Present Landfill Monitoring and Maintenance Plan and Post-Closure Plan
U.S. Department of Energy
Rocky Flats, Colorado, Site

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## Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>CAD/ROD</td>
<td>Corrective Action Decision/Record of Decision</td>
</tr>
<tr>
<td>CCR</td>
<td>Code of Colorado Regulations</td>
</tr>
<tr>
<td>CDPHE</td>
<td>Colorado Department of Public Health and Environment</td>
</tr>
<tr>
<td>DOE</td>
<td>U.S. Department of Energy</td>
</tr>
<tr>
<td>DQO</td>
<td>data quality objective</td>
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<tr>
<td>EPA</td>
<td>U.S. Environmental Protection Agency</td>
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<tr>
<td>FML</td>
<td>flexible membrane liner</td>
</tr>
<tr>
<td>GCL</td>
<td>geosynthetic clay liner</td>
</tr>
<tr>
<td>GWIS</td>
<td>Groundwater Intercept System</td>
</tr>
<tr>
<td>IDW</td>
<td>investigation-derived waste</td>
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<tr>
<td>IHSS</td>
<td>Individual Hazardous Substance Site</td>
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<tr>
<td>IM/IRA</td>
<td>Interim Measure/Interim Remedial Action</td>
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<tr>
<td>IMP</td>
<td>Integrated Monitoring Plan</td>
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<tr>
<td>LM</td>
<td>Legacy Management</td>
</tr>
<tr>
<td>M&amp;M Plan</td>
<td>Monitoring and Maintenance Plan and Post-Closure Plan</td>
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<tr>
<td>OU</td>
<td>Operable Unit</td>
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<tr>
<td>PLF</td>
<td>Present Landfill</td>
</tr>
<tr>
<td>PLFTS</td>
<td>Present Landfill Treatment System</td>
</tr>
<tr>
<td>QA</td>
<td>quality assurance</td>
</tr>
<tr>
<td>QC</td>
<td>quality control</td>
</tr>
<tr>
<td>RCRA</td>
<td>Resource Conservation and Recovery Act</td>
</tr>
<tr>
<td>RFCA</td>
<td>Rocky Flats Cleanup Agreement</td>
</tr>
<tr>
<td>RFLMA</td>
<td>Rocky Flats Legacy Management Agreement</td>
</tr>
<tr>
<td>RL</td>
<td>reporting limit</td>
</tr>
<tr>
<td>UHSU</td>
<td>upper hydrostratigraphic unit</td>
</tr>
<tr>
<td>VOC</td>
<td>volatile organic compound</td>
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1.0 Introduction

This Monitoring and Maintenance Plan and Post-Closure Plan (M&M Plan) applies to the Present Landfill (PLF) (historical Individual Hazardous Substance Site [IHSS] 114) at the Rocky Flats Site (Rocky Flats). The PLF M&M Plan was approved in 2006 and was modified in 2008. This PLF M&M Plan incorporates a minor modification of the PLF M&M Plan, as described further in this section, below.

The PLF M&M Plan fulfills the requirements for a post-closure plan in 6 Code of Colorado Regulations (CCR) 1007-3 §265.118 and the requirements of 6 CCR 1007-3 §265.121(a)(3).¹

Under the Final Interim Measure/Interim Remedial Action (IM/IRA) for IHSS 114 and Resource Conservation and Recovery Act (RCRA) Closure for the Present Landfill (DOE 2004, DOE 2006a), a RCRA Subtitle C-compliant cover was selected to address closure of the PLF. The cover is a geosynthetic composite cover with a rock layer to deter burrowing animals and a 2-foot-thick topsoil layer, and includes installation of perimeter drainage channels to control surface water run-on and runoff around the PLF cover. The closure also included modification of the existing PLF Seep Treatment System (PLFTS). Construction of the PLF cover included removing sediments from the East Landfill Pond, drying the sediments, and placing the dried sediments under the PLF cover. Construction was completed in May 2005, with a minor drainage modification on the PLF east face completed in August 2005.

The original PLF M&M Plan was approved in May 2006, prior to the September 2006 Corrective Action Decision/Record of Decision (DOE, EPA, and CDPHE 2006) (CAD/ROD) for Rocky Flats. Pursuant to the CAD/ROD Rocky Flats was configured into two Operable Units (OUs). The Central OU consolidates all areas of Rocky Flats that have remaining hazardous substance contamination and require additional remedial actions, including the PLF. The Peripheral OU surrounds the Central OU and includes the other generally unaffected portions of Rocky Flats that served as a buffer zone surrounding the former industrial area. Under the CAD/ROD, the final remedy is no action for the Peripheral OU, and institutional controls, physical controls, and continued monitoring for the Central OU.

The Rocky Flats Legacy Management Agreement (DOE, EPA, and CDPHE 2007) (RFLMA), signed by the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA), and the Colorado Department of Public Health and Environment (CDPHE), to implement the CAD/ROD became effective March 14, 2007. The PLF M&M Plan is incorporated by reference as an enforceable requirement of RFLMA (See RFLMA Attachment 2, “Legacy Management Requirements,” Section 5.3.1). RFLMA terminated and superseded the Rocky Flats Cleanup Agreement (RFCA).

Modifications to the PLF M&M Plan and to RFLMA requirements pertaining to the PLF monitoring and maintenance are subject to CDPHE review and approval in accordance with RFLMA Part 10, Amendment of Agreement and Modification of Attachments.

¹ 6 CCR 1007-3 §265.121 is identified as an Applicable or Relevant and Appropriate Requirement in the CAD/ROD. Subsection (a)(3) refers to requirements for monitoring programs in 6 CCR 1007-3 §264.91 - §264.100.
The 2008 PLF M&M Plan modification and this modification were based on the outcome of consultation in accordance with RFLMA consultative process as documented in RFLMA Contact Record (CR) 2007-08, approved December 21, 2007, and CR 2014-02, approved February 18, 2014.

1.1 Purpose

The PLF M&M Plan is designed to meet the following objectives:

1. Describe the procedures to maintain the integrity and effectiveness of the final cover, including making repairs as necessary (Section 3.0);

2. Describe the features to maintain and monitor the groundwater monitoring system (Section 4.0); and

3. Present the PLFTS Environmental Monitoring Plan (Section 5.0).

For consistency and simplicity, when specific evaluations and follow-up actions related to these objectives are contained in RFLMA requirements, the PLF M&M Plan refers to the RFLMA requirements.

1.2 Facility Location and Units

Rocky Flats is a government-owned facility formerly used for the fabrication of miscellaneous weapons components for national defense. Rocky Flats is located in Jefferson County, Colorado, approximately 16 miles northwest of Denver (Figure 1). The Central OU comprises approximately 1,309 acres situated in the central portion of the former Rocky Flats Environmental Technology Site. The PLF is located within the northern portion of the Central OU, as shown on Figure 2.

1.3 Site Operations

The PLF is located in the No Name Gulch drainage, at the western limit of headward erosion and pediment dissection. Beginning in 1968, a portion of the natural drainage at the headwaters of the No Name Gulch drainage was filled with soil from an onsite borrow area to a thickness of approximately 5 feet to construct a surface on which to begin landfilling operations. The PLF does not have a bottom liner. Waste delivered to the PLF was spread across the work area, compacted, and covered with a daily soil cover, eventually filling the valley to the top of the pediment. The PLF eventually consumed the West Landfill Pond; the earthen dam for the PLF Pond (also known as the East Landfill Pond) was breached in 2012 as described in CR 2011-07.

