the acceptable risk range (1×10^{-6} to 1×10^{-4}). Potential risk associated with the tailing period slightly exceeds the high-end of the risk range (10^{-4}); current concentrations (approximately 1,000 µg/L) exceed the range by an order of magnitude. Carcinogenic risks associated with the OU III remediation goal (MCL) are within the risk range. Noncarcinogenic risks associated with present-day concentrations are about an order of magnitude higher than acceptable (hazard quotient = 1); risks at the tailing-off level are approximately five times the acceptable risk. Noncarcinogenic risk at the MCL is acceptable compared to the hazard quotient. Each of these estimated risks conservatively assumes the use of contaminated groundwater as the sole source of drinking water for a residential user.

Table 3. Comparison of Human Health Risk

	Present	Tailing Period	MCL
Uranium concentration (µg/L)	1,000 (680 pCi/L)	200 (136 pCi/L)	30 (20.4 pCi/L)
Carcinogenic risk (uranium-238 + daughters)[a]	1.1×10^{-3}	2.2×10^{-4}	3.3×10^{-5}
Noncarcinogenic risk (hazard quotient)[b]	21	4.2	0.64

[a] Based on EPA's preliminary remediation goal of 0.607 pCi/L (at 10^{-6} risk level) for residential tap water (1 µg = 0.68 pCi).
[b] Hazard quotient based on EPA's preliminary remediation goal of 47 µg/L for residential tap water.

6.1 Short-Term Effectiveness and Risk Reduction

6.1.1 Protection of the Community During Remedial Actions

- Implementation and operation of the remedy optimization presents an increase in vehicle traffic on local roads.
- Implementation and operation of the remedy optimization affects one private property owner. The general community is otherwise not affected.
- Implementation and operation of the remedy optimization affects City-owned property. The affected City property is rural, undeveloped, and receives some use as a public park. The general community will not be affected by the planned remedy optimization.
- The disposal site is secured and maintained under LM protocol to prevent human intrusion. Implementing the remedy optimization will not compromise this protection to the community.

6.1.2 Protection of Workers During Remedial Actions

Standard construction practices, equipment, and materials will be used to implement, operate, and maintain the groundwater remedy optimization. The planned work does not rely on practices that would pose inordinate risk to worker safety. Worker protection will be ensured through LM subcontractor procurement and health and safety protocol as described in Section 5.5 of this work plan.

All work will be conducted on properties that were remediated to the established radium-226 cleanup standards for MMTS; therefore, worker exposure to mill tailings is not of concern. The potential for unacceptable worker exposure to contaminants in the groundwater encountered during well installation or system operation is insignificant because concentrations in the water are too low to present significant risk.

6.1.3 Potential Environmental Impacts

Baseline ecological risks were evaluated during the RI for OU III (DOE 1998a). These were summarized and updated for the RI Addendum/Focused Feasibility Study (DOE 2004b) and are the basis for evaluating potential environmental impacts of the contingency remedy optimization.

- Response actions associated with the hypothetical release of contaminated water to the environment from Pond 4 are addressed in *Repository and Pond 4 Groundwater Contingency Plan—Final* (DOE 1998c). That plan specifies actions levels whereby specified rates of leakage through the liner system at Pond 4 will initiate a response action. As reported in the MMTS FFA quarterly reports, leakage to the Pond 4 collection sumps is generally absent; therefore, response actions have never been required.
- Ecological exposure (habitat)—Evaporative treatment at Pond 4 potentially presents a new exposure pathway for some organisms because of the increased quantity of water in the pond. However, access to Pond 4 by large mammals (e.g., mule deer, coyotes) is prevented by regular surveillance and maintenance of the locked perimeter fence.

  Limited habitat for small mammals exists within the Pond 4 perimeter fence, but no significant populations of such animals have been identified during routine and annual inspections. Because small rodents (e.g., voles) generally derive much of their water from food, use of Pond 4 water by these animals is not expected to be significant. No significant food source would exist in the pond.

  The growth of a significant plant community in Pond 4 is not expected because of the steep, smooth walls and the depth of water during operation. Therefore, benthic macroinvertebrates, which inhabit sediments and stands of vegetation and provide a food source for aquatic birds, would also not be abundant.

