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John Kieling, Bureau Chief
Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505-6303

Subject: Evaluation Report for Surface Corrective Measures Implementation Closure, Consolidated Unit 16-021(c)-99

Dear Mr. Kieling:

Enclosed please find two hard copies with electronic files of the Evaluation Report for Surface Corrective Measures Implementation Closure, Consolidated Unit 16-021(c)-99. This report was developed in response to the New Mexico Environment Department's (NMED's) approval with modifications (AWM) for the Semiannual Progress Report for Corrective Measures Evaluation/Corrective Measures Implementation for Consolidated Unit 16-021(c)-99, dated February 15, 2016. NMED's AWM required the U.S. Department of Energy and Los Alamos National Security, LLC (DOE/LANS) to address unresolved issues pertaining to the 2009–2010 corrective measures implementation (CMI) at Consolidated Unit 16-021(c)-99 within Technical Area 16 (TA-16) at Los Alamos National Laboratory.

The AWM directed DOE/LANS to provide (1) correspondence "outlining actions pertinent to the closure of the 260 surface CMI" and (2) an evaluation report "describing all current and unresolved issues relevant to the CMI"; furthermore, NMED stated that the report "must contain a proposed submittal date for the required work plan." As discussed with NMED staff, DOE/LANS proposed submitting a single evaluation report (enclosed) that will include the recommendations/work plan for each of the issues evaluated. Therefore, this evaluation report meets the requirements of NMED's AWM. A review was conducted with NMED staff on September 15, 2016, to go over the technical approach and organization of the evaluation report. No issues were identified by any of the parties during the meeting.

The evaluation report provides (1) recommendations for removing the damaged permeable reactive barrier in Cañon de Valle, (2) an evaluation of the alluvial groundwater monitoring network in Cañon de Valle and recommendations for additional monitoring locations, and (3) recommendations for removing the carbon filtration treatment systems at SWSC, Burning Ground, and Martin Springs based on declining contaminant concentrations in the alluvium.

If you have any questions, please contact Stephani Swickley at (505) 606-1628 (sfuller@lanl.gov) or Cheryl Rodriguez at (505) 665-5330 (cheryl.rodriguez@em.doe.gov).

Sincerely,

Bruce Robinson, Program Director
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Sincerely,

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Enclosure: Evaluation Report for Surface Corrective Measures Implementation Closure, Consolidated Unit 16-021(c)-99 (EP2016-0119)

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Evaluation Report for Surface Corrective Measures Implementation Closure, Consolidated Unit 16-021(c)-99

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Prepared by the Associate Directorate for Environmental Management

EP2016-0119

Evaluation Report for Surface Corrective Measures Implementation Closure, Consolidated Unit 16-021(c)-99

September 2016

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1.0 INTRODUCTION

This report was developed to address current unresolved issues relevant to the 2009–2010 corrective measures implementation (CMI) at Consolidated Unit 16-021(c)-99 within Technical Area 16 (TA-16), Los Alamos National Laboratory (LANL or the Laboratory), conducted in accordance with the 2007 "Corrective Measures Implementation Plan for Consolidated Unit 16-021(c)-99, Revision 1," (LANL 2007, 098192). Figure 1.0-1 shows the location of TA-16 with respect to other Laboratory TAs.

The report was also developed in response to the New Mexico Environment Department (NMED) approval with modifications (AWM) for the "Semiannual Progress Report for Corrective Measures Evaluation/Corrective Measures Implementation for Consolidated Unit 16-021(c)-99" (NMED 2016, 601213). The AWM directed the Laboratory to submit an evaluation report to NMED by September 30, 2016, addressing current and unresolved issues relevant to the CMI, including (1) removal or reclamation of the permeable reactive barrier (PRB); (2) the adequacy of the alluvial groundwater well network; and (3) the potential for use of the carbon-filtration treatment systems at Burning Ground, Sanitary Wastewater Systems Consolidation (SWSC), and Martin Springs.

This report summarizes the CMI work completed to date, provides an evaluation of current and unresolved issues relevant to the CMI, and proposes an approach to resolve the remaining requirements. The report includes a discussion of the following:

- Recommendations for removal of the damaged PRB in Cañon de Valle, and plugging and abandonment (P&A) of PRB wells
- Evaluation of the alluvial groundwater monitoring network in Cañon de Valle and recommendations regarding the need for additional monitoring locations to provide long-term monitoring
- Review of RDX (hexahydro-1,3,5-trinitro-1,3,5-triazine) trends in Cañon de Valle and Martin Spring Canyon springs and alluvium and recommendations for a path forward regarding the need to treat water discharging from SWSC, Burning Ground, and Martin Springs

This report includes plans for P&A of PRB monitoring wells, removal of Cañon de Valle PRB debris, and installation of one additional alluvial monitoring well in Cañon de Valle. It also recommends removing the spring treatment units and continued monitoring at SWSC, Burning Ground, and Martin Springs. Pending approval by NMED, the proposed activities will be conducted in fiscal year 2017, and a surface CMI closure report for Consolidated Unit 16-021(c)-99 will be prepared documenting completion of the surface CMI activities discussed in this report as well as all other activities associated with the surface CMI.

1.1 Background

The objective of the 2009–2010 CMI was to remediate high explosives (HE) and other contaminants detected at the 260 Outfall, including a concrete trough, former settling pond, and outfall drainage channel, and in the alluvial systems of Cañon de Valle and Martin Spring Canyon. The CMI was conducted in accordance with the approved CMI plan (LANL 2007, 098192; NMED 2007, 098449). Corrective actions at the Laboratory are subject to the June 2016 Compliance Order on Consent (the Consent Order). The activities conducted in 2009 and 2010 were completed under plans approved under the March 2005 Consent Order and are referred to throughout this report as the surface CMI activities.

The target cleanup levels for soils under the CMI at the 260 Outfall were based on a target risk of 10^{-5} for carcinogens and a hazard index of 1 for noncarcinogens for the on-site worker. Three chemicals of potential concern were identified during the 2009–2010 CMI: RDX; TNT (2,4,6-trinitrotoluene); and barium. The target cleanup levels were site-specific screening action levels of 36.9 mg/kg for RDX and 135.0 mg/kg for TNT and the NMED residential soil screening level of 15,600 mg/kg for barium.

Remediation activities conducted during the 2009–2010 CMI are discussed in the "Summary Report for the Corrective Measures Implementation at Consolidated Unit 16-021(c)-99" (LANL 2010, 108868) and in the "Addendum to the Summary Report for the Corrective Measures Implementation at Consolidated Unit 16-021(c)-99" (LANL 2010, 110508). The activities included

1. removing the concrete trough outfall next to building 16-260 at the 260 Outfall channel;
2. removing soil and sediment within the former settling pond within the 260 Outfall drainage channel;
3. replacing a low-permeability cap on the former settling pond;
4. removing soil and tuff from the 260 Outfall drainage channel;
5. sampling soil in the SWSC cut of Cañon de Valle;
6. installing surge bed injection grouting within the former settling pond at the 260 Outfall channel;
7. excavating soil and tuff and collecting a final confirmation sample at the lower 260 Outfall drainage channel;
8. resampling sediment for ecotoxicity at the SWSC cut;
9. installing carbon filter treatment systems at SWSC and Burning Ground Springs in Cañon de Valle and modifying the existing carbon filter at Martin Spring in Martin Spring Canyon; and
10. installing a pilot PRB for treatment of HE and barium in Cañon de Valle.

Figure 1.1-1 shows the locations of SWSC, Burning Ground, and Martin Springs and the PRB at TA-16. A long-term monitoring and maintenance plan for the CMI was submitted to NMED on April 30, 2010 (LANL 2010, 109252).

The following sections of this report provide an evaluation and recommendations for the activities necessary to close out the surface CMI.

2.0 EVALUATION AND RECOMMENDATIONS FOR THE PRB

This section summarizes the damage to the PRB and its monitoring well network from flooding in 2011 and provides recommendations for removal of the damaged PRB components. For the purpose of this report, the PRB consists of the cutoff wall, the treatment vessel and infiltration gallery, associated infrastructure piping, and 16 alluvial wells and 4 piezometers (LANL 2010, 108868).

Between June 26 and August 3, 2011, the Las Conchas fire consumed more than 156,000 acres across the Santa Fe National Forest in Sandoval, Los Alamos, and Rio Arriba Counties; Santa Clara Pueblo; Jemez Pueblo; Cochiti Pueblo; Santo Domingo Pueblo; Bandelier National Monument; Valles Caldera National Preserve; and state and private land holdings (LANL 2011, 206408). The Cañon de Valle watershed and large areas upgradient of the PRB and 260 Outfall sustained moderate to severe fire damage. While Laboratory property and the PRB and the 260 Outfall were not directly burned in the Las Conchas fire, the subsequent burn scar left the watershed vulnerable to flash flooding.

Between July 28 and August 3, 2011, a series of storms produced 4.1 in. of rain in Cañon de Valle watershed, resulting in flooding in Cañon de Valle that significantly damaged many parts of the PRB, rendering the treatment unit inoperable. Floodwater, sediment, and ash infiltrated the PRB vessel chambers, significant headcutting occurred in the Cañon de Valle channel immediately east (downgradient) of the PRB cutoff wall, and piping and sampling components of the PRB sustained considerable damage.

On August 21, 2011, another large storm produced a severe flood in Cañon de Valle that destroyed a number of alluvial wells in Cañon de Valle and caused considerable additional damage to the PRB. The flood damage to the PRB and alluvial monitoring network from the August 2011 events are summarized in the "2010/2011 Monitoring Summary Report for the Technical Area 16 Permeable Reactive Barrier and Associated Corrective Measures Implementation Projects" (LANL 2011, 206408).

The August 21, 2011, flood eroded backfill around the PRB cutoff wall down to bedrock, with an incision approximately 10 ft wide and about 5 ft deep. The cutoff wall was broken and splayed open downstream. Sediment from the channel bed and adjacent stream banks eroded, and sediment and rocks as large as 2 ft to 3 ft in diameter were deposited on top of the PRB vessel and throughout the canyon. The PRB monitoring tubes and plumbing around the treatment vessel were either transported downstream or buried, and the plumbing connecting the cutoff wall to the vessel was ripped out of the vessel and the cutoff wall. Debris from the PRB was found approximately 1 mi downstream.

In addition to the considerable damage to the PRB, the August 2011 floods also destroyed or damaged 8 of the 20 PRB monitoring wells and piezometers (LANL 2011, 206408). Table 2.0-1 summarizes the damage to the PRB monitoring wells and piezometers.

The hydrologic system in Cañon de Valle was strongly perturbed by the August 2011 flooding as a result of severe damage to the watershed caused by the Las Conchas wildfire. The flooding also destroyed two alluvial monitoring wells in Cañon de Valle used for monitoring under the Laboratory's Interim Facility-Wide Groundwater Monitoring Plan. Alluvial monitoring well CdV-16-02657, located near the 260 Outfall, and alluvial monitoring well CdV-16-02658, located immediately upgradient of the PRB (Figure 2.0-1), were destroyed. These wells and recommendations for wells that will comprise the long-term alluvial monitoring network are discussed in section 3.

On April 15, 2016, NMED and Laboratory personnel conducted a site visit to Cañon de Valle to assess the remnants of the PRB and to evaluate the adequacy of the alluvial monitoring well network for long-term monitoring. After reviewing the condition of the PRB, it was determined that the PRB debris should be removed, but the buried portions of the cutoff wall should be left in place to minimize impacts by heavy equipment to the area. Fill material used around the cutoff wall is favorably compact with established vegetation. Disruption of that material would likely render the alluvium comprising the floodplain less stable. Additionally, Cañon de Valle provides core habitat for both the Jemez Mountain Salamander and the Mexican Spotted Owl, both federally listed endangered species under the Endangered Species Act. The approach recommended below minimizes the potential for negative impacts to threatened and endangered species.

Concentrations of RDX in alluvial monitoring wells in Cañon de Valle show long-term declines over the last 15 yr, with concentrations typically at or below the NMED tap-water screening level of 7.02 µg/L for RDX (section 4.1). These declining concentrations likely result from a number of factors, including the implementation of cleanup measures at the 260 Outfall through several campaigns (including a 2000–2001 interim measure cleanup (LANL 2002, 073706) and the 2009–2010 CMI campaign), and changed hydrology in Cañon de Valle as a result of the Las Conchas fire, with more rapid runoff responses to precipitation, increased runoff, earlier snowmelt, and spring runoff.

Given the continued susceptibility to flooding in the area, the significant geomorphological changes to the channel in Cañon de Valle as a result of recent flooding, and the declining concentrations of HE in the alluvium, PRBs are not considered a viable or necessary remedial alternative for the HE in shallow alluvial groundwater within Cañon de Valle. Based on these factors, the Laboratory recommends removing the pilot PRB in Cañon de Valle, with the exception of the buried portion of the cutoff wall, which as discussed above should remain in place, in addition to the two PRB alluvial wells discussed above. Details of removal actions are presented below.

2.1 Proposed PRB Removal Activities

The following activities will be undertaken to remove the pilot PRB.

1. The PRB treatment vessel will be removed and filtration media from the treatment box will be containerized and disposed of. As-built drawings for the PRB are presented in Figures 2.1-1 and 2.1-2.
2. The corrugated steel culverts (identified as manholes in Figure 2.1-1) and piping immediately above and below the PRB will be removed, including the piping between the culverts and the PRB.
3. The exposed portions of the cutoff wall and the infiltration gallery (Figure 2.1-2) will be removed, and associated PRB debris up to 1500 ft downcanyon will be collected and disposed of.
4. Two PRB alluvial monitoring wells, CdV-16-611923 and CdV-16-611937, will be retained for long-term monitoring under the Interim Facility-Wide Groundwater Monitoring Plan, as discussed in section 3.0, and the remaining PRB alluvial wells will be plugged and abandoned. The four PRB piezometers will be retained to preserve the geochemistry of the PRB Alluvial Seep (section 3.0).

   The PRB alluvial monitoring wells are constructed of Schedule 40 2-in.–inside diameter polyvinyl chloride (PVC) and are completed to depths of 8.0 ft to 13.1 ft (LANL 2010, 108868). Figure 2.1-3 shows the locations of the monitoring wells and piezometers at the PRB. Table 2.0-1 summarizes the PRB well and piezometer completion depths and the recommended disposition for each well (retain or P&A). Well completion diagrams for the PRB monitoring wells are presented in Appendix A (excerpted from LANL 2010, 108868). Table 2.0-1 cross-references the alternate names for PRB wells and piezometers.

5. A P&A plan for the monitoring wells will be developed and submitted to the New Mexico Office of the State Engineer (NMOSE) for approval. Once approved, P&A activities will be initiated as outlined below.

   The proposed approach to P&A will be to remove the surface pads and protective casings, pull the inner casings, and backfill the boreholes with cement grout to ground surface. If the casings cannot be extracted, they will be cut off at 6 in. below ground surface (bgs), and the boreholes and casing will be filled with cement grout to ground surface. All remaining PRB wells will be plugged and abandoned, except the two wells planned for retention for long-term monitoring (CdV-16-611923 and CdV-16-611937).
6. Following P&A of the alluvial monitoring wells, the PRB site will be graded and restored.
7. All waste will be properly characterized and managed in accordance with EP-DIR-SOP-10021, Characterization and Management of Environmental Waste.
8. Should a temporary access road be required, the roadway will also be restored.

3.0 EVALUATION OF THE ALLUVIAL GROUNDWATER MONITORING WELL NETWORK

The alluvial monitoring well network in Cañon de Valle was evaluated to determine whether additional wells are needed to replace monitoring wells that have been destroyed in flooding events in recent years. Figure 2.0-1 shows the locations of SWSC and Burning Ground Springs, the 260 Outfall, and alluvial wells in Cañon de Valle. Alluvial monitoring wells CdV-16-02657 and CdV-16-02658 were destroyed during the flooding of August 2011 and have not been replaced. These wells were part of the monitoring well network for the TA-16 260 monitoring group and were sampled under the Interim Facility-Wide Groundwater Monitoring Plan. An evaluation of the alluvial monitoring well network in Cañon de Valle was also conducted to determine the adequacy of the network for long-term monitoring.

Analytical data from the alluvial monitoring wells and from SWSC, Burning Ground, and Martin Springs were reviewed to assess long-term trends in RDX concentrations. In general, downgradient alluvial monitoring wells show long-term decreases in RDX, with concentrations currently near or below the NMED tap-water screening level of 7.02 µg/L.

Several possible reasons exist for the decrease in RDX concentrations in alluvial groundwater. These include the extensive removal of contaminant source during the 2010–2011 soil cleanup at the 260 Outfall (LANL 2010, 108868), during which HE and other contaminants in the 260 Outfall channel were removed to risk-based target cleanup levels (36.9 mg/kg for RDX and 135.0 mg/kg for TNT). In addition, the post–Las Conchas hydrology for has changed, which has manifested as (1) earlier and potentially longer snowmelt runoff resulting in greater mixing of noncontaminated water from the upper watershed, (2) more frequent flooding with higher peak flows, and (3) local erosion of RDX-contaminated alluvium in the reach below the outfall. NMED and Laboratory personal visited the Cañon de Valle site on April 15, 2016, to assess cleanup options for the destroyed PRB, to review the remaining alluvial monitoring wells, and to identify possible locations for replacement monitoring wells, if necessary. During the visit, P&A of the PRB monitoring wells was discussed.

To improve the coverage of the alluvial monitoring well network in Cañon de Valle, two PRB alluvial wells (CdV-16-611923 and CdV-16-611937) are proposed for retention and are included as sampling locations in the monitoring year (MY) 2017 Interim Facility-Wide Groundwater Monitoring Plan (LANL 2016, 601506). PRB well CdV-16-611923 is located immediately upstream of the cutoff wall (Figure 2.1-3) and was proposed as a replacement for alluvial well CdV-16-02658 in 2012 because of its close proximity to the former location of CdV-16-02658 and its similar completion depth in the alluvium. Although the monitoring period for both wells overlapped for only a short period, RDX concentrations in both wells were quite similar during this period (Figure 3.0-1). After the destruction of CdV-16-02658 in August 2011, PRB alluvial well CdV-16-611923 was added to subsequent Interim Facility-Wide Groundwater Monitoring Plans as a replacement for the destroyed well (LANL 2012, 225493; LANL 2013, 241962; LANL 2014, 256728; LANL 2015, 600467; LANL 2016, 601506).

PRB well CdV-16-611937 is located downstream of the PRB vessel on the south side of the channel (Figure 2.1-3) and was proposed as an additional monitoring location for the MY2017 Interim Facility-Wide Groundwater Monitoring Plan (LANL 2016, 601506) to provide additional monitoring coverage downcanyon of the PRB.

In addition, a perennial seep has emerged along the west side of the PRB cutoff wall, with an estimated seepage rate on the order of 3 to 5 gallons per minute (gpm). The seep seems to flow year-round, and provides an ideal location for sampling emergent alluvial groundwater on the south side of Cañon de Valle. Because the PRB cutoff wall is tied to the underlying bedrock, the seep provides an accessible sampling location for alluvial groundwater on the south side of the incised Cañon de Valle channel. This seep has been named the “PRB Alluvial Seep” and was added to the MY2017 Interim Facility-Wide

Groundwater Monitoring Plan as a monitoring location. Sampling of the PRB Alluvial Seep is recommended for long-term monitoring in the vicinity of the PRB. Because CdV-16-611923 monitors the alluvial groundwater north of the incised channel at the PRB (Figures 2.0-1 and 2.1-3), the monitoring of this PRB alluvial well and the PRB Alluvial Seep will provide good coverage for the area near the PRB.

3.1 Proposed Alluvial Monitoring Well CdV-16-02657r

Alluvial monitoring well CdV-16-02657 was destroyed during the flooding on August 21, 2011. This shallow (5.7-ft-deep) alluvial well was located immediately downgradient of the 260 Outfall (Figure 2.0-1), and samples from this well have historically shown relatively high concentrations of RDX because of its proximity to the 260 Outfall (Figure 3.1-1).