The PLF remained in operation until March 1998, at which time it was placed in a contingent closure status and seeded to stabilize soil and control erosion. Final closure was completed in 2005, in accordance with the PLF IM/IRA. The PLF occupies an area of approximately 20 acres. Waste material is generally thinnest along the boundaries and thickest along the east-west axis of the PLF. Thicknesses range from less than 1 foot to approximately 40 feet near the eastern face of the PLF.

Additional information can be found in the PLF IM/IRA.
2.0 Site Physical Description

This section describes the physical conditions at the PLF site such as topography, hydrology, climate and precipitation, hydrogeology, and site features, which include the final cover, the stormwater management system, the RCRA groundwater monitoring network, the PLFTS, and the East Landfill Pond.

2.1 Topography

The final topography of the PLF is as shown on the post-construction survey (Figure 3). The slopes of the landfill cover are generally between 3 to 5 percent in accordance with EPA guidance for landfill covers (EPA 2002). The east face of the PLF has a maximum slope of 4 horizontal to 1 vertical (4H:1V). Perimeter drainage channels were built to control surface water run-on and runoff and are sloped to drain to the east of the PLF below the former PLF Pond. A diversion berm was built at the top of the east face to direct surface water into the perimeter channels. Two additional stormwater drainage channels were built to direct surface water at the toe of the east face.

2.2 Hydrology

The PLF is located within the No Name Gulch drainage. Perimeter channels have been constructed around the PLF to route stormwater off the cover and prevent run-on from the surrounding watersheds. On the northern side of the PLF, the western portion of the perimeter channel runs under a perimeter road through a culvert and east into a natural drainage that eventually joins the No Name Gulch drainage east of the former PLF Pond. The northeastern portion of the channel empties into the same natural drainage that eventually joins No Name Gulch. On the southern side of the PLF, the perimeter channel runs eastward and drops into the No Name Gulch drainage (Figure 3).

The Groundwater Intercept System (GWIS) was installed around the north, east, and south PLF perimeter in 1974 to reduce groundwater inflow to the PLF from the surrounding area. Two 900 foot soil-bentonite slurry walls were also installed on the north and south PLF perimeter in 1984 and tied into the north and south arms of the GWIS. The flow of groundwater from within the PLF to the north and south is also limited by the GWIS. Groundwater collected by the GWIS flows to the PLFTS.

A diversion berm constructed at the top of the east slope directs surface water from the cover away from the east face and into the perimeter channels.

2.3 Climate and Precipitation

Rocky Flats is located in the southern Rocky Mountains and has a continental, semiarid climate. The region is noted for large seasonal temperature variations, occasional dramatic short-term temperature changes, and strong, gusty winds that can exceed 100 miles per hour. Mean annual precipitation is approximately 15.5 inches, with approximately one-half of that amount occurring as snow.
2.4 Hydrogeology

In the area of the PLF, groundwater flows predominantly within the upper hydrostratigraphic unit (UHSU). The UHSU is composed of materials that include the Rocky Flats Alluvium, colluvium, Valley Fill Alluvium, and weathered bedrock (predominantly claystone). Unweathered bedrock is part of the lower hydrostratigraphic unit. The thickness of the weathered bedrock material varies considerably in the vicinity of the PLF, ranging from approximately 4 to 35 feet. In the past, the average depth to groundwater ranged from 5 to 15 feet in unconsolidated surficial deposits around the PLF.

2.5 Site Features

Site features at the PLF include the final cover, the stormwater management system, the RCRA groundwater monitoring network, the PLFTS, and the East Landfill Pond. Each of the site features is discussed in this plan. Monitoring procedures are provided in subsequent sections.

2.5.1 Final Cover

The final cover of the PLF includes the following components, beginning with the top layer:

- A 2-foot-thick soil layer to facilitate vegetation, route surface water, and protect the cover system below;
- A 1-foot-thick rock layer with soil in the interstices to deter burrowing animals from impacting the underlying geosynthetics;
- A 10-inch-thick rock cushion soil layer to protect the underlying geosynthetics from rocks;
- Geocomposite drainage net to act as a drainage layer to route infiltrating water off of the cover;
- Flexible membrane liner (FML) to act as an impermeable layer and prevent water infiltration to the waste material below;
- Geosynthetic clay liner (GCL) to act as a secondary impermeable layer and also to “heal” punctures in the FML by the swelling of the GCL; and
- A 6-inch-thick GCL cushion soil layer to protect the geosynthetics above. This layer also includes a barometric vent system to equalize atmospheric pressure under the cover.

Inspection and monitoring procedures to maintain the integrity and effectiveness of the final cover are included in Section 3.0.

2.5.2 Stormwater Management System

2.5.2.1 Introduction

The stormwater management plan is presented in Appendix H of the Present Landfill Design Submittal (Earth Tech, Inc. 2004). This appendix presents the results of calculations used to determine the stormwater run-on and runoff volumes to adequately design the perimeter channels and culverts. The calculations use a 100-year, 24-hour storm event and check the capacity of this
design to handle a 1,000-year, 24-hour storm event. The contributing area for storm events is approximately 54 acres.

2.5.2.2 Applications

Effective stormwater management is achieved in the system by applying the following principles:

- Protect the land surface from erosion;
- Manage run-on and runoff, keeping velocities low; and
- Inspect and maintain the erosion and stormwater management practices (discussed in Section 3.0).

2.5.2.3 Erosion Control

Stormwater management features at the PLF have been designed with erosion control features to limit both short-term and long-term erosion (Figure 3). Erosion control is any practice that protects soil surfaces and prevents the soil particles from being detached by rainfall or wind. The PLF cover is covered with a NAG C125 temporary erosion mat and the cover sideslopes, perimeter channel bottom, perimeter channel sideslopes, and diversion berms are all covered with a NAG SC150 temporary erosion control mat. These mats have a design life of approximately 3 years, depending on weather conditions. This will limit short-term erosion until vegetation is established. Portions of the perimeter channel with steeper slopes are lined with riprap, a more robust erosion control measure. The diversion berm outfalls to the perimeter channel are also lined with riprap to prevent scouring. The cover of the cap has been seeded, mulched, and covered with erosion matting to limit erosion until vegetation is established. The east face and portions of the diversion berms have a more permanent erosion control mat (NAG C350) because the slope is longer and is more susceptible to erosion. Vegetation will also reduce erosion on the east face.

2.5.2.4 Run-on and Runoff Control

The PLF stormwater management system has two purposes:

- To collect, route, and discharge stormwater run-on and runoff while minimizing unnecessary ponding and subsequent infiltration into the cover; and
- To control erosion and sediment transport.

Run-on stormwater is conveyed from west of the PLF as overland flow and in intermittent, grassed waterways, and then enters the perimeter channel. Other run-on is from overland flow from the contributing areas on the non-PLF sides of the perimeter channel.

Runoff enters the perimeter channel from overland flow on the cover as well as grassed waterway flow from the diversion berms constructed on the top of the slope at the east face.
2.5.3 RCRA Groundwater Monitoring Network

Six RCRA monitoring wells are used for groundwater monitoring at the PLF as discussed in Section 4.0. Three RCRA wells are upgradient and three RCRA wells are downgradient of the PLF.