  Three avian surveys were conducted at wetlands in Montezuma Creek (summarized in DOE 2011), during which 87 total species were observed. Of these, nine could land on and potentially ingest the pond water but would not nest in the area because vegetation and/or food would not be present. These species include blue-winged teal, cinnamon teal, common snipe, gadwall, great blue heron, mallard, sora, spotted sandpiper, and white-faced ibis. Potential habitat exists in the vicinity of the pond for ground-nesting species, including blue grosbeak, Brewer's blackbird, common nighthawk, European starling, horned lark, lark sparrow, spotted towhee, vesper sparrow, Virginia's warbler, and western meadowlark. Although they may ingest pond water, these species are terrestrial feeders and would not be exposed to food sources from the pond.

  Nesting habitat may also exist for killdeer, which feed on both terrestrial and aquatic invertebrates, and for Canada geese, which eat mostly vegetation. Pond 4 would not be expected to provide significant food for either species.

- Ecological exposure (contaminants)—Sample and others (1996) have calculated screening-level ecological benchmarks for ingestion of water by various bird species. These are summarized in Table 3. Also included are maximum concentrations of those constituents in OU III groundwater. Concentrations of COCs in Pond 4 will increase as water evaporates; however, a comparison of the benchmarks with maximum groundwater concentrations indicates that contaminants in groundwater discharged to Pond 4 would need to undergo increases of one or more orders of magnitude before approaching concentrations that could pose potential harm to birds if consumed on a regular basis. The relatively low groundwater concentrations combined with the pond's infrequent use by birds would result in no significant risk to the most likely ecological receptors.

Table 4. Screening-Level Avian Benchmarks for OU III Contaminants of Concern

Contaminant	NOAEL-Based Water Concentration (mg/L) for Avian Species[a]	Maximum in OU III Groundwater (mg/L)
Arsenic	10.6–156	0.01
Manganese	4,284–30,435	0.044
Molybdenum	15–106	0.1
Selenium	1.7–15.2	0.11
Uranium	68–488	1–2
Vanadium	48–348	0.25

[a] Source: Sample et al. 1996
NOAEL = no observed adverse effects level
mg/L = milligrams per liter

- Consumptive use of groundwater—Transfer of the contaminated groundwater to Pond 4 for evaporative treatment may impact stream ecology downstream of the AOA and may affect the quantity of water in Montezuma Creek available to current holders of surface water allocations. The reach of Montezuma Creek that is most likely to be affected by groundwater withdrawal flows through agricultural land and often runs dry at many locations during dry seasons. Below this reach, in the undeveloped portion of the canyon, groundwater discharge from the underlying Burro Canyon aquifer generally maintains perennial creek flow, and groundwater withdrawal may not significantly affect this reach.
- Environmental releases—The remediation system has the potential to leak contaminated groundwater from the associated piping, groundwater transfer tank, and Pond 4. A contingency response plan is in place for Pond 4 leakage (DOE 1998c). Section 7.0 of this work plan addresses contingency actions that will be implemented in response to evidence of pipeline and transfer tank leakage.
- Waste generation—Dissolved solids that precipitate in the evaporation pond will require eventual disposal when the pond is decommissioned. These solids may be radioactively contaminated. Pond 4 decommissioning will be conducted under a separate closure plan to be prepared when Pond 4 is considered no longer necessary. No other waste byproducts are associated with the remedy optimization.
- Hazardous substances—Except for motor fuels and fluids associated with operating construction equipment and vehicles, no hazardous substances that could be released to the environment or cause unacceptable exposure to workers are associated with constructing, operating, or maintaining the optimized remedy.

7.0 Operation, Monitoring, and Reporting

7.1 Operating Plan

LM will develop an operating plan following confirmation that the system was installed and is functioning according to design. The plan will provide schematic and text description to identify the main system modules (e.g., extraction wells, transfer pump, telemetry and control system, and pipeline) and describe the overall system process and how the individual modules interrelate.

The objective of the operating plan is to provide a concise description of the working components of the remediation system and associated operating procedures. This will enable operations and project personnel to diagnose and respond to potential maintenance needs. The plan will also identify roles and responsibilities for system operation and response actions required in the event of non-normal operating conditions.