To assess long-term trends of contaminant concentrations in the alluvium near the 260 Outfall and to evaluate the influence of the 2009–2010 CMI activities on HE concentrations in the alluvium near the 260 Outfall, it is recommended that a shallow well be installed to replace CdV-16-02657. The replacement well, designated CdV-16-02657r, will be hand-augered to the alluvium-tuff interface (estimated at approximately 5.0 ft bgs) and will be screened from approximately 1.0 ft bgs to the tuff interface using 0.020-in. prepacked 1.7 in.–outside diameter (O.D.) stainless-steel casing. The borehole will be backfilled to within 1.0 ft of ground surface with 10/20 sand, and the remainder of the borehole will be filled with bentonite chips to ground surface and completed with a 1.1-in.-O.D. PVC surface casing.

Because the proposed location of the new monitoring well in Cañon de Valle is remote and poses access issues for heavy equipment and because of environmental concerns related to threatened and endangered species and the shallow depth of the well, the well will be installed manually. Should the attempt to hand-auger CdV-16-02657r be unsuccessful because of auger refusal at several locations, installation of this well will be cancelled, and no further attempts will be made to install the well.

3.2 Summary of the Cañon de Valle Alluvial Monitoring Well Network Evaluation

The Laboratory recommends the following actions for the alluvial monitoring network:

- continue monitoring CdV-16-611923 as a replacement for alluvial well CdV-16-02658 that was destroyed by flooding in 2011;
- initiate monitoring in CdV-16-611937 downgradient of the PRB cutoff wall to enhance the monitoring network downgradient of the PRB;
- monitor PRB Alluvial Seep to sample the alluvium south of the incised Cañon de Valle channel, augmenting the data collected from CdV-16-611923; and
- install a hand-augered alluvial well CdV-16-02657r to replace CdV-16-02657 that was destroyed by flooding in 2011.

4.0 EVALUATION OF THE NEED FOR RDX TREATMENT AT SWSC, BURNING GROUND, AND MARTIN SPRINGS

This section provides an evaluation and recommendations regarding the need to treat for RDX at SWSC, Burning Ground, and Martin Springs. The locations of the three springs are shown in Figure 1.1-1. Data from the springs were reviewed to assess RDX concentration trends in the spring discharge to alluvial groundwater and base flow in Cañon de Valle and in Martin Spring Canyon. In addition, long-term trends in RDX concentrations within downgradient alluvial monitoring wells were evaluated. The results were used to develop the recommendations in this report for treatment of RDX at the three springs.

As part of the cleanup of the 260 Outfall, the Laboratory submitted a corrective measures study report for the surface/alluvial system to NMED in November 2003 (LANL 2003, 085531), which recommended several corrective measures, including the installation of granular activated carbon filters to treat contaminated groundwater being discharged from three springs. The objective of installing the carbon-filtration treatment systems was to remove RDX from water that discharges from the springs and that subsequently infiltrates the alluvium and ultimately the underlying vadose zone (including perched-intermediate groundwater) and regional aquifer.

In October 2006, NMED issued a final decision for remedy selection that included the Laboratory's recommendation to install carbon-filtration treatment systems at the springs to reduce concentrations of RDX in alluvial groundwater, thereby minimizing potential impacts to deeper groundwater zones.

4.1 Review of RDX Trends in Cañon de Valle and Martin Spring Canyon

Considerable time has elapsed since the initial installation of the carbon-filtration treatment systems at SWSC, Burning Ground, and Martin Springs. To assess whether the systems are still needed at this point, RDX concentration trends in SWSC, Burning Ground, and Martin Springs, alluvial groundwater, and base flow in Cañon de Valle and Martin Spring Canyon are evaluated below, and recommendations for the treatment systems are provided.

4.1.1 RDX Concentration Trends in Cañon de Valle

Figure 4.1-1 shows RDX concentrations in discharge from SWSC and Burning Ground Springs; in downgradient alluvial monitoring wells CdV-16-02658 (destroyed in 2011 by flooding); in CdV-16-611923 (the PRB well serving as a replacement for CdV-16-02658); and in CdV-16-02659, the farthest downgradient well in the Cañon de Valle alluvium. The locations of these wells are shown in Figure 2.0-1.

SWSC Spring:

Figure 4.1-2 shows discharge rates measured at SWSC, Burning Ground, and Martin Spring since 2005, and Figure 4.1-3 shows the average annual RDX concentrations in discharge from SWSC, Burning Ground, and Martin Springs. The average discharge rate for SWSC Spring is 0.63 gpm, based on discharge measurements collected during sampling events from 2005 to 2016 (Figure 4.1-2). Around the time following the 2009–2010 CMI activities were completed at the 260 Outfall, discharge from SWSC Spring decreased considerably, and the spring has generally not been flowing in recent years. Attempts to sample SWSC Spring in 2015 were unsuccessful. However, in March 2016 SWSC Spring was observed flowing at a rate of 0.18 gpm and was sampled.

The cause for the significant reduction in flow from SWSC Spring is not known. One possible cause may be the 2009–2010 CMI activities, when 9080 gal. of grout was injected into 16 boreholes to plug porosity within volcanic surge beds surrounding the former settling pond at the 260 Outfall channel and a low-permeability cap was replaced on the former settling pond (LANL 2010, 108868). A second factor may be the prolonged drought conditions in the area in recent years, which may have influenced discharge rates from SWSC Spring. This hypothesis is supported by the recent observation that SWSC Spring was observed flowing again in 2016, after the severe drought conditions in recent years had abated. Nonetheless, discharge from SWSC Spring has been significantly reduced in recent years.

Recommendation for SWSC Spring:

Based on the reduced discharge from SWSC Spring in recent years (Figure 4.1-2), the contribution of discharge from SWSC Spring to downgradient alluvial groundwater quality has been reduced significantly. It is recommended that discharge from SWSC Spring continue to be monitored using the automated flow measurement equipment recently installed at this spring (as well as at Burning Ground and Martin Springs). In addition, SWSC Spring should continue to be sampled under the Interim Facility-Wide Groundwater Monitoring Plan, if it is flowing. The spring discharge and analytical data will be used during preparation of the updated corrective measures evaluation (CME) report.

Finally, given the significantly reduced discharge from SWSC Spring and the limited RDX released by the spring in recent years and the reducing trend in RDX concentrations in downgradient alluvial wells, it is recommended that no treatment is necessary at SWSC Spring and that the treatment unit be removed and the site restored. Long-term monitoring of surface water and alluvial groundwater in Cañon de Valle will be conducted under the Interim Facility-Wide Groundwater Monitoring Plan.

Burning Ground Spring:

Figure 4.1-2 shows discharge rates measured at Burning Ground Spring since 2005. The average discharge rate for SWSC Spring is 6.34 gpm, based on discharge measurements collected during sampling events from 2005 to 2016.

Figure 4.1-3 shows the average annual RDX concentrations in discharge from Burning Ground Spring. Average annual RDX concentrations in discharge from Burning Ground Spring have ranged from 13 µg/L to 32.9 µg/L since 1997, peaking in 2009 at an average annual concentration of 32.3 µg/L. Since 2009, average RDX concentrations in Burning Ground Spring have generally decreased, with average annual concentrations in the period from 2012 to 2015 below 20 µg/L.

Although Burning Ground Spring continues to discharge RDX into Cañon de Valle, RDX concentrations in downgradient alluvial wells have declined in recent years and in general are around or below the NMED tap-water screening level of 7.02 µg/L. Figure 4.1-1 shows RDX concentrations in discharge from SWSC and Burning Ground Springs and in alluvial wells downgradient of the springs. Concentrations in CdV-16-02659, the farthest most downgradient alluvial well, have gradually declined, with a maximum value of 112 µg/L measured on March 21, 2001. However, over the last 5 yr, RDX concentrations in CdV-16-02659 have averaged 6.4 µg/L, below the NMED tap-water screening level of 7.02 µg/L and considerably lower than RDX concentrations from 15 yr ago.

Several possible reasons may explain the decrease in concentrations in alluvial groundwater in Cañon de Valle. These include the mitigative effects of the extensive soil cleanup and contamination reduction activities that occurred during the 2009–2010 CMI at the 260 Outfall, the possible reduction of RDX inventory in the vadose zone, and changes in the hydrology of Cañon de Valle after the Las Conchas fire in 2011, including the recent flooding events in 2011 and 2013. Manifestations of the fire damage to the upper watershed include earlier and potentially greater snowmelt runoff, resulting in greater mixing of noncontaminated water from the upper watershed, more frequent flooding with higher peak flows, and potential erosion and transport of RDX-contaminated alluvium in the reach below the outfall. These changes in the hydrology may be a factor in the declining RDX concentrations observed in alluvial monitoring wells in Cañon de Valle.

RDX concentrations measured in base flow at Cañon de Valle below Material Disposal Area (MDA) P have shown lower concentrations in recent years, reflecting lower contributions of RDX from SWSC and Burning Ground Springs. Figure 4.1-4 shows RDX concentrations in base flow at the location Cañon de Valle below MDA P from 2004 to present. Average RDX concentrations in base flow for the period from 2004 to present are 10.8 µg/L, while RDX concentrations in the last 5 yr have averaged 8.3 µg/L. In 2015 and 2016, RDX concentrations in base flow at this location averaged 6.9 µg/L, below the NMED tap-water screening level of 7.02 µg/L.

Recommendation for Burning Ground Spring:

Average annual RDX concentrations in discharge from Burning Ground Spring have declined somewhat in recent years (Figure 4.1-3), although spring discharge rates vary considerably (Figure 4.1-2). Various factors have likely influenced the RDX concentrations in downgradient alluvial wells and in base flow within Cañon de Valle. These include the mitigative effects of the surface CMI cleanup activities from 2009 and 2010, the possible reduction of RDX inventory in the vadose zone, changes in Cañon de Valle surface hydrology following the Las Conchas fire (discussed above), and the influence of the recent flooding events in both 2011 and in 2013. RDX concentrations in downgradient alluvial wells and in base flow are now at or below the NMED tap-water screening level of 7.02 μg/L.

Based on this analysis, it is recommended that flow from Burning Ground Spring continue to be monitored using the automated flow measurement equipment and that the spring continue to be sampled under the Interim Facility-Wide Groundwater Monitoring Plan. The flow measurements and contaminant concentration data collected will be used during development of the updated CME report. Given that RDX concentrations in downgradient alluvial groundwater and base-flow monitoring locations are now at or below NMED tap-water screening levels, it is recommended that no treatment is necessary at Burning Ground Spring and that the treatment unit be removed and the site restored. Long-term monitoring of surface water and alluvial groundwater in Cañon de Valle will be conducted under the Interim Facility-Wide Groundwater Monitoring Plan.

4.1.2 RDX Concentration Trends in Martin Spring Canyon

Figure 4.1-5 shows the location of Martin Spring in Martin Spring Canyon and downgradient alluvial monitoring wells MSC-16-06293, MSC-16-06294, and MSC-16-06295. Figure 4.1-6 shows the RDX concentrations in discharge from Martin Spring and in downgradient alluvial monitoring wells MSC-16-06293, MSC-16-06294, and MSC-16-06295, with nondetects shown as open circles on the plot. For comparison, average annual RDX concentrations in discharge from Martin, SWSC, and Burning Ground Springs are shown on Figure 4.1-3.

Martin Spring:

Figure 4.1-2 shows discharge rates measured at Martin, SWSC, and Burning Ground Springs since 2005. The average discharge rate at Martin Spring is 2.79 gpm, based on measurements collected during sampling events from 2005–2016.

Average annual RDX concentrations in discharge from Martin Spring have declined over the years, with a maximum value of 208 μg/L in 1999, and an average RDX value of 56.9 μg/L in 2015, the last full year of record. The long-term trend in RDX concentrations is declining at a fairly significant rate with RDX concentrations in recent years less than half of the concentrations measured during the 2000–2002 time period (Figure 4.1-3), possibly indicating the contaminant source of RDX in Martin Spring may have gradually depleted with time.

Although Martin Spring continues to release RDX into Martin Spring Canyon, RDX concentrations in downgradient alluvial wells MSC-16-06293, MSC-16-06294, and MSC-16-06295 are well below the NMED tap-water screening level of 7.02 μg/L, and in most cases, are less than 1.0 μg/L.

Samples from Martin Spring also show elevated concentrations of boron. Figure 4.1-7 shows boron concentrations in discharge from Martin Spring and in downgradient alluvial wells MSC-16-06293, MSC16-06294, and MSC-16-06295. The source of boron is thought to originate from the former laundry facility at TA-16, although boron is also used in the explosive compound Boracitol, which was processed at some facilities at TA-16, including the V-Site and building 260 (LANL 2003, 077965; LANL 2011, 207069).

Boron concentrations in discharge from Martin Spring and in downgradient alluvial monitoring wells are below the NMED tap-water screening level of 3950 µg/L. Boron concentrations in discharge from Martin Spring (Figure 4.1-7) are declining in a manner similar to the decline in RDX concentrations (shown in Figure 4.1-6). However, unlike RDX, which does not persist in downgradient alluvial groundwater at high concentrations, boron is more persistent in Martin Spring Canyon alluvial wells. The highest concentrations are in the closest alluvial well, MSC-16-06293. Boron is detected at lower concentrations in alluvial wells MSC-16-06294 and MSC-16-06295, damaged during the flooding of September 2013.

Because the boron is more persistent downcanyon than RDX, natural attenuation of RDX may be occurring at a greater relative rate than attenuation of boron as the contaminated discharge flows downcanyon. Factors that may play a role in the natural attenuation of RDX in Martin Spring Canyon include photolysis (degradation of RDX by sunlight) as well as biodegradation, which may be occurring in the relatively slow-flowing reaches of the stream downcanyon. Investigations are underway to better understand RDX degradation at TA-16.

Recommendation for Martin Spring:

RDX and boron concentrations in discharge from Martin Spring have declined significantly since 2000 and continue to decline (Figures 4.1-6 and 4.1-7), possibly reflecting a decreasing contaminant source at Martin Spring Canyon. Although RDX concentrations in discharge from Martin Spring are relatively higher than RDX concentrations in discharge from Burning Ground or SWSC Springs, the influence downcanyon is less. Concentrations of RDX in downgradient alluvial wells are considerably lower than the NMED tap-water screening level of 7.02 µg/L and are typically less than 1 µg/L (Figure 4.1-6).

It is recommended that flow from Martin Spring continue to be monitored using the automated flow measurement equipment installed at this spring and that the spring continue to be sampled under the Interim Facility-Wide Groundwater Monitoring Plan. The flow measurements and contaminant concentration data collected will be used during development of the updated CME report. Given that RDX concentrations in downgradient locations are well below the NMED tap-water screening levels, it is recommended that no treatment is necessary at Martin Spring and that the treatment unit be removed and the site restored. Long-term monitoring of alluvial groundwater in Martin Spring Canyon will be conducted under the Interim Facility-Wide Groundwater Monitoring Plan.

5.0 SCHEDULE FOR COMPLETION OF SURFACE CMI CLOSURE ACTIVITIES

The proposed CMI closure activities include the following:

- Submittal of a P&A plan for the PRB monitoring wells to the NMOSE.
- P&A of PRB monitoring wells.
- Removal of the PRB and restoration or the PRB site.
- Installation of the new alluvial well CdV-16-02657r.
- Removal of the spring carbon filters and subgrade piping, and site restoration at all three springs.

A surface CMI closure report for Consolidated Unit 16-021(c)-99 will be prepared to document completion of the surface CMI activities discussed in this evaluation report. The report will summarize all work completed under the CMI and will address the need for additional PRBs, if required. The report will be submitted to NMED by September 15, 2017.

6.0 REFERENCES

The following list includes all documents cited in this report. Parenthetical information following each reference provides the author(s), publication date, and ER ID or ESH ID. This information is also included in text citations. ER IDs were assigned by the Environmental Programs Directorate's Records Processing Facility (IDs through 599999), and ESH IDs are assigned by the Environment, Safety, and Health (ESH) Directorate (IDs 600000 and above). IDs are used to locate documents in the Laboratory's Electronic Document Management System and, where applicable, in the master reference set.

Copies of the master reference set are maintained at the NMED Hazardous Waste Bureau and the ESH Directorate. The set was developed to ensure that the administrative authority has all material needed to review this document, and it is updated with every document submitted to the administrative authority. Documents previously submitted to the administrative authority are not included.

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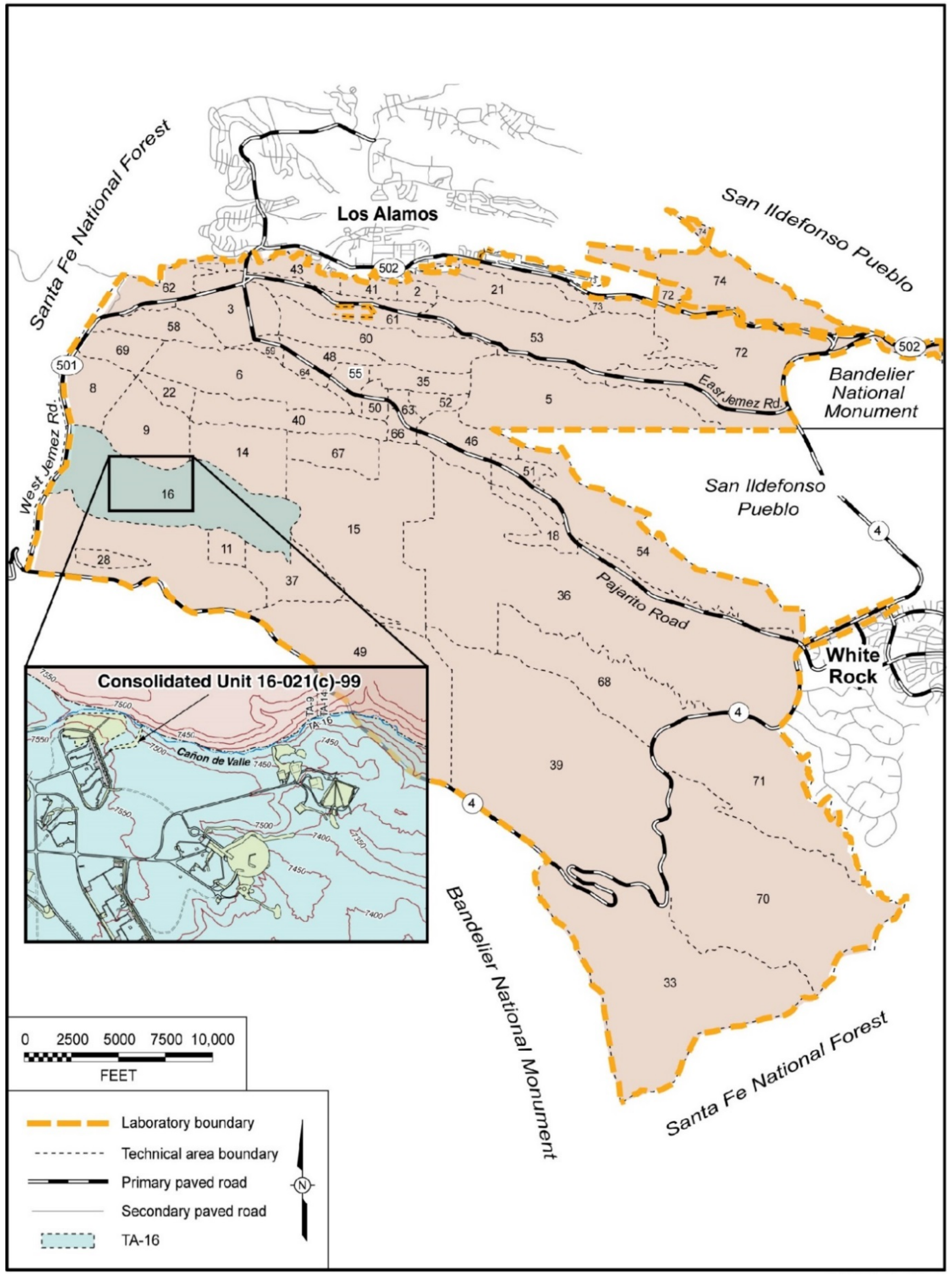


Figure 1.0-1 Location of TA-16 with respect to Laboratory TAs and surrounding landholdings. Consolidated Unit 16-02(c)-99 is also shown.