2.5.4 PLF Seep

A seep, known as the PLF seep, exists at the eastern end of the PLF. As part of final closure, subsurface strip drains were placed below the east face cover to collect water under the east face cover including the seep and route the water to the PLFTS. The PLFTS replaced a similar seep treatment system installed in 1996. This new PLFTS also collects and treats groundwater (if any) from the GWIS and flow from the east face subsurface strip drains. As part of the construction supporting the PLF closure, the existing GWIS pipelines were routed to the PLFTS (see Figure 5). Concentrations of most contaminants in the PLF seep have been reported below the RFLMA surface water standards; however, a few constituents may exceed these levels. Monitoring is discussed in Section 5.0.

2.5.5 Former East Landfill Pond

The East Landfill Pond Dam (also referred to as the PLF Pond Dam) was breached in 2012 and the area was filled and contoured to improve riparian habitat and to configure the No Name Gulch drainage to the approximate conditions prior to construction of the dam. The monitoring location in No Name Gulch is discussed in Section 5.0.

2.5.6 Access Controls

Access controls will be maintained in accordance with the RFLMA requirements for physical controls, including signs. RFLMA requirements meet the intent of warning signs in accordance with 6 CCR 1007-3 §265.14.

3.0 Final Cover and Stormwater Management System Inspection and Monitoring

This section outlines the inspection and monitoring program to be undertaken at the PLF to ensure that the integrity of the cover is not compromised and continues to function as designed. Inspection and monitoring tasks include surface water and groundwater monitoring, monitoring and inspection of subsidence/consolidation, slope stability, soil cover, vegetation, stormwater management structures, and erosion in surrounding features so that maintenance actions can be taken in a timely manner.

DOE will follow RFLMA requirements for informing the other RFLMA Parties of any RFLMA reportable conditions resulting from conducting the inspection and monitoring program described in this PLF M&M Plan. Final plans and schedules for mitigating actions, if any, will be developed and approved in accordance with RFLMA requirements.
3.1 Inspection Procedures

The frequency for each inspection and monitoring item will be conducted as specified in RFLMA. Modifications to the inspection program, including inspection frequency, will be evaluated using the RFLMA consultative process, and approved as specified by RFLMA modification requirements. More frequent inspection may occur any time conditions warrant.

In accordance with the IM/IRA (DOE 2006a), to maintain integrity and effectiveness of the final cover, site inspections of the area will be conducted on a regular, periodic basis following construction of the final cover. In addition to regularly scheduled inspections, weather-related inspections will be conducted as follows:

- The PLF will be inspected after a storm event of 1 inch or more of rain in a 24-hour period; and
- The PLF will be inspected after significant melt of an accumulation of snow greater than 10 inches (assuming 10 inches of snow is equivalent to 1 inch of water).

Inspections will be performed by qualified personnel and reviewed by a competent professional. Inspections will encompass the following subjects, as described in Sections 3.2 through 3.8: subsidence/consolidation, slope stability, soil cover, vegetation, stormwater management structures, run-on erosion controls, and institutional controls and related matters. Inspections will be performed using a prescribed form containing a checklist of items that documents the evaluation of site conditions. The inspection form is presented in Appendix A. The inspection form will be signed and dated by the inspector and the reviewer. The findings and observations of the site inspection will be entered on the form and presented in an annual PLF monitoring report, as described in Section 6.1. Minor repairs or maintenance may be performed in conjunction with the inspection and will be noted on the inspection form.

3.2 Subsidence/Consolidation

Subsidence and consolidation at the PLF largely depend on how well the waste, cover, and fill were compacted when placed, and the waste thickness, age, rate of degradation, and composition. Waste subsidence or continued consolidation may result in differential settlement which generally occurs when one area of waste settles more readily than another because of differences in waste composition, degradation, compaction, thickness, and moisture content. Differential settlement across the PLF may create cracks on the surface, which would allow precipitation to infiltrate more easily. Differential settlement can also change the topography of the PLF and create areas on the surface where ponding of water can occur. Localized waste subsidence can manifest itself in the form of cracks, depressions, and sinkholes. Construction of the final cover system included placement of engineered fills and repair of unsuitable areas. In addition, the waste was compacted when placed, and decomposition is nearly complete as indicated by measurement of PLF gases. Therefore, cover subsidence or consolidation is of little concern. Nevertheless, differential settlement may occur.

3.2.1 Monitoring Locations and Procedures

Subsidence/consolidation monitoring will be conducted to evaluate actual settlement compared to the expected settlement calculated in the final design and to observe areas of water ponding on
the PLF surface or other indicators of differential settlement. Subsidence/consolidation at the
PLF will be monitored by visually inspecting the surface of the PLF cover for cracks,
depressions, heaving, and sinkholes. Visual inspections will involve traversing the PLF to gain
perspective on regions of the PLF (i.e., every square foot of the PLF will not be inspected). In
addition, the settlement plates (monument locations) were installed as shown on Figure 3. For
each monument location, the calculated settlement from the final design will be established to be
compared to measured settlement. (There is no calculated settlement plate data for plates H
and I; these locations will be monitored for settlement trends based on their initial survey
coordinates.) Areas of observed differential settlement, including ponding, will be staked,
photographed, measured, and located on the PLF site map prior to any maintenance action.
Survey Control Point 1006 (shown on Figure 3) will be maintained as the control for surveying
the PLF.

3.2.2 Maintenance Activities

The maintenance actions that will normally occur to correct the effect of adverse differential
settlement are to place additional soil and regrade the affected area. This action will eliminate the
potential for ponding and/or correct the slope of the surface. Maintenance that addresses
differential settlement will be photographed, and the area will be measured and located on the
PLF site map. Replacement soil will be Rocky Flats Alluvium meeting the specifications in the
Accelerated Action Design. This requirement will be met by stockpiling appropriate soil,
identifying appropriate borrow locations, or ensuring that a supplier meets the specifications.

Settlement plate data will be tabulated and the measured settlement will be compared to the
anticipated settlement calculated in the final design. Should measured settlement exceed
30 percent of the calculated maximum settlement and be expressed as differential settlement, the
area will be photographed, located on the PLF site map, as described above, repaired, and
reported in the inspection reports. Should the measured settlement exceed 90 percent of the
calculated maximum settlement and be expressed as differential settlement, a qualified
geotechnical engineer will be consulted to determine a maintenance action and the results of the
gеotechnical engineer’s evaluation will be reported by DOE to CDPHE. The area(s) where
maintenance actions have taken place will be specifically inspected and reported during
subsequent periodic inspections of the cover for as long as detailed follow-up evaluation is
needed to monitor any continued subsidence. DOE will follow RFLMA requirements for
reportable conditions if differential settlement or localized subsidence appears to be substantial
and likely to influence the integrity, and thus the effectiveness, of the existing cover and surface
water drainage over the PLF after taking these maintenance actions.

3.3 Slope Stability

Some areas of the PLF site may be susceptible to instability due to lateral movement. Slope
failures can be caused by the weight of the wastes and cover material, steeply regraded slopes,
and seepage forces resulting from water infiltration. Seismic forces can also cause slope failures.
Steep slopes produce less stable conditions and are more susceptible to failure. Slope failures can
also occur within the waste mass, resulting in downslope sliding of the cover components. The
cover system has been designed and constructed with applicable safety factors to guard against
slope failure. Nevertheless, slope stability will be monitored to verify that slope failure is not in
progress. In addition, if areas of slope stability concerns are found outside the boundaries of the
PLF footprint but within the general area of the PLF, the area of the inspection will be expanded to include these areas.