7.2 Monitoring

Monitoring will occur in the remedy optimization monitoring wells and will consist of periodic measurement of groundwater levels and collection of water samples for laboratory analysis of uranium and selected general water quality parameters (e.g., total dissolved solids and major ion chemistry). These data will be used to evaluate groundwater flow directions, groundwater capture in the AOA, and uranium concentration trending. DOE will also monitor water table and water quality conditions at least once before placing the remediation system in operation. This will measure the baseline condition before the remedy optimization is activated and will be complemented by data from other wells that are monitored semiannually under the OU III monitoring program.

During system operation, DOE will monitor water levels continually using data loggers in the extraction wells and in the remedy optimization monitoring wells. Water quality monitoring will be conducted in the monitoring wells at a frequency of 1 million gallons of groundwater extracted. One million gallons of groundwater is equivalent to approximately one-half the volume (pore volume) of contaminated groundwater in the AOA. Extraction wells will be sampled on an as-needed basis for analysis of uranium as this will allow pumping rates to be adjusted at individual wells to maximize uranium recovery. Additionally, water quality monitoring will be conducted at the transfer tank sampling port to evaluate bulk uranium removal from the aquifer. This sampling will be conducted at the same frequency as the monitoring wells (every 1 million gallons).

A description of the monitoring locations, frequency, analytes, and sampling methods for the remedy optimization will be appended to the Monticello-specific section of the LM-wide Sampling and Analysis Plan (LMS/PRO/S04351). As the remedial action progresses, DOE will determine and implement, with the concurrence of EPA and UDEQ, any necessary modifications to the scope and frequency of monitoring.

7.3 Reporting

Groundwater extraction quantities, uranium mass removal, and operating conditions will be reported semiannually in the April and October submittal of the quarterly FFA reports to EPA and UDEQ. More comprehensive evaluation of the remedy optimization performance, including water quality data, uranium concentration trends, and water table response to groundwater extraction (water table drawdown and groundwater flow directions) will be reported in the annual groundwater reports, which are typically submitted to EPA and UDEQ in September.

The uranium concentration data will also be computed as an average for each sampling event among the 16 remedy optimization monitoring wells. The computed averages will then be used to measure the progress of the remedy optimization toward meeting the 30 µg/L remediation goal. Additionally, DOE will notify EPA and UDEQ of significant anomalous operating conditions as such conditions arise.

7.4 Response Actions

Non-normal operating conditions are possible and may prompt DOE to implement corrective measures to ensure that groundwater remediation proceeds with minimal interruption and with minimal adverse impact to the environment.

Response actions associated with the hypothetical release of contaminated water to the environment from Pond 4 are addressed in *Repository and Pond 4 Groundwater Contingency Plan—Final* (DOE 1998c). That plan specifies actions levels whereby specified rates of leakage through the liner system at Pond 4 will initiate a response action.

7.4.1 Spill Management

Although secondary containment of the transfer tank is not required by regulation and double-wall pipe will not be used to convey the groundwater, the system will be designed with automatic tank overfill prevention controls and a sump will be built into the flooring below the tank, and will be controlled to shut off extraction well pumping should water be detected in the sump. Additionally, the system will have flow meters and pressure gauges which will be monitored for indications of system leakage.

Leakage of contaminated groundwater from piping between the extraction wells and the groundwater transfer building, within the building, and from the pipeline to Pond 4 will prompt DOE to deactivate and drain affected components of the system for repair. If contaminated groundwater is released to the environment, the LMS contractor Environmental Compliance site lead will be notified to determine follow-up actions that must be taken. Specific response actions will be identified in the pending operating plan, which was discussed in Section 7.1.

Because of the concentration of constituents in the groundwater and the volume of water being managed by the remedy optimization system, the notification and reporting requirements under 40 CFR 302.4, “Designation of Hazardous Substances,” are not applicable for releases of

hazardous constituents to the environment from the contingency remedy optimization system because the reportable quantities (RQs) could not be exceeded.[3]

7.5 Closure Plan

Design specifications assume that the remedy optimization infrastructure will sustain 10 years of effective operation. However, the duration of the remedy may be shortened due to Pond 4 storage capacity limitations or primary liner integrity concerns. A clean-closure plan will be prepared at a later date to address the management of any waste materials associated with decommissioning the remedy infrastructure. Final disposition of any radiologically contaminated material will occur at the LM disposal cell near Grand Junction, Colorado. The projected closure date of that facility is 2023.