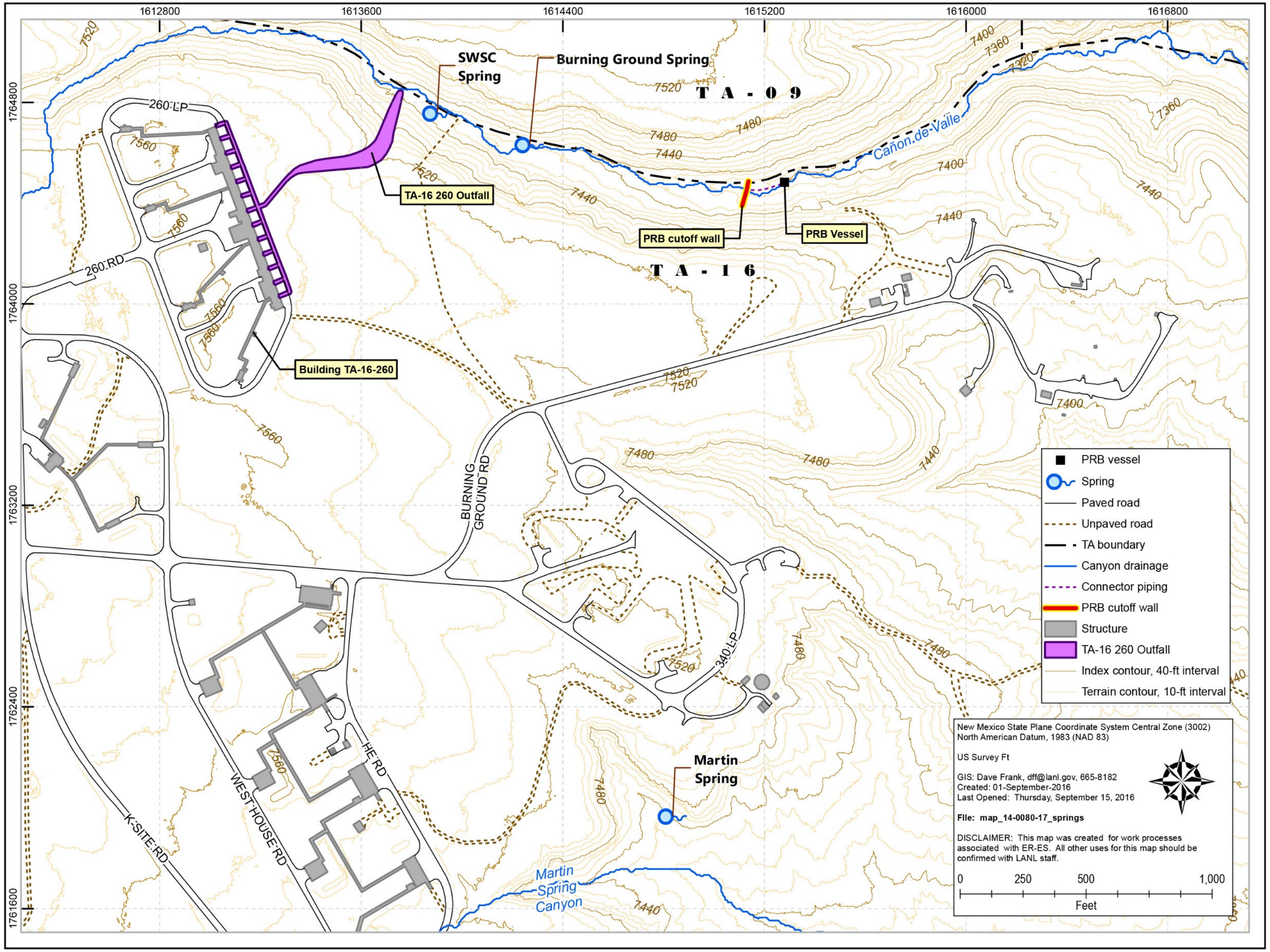


Figure 1.1-1 Locations of SWSC, Burning Ground, and Martin Springs and the PRB cutoff wall

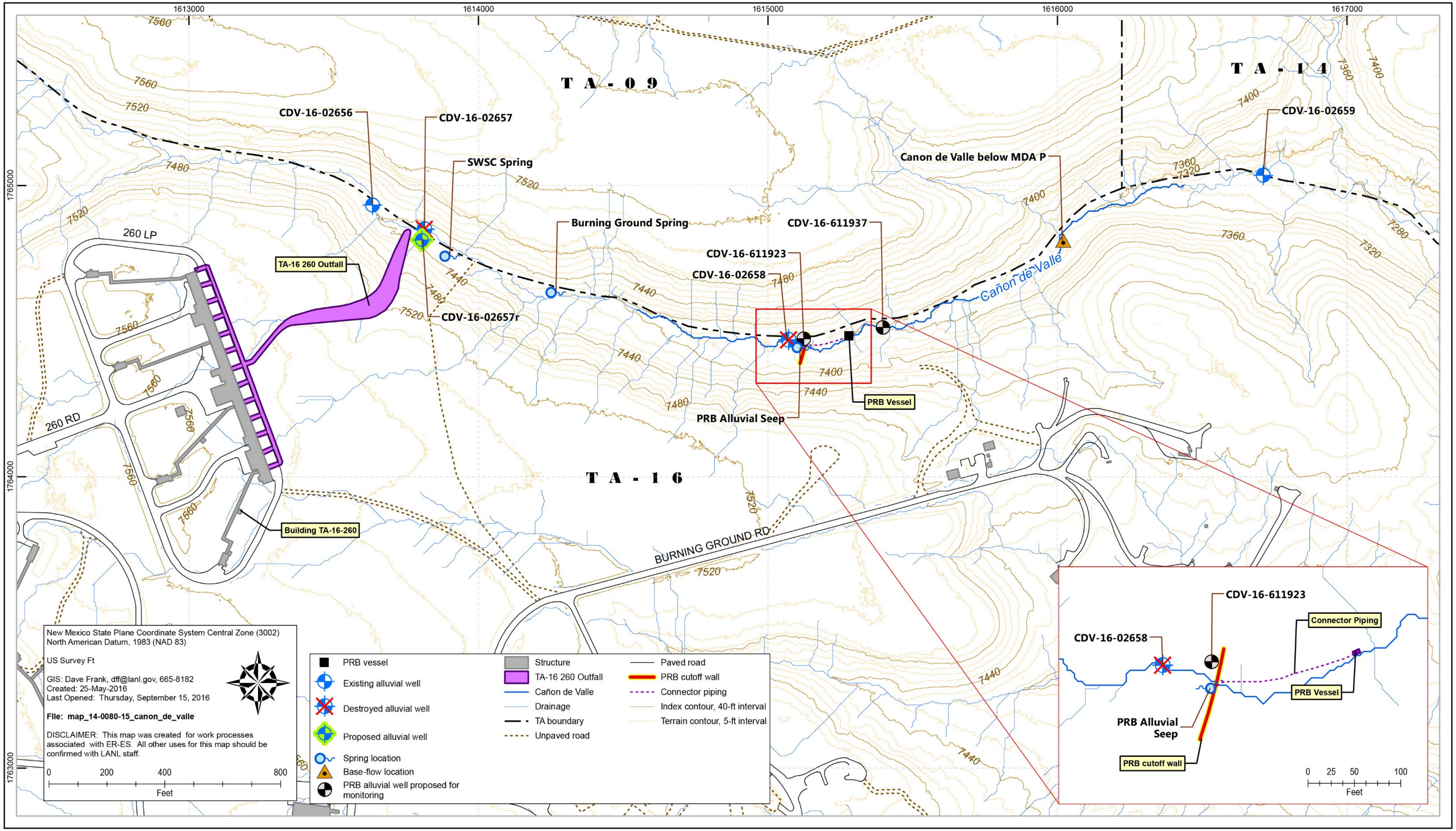


Figure 2.0-1 Alluvial monitoring well network in Cañon de Valle with locations of proposed new alluvial well CdV-16-02657r and proposed PRB monitoring

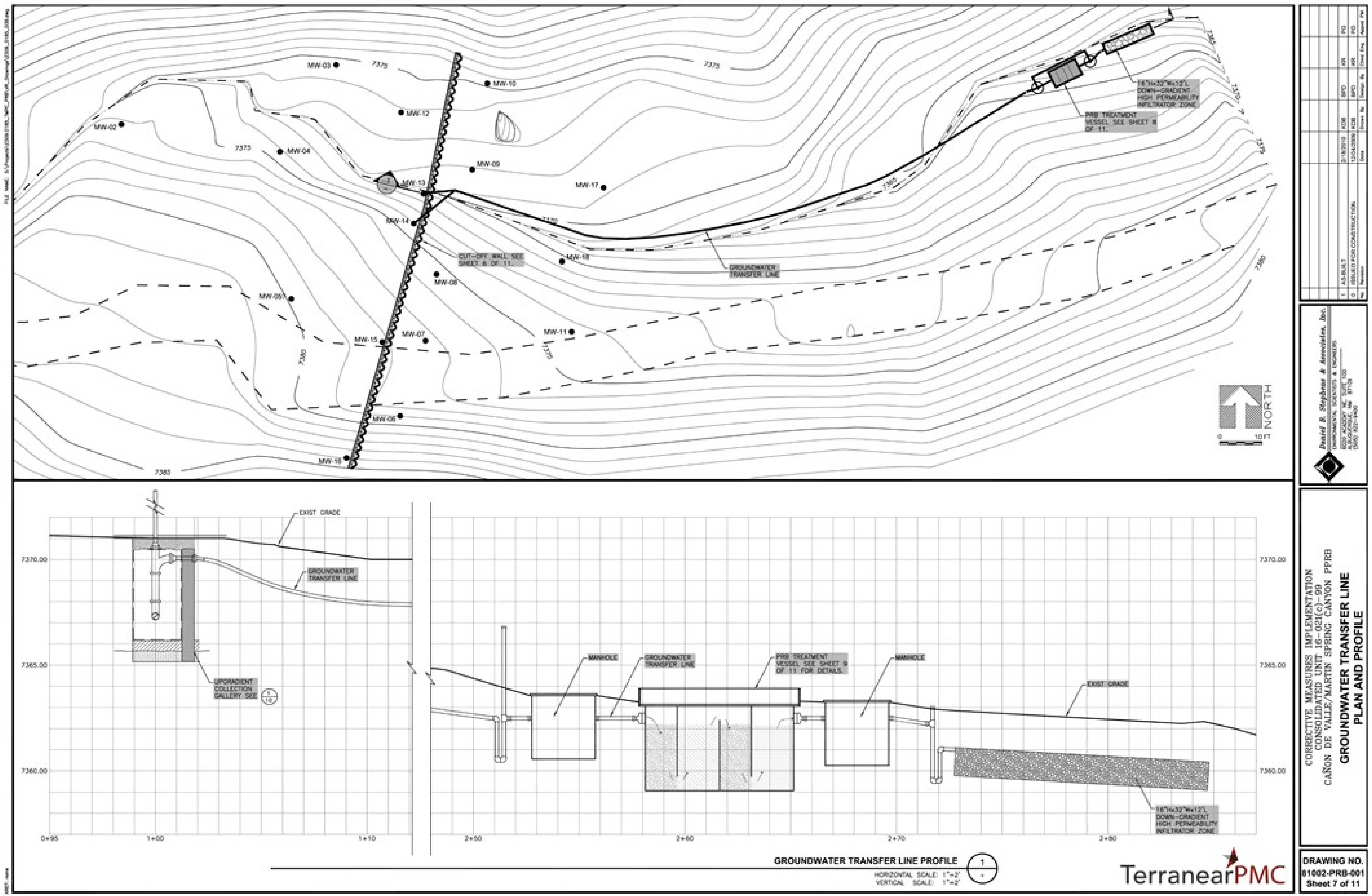


Figure 2.1-1 As-built drawing for the PRB, showing the PRB treatment vessel, groundwater transfer line, and high-permeability infiltration zone

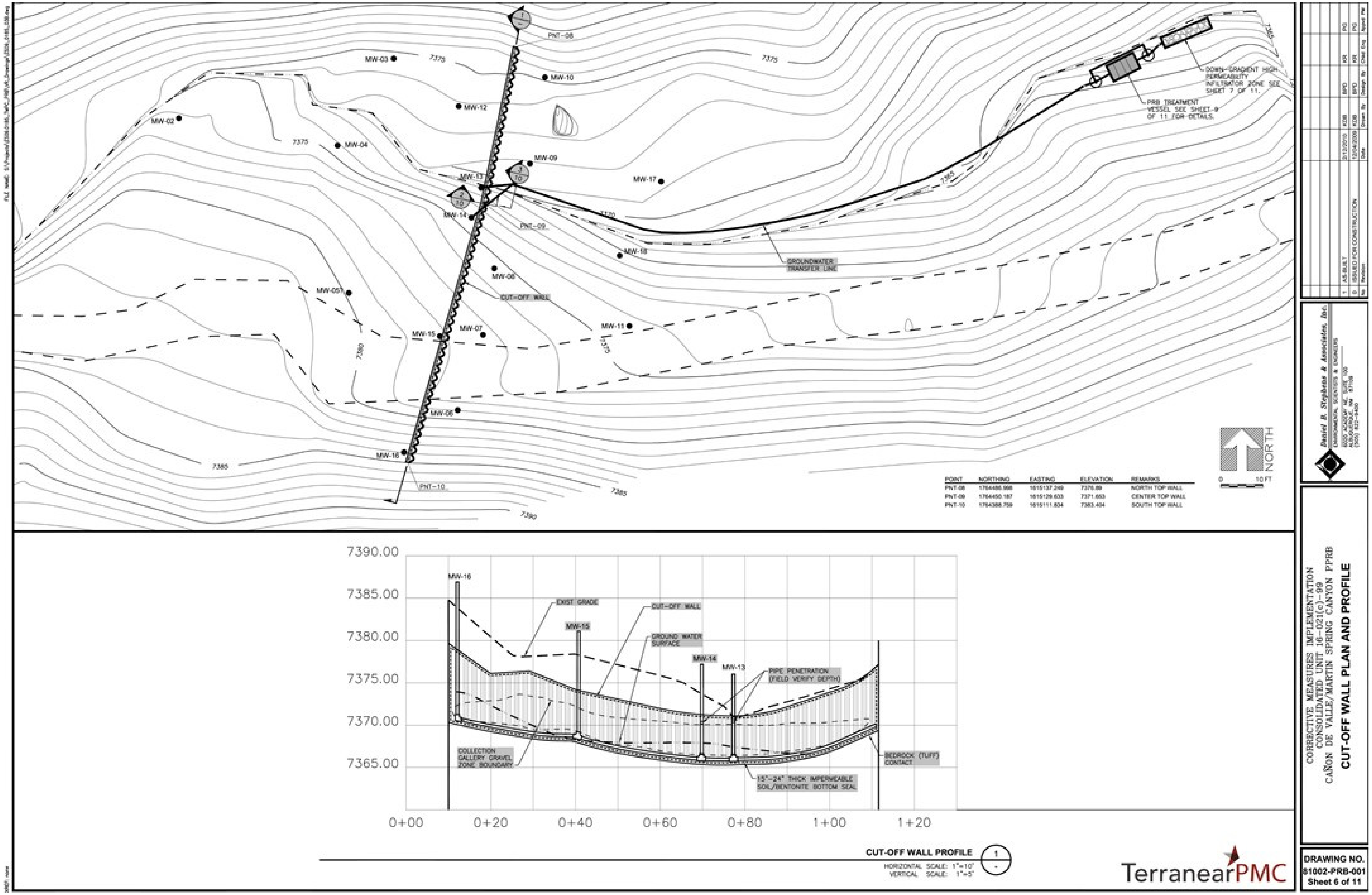


Figure 2.1-2 As-built drawing for the PRB, showing the cutoff wall plan and profile