3.3.1 Monitoring Locations and Procedures

Slope stability at the PLF will be monitored by visually inspecting the cover system sideslopes, perimeter channel sideslopes, east face slope, and area above the GWIS pipeline that was rerouted to the PLFTS (outside the PLF closure boundary) for signs of cracks, evidence of block failure, and evidence of circular failure. The inspection will categorize the observed cracking. Visual inspection will involve traversing the slope to gain a perspective of the entire slope. Particular attention will be provided at the drainage divide where the east (central) area meets both the north and south areas of the east face. Any areas where a surface seep is identified will be photographed, marked, located on the PLF site map, and monitored for signs of slope instability. Areas identified during the inspections as potential slope stability concerns will be photographed, located on the PLF site map, and staked for further monitoring. If adverse surface water flow into cracks is likely, actions such as filling the cracks or controlling surface water flows will be taken to prevent surface water from entering the cracked area. DOE will follow RFLMA requirements for reportable conditions if further monitoring indicates a continued stability concern after taking these maintenance actions and will consult a qualified geotechnical engineer.

In addition to the visual inspections, several sideslope monitoring points were placed on the east face slope and will be monitored for vertical and horizontal movement. These will be visually inspected on each field inspection and surveyed at the same frequency as the settlement plates. Observations gathered will be combined with the other inspection data to evaluate the overall performance of the east face.

3.3.2 Maintenance Activities

Based on the site monitoring data and consultation with a qualified geotechnical engineer, maintenance actions will be taken to address any potential slope failure at the PLF that would likely compromise the remedy. The actions may include, but not be limited to, regrading affected areas, filling areas, maintaining positive drainage of surface water, creating slopes ranging from 2 to 5 percent on top of the waste, and regrading steep sections to achieve sideslopes no greater than 4:1. Areas where maintenance actions have taken place will be closely monitored and documented for further slope stability concerns. DOE will follow RFLMA requirements for reportable conditions if inspections show continued slope stability concerns in an area of the PLF closure after taking these maintenance actions.

3.4 Soil Cover

The cover system at the PLF was designed and installed to meet the minimum soil erosion requirements from both water and wind erosion. During the post-closure period, it is important to ensure that both temporary and permanent erosion controls are functioning properly. Regardless, the soil cover thickness may change over time due to wind and water erosion. Subsidence due to waste settlement and lateral movement of wastes or slopes may also contribute to changes in differential soil cover thickness. Monitoring of the soil cover is conducted to verify the cover is
performing in accordance with the design and the PLF system as a whole continues to meet performance objectives.

3.4.1 Monitoring Locations and Procedures

Monitoring of the soil cover at the PLF includes the following:

- Visually inspecting the soil cover for erosion or deposition areas;
- Visually inspecting the soil cover for signs of burrowing animals; and
- Visually inspecting the diversion berm, diversion berm outfalls, and the east face for erosion rills or excessive deposition.

Visual inspection involves traversing the slope to gain perspective of the entire area. Particular attention will be provided at the drainage divide where the east (central) area meets both the north and south areas of the east face. Signs of rill and gully erosion will be photographed, marked with stakes, measured, located on the PLF site map, and reported on the inspection form. Additionally, areas of observed soil deposition will also be photographed, marked, measured, located on the PLF site map, and reported on the inspection form.

3.4.2 Maintenance Activities

If monitoring indicates significant loss of soil over time, maintenance actions will be taken. If a gully is measured at equal to or more than 6 inches deep, maintenance actions will be implemented. The actions may include, but not be limited to, soil replacement, regrading the affected areas to match adjacent grades, and removing and relocating any deposited eroded soils (if necessary). The regraded areas will be vegetated to prevent further erosion. Erosion control measures will be implemented to prevent further erosion of cover soils (e.g., erosion control mat and/or revegetation), if necessary. The amount of soil used to fill areas of erosion will be estimated, recorded, and reported in the quarterly monitoring report. DOE will follow RFLMA requirements for reportable conditions if soil erosion concerns persist after taking these maintenance actions. Areas of soil deposition that hinder the flow of surface water in a stormwater channel will be removed to maintain the designed channel configuration and flow capacity. Maintenance of these areas will also be documented and reported in the quarterly report.

3.5 Vegetation

Vegetation is important at the PLF to aid with short-term and long-term erosion control although the design calculations have shown that the materials used for construction are resilient to water and wind erosion. The approved PLF IM/IRA (Section 5.1) states: “Additionally, surface vegetation will be established on this soil layer to enhance resistance to surface erosion, prevent intrusion of noxious weeds and burrowing animals, and to provide an aesthetic appearance to the cover, using appropriate native seed mixes.” Section 6.1.1 of the PLF IM/IRA also states: “Vegetation of a soil cover is planned to further reduce erosion, although vegetation and weed control measures will be employed to maintain a healthy stand of vegetation consistent with the wildlife refuge end-state.” Vegetation on the PLF cover is established properly. Maintenance of the cover vegetation will be consistent with the Revegetation Plan (DOE 2009) and the Vegetation Management Plan (DOE 2012) for site-wide vegetation management.
3.5.1 Monitoring Locations and Procedures

The vegetation success criteria have been met, and quantitative vegetation monitoring has been discontinued.

3.5.2 Maintenance Activities

If visual inspections indicate vegetation concerns on the cover, maintenance action will be taken. Actions may include, but not be limited to, the following:

- Reseeding of the soil cover;
- Spot herbicide applications;
- Maintenance/repair of erosion controls; and
- Removal of deep-rooting trees or shrubs growing in the cap and repair of the area.

Maintenance of the cover vegetation will be consistent with the Revegetation Plan and the Vegetation Management Plan for site-wide vegetation management. DOE will notify and consult with CDPHE should an area consistently show vegetation concerns to determine if this condition could result in a RFLMA reportable condition.

3.6 Stormwater Management Structures

Stormwater management will be required at the PLF to ensure that existing stormwater control structures (man-made drainage features) are functioning adequately to achieve the following objectives:

- Prevent run-on and runoff from eroding or damaging the cover; and
- Limit transport of sediment from the disturbed areas to offsite drainage ways.

Existing stormwater controls at the PLF include the following (Figure 3):

- Diversion berm;
- Diversion berm outfall-north;
- Diversion berm outfall-south;
- Culvert 1;
- Culvert 2;
- Southwest culvert outfall;
- Vegetation-lined perimeter channel-north;
- Vegetation-lined perimeter channel-south;
- Riprap-lined perimeter channel;
- East face riprap channel-north;
- East face riprap channel-south; and
- NAG C350-lined east face (hillside).
Details of each type of structure are included on Figure 4.

3.6.1 Monitoring Locations and Procedures

Stormwater management structures will be monitored visually by walking the structures and examining all components. Problem areas will be noted on the inspection form, graphically depicted, and photographed. At a minimum, these structures will be inspected for signs of excessive erosion, settlement, bank failure, breaching of the diversion berms, subsidence, burrowing animals, and blockage. Signs of potential problems include, but are not limited to, gullying, sediment buildup, and depressions.

The perimeter channel lining will be inspected for evidence of damage, displacement, undermining, scour, or deterioration. Repairs will be made to restabilize the channel in accordance with the design specifications. Permanent (extended term) erosion control mat lining on the east face will also be inspected. The erosion control mat will be inspected for holes, rips, and separation. In addition, any evidence of erosion rills or gullies will be monitored during the inspection.

3.6.2 Maintenance Activities

If the inspections indicate that the existing stormwater management structures are not adequately controlling surface water run-on and runoff, maintenance actions will be taken.

As necessary, routine maintenance of the surface water controls will include removing any blockages, filling eroded areas, replacing erosion control mat, or repairing other disturbances. Sediment will be removed from the stormwater management structures to restore the design characteristics of the structure. Areas that exhibit excessive erosion may require placement of erosion control material or strengthening of the existing erosion control measures. DOE will follow RFLMA requirements for reportable conditions if stormwater management structures continue to show evidence they are not adequately controlling surface water run-on and runoff after taking these maintenance actions.