[3] Of the seven contaminant of concern in the OU III groundwater, RQs exist for arsenic, selenium, and uranium. Using conservative assumptions to calculate the possible maximum quantity of each constituent that could be released to the environment in a 24-hour period, it was determined that releases could only occur at quantities several orders of magnitude below each constituent's applicable RQ. Calculations supporting this determination will be included in the pending operating plan.

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8.0 Potential Limitations of Pump-and-Treat Technology

8.1 Concentration Tailing Effect

Pump-and-treat remediation will likely remove significant uranium mass from the aquifer. However, the rate of mass removal and reduction in uranium concentration is expected to decrease over time because of subsurface heterogeneity and geochemical complexity. These factors are expected to result in persistent concentrations of between 100 and 200 µg/L uranium (concentration tailing effect), thereby limiting the ability of pump-and-treat remediation to reach the remediation goal for uranium in a reasonable time in the AOA.

This tailing effect was demonstrated in an OU III column test study (DOE 2001). In that study, uranium concentrations were observed to leach from alluvial sediments at a rapid rate through the initial 5 to 7 pore volumes (2 million gallons of contaminated groundwater is equivalent to approximately 1 pore volume in the AOA). Effluent concentrations then became relatively stable between about 100 and 200 µg/L through additional pore volumes of flushing (up to about 25 pore volumes). These test results provide a benchmark by which the extraction of multiple pore volumes (possibly 5 to 10) from the AOA within several years should be adequate to recognize a possible tailing effect and to project the restoration potential of the alluvial aquifer.

8.2 Aquifer Recharge to the AOA

The amount of recharge to the alluvial aquifer in the AOA may be minor. As the area is dewatered by the extraction system, subsequent recharge may be slow, depending on the recharge potential from Montezuma Creek. Also, groundwater underflow from the west is limited to a narrow, thin section of the alluvial aquifer, as depicted in Figure 4 (underflow boundary). The rate of groundwater recovery in the AOA will directly affect the periodicity of pore volume removal and ultimately the progress of the remedial action. Additionally, prolonged drought conditions in the Monticello area could adversely affect the performance of the remedy optimization but are beyond the control of this project.

8.3 Suspension of Water Appropriation

Extraction of the contaminated groundwater from OU III for evaporative treatment required a water use appropriation through the Utah Office of the State Engineer. DOE therefore secured a fixed-time appropriation for this consumptive use. However, at the discretion of the State Engineer, the appropriation may be suspended at any time to ensure that senior surface water rights are not compromised. This outcome is beyond the control of DOE and would interrupt operation of the extractive component of the remediation system.

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9.0 Remedy Evaluation

DOE, in consultation with EPA and UDEQ, will develop criteria in a Remedy Performance Evaluation Plan to assess the success of the remedy optimization toward meeting the uranium remediation goal of 30 µg/L. These criteria will provide the basis for determining the duration (termination) of the remedy optimization. The criteria will be prepared after the remedy optimization has been implemented and several pore volumes of groundwater have been removed from the AOA. Operation and monitoring of the remedy optimization through that time should provide sufficient data to evaluate uranium concentration trending, groundwater capture analysis, extraction/recharge cycling, and Pond 4 performance (fill rate, evaporation rate, liner system integrity). Progress of the remedy optimization will be evaluated in annual reports and evaluated for protectiveness to human health and the environment in CERCLA 5-year reviews.

Any of these factors may limit the remedy optimization in attaining the remediation goal for uranium, as determined by uranium concentration averaging of the monitoring well network in the AOA. Alternative remedy options to active remediation as identified in the ESD may include application of an alternate concentration limit for uranium or a waiver of the uranium remediation goal based on reasons of technical impracticability. Additionally, the remedy could be restored to MNA throughout all of OU III by removing the PRB once the uranium concentration tailing effect has been established. The Remedy Performance Evaluation Plan will include a sampling and analysis strategy to confirm that attainment of the remediation goal is probable without significant concentration rebounding following cessation of active remediation.

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