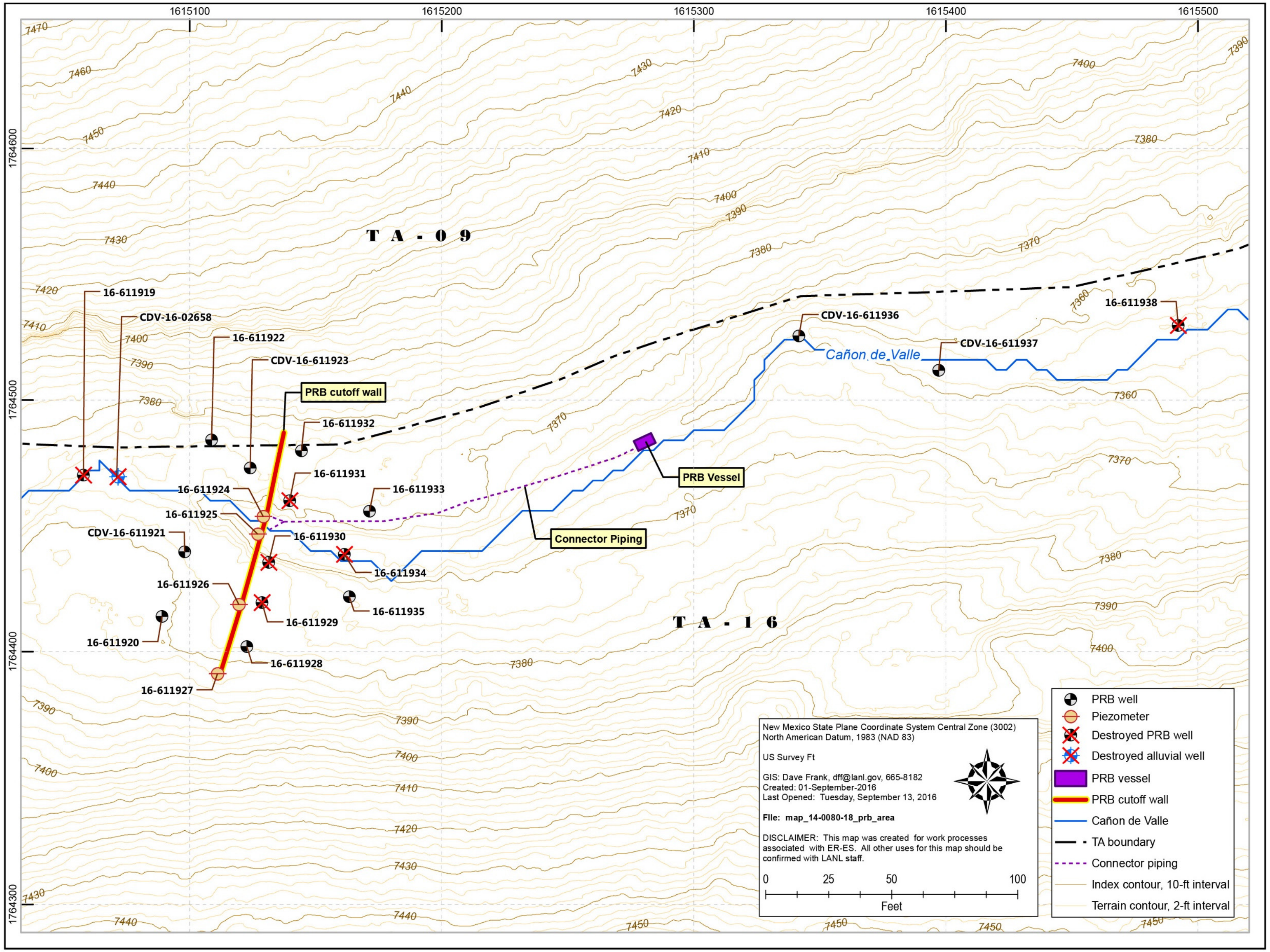
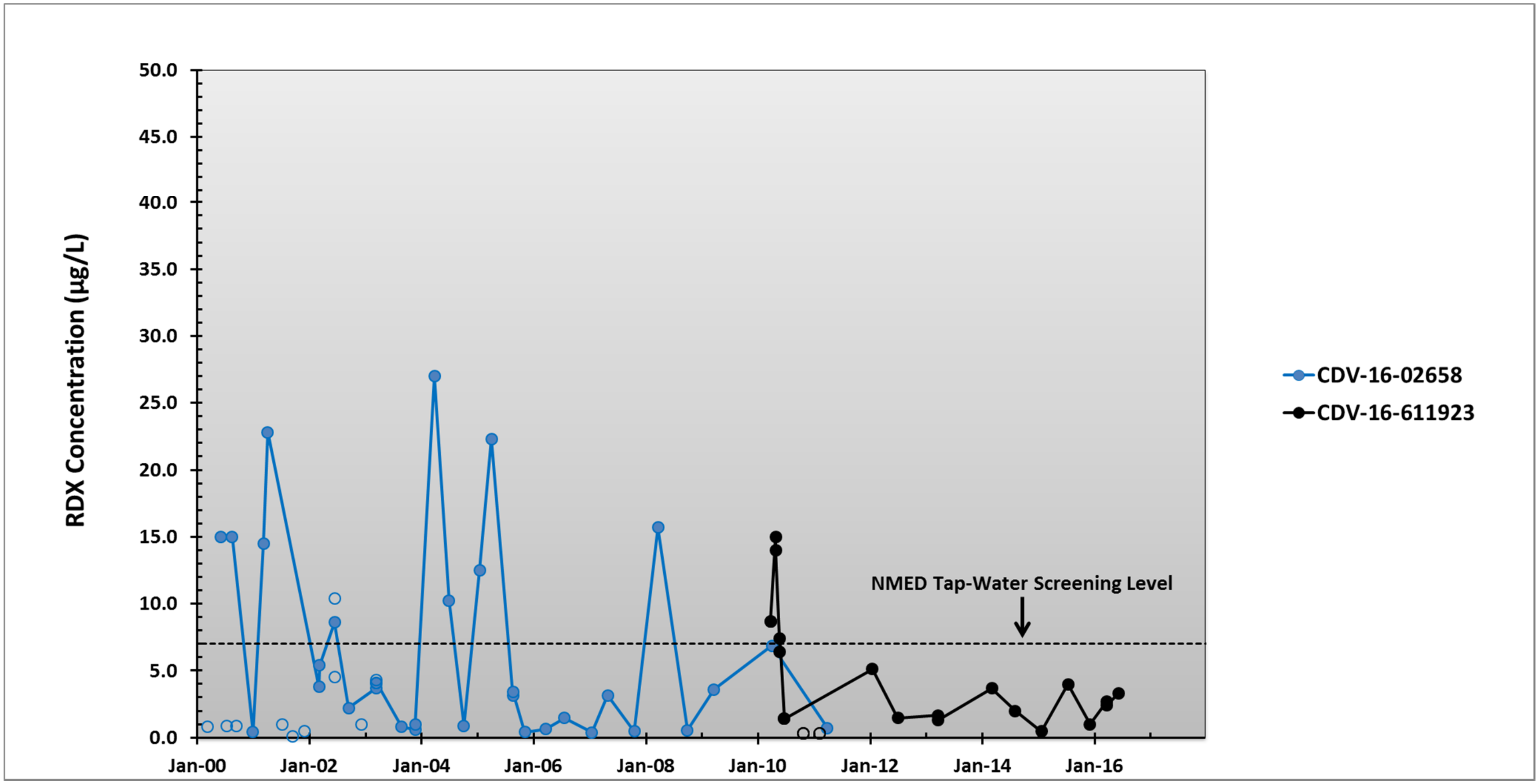
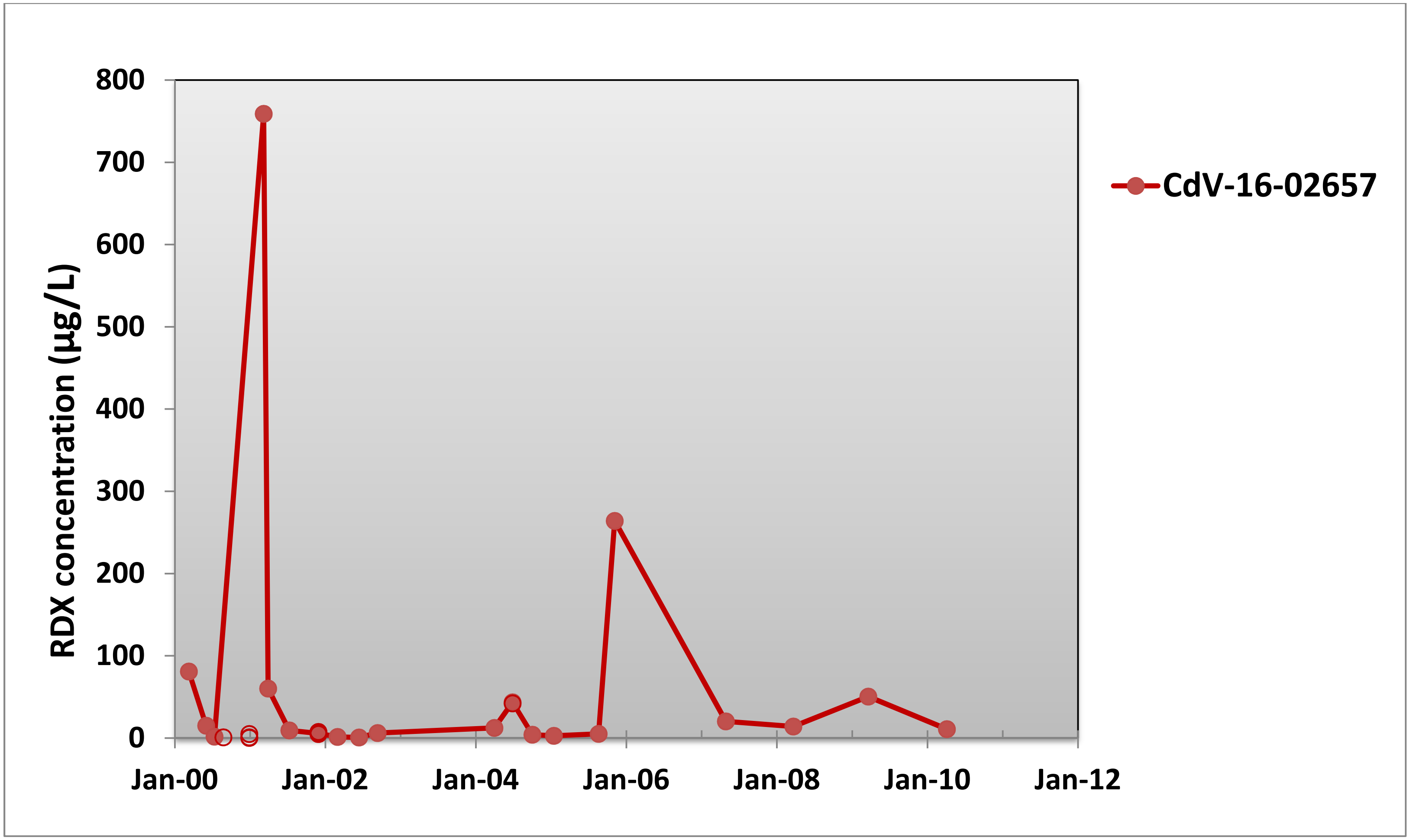


Figure 2.1-3 Locations of the alluvial wells and piezometers in the vicinity of the PRB



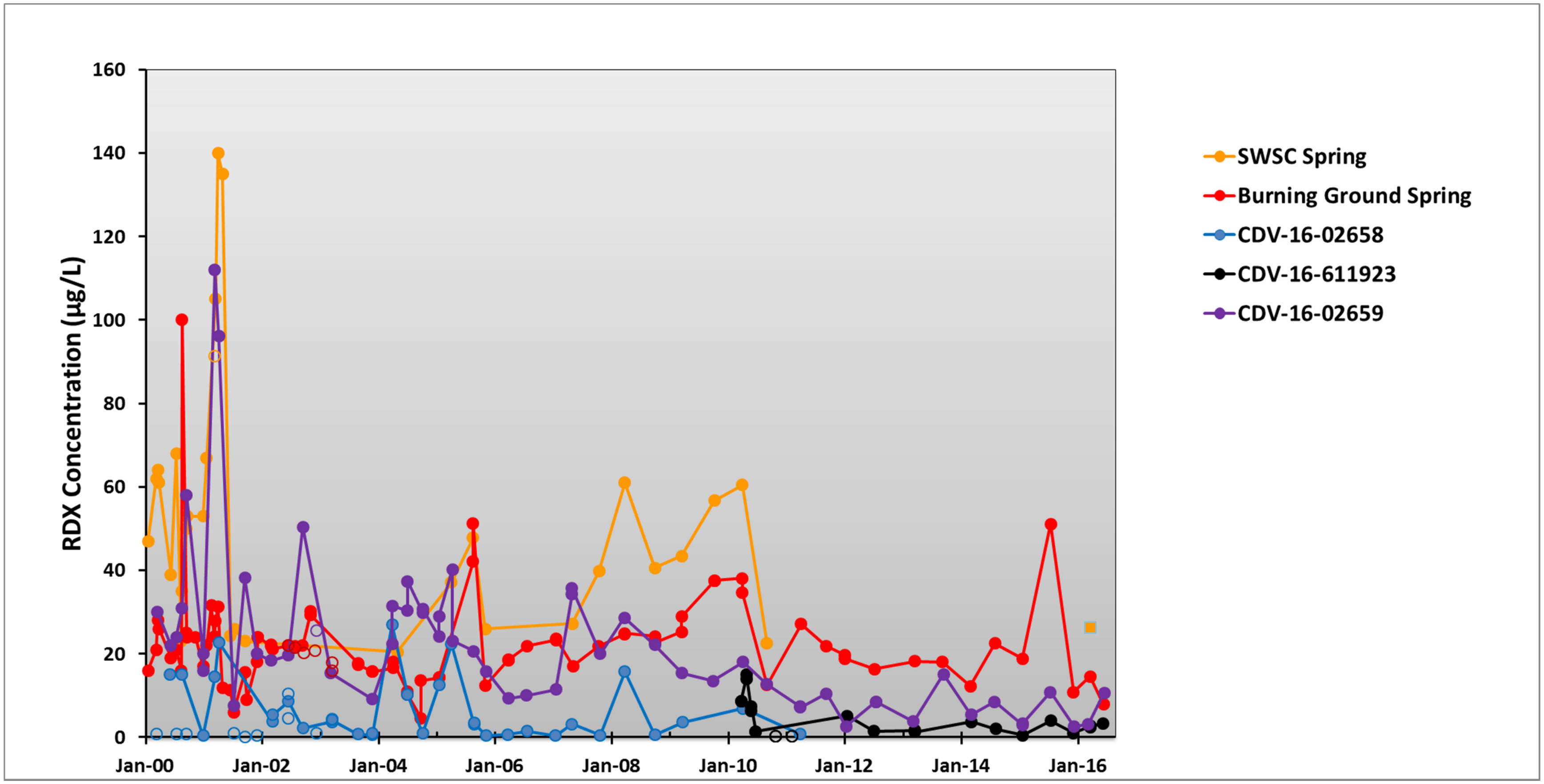
Notes: Nondetects are shown as open circles. The New Mexico tap-water screening level is 7.02 µg/L.

Figure 3.0-1 RDX concentrations in CdV-16-02658 and in proposed PRB replacement well CdV-16-611923



Notes: Nondetects are shown as open circles. The New Mexico tap-water screening level is 7.02 µg/L.

Figure 3.1-1 RDX concentrations in destroyed well CdV-16-02657, located near the 260 Outfall



Notes: Nondetects are shown as open circles. The New Mexico tap-water screening level is 7.02 µg/L.

Figure 4.1-1 RDX concentrations in discharge from SWSC and Burning Ground Springs and in downgradient alluvial monitoring wells CdV-16-02658, CdV-16-611923, and CdV-16-02659

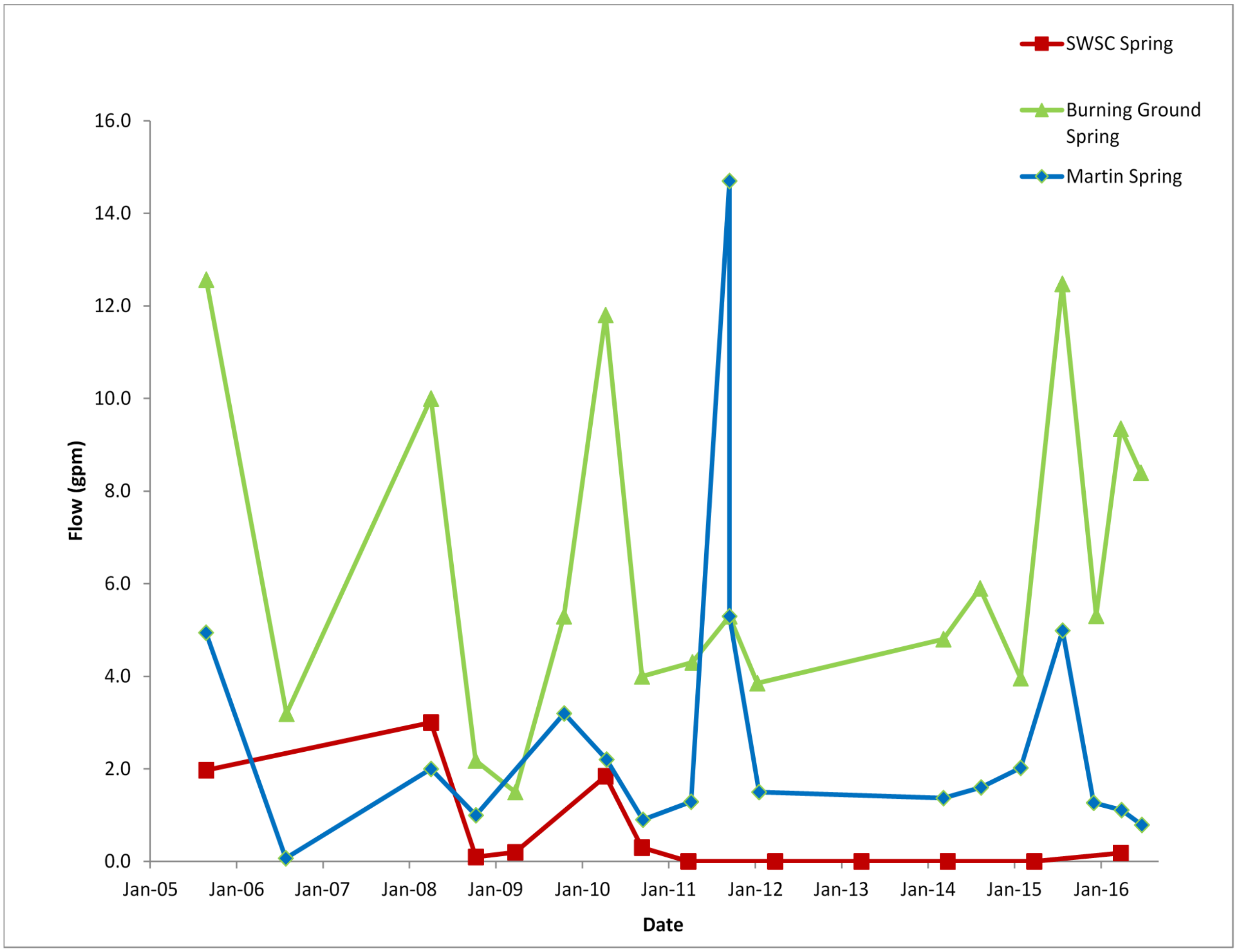


Figure 4.1-2 Discharge rates measured at SWSC, Burning Ground, and Martin Springs, 2005 to 2016

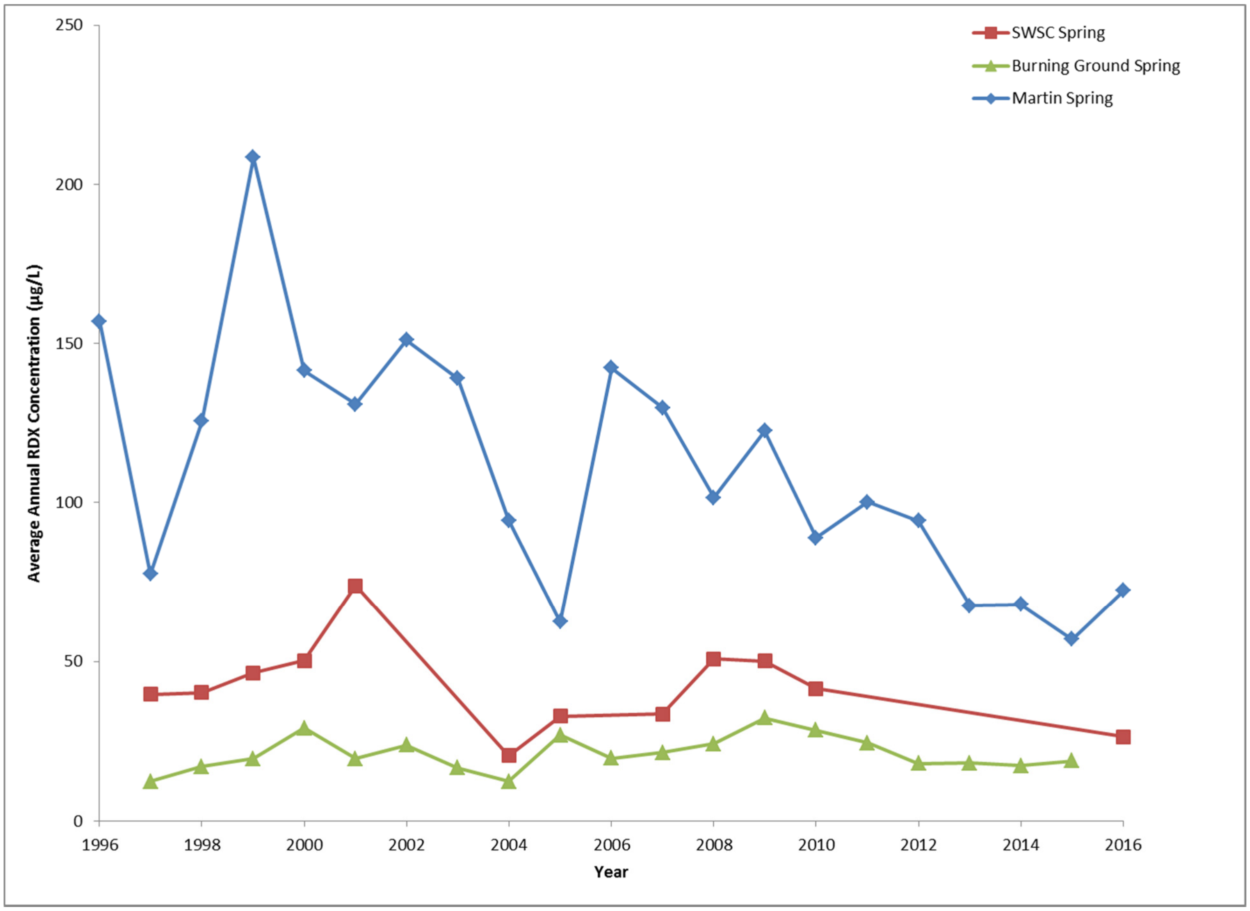
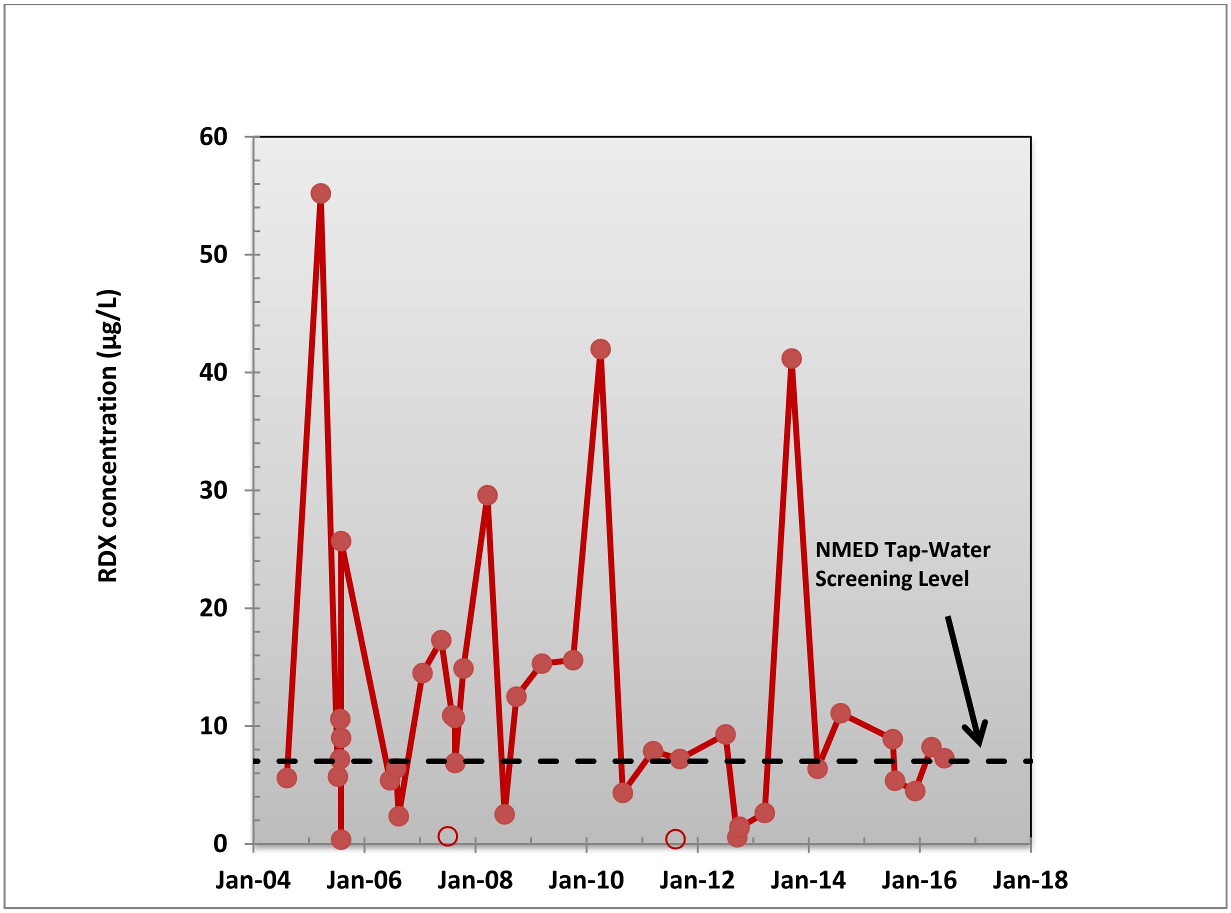


Figure 4.1-3 Average annual RDX concentrations in SWSC, Burning Ground, and Martin Springs, 1996 to 2016



Notes: Nondetects are shown as open circles. The New Mexico tap-water screening level is 7.02 µg/L.