3.7 Run-On Erosion Control

Erosion control inspections will take place in natural drainages around the PLF to prevent excess sediment load to the PLF system and to ensure erosion is not problematic. Natural drainages and slopes around the PLF to be inspected for excess erosion as shown on Figure 3 include the following:

- Natural drainage fed by Culvert 1;
- Natural drainage fed by the northeast portion of the perimeter channel;
- Natural drainage fed by the south perimeter channel; and
- Natural area sideslopes of the perimeter channel.

The inspection will include areas where flows from the channels discharge to the existing downstream land surface.
3.7.1 Monitoring Locations and Procedures

The natural drainages will be visually monitored to identify signs of soil erosion that could adversely impact the PLF or conditions that may cause an overload on existing stormwater management structures.

3.7.2 Maintenance Activities

If inspections indicate soil loss, excessive disturbance in the areas, the presence of erosion gullies, or other evidence of erosion, maintenance action will be taken. The slope areas are more susceptible to water erosion in the event of high-intensity rainfall and are of particular concern. Actions may include placing additional soil, regrading, and seeding of the affected areas. Other erosion control measures that may be implemented include, but are not limited to, placing erosion mat, riprap, straw bale barrier(s), and silt fencing. DOE will follow RFLMA requirements for reportable conditions if areas consistently show signs of erosion after taking these maintenance actions.

3.8 Institutional Controls and Other Inspections

In addition to the inspection and monitoring activities discussed above, the PLF site inspection will include assessment of other items related to institutional controls, the condition of established monitoring points, and site security. DOE will follow RFLMA requirements for informing the other RFLMA Parties of any RFLMA reportable conditions related to institutional controls and other inspections.

3.8.1 Institutional Controls

Institutional controls are specified in RFLMA Attachment 2, Table 4, “Institutional Controls for the Central Operable Unit.” These institutional controls are used to control access and restrict activities at the PLF to ensure the effectiveness of the engineered controls and the monitoring systems. PLF inspections will monitor conditions that violate the institutional controls or damage the physical controls. Inspections will be conducted to look for evidence of the following activities:

- Excavation(s) of the cover and in the immediate vicinity of the cover;
- Construction of roads, trails, or buildings on the cover;
- Drilling of wells or use of groundwater except for remedy-related purposes;
- Disruption or damage of the seep treatment system;
- Damage or removal of any signage or groundwater monitoring wells at the PLF;
- Evidence of unauthorized entry, including damage from vehicular traffic; and
- Damage from burrowing animals.

A checklist of these items is included on the inspection form found in Appendix A.
3.8.2 Condition of Monitoring Points

All established monitoring locations, such as monitoring wells and the seep treatment system or other items placed to assist inspection efforts, will be evaluated for ongoing integrity. The inspection will include documentation of any damage to the monitoring points that would impact their usefulness for inspections.

3.8.3 Site Conditions

During site inspections, signs, markers, and the overall condition of the PLF site will be checked to determine continuing effectiveness of institutional and physical controls.

3.8.4 Reporting and Record Keeping

Inspection forms and findings will be included in the annual PLF monitoring reports discussed in Section 6.1, which will be included in the annual reports specified in RFLMA Attachment 2, Section 7.0, “Periodic Reporting Requirements.”

4.0 Groundwater Monitoring Plan

This section presents the plan to maintain and monitor the groundwater monitoring system for the PLF during the post-closure period.

4.1 Purpose and Requirements

The constituents monitored, frequency of monitoring, and other requirements of §264.98 and the IM/IRA are specified in RFLMA Attachment 2, as outlined in this section. RFLMA Attachment 2 requirements replaced the RFCA Integrated Monitoring Plan (IMP) requirements (DOE 2005b). The PLF groundwater monitoring plan has been implemented to determine groundwater quality impacts of the PLF pursuant to the detection monitoring requirements of 6 CCR 1007-3, §264.91(d) and §264.98. The groundwater monitoring will be used to evaluate upgradient versus downgradient groundwater quality at the PLF as set forth in RFLMA Attachment 2.

4.2 Data Quality Objectives

The PLF groundwater monitoring data quality objectives (DQOs) were generally developed using EPA guidance documents. Quality assurance/quality control (QA/QC) requirements are specified in RFLMA Attachment 2, Section 5.0, “Monitoring Requirements.” Groundwater monitoring wells at the PLF are categorized in RFLMA as RCRA monitoring wells and monitoring results will be evaluated in accordance with RFLMA Attachment 2, Figure 10, “RCRA Wells,” which incorporates the DQO process.

4.3 Well Locations

Well locations were selected and approved by CDPHE and EPA. Six RCRA groundwater monitoring wells, three downgradient and three upgradient (Figure 3), are employed.
Upgradient monitoring wells include wells 70193, 70393, and 70693. Downgradient monitoring wells include wells 73005, 73105, and 73205. Monitoring well details are summarized in Table 1. Boring logs are included in Appendix B.

4.4 Sampling Procedures Summary

Groundwater sampling will be conducted in accordance with Office of Legacy Management (LM) operational documents related to monitoring as provided in RFLMA Attachment 2, Section 5.0, “Monitoring Requirements.” Groundwater monitoring will include water level measurements, conventional groundwater purging and sampling, QC field samples, and proper equipment decontamination. Investigation-derived waste (IDW) (e.g., for purge and decontamination waters) will also be managed in accordance with the LM operational documents.

4.5 Laboratory Procedures Summary

Analytical methodologies and reporting limits (RLs), data reporting procedures, laboratory QA/QC procedures, and laboratory data validation and contractor validation procedures are to be conducted in accordance with EPA-approved methods. Groundwater samples will be submitted to an EPA-approved analytical laboratory for the following analyses:

- SW-846 Method 8260B—Volatile organic compounds (VOCs);
- SW-846 Method 6010B—Metals; and
- SW-846 Method 7470A—Mercury.

The remedy performance standards for surface water are in RFLMA Attachment 2, Table 1, “Surface Water Standards.” Sampling criteria for surface water are presented in RFLMA Attachment 2, Table 2, “Water Monitoring Locations and Sampling Criteria.” The analytical results obtained by these methods will be reported as described in Section 4.6.

Sample results are reported according to laboratory analytical method Standard Operating Procedures or contract specifications. The laboratory will report any analyte of interest detected at or above the RL as a positive value. Any analyte of interest not detectable or detected below the RL will be reported as “not detected” at the RL or an estimated value between the RL and the instrument or method detection limit. Data are generally reported in a tabular format or posted on maps and figures. RLs are adjusted for dilution when necessary.

4.6 Reporting and Schedule

Groundwater monitoring results will be included in the quarterly and annual reports specified in RFLMA Attachment 2, Section 7.0, “Periodic Reporting Requirements.” The annual PLF monitoring reports, discussed in Section 6.1, will be included in the RFLMA annual reports.
5.0 Present Landfill Seep Environmental Monitoring Plan

As part of PLF closure, the PLFTS, a passive seep interception and treatment system, was installed to treat PLF seep water and GWIS water. Effluent from the PLFTS eventually flows to No Name Gulch. This section presents the monitoring plan for the PLFTS as required by the DQO process, if PLFTS effluent exceeds RFLMA Attachment 2, Table 1, “Surface Water Standards.”

5.1 Purpose and Requirements

The Monitoring Plan is implemented to determine surface water quality impacts of the PLF. Sampling parameters, sampling frequency and applicable surface water standards are listed in RFLMA Attachment 2, Table 1, “Surface Water Standards,” and Table 2, “Water Monitoring Locations and Sampling Criteria.” The decision framework for this sampling is found in RFLMA Attachment 2, Figure 11.

5.2 Data Quality Objectives

The PLF surface water monitoring DQOs were generally developed using EPA guidance documents. QA/QC requirements are specified in RFLMA Attachment 2, Section 5.0, “Monitoring Requirements.” Monitoring results will be evaluated in accordance with RFLMA Attachment 2, Figure 11, “Groundwater Treatment Systems,” which incorporates the DQO process.

5.3 Sample Locations

Sampling will be conducted at both the influent and effluent of the PLFTS at the locations shown on Figure 5 in accordance with RFLMA Attachment 2 requirements. Flow at the seep influent (pipe from south manhole) to the PLFTS will be manually measured (calibrated bucket and stopwatch) when a sample is collected. GWIS north and south influent enters the north manhole at two locations. The north manhole is the designated sampling point for the GWIS. In accordance with RFLMA Attachment 2, Figure 11, and after consultation with CDPHE, sampling of the GWIS was discontinued for monitoring purposes. Any subsequent GWIS sampling will be as required in RFLMA Attachment 2. The PLFTS effluent sample will be collected from the base of the treatment unit or after the last step.

In addition, sampling at NNG01 (Figure 5) may be required in accordance with RFLMA Attachment 2, Figure 11, “Groundwater Treatment Systems,” if PLFTS effluent exceeds RFLMA Attachment 2, Table 1, “Surface Water Standards.”

5.4 Sampling Procedures Summary

Surface water sampling will be conducted in accordance with LM operational documents related to monitoring as provided in RFLMA Attachment 2, Section 5.0, “Monitoring Requirements.” Surface water monitoring will include QC field samples and proper equipment decontamination. IDW (e.g., for excess sample and decontamination waters) will also be managed in accordance with the LM operational documents.
5.5 Laboratory Procedures Summary

Analytical methodologies and RLs, data reporting procedures, laboratory QA/QC procedures, and laboratory data validation and contractor validation procedures are to be conducted in accordance with EPA-approved methods. Samples will be submitted to an EPA-approved analytical laboratory for the following analyses:

- SW-846 Method 8260B—VOCs;
- SW-846 Method 6010B—Metals;
- SW846 Method 8270C—Semivolatile organic compounds;
- Alpha Spectrometry—Isotopic uranium or SW-846 Method 6010B—Metals (uranium) as appropriate for the applicable standard in RFLMA; and
- EPA-600/4-79-020 Method 353.2—Nitrate/nitrite.

The surface water monitoring details are in RFLMA Attachment 2, Table 2, “Water Monitoring Locations and Sampling Criteria.” The analytical results obtained by these methods will be reported as described in Section 5.6.

Sample results are reported according to laboratory analytical method Standard Operating Procedures or contract specifications. The laboratory will report any analyte of interest detected at or above the RL as a positive value. Any analyte of interest not detectable or detected below the RL will be reported as “not detected” at the RL or an estimated value between the RL and the instrument or method detection limit. Data are generally reported in a tabular format or posted on maps and figures. RLs are adjusted for dilution when necessary.

5.6 Reporting and Schedule

PLFTS and NNG01 sampling results will be included in the quarterly and annual reports specified in RFLMA Attachment 2, Section 7.0, “Periodic Reporting Requirements.” The annual PLF monitoring reports, discussed in Section 6.1, will be included in the RFLMA annual reports.

5.7 Seep Treatment System Inspections

During sampling of the PLFTS, the system components will be inspected to ensure proper operation. The PLFTS is shown on Figure 5 and includes the following components:

- Former seep treatment system influent pipe;
- East face strip drain influent pipe;
- Concrete manholes (two);
- GWIS influent pipes (two);
- Treatment unit influent pipes (two);
- Treatment unit, which includes 10 steps; and
- Treatment unit effluent pipe.
The concrete manholes and treatment unit will be inspected for signs of damage as will the piping contained within. The influent and effluent pipes within the manhole and the PLFTS effluent pipe will be inspected for signs of blockage.

### 6.0 Reporting and Contact Information

#### 6.1 Reporting

The annual PLF monitoring report, including inspection results, repairs, groundwater monitoring data, PLFTS monitoring data, and NNG01 monitoring data if applicable, will be submitted as part of the RFMLA annual report. Any maintenance actions during the year will be detailed in the report. DOE will follow RFLMA requirements for reportable conditions and potentially impacted communities will be notified immediately of conditions that occur at any time that require immediate attention. The annual PLF monitoring report will include at a minimum:

- All inspection forms/reports for the year;
- Notations of problems, actions taken, maintenance, or repairs as a result of the inspections;
- Any deviations from this M&M Plan and the rationale for such deviations;
- Summary of monitoring locations;
- Tables with depth to water, well elevations, and groundwater elevations;
- Table with groundwater results and associated qualifiers;
- Tables with PLFTS sampling results and associated qualifiers;
- Tables with GWIS sampling (if required by RFLMA) results;
- Tables with NNG01 sampling results if applicable;
- Figures with groundwater monitoring points, NNG01, and location(s) of problems and/or repairs; and
- Groundwater and seep/PLFTS/NNG01 water sampling forms, as appropriate.

During the year, DOE will transmit completed inspection forms as they become available, but in no case later than 1 month after the field activity is completed.

#### 6.2 Contact Information

The point of contact and contact information for the PLF during the monitoring and maintenance phase is as follows:

Scott Surovchak/U.S. Department of Energy
Rocky Flats Office of Legacy Management
11025 Dover St., Suite 1000
Westminster, CO 80021
Ph. (720) 377-9682
7.0 References


Figure 2. PLF Site Map
Figure 4. Stormwater Management Structure Details
Figure 5. PLF Seep Treatment System
### Table 1. Groundwater Monitoring Wells at the PLF

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<thead>
<tr>
<th>Well ID</th>
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<th>Installation Date</th>
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<th>Depth to Top of Screen (feet bgs)</th>
<th>Depth to Bedrock (feet bgs)</th>
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**Notes:**

bgs = below ground surface
Appendix A

Present Landfill Inspection Form
PRESENT LANDFILL – MONITORING AND MAINTENANCE PROGRAM

INSPECTION FORM

INSPECTOR: _______________________________________________ DATE: ________ TIME: ____________ REVIEWED BY: ______________________

TEMPERATURE: ________________ WEATHER CONDITIONS: _______________________________ REVIEW DATE: _________________________________

METEOROLOGICAL STATION LOCATION: ___________________________________________________

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<th>EVIDENCE OF DEPRESSIONS?</th>
<th>EVIDENCE OF SINK HOLES?</th>
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<tr>
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</table>

Settlement Plates and side-slope monitoring points to be inspected for integrity. Integrity intact? □ Yes □ No

During Year 1, they will be surveyed quarterly, and annually thereafter

MAINTENANCE REQUIRED/COMMENTS/PHOTO LOG

________________________________________________________________________

________________________________________________________________________

* AREA OF SEEP IS OUTSIDE OF LANDFILL COVER AND EAST OF THE COVER ANCHOR TRENCH
## SLOPE STABILITY

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<th>REGION</th>
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MAINTENANCE REQUIRED/COMMENTS/PHOTO LOG