Figure 4.1-4 RDX concentrations in base flow at Cañon de Valle below MDA P

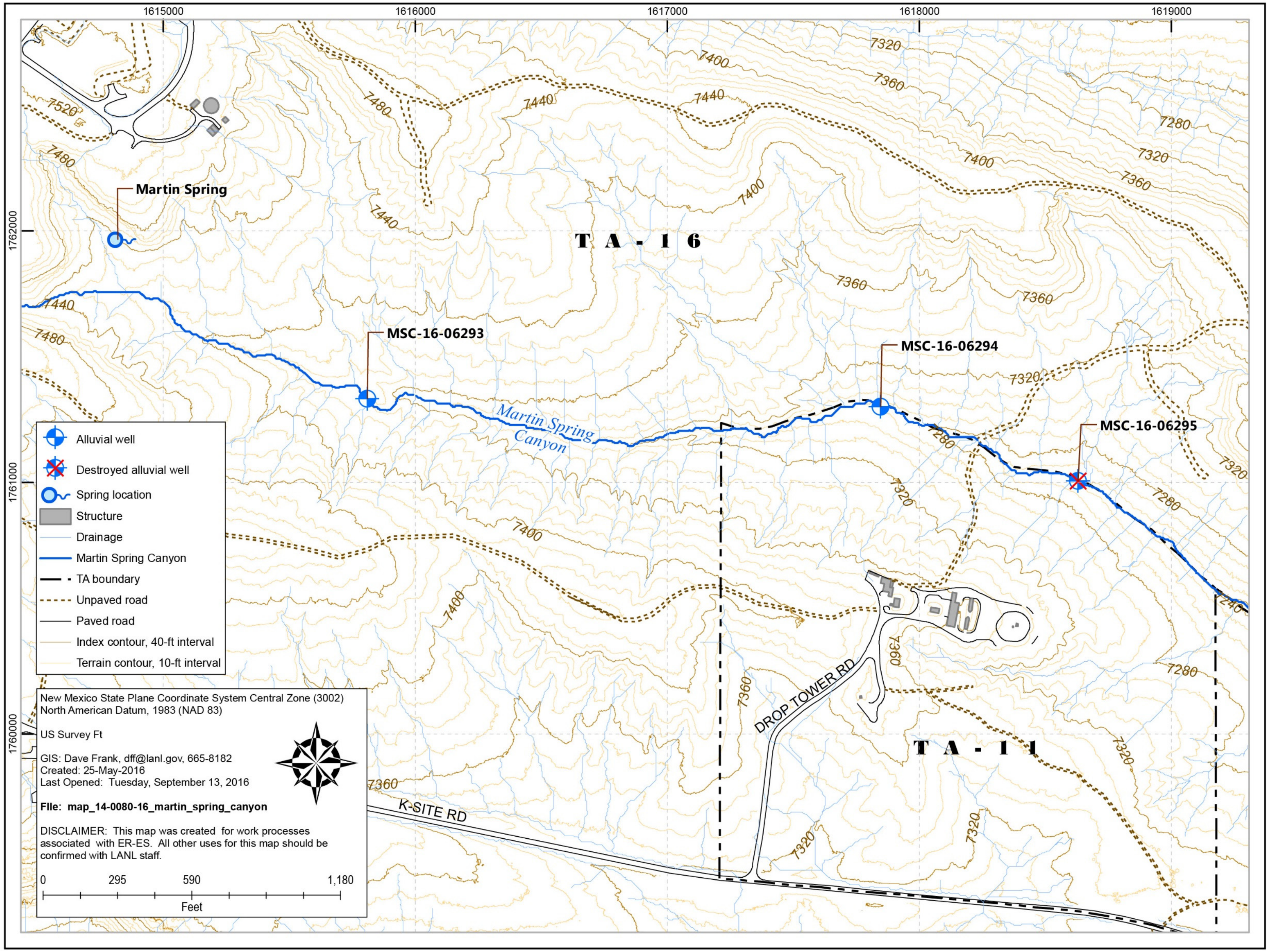
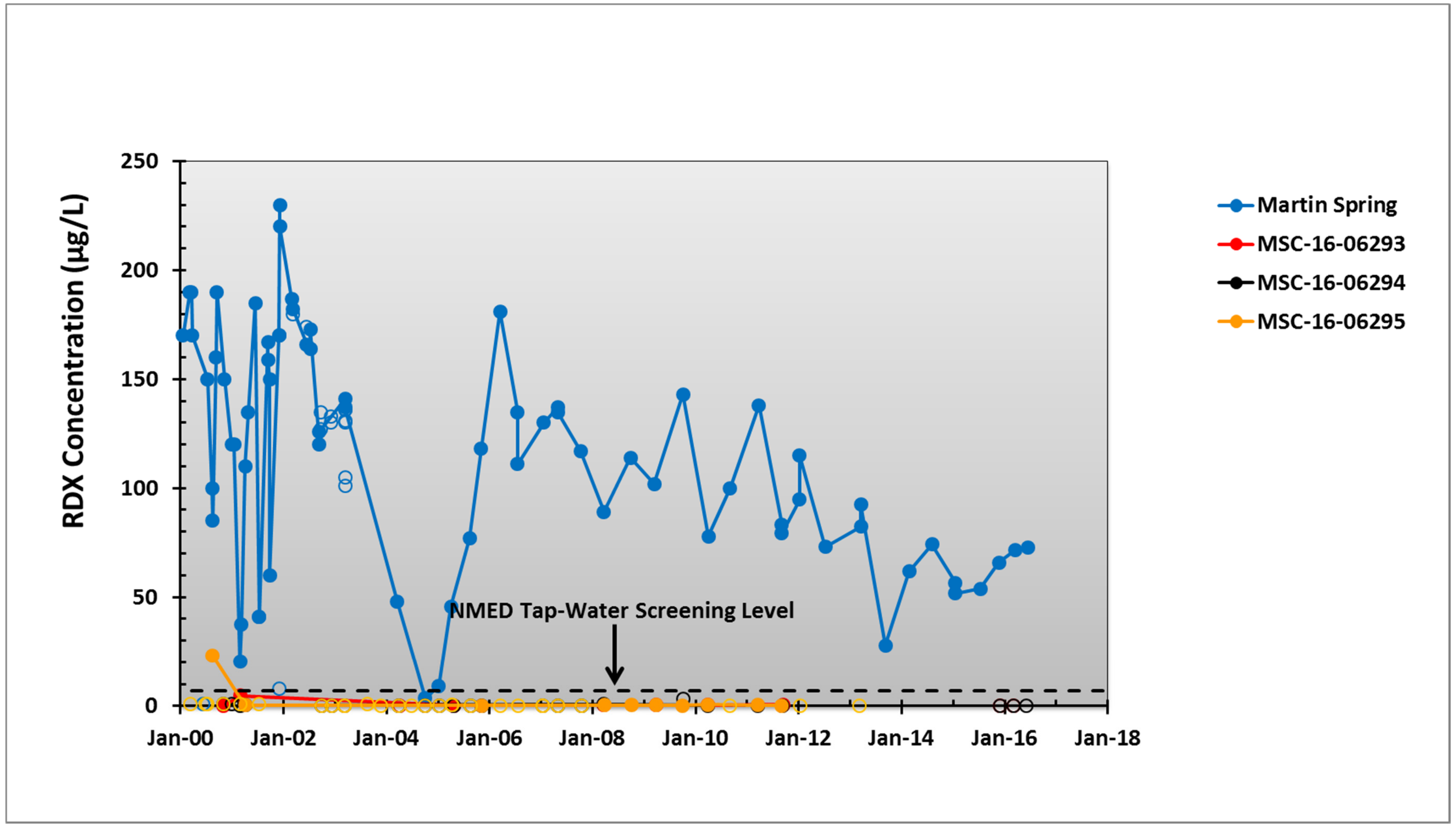
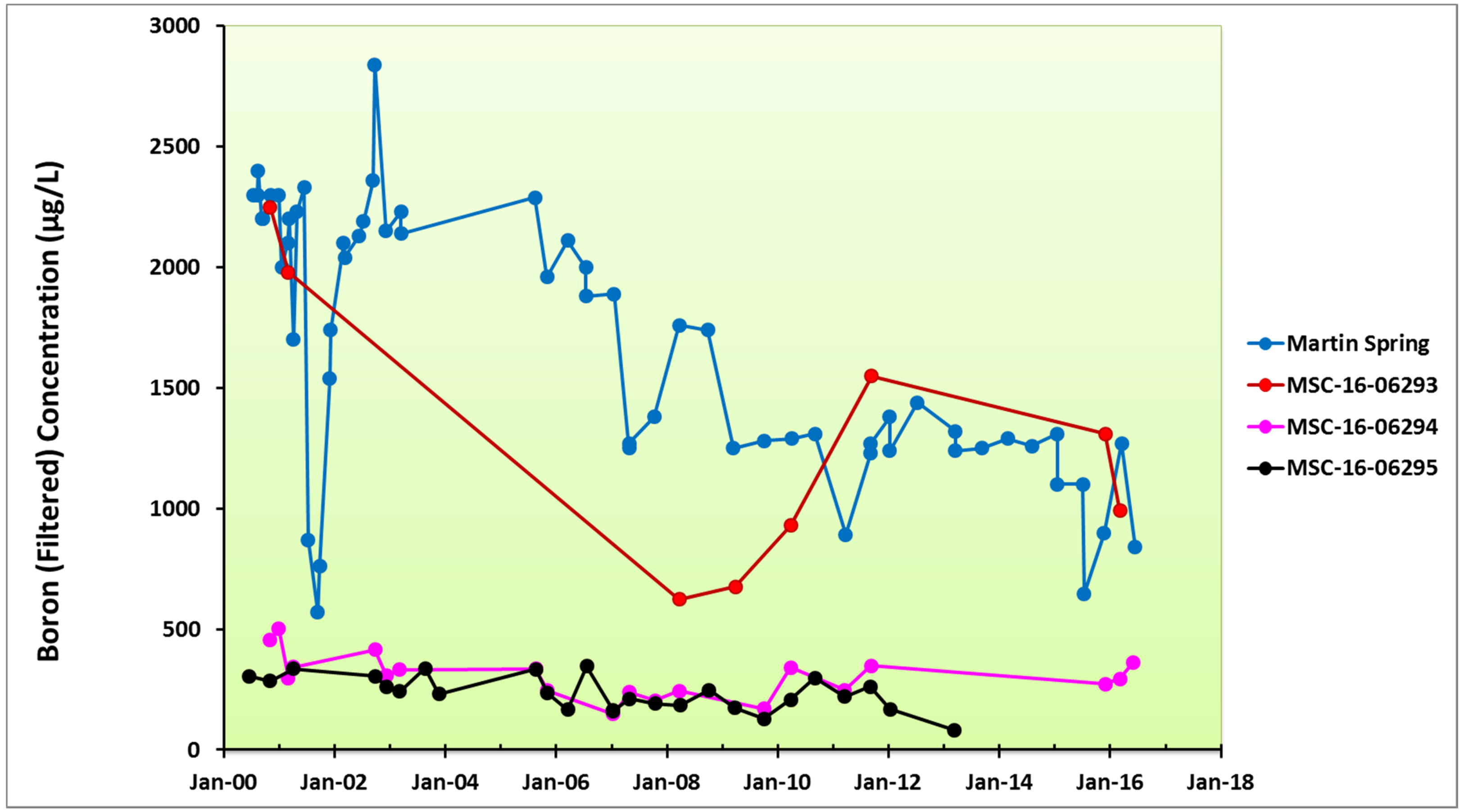


Figure 4.1-5 Locations of Martin Spring and downgradient alluvial monitoring wells in Martin Spring Canyon



Notes: Nondetects are shown as open circles. The New Mexico tap-water screening level is 7.02 µg/L.

Figure 4.1-6 Average annual RDX concentrations in Martin Spring



Notes: Nondetects are shown as open circles. The New Mexico tap-water screening level is 3950 µg/L.

Figure 4.1-7 Boron concentrations in discharge from Martin Spring and in downgradient alluvial monitoring wells MSC-16-06293, MSC-16-06294, and MSC-16-06295

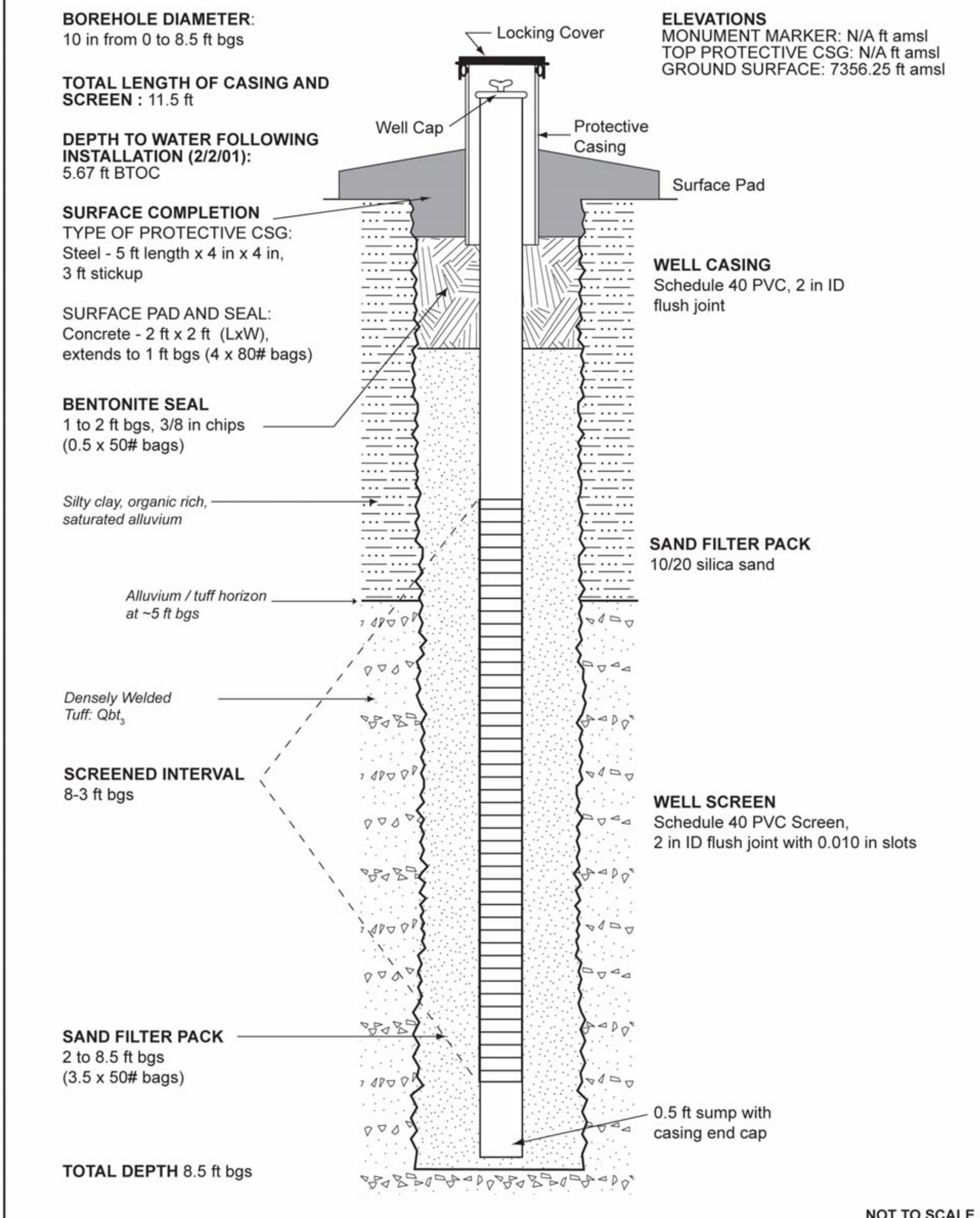
Table 2.0-1
Summary of PRB Monitoring Wells and Piezometers and Recommended Disposition for Each Location

Location	Alternate Name	Total Depth (ft bgs)	Recommended Disposition	Notes
Upgradient Alluvial Wells				
CdV-16-611919	MW-2	8.0	No longer exists	Washed away during August 21, 2011, flood
CdV-16-611920	MW-5	12.5	P&A	
CdV-16-611921	MW-4	14.4	P&A	
CdV-16-611922	MW-3	13.3	P&A	
CdV-16-611923	MW-12	8.7	Retain for long-term monitoring	MY2016 and MY2017 Interim Facility-Wide Groundwater Monitoring Plan location. Retain for long-term monitoring.
Upgradient Piezometers				
16-611924	MW-13, PZ-13	~ 10 to 15	Retain	Piezometer damaged by August 3, 2011, floodwater and debris
16-611925	MW-14, PZ-14	~ 10 to 15	Retain	
16-611926	MW-15, PZ-15	~ 10 to 15	Retain	
16-611927	MW-16, PZ-16	~ 10 to 15	Retain	
Downgradient Alluvial Wells				
CdV-16-611928	MW-6	13.0	P&A	
CdV-16-611929	MW-7	13.1	P&A remaining portion of piezometer	Well broken off during August 21, 2011, flood
CdV-16-611930	MW-8	13.0	P&A remaining portion of piezometer	Well broken off during August 21, 2011, flood
CdV-16-611931	MW-9	12.0	P&A	Surface completion and well housing destroyed during August 21, 2011, flood, leaving only PVC well casing
CdV-16-611932	MW-10	13.0	P&A	
CdV-16-611933	MW-17	9.0	P&A	
CdV-16-611934	MW-18	8.0	No longer exists	Alluvial well washed away during August 21, 2011, flood.
CdV-16-611935	MW-11	12.0	P&A	
CdV-16-611936	MW-19	7.5	No longer exists	Alluvial well washed away during August 21, 2011, flood.
CdV-16-611937	MW-20	8.5	Retain for long-term monitoring	MY2017 Interim Facility-Wide Groundwater Monitoring Plan monitoring location. Retain for long-term monitoring.
CdV-16-611938	MW-1	8.5	No longer exists	Alluvial well washed away during August 21, 2011, flood.