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<td>AREA WHERE EAST SLOPE CENTRAL MEETS EAST SLOPE SOUTH</td>
<td>☐ Yes ☐ No</td>
<td>☐ Yes ☐ No</td>
<td>☐ Yes ☐ No</td>
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<tr>
<td>VENT CAPS IN PLACE &amp; SECURE?</td>
<td>☐ Yes ☐ No</td>
<td>☐ Yes ☐ No</td>
<td>☐ Yes ☐ No</td>
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<td>STANDPIPES IN GOOD CONDITION?</td>
<td>☐ Yes ☐ No</td>
<td>☐ Yes ☐ No</td>
<td>☐ Yes ☐ No</td>
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<tr>
<td>BIRDS OR INSECTS IN VENT CAPS?</td>
<td>☐ Yes ☐ No</td>
<td>☐ Yes ☐ No</td>
<td>☐ Yes ☐ No</td>
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MAINTENANCE REQUIRED/COMMENTS/PHOTO LOG

---

PAGE 3 OF 9
## SEEP TREATMENT SYSTEM

<table>
<thead>
<tr>
<th>REGION</th>
<th>EVIDENCE OF PLUGGING, OBSTRUCTIONS, OR EXCESS DEBRIS?</th>
<th>EVIDENCE OF CRACKS OR DETERIORATION?</th>
<th>OTHER (DESCRIBE BELOW)</th>
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<tbody>
<tr>
<td>GWIS INLET PIPES</td>
<td>□ Yes □ No</td>
<td>□ Yes □ No</td>
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<td>STRIP DRAIN INLET PIPE</td>
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<td>□ Yes □ No</td>
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<tr>
<td>NORTH MANHOLE OUTLET PIPE</td>
<td>□ Yes □ No</td>
<td>□ Yes □ No</td>
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<tr>
<td>SOUTH MANHOLE OUTLET PIPE</td>
<td>□ Yes □ No</td>
<td>□ Yes □ No</td>
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<tr>
<td>TREATMENT UNIT</td>
<td>□ Yes □ No</td>
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</tr>
<tr>
<td>TREATMENT UNIT OUTLET PIPE</td>
<td>□ Yes □ No</td>
<td>□ Yes □ No</td>
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<tr>
<td>NORTH MANHOLE</td>
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<td>□ Yes □ No</td>
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<tr>
<td>SOUTH MANHOLE</td>
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<td>□ Yes □ No</td>
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<tr>
<td>TREATMENT UNIT GRATING</td>
<td>NA</td>
<td>□ Yes □ No</td>
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MAINTENANCE REQUIRED/COMMENTS/PHOTO LOG

__________________________________________________________________________

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PAGE 4 OF 9
## STORMWATER MANAGEMENT STRUCTURES

### CHANNELS/LINING

<table>
<thead>
<tr>
<th></th>
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<td>□ Yes □ No</td>
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<tr>
<td>VEGETATION-LINED PERIMETER CHANNEL – NORTH</td>
<td>□ Yes □ No</td>
<td>□ Yes □ No</td>
<td>□ Yes □ No</td>
<td>□ Yes □ No</td>
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<td>□ Yes □ No</td>
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<tr>
<td>VEGETATION-LINED PERIMETER CHANNEL – SOUTH</td>
<td>□ Yes □ No</td>
<td>□ Yes □ No</td>
<td>□ Yes □ No</td>
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<td>RIPRAP-LINED PERIMETER CHANNEL</td>
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<td>□ Yes □ No</td>
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<td>C350-LINED EAST FACE</td>
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<td>□ Yes □ No</td>
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<tr>
<td>EAST FACE RIPRAP CHANNEL – NORTH</td>
<td>□ Yes □ No</td>
<td>□ Yes □ No</td>
<td>□ Yes □ No</td>
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<tr>
<td>EAST FACE RIPRAP CHANNEL – SOUTH</td>
<td>□ Yes □ No</td>
<td>□ Yes □ No</td>
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OTHER DEFICIENCIES?

__________________________________________________________

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MAINTENANCE REQUIRED/COMMENTS/PHOTO LOG

__________________________________________________________

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### OUTFALLS

Check each structure for excessive erosion and sediment depth. If sediment depth is compromising the design characteristics, remove sediment.

<table>
<thead>
<tr>
<th>STRUCTURE</th>
<th>CONDITION/SEDIMENT DEPTH</th>
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</thead>
<tbody>
<tr>
<td>DIVERSION BERM OUTFALL – NORTH</td>
<td></td>
</tr>
<tr>
<td>DIVERSION BERM OUTFALL – SOUTH</td>
<td></td>
</tr>
<tr>
<td>CULVERT 1 OUTFALL</td>
<td></td>
</tr>
<tr>
<td>CULVERT 2 OUTFALL</td>
<td></td>
</tr>
<tr>
<td>SOUTHWEST CULVERT OUTFALL</td>
<td></td>
</tr>
</tbody>
</table>

### CULVERTS

Check each structure for blockage, surrounding conditions, breaching, sediment build-up, and inlet/outlet conditions.

<table>
<thead>
<tr>
<th>STRUCTURE</th>
<th>CONDITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>CULVERT 1</td>
<td></td>
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<tr>
<td>CULVERT 2</td>
<td></td>
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<tr>
<td>SOUTHWEST CULVERT</td>
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**MAINTENANCE REQUIRED/PHOTO LOG**
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<th>AREA</th>
<th>ADVERSELY AFFECTING PLF?</th>
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<td>RUN-ON INTO PERIMETER CHANNEL – NORTH</td>
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<td>COMMENT:</td>
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<td>RUN-ON INTO PERIMETER CHANNEL – SOUTH</td>
<td>☐ Yes ☐ No</td>
<td>COMMENT:</td>
</tr>
<tr>
<td>NATURAL DRAINAGE FED BY CULVERT 1</td>
<td>☐ Yes ☐ No</td>
<td>COMMENT:</td>
</tr>
<tr>
<td>NATURAL DRAINAGE FED BY NORTHEAST PERIMETER CHANNEL</td>
<td>☐ Yes ☐ No</td>
<td>COMMENT:</td>
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<tr>
<td>NATURAL DRAINAGE FED BY RIPRAP</td>
<td>☐ Yes ☐ No</td>
<td>COMMENT:</td>
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</tbody>
</table>

MAINTENANCE REQUIRED/PHOTO LOG

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| ITEM                                                                 |  |  | COMMENT: |
|----------------------------------------------------------------------|  |  |          |
| EVIDENCE OF EXCAVATION(S) OF COVER AND IMMEDIATE VICINITY OF COVER? | ☐ Yes ☐ No |  |          |
| EVIDENCE OF CONSTRUCTION OF ROADS OR TRAILS ON COVER OR BUILDINGS?  | ☐ Yes ☐ No |  |          |
| EVIDENCE OF UNAUTHORIZED ENTRY?                                      | ☐ Yes ☐ No |  |          |
| EVIDENCE OF DRILLING OF WELLS OR USE OF GROUNDWATER?                | ☐ Yes ☐ No |  |          |
| DISRUPTION OR DAMAGE OF SEEP TREATMENT SYSTEM?                      | ☐ Yes ☐ No |  |          |
| DAMAGE OR REMOVAL OF ANY SIGNAGE OR GROUNDWATER MONITORING WELLS?   | ☐ Yes ☐ No |  |          |

OTHER DEFICIENCIES/PHOTO LOG

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<th>DATE COMPLETED</th>
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INSPECTOR SIGNATURE: ____________________________ DATE: __________________________

REVIEWER SIGNATURE: ____________________________ DATE: __________________________

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Appendix B

Groundwater Well Boring Logs/Construction Summaries
STATE PLANE COORDINATES: NORTH: 7765803, EAST: 5637717
TOTAL DEPTH: 25 ft, GROUND ELEVATION: 471 ft
PROJECT NUMBER: 70193
LOG OF DRILLING HOMES:

- SAMPLE 1: Sandy gravel with some silt. Light brown (7.5 YR 5/4). Course to fine gravel (5 ac 2/2), nearly 1/4" diam, very fine to course sand. Hemorrhoidal in clayey silt matrix. Well graded. Subangular to subrounded gravel and sand composed mostly of quartzite, quartz, and granite. Bedded. Densometric test. Not bedded, slightly moist (SG 2.01). Sand, 54% sand, 12% silt, and 34% clay.