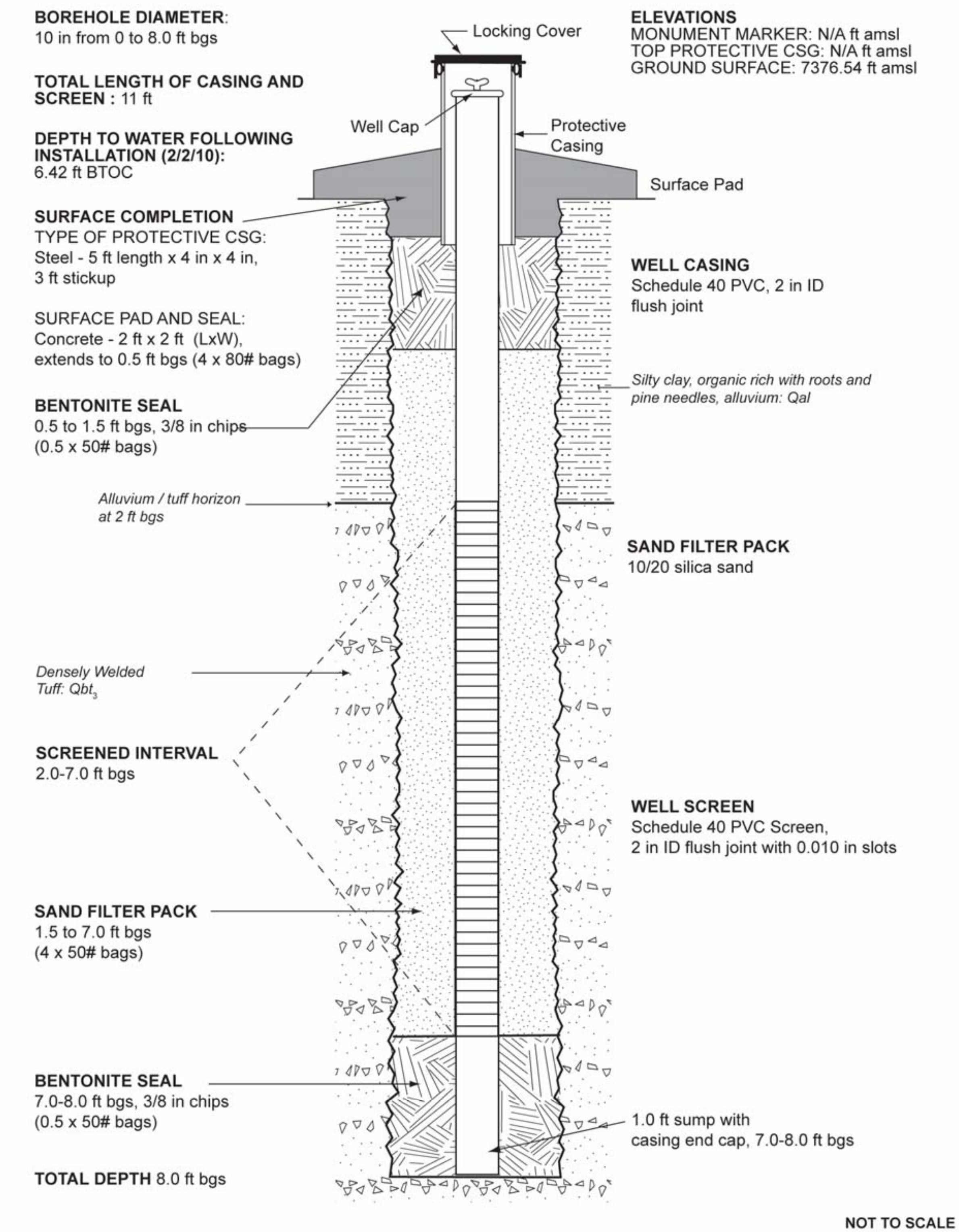
Note: All PRB monitoring wells and piezometers are 2-in.-I.D. PVC.

Appendix A

Well Completion Diagrams for Permeable
Reactive Barrier Monitoring Wells



TerranearPMC	Drafted By: A. Stocker	PRB ALLUVIAL MONITORING WELL SCHEMATIC: MW-1
	Date: February 8, 2010	Technical Area 16 Los Alamos National Laboratory, Los Alamos, New Mexico



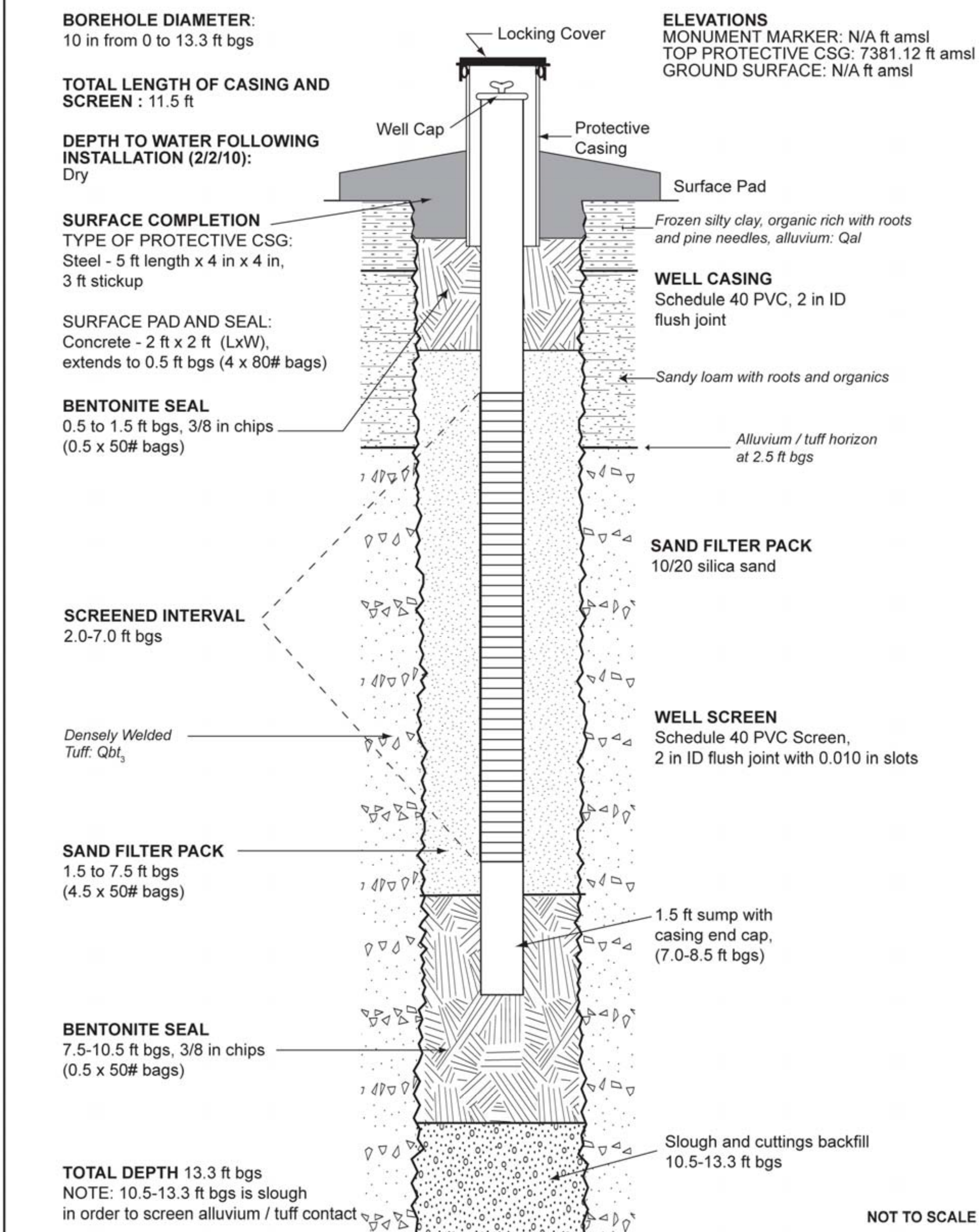
TerranearPMC

Drafted By: A. Stocker

Date: February 8, 2010

PRB ALLUVIAL MONITORING WELL SCHEMATIC: MW-2

Technical Area 16 Los Alamos National Laboratory, Los Alamos, New Mexico



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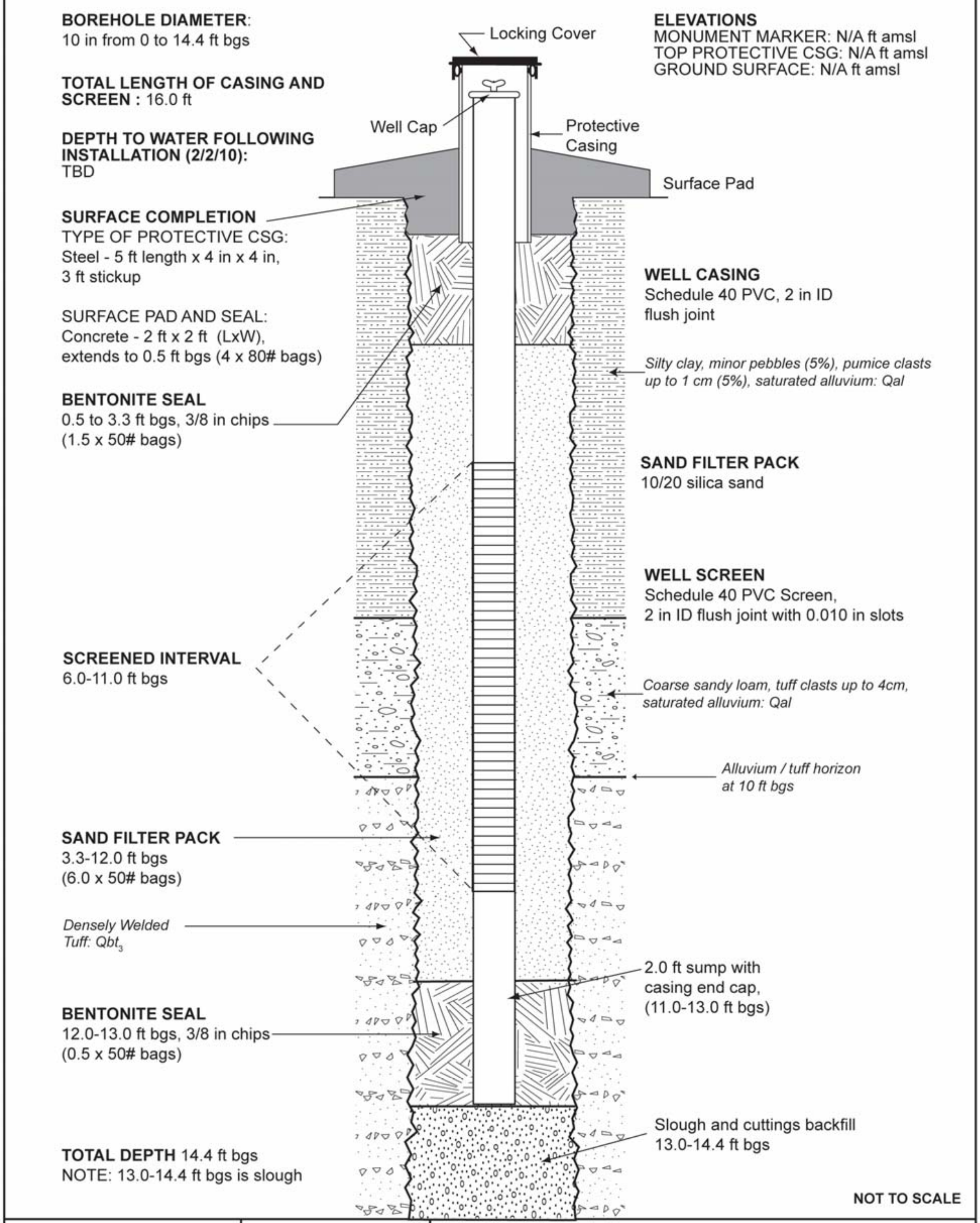

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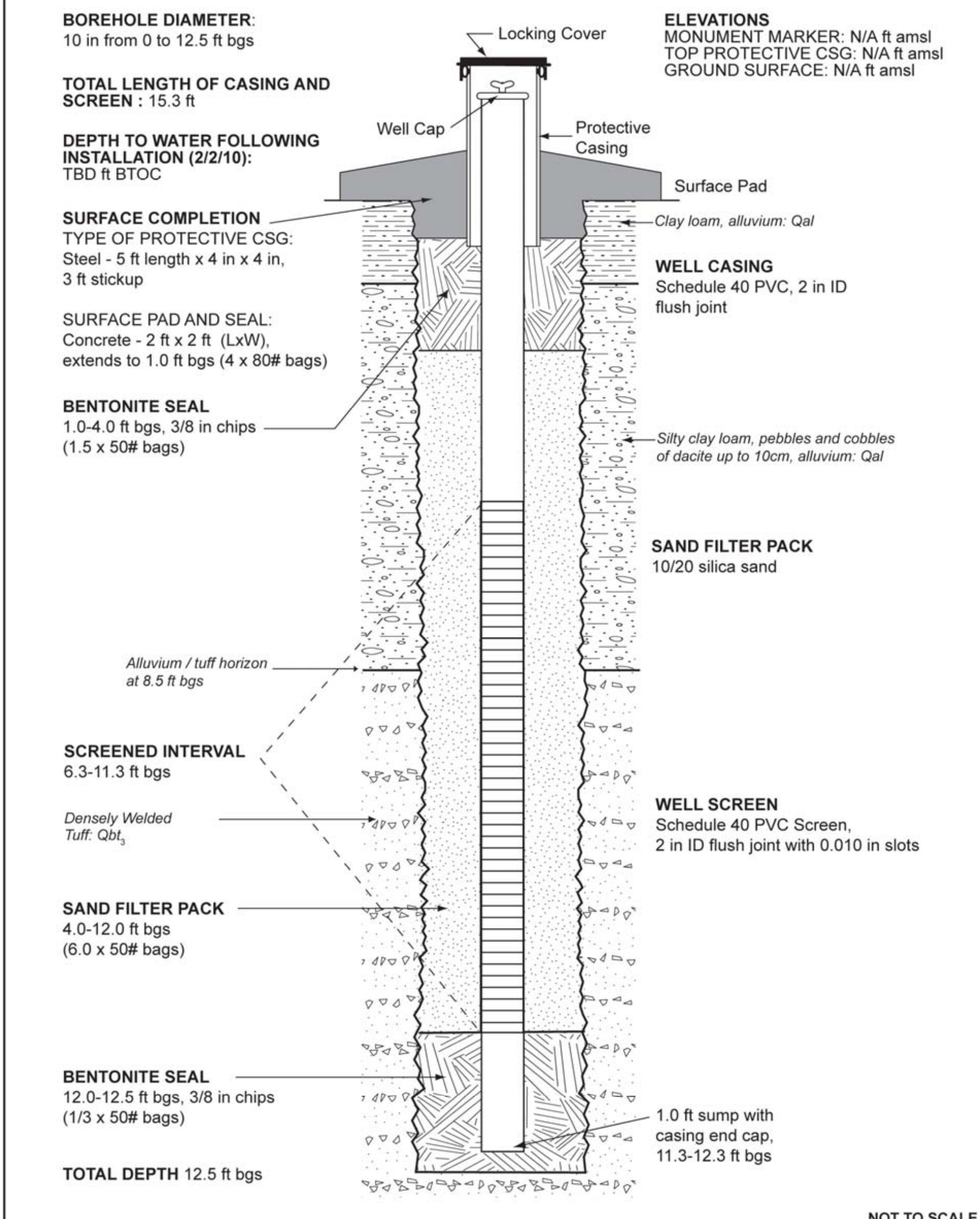

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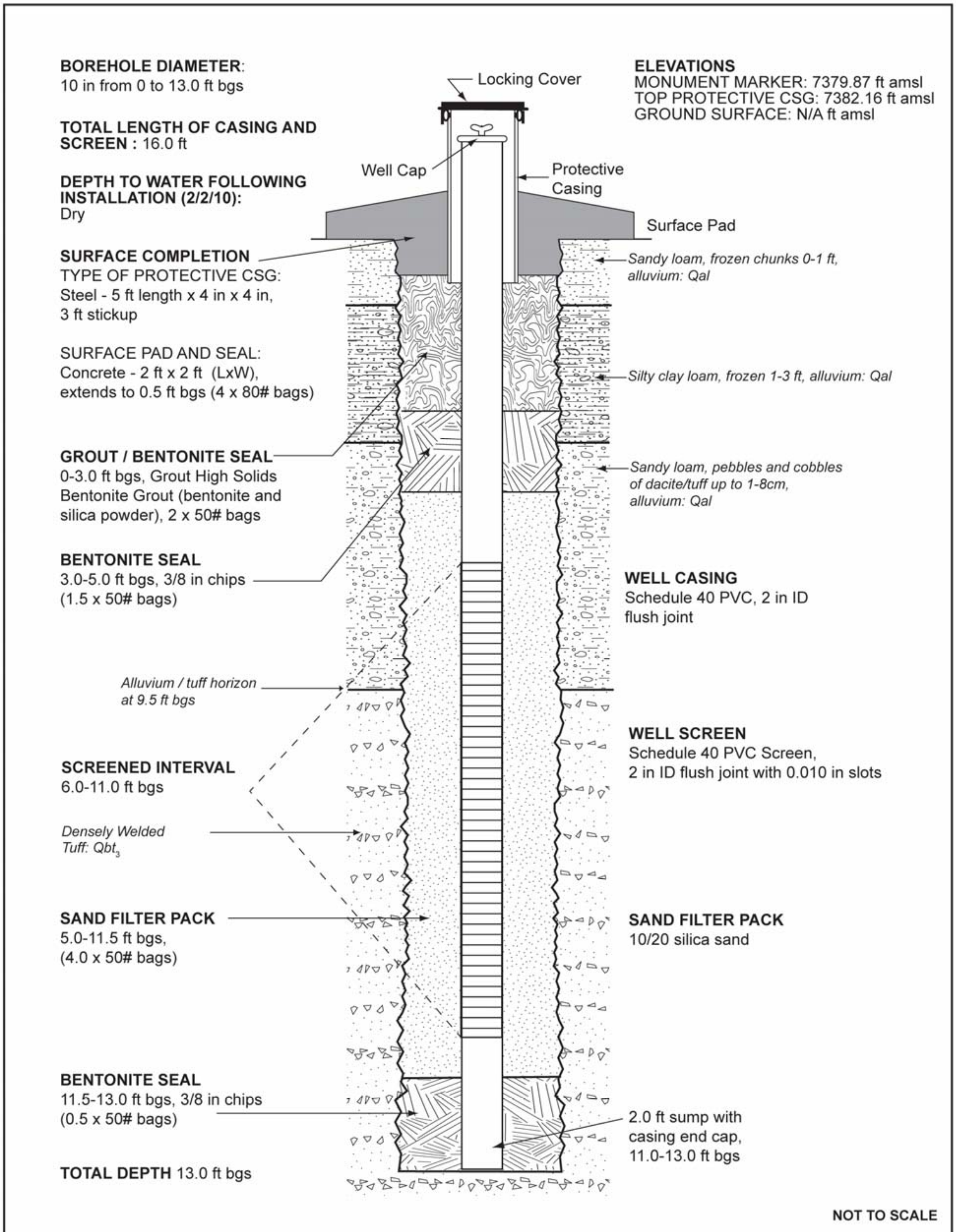

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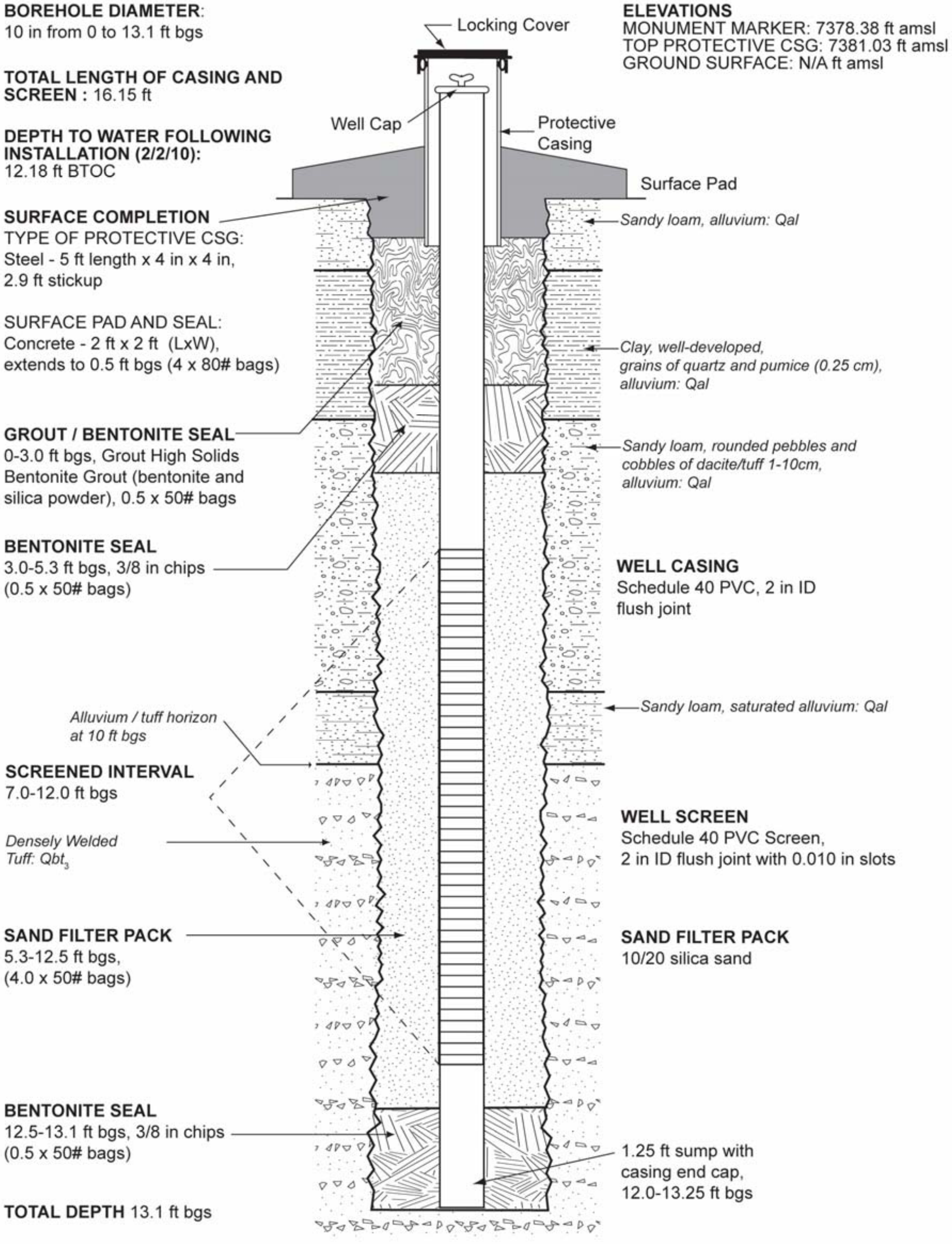

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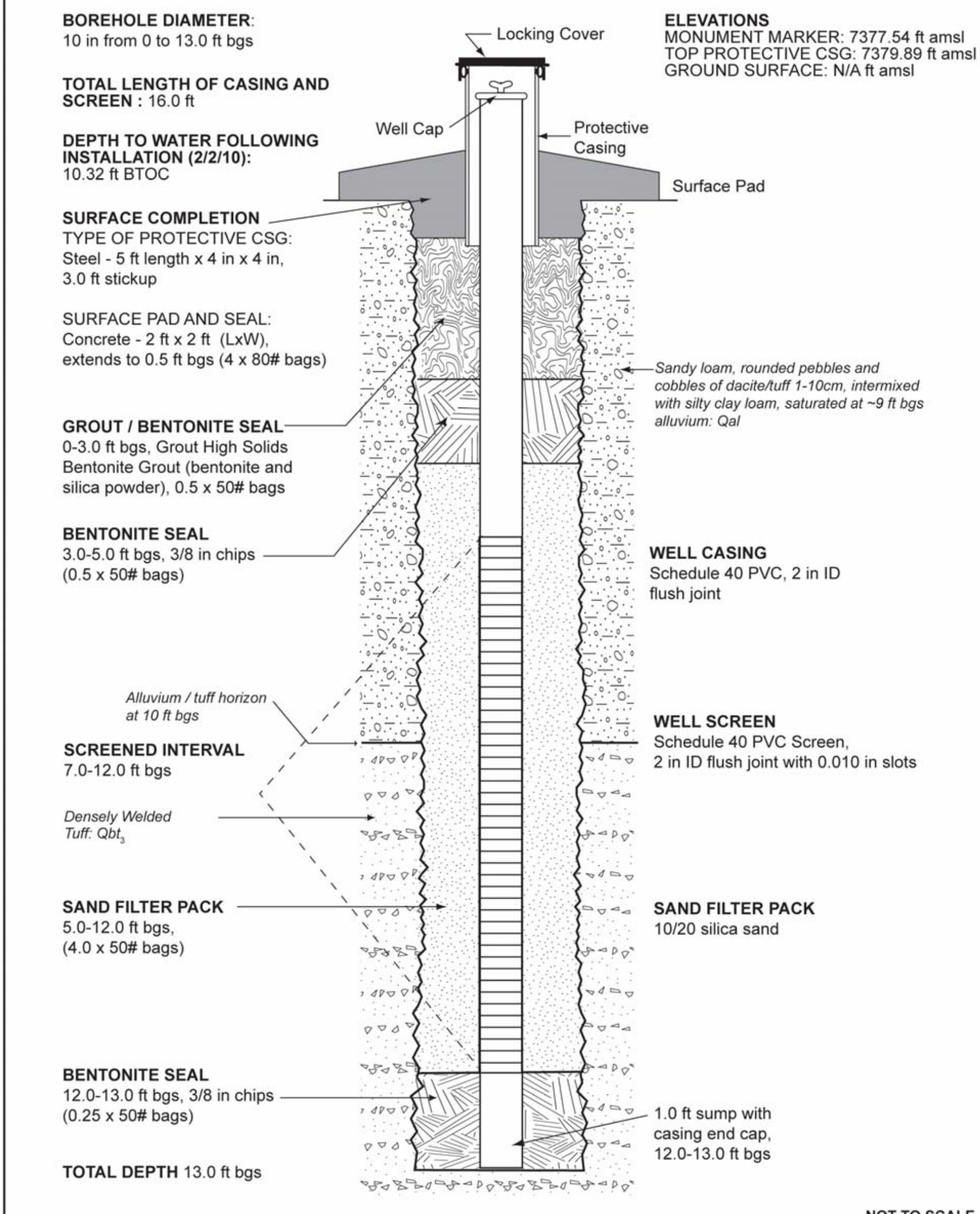

TerranearPMC	Drafted By: A. Stocker	PRB ALLUVIAL MONITORING WELL SCHEMATIC: MW-8
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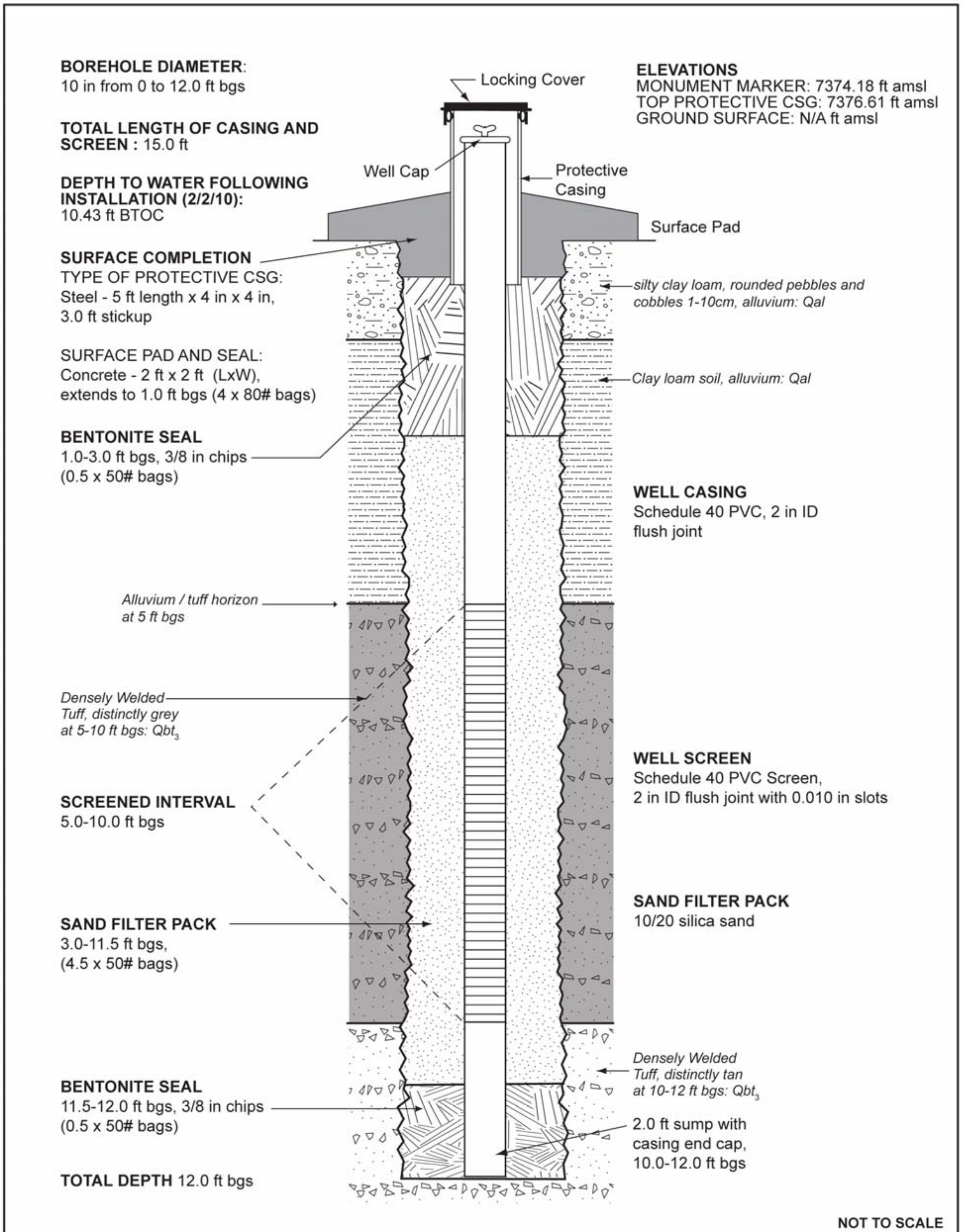


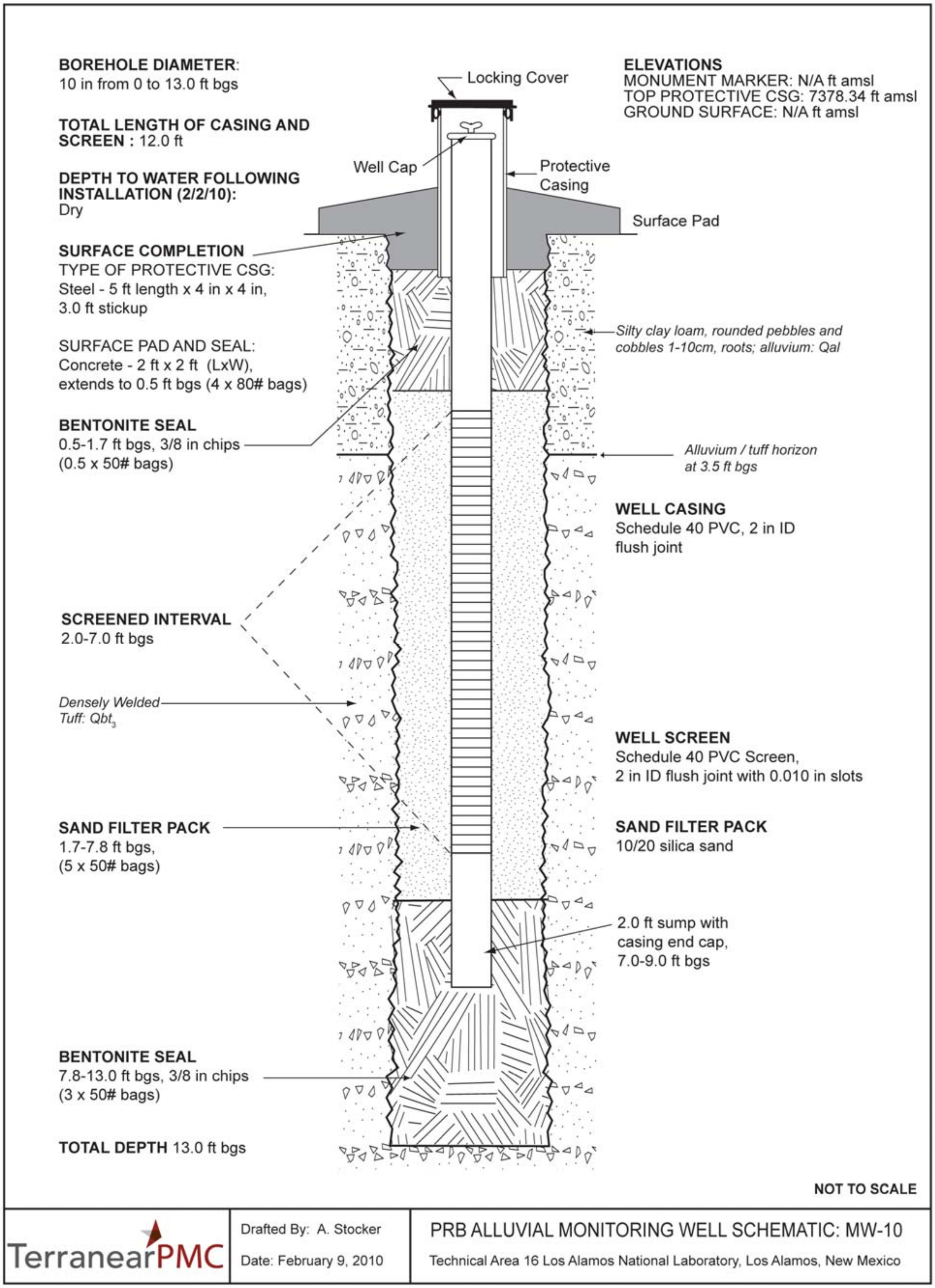
TerranearPMC

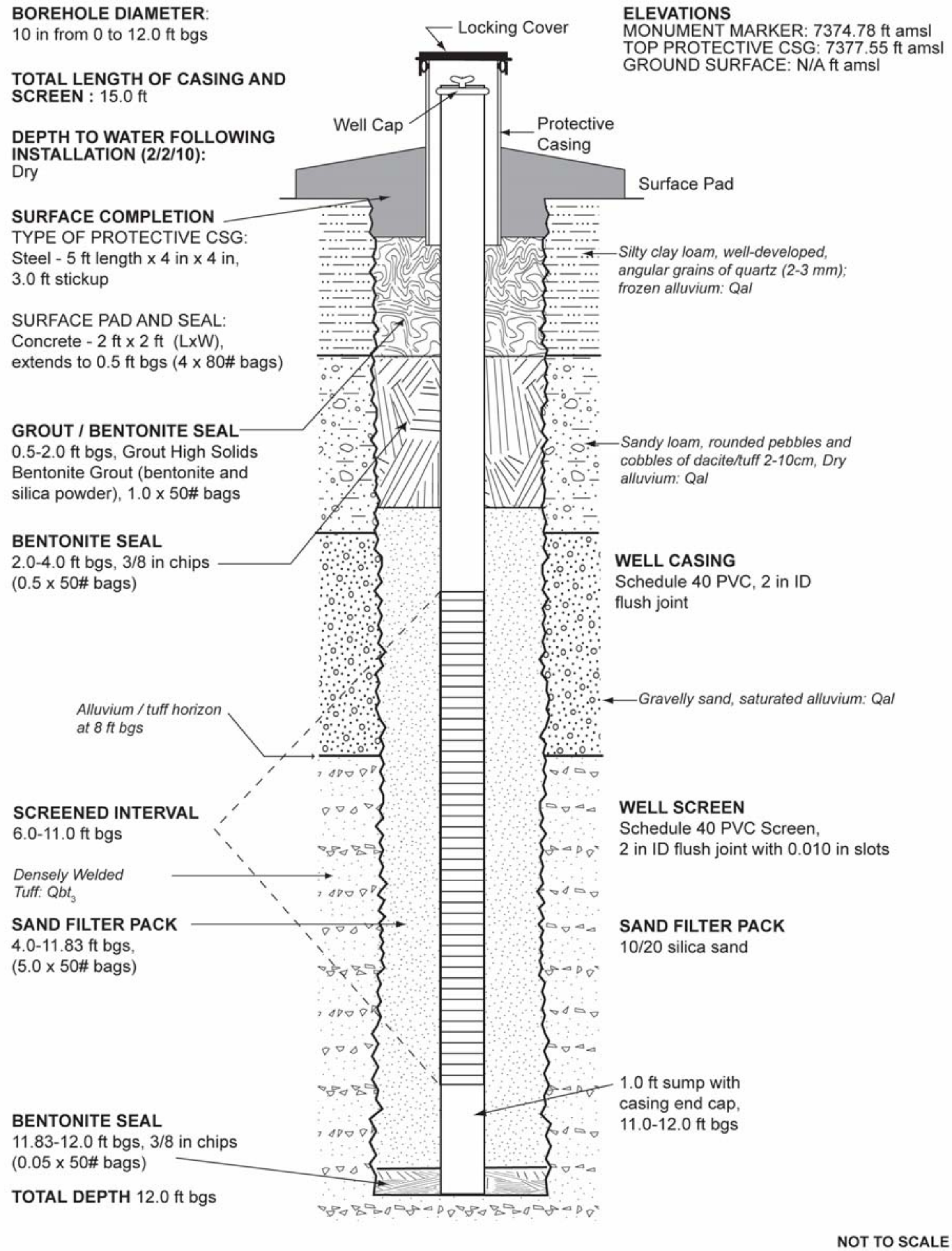
Drafted By: A. Stocker

Date: February 9, 2010

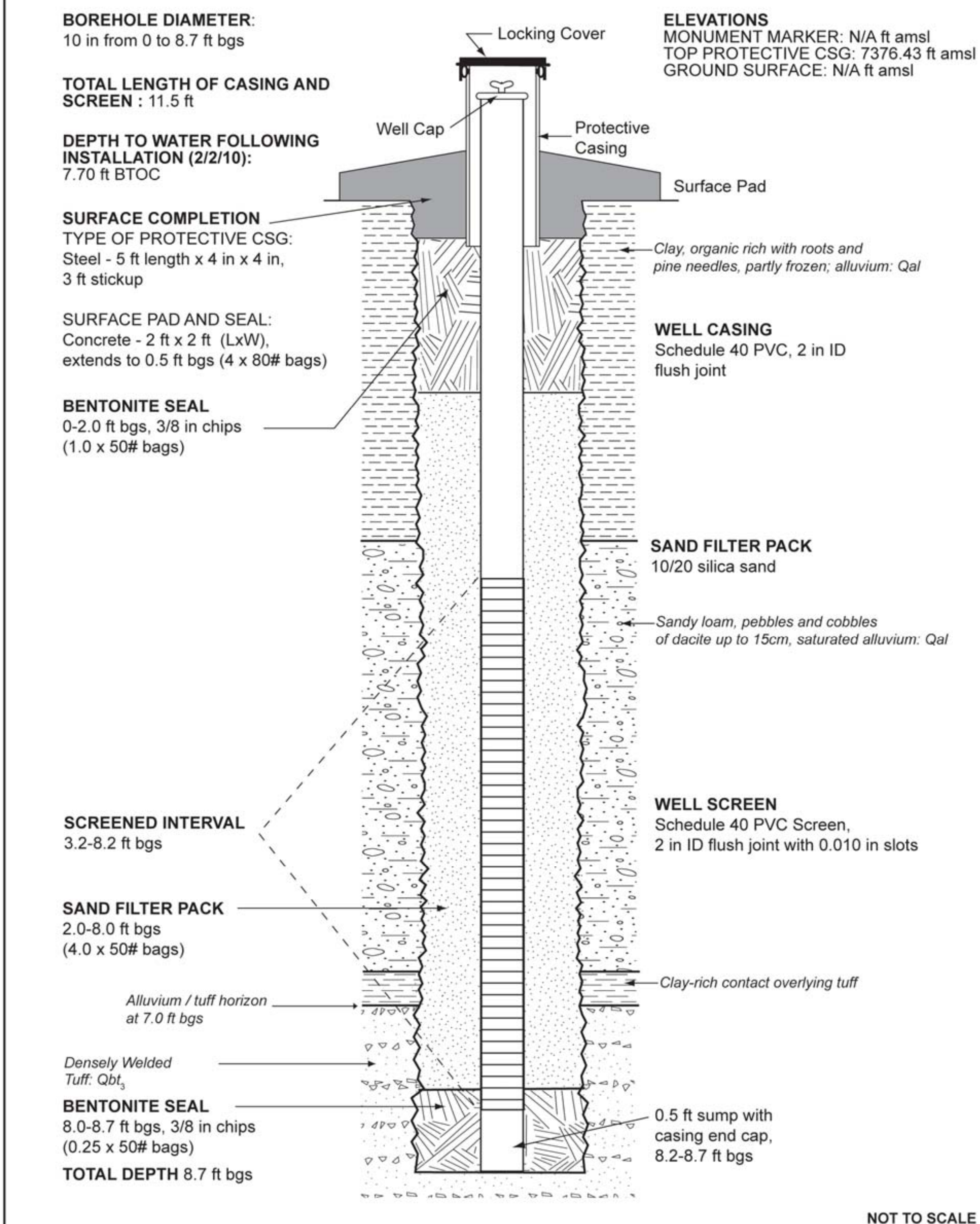
PRB ALLUVIAL MONITORING WELL SCHEMATIC: MW-9

Technical Area 16 Los Alamos National Laboratory, Los Alamos, New Mexico


BOREHOLE DIAMETER:
10 in from 0 to 13.0 ft bgs
TOTAL LENGTH OF CASING AND SCREEN : 12.0 ft
DEPTH TO WATER FOLLOWING INSTALLATION (2/2/10):
Dry
SURFACE COMPLETION
TYPE OF PROTECTIVE CSG:
Steel - 5 ft length x 4 in x 4 in,
3.0 ft stickup
SURFACE PAD AND SEAL:
Concrete - 2 ft x 2 ft (LxW),
extends to 0.5 ft bgs (4 x 80# bags)
BENTONITE SEAL
0.5-1.7 ft bgs, 3/8 in chips
(0.5 x 50# bags)
SCREENED INTERVAL
2.0-7.0 ft bgs
Densely Welded Tuff: Qbt3
SAND FILTER PACK
1.7-7.8 ft bgs,
(5 x 50# bags)
BENTONITE SEAL
7.8-13.0 ft bgs, 3/8 in chips
(3 x 50# bags)
TOTAL DEPTH 13.0 ft bgs
Locking Cover
Well Cap
Protective Casing
Surface Pad
ELEVATIONS
MONUMENT MARKER: N/A ft amsl
TOP PROTECTIVE CSG: 7378.34 ft amsl
GROUND SURFACE: N/A ft amsl
Silty clay loam, rounded pebbles and cobbles 1-10cm, roots; alluvium: Qal
Alluvium / tuff horizon at 3.5 ft bgs
WELL CASING
Schedule 40 PVC, 2 in ID
flush joint
WELL SCREEN
Schedule 40 PVC Screen,
2 in ID flush joint with 0.010 in slots
SAND FILTER PACK
10/20 silica sand
2.0 ft sump with
casing end cap,
7.0-9.0 ft bgs
NOT TO SCALE
TerranearPMC
Drafted By: A. Stocker
Date: February 9, 2010
PRB ALLUVIAL MONITORING WELL SCHEMATIC: MW-10
Technical Area 16 Los Alamos National Laboratory, Los Alamos, New Mexico



TerranearPMC	Drafted By: A. Stocker Date: February 9, 2010	PRB ALLUVIAL MONITORING WELL SCHEMATIC: MW-11 Technical Area 16 Los Alamos National Laboratory, Los Alamos, New Mexico



TerranearPMC	Drafted By: A. Stocker	PRB ALLUVIAL MONITORING WELL SCHEMATIC: MW-12
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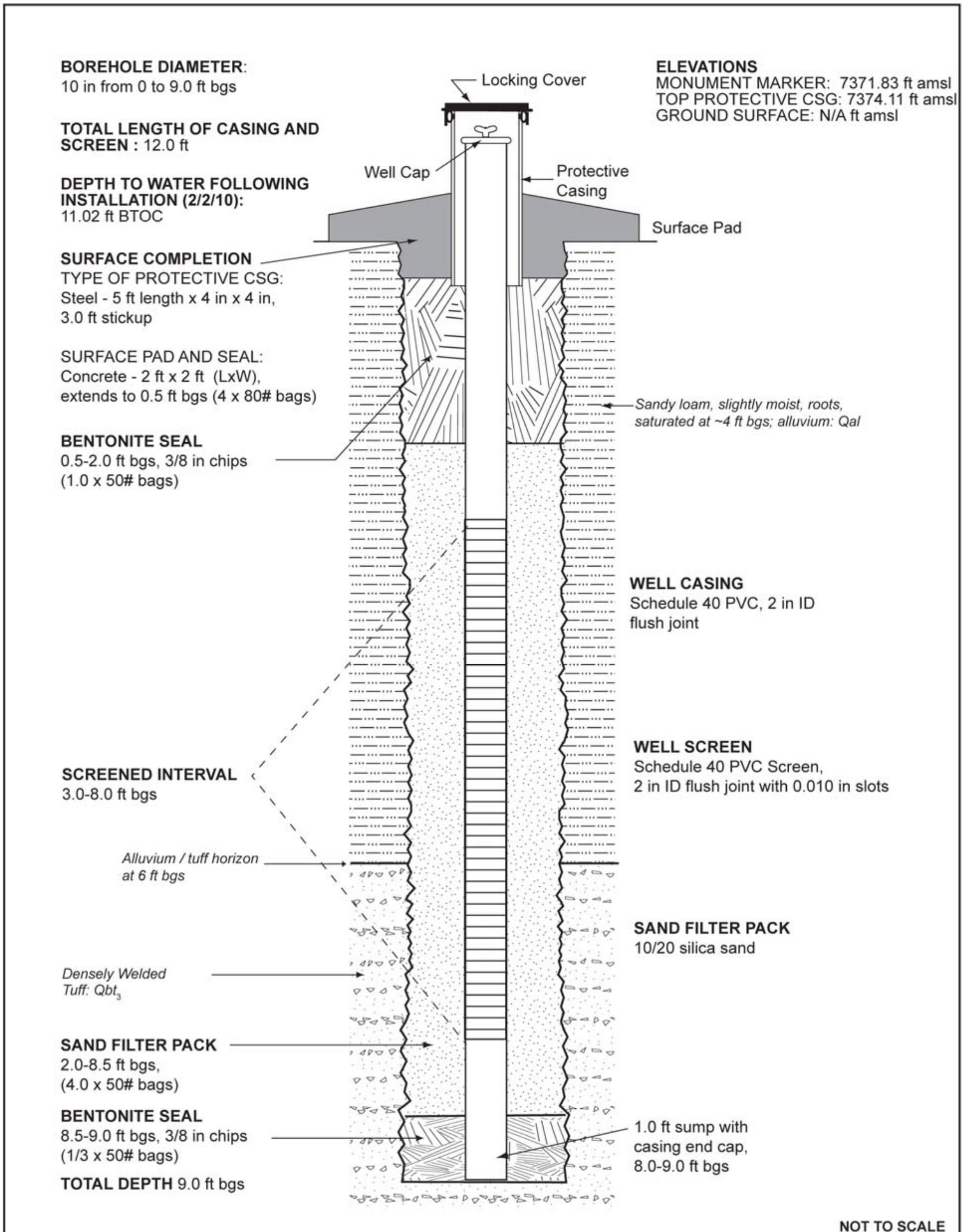

TerranearPMC	Drafted By: A. Stocker	PRB ALLUVIAL MONITORING WELL SCHEMATIC: MW-17
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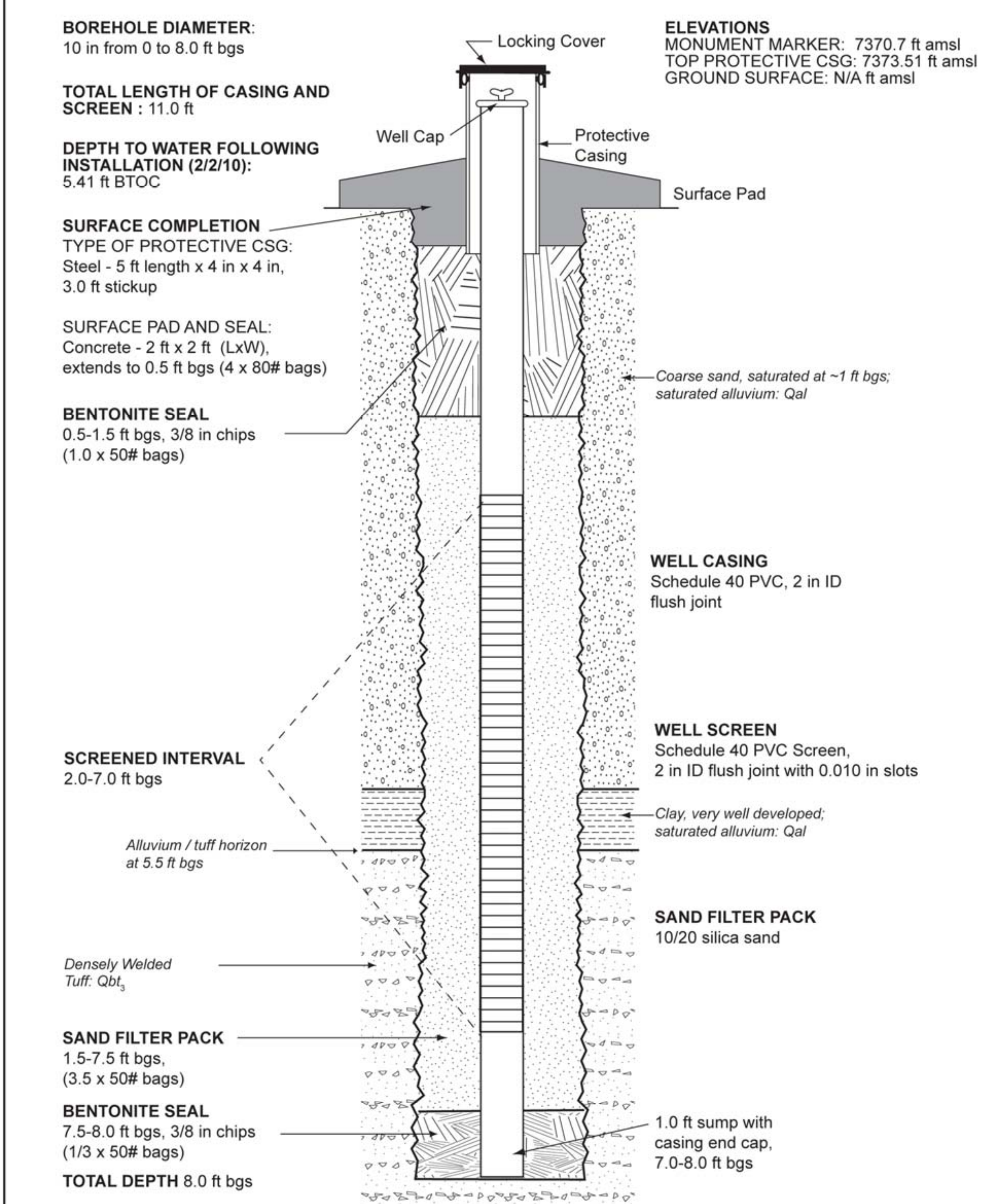

TerranearPMC	Drafted By: A. Stocker	PRB ALLUVIAL MONITORING WELL SCHEMATIC: MW-18
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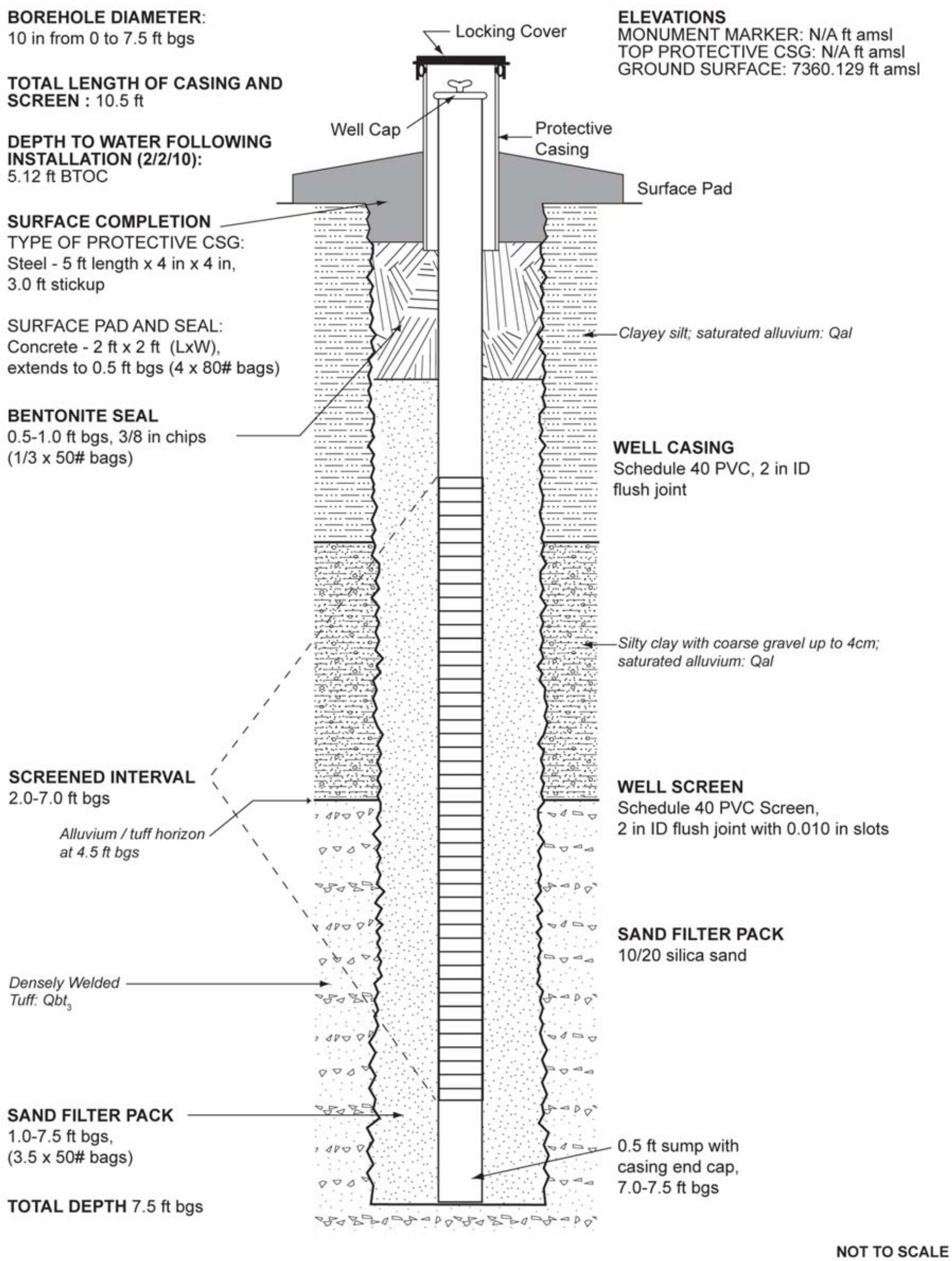

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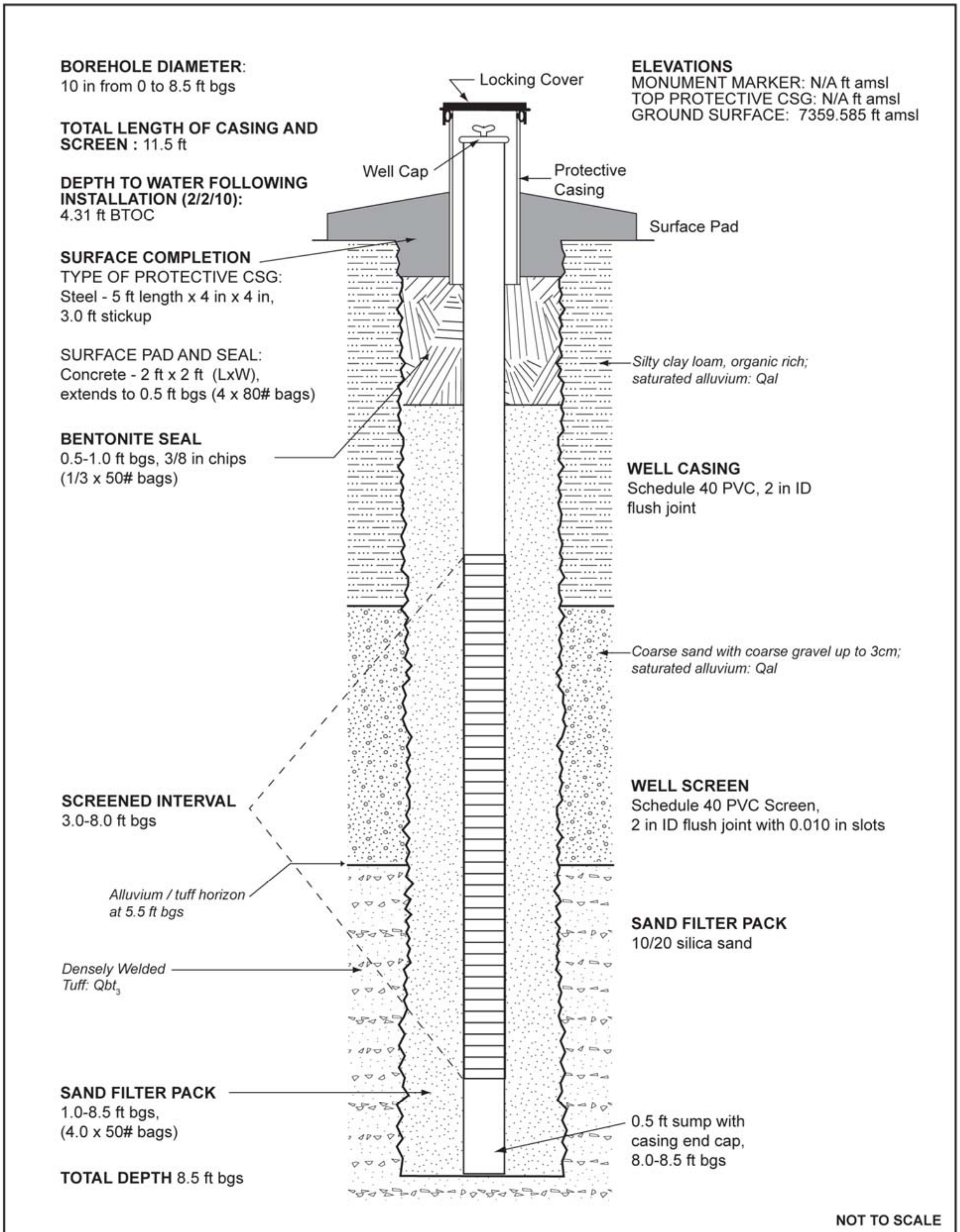

TerranearPMC | Drafted By: A. Stocker | Date: February 10, 2010

PRB ALLUVIAL MONITORING WELL SCHEMATIC: MW-20

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