- SAMPLE 2: Gravelly sand with some silt and clay. reddish brown (2.5 Y) 3/4" fine to medium sand (7.5 YR 2/1), very fine to course sand. Hemorrhoidal, in a clayey matrix. Well graded. Angular to subangular gravel and sand composed of granite, quartzite, quartz, and granite. Bedded, strongly weathered and of thin form to puddle. Not bedded, moist (SG 2.3) gravel, 38% sand, 40% silt, and 22% clay.

- SAMPLE 3: Sandy gravel. Light olive brown (2.5 Y 5/2), fine to coarse gravel (7.5 YR 2/1), angular to subrounded. Very fine to course sand (5 ac 2/2), angular to subrounded. Subangular to subrounded gravel and sand mainly composed of rock fragments, weathered granite, schist, and quartzite. Not bedded, slightly moist (SG 2.06) gravel, 65% sand, 25% silt, 10% clay.

- SAMPLE 4: Same as above.

- SAMPLE 5: Gravelly sand on the same slope. Light olive brown (2.5 Y 5/6) to 2.5 Y 4/4). Course to fine gravel (7.5 YR 2/1), nearly 1/2" diam, and very fine to course (hemorrhoidal) sand, on clayey silt matrix. Well graded. Angular to subangular gravel and sand composed of quartzite, granite, and granite. Bedded. No bedded, moist (SG 2.06) gravel, 65% sand, 25% silt, 10% clay.

- SAMPLE 6: Same as above.

- SAMPLE 7: Clayey Sand with some silt and gravel. Light yellowish brown (2.5 Y 6/4). Course to fine gravel (7.5 YR 2/1), and very fine to course sand (hemorrhoidal) in clayey silt matrix. Well graded. Angular to subangular sand and gravel composed of quartzite, granite, and granite. Bedded. Not bedded, moist (SG 2.06) gravel, 35% sand, 28% clay, and 37% silt.

- SAMPLE 8: Same as above.
<table>
<thead>
<tr>
<th>Sample Size</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>5 cm x 5 cm</td>
<td>Clayey Siltstone. Light olive brown 2.5 Y 5/6. Gradually overlain with yellow 2.5 Y 6/4. Varied in porosity 32% - 45%. No cement, highly fissile, friable and clayey throughout. Internal bedding is not apparent. Beds of coarse, heavily damaged through filling, inhibited due to fresh weathering, weathered not friable as except where damaged, moist to wet. Beds stained bottom 0.5 ft. of outer stained bright olive yellow 7.5YR 3/3 - 7.5YR 4/4. Carbonates fragments present, especially from 30.0 - 30.5 ft. Red Silt and Red Clay.</td>
</tr>
<tr>
<td>5 cm x 5 cm</td>
<td>Silty Claystone. Dark grey-brown 2.5 Y 5/2, porosity 25% - 32%. No cement, high fissility. Clay content varies. Sub-horizontal bedding occurs in silty materials. Not fractured but damaged during drilling. Most 28% Silt and 32% clay.</td>
</tr>
<tr>
<td>5 cm x 5 cm</td>
<td>Silt Claystone. Dark grey-brown 2.5 Y 5/2, porosity 18% - 25%. No cement, slightly to moderately fissile, graded and interbedded with sandstone, not bedded, non-fractured but highly damaged during drilling. Most 18% Silt and 32% sand.</td>
</tr>
<tr>
<td>5 cm x 5 cm</td>
<td>Clayey Siltstone. Light grey 10 Y 5/1 to olive yellow 7.5 Y 5/6. Porosity 25% - 32%. No cement, slightly to moderately fissile, arrested with claystone and silty sandstone. Not bedded but fractured. Most 32% clay and 28% sand.</td>
</tr>
<tr>
<td>5 cm x 5 cm</td>
<td>Siltstone. Light grey 5 Y 5/1 to grey 7.5 Y 7/4. Porosity 18% - 25%. No cement, moderately fissile, graded and interbedded with sandstone, not bedded, non-fractured. Most 28% Silt and 18% sand.</td>
</tr>
<tr>
<td>5 cm x 5 cm</td>
<td>Siltstone. Light grey 5 Y 5/1 to grey 7.5 Y 7/4. Porosity 18% - 25%. No cement, moderately fissile, graded and interbedded with sandstone, not bedded, non-fractured. Most 28% Silt and 18% sand.</td>
</tr>
<tr>
<td>Sample</td>
<td>Grain Size</td>
</tr>
<tr>
<td>--------</td>
<td>------------</td>
</tr>
<tr>
<td>1</td>
<td>Fine sand</td>
</tr>
<tr>
<td>2</td>
<td>Silty sand</td>
</tr>
<tr>
<td>3</td>
<td>Clayey sand</td>
</tr>
<tr>
<td>4</td>
<td>Silty sand</td>
</tr>
</tbody>
</table>

**No core recovery:**
- 10.5±10.5
- 6±6

**Dielectric Constant:**
- 10.5±10.5
- 6±6

**Dielectric Loss:**
- 10.5±10.5
- 6±6
MONITORING WELL INSTALLATION REPORT: Form PRO.118

MONITORING WELL INSTALLATION
INSTALLATION

PRO-1059-WELL-118
Revision 0
Page 37

LOCATION CODE: JOX05
PROJECT NAME: MONITORING WELL INSTALLATION
PROGRAM: PRESENT LANDYARD
SCREENED FORMATION: Water Drilling Contractor: LUCAS
DATE DRILLED: 9/14/05
DATE COMPLETED: 9/14/05
TOTAL DEPTH: 28.0'
COMPLETED DEPTH: 25.0'
ESTIMATED DEPTH TO R.B.: 5.5'
LOGGING GEOLOGIST: C. WERSH
BOREHOLE DIAMETER: 3.5" QUANTITY OF FLUIDS LOST DURING DRILLING: N/A
INITIAL WATER LEVEL (FT, DATE): 9/14/05
COMPLETED WATER LEVEL (FT, DATE): 9/14/05
DIAMETER & TYPE OF INSTALLATION (WELL, REZONER, REZONER, POINT/ETC.): 2.0" PVC WELL
TYPE OF PROTECTION (FLUSH-MOUNT VS. ABOVE GROUND, ASEOIC, ETC.): FLUSH-MOUNT STRESS PROTECTION

ALL MEASUREMENTS WILL BE MADE IN FEET FROM GROUND SURFACE

* DENOTES ITEMS THAT MAY NOT BE APPLICABLE, DEPENDING ON BORING METHOD, WELL PROTECTION & PURPOSE

---

*PROTECTIVE CASING TOP* (STICKER OR FLUSH-MOUNT): 3.1'
*SECONDARY CASING TOP: N/A BOTTOM: N/A TYPE: N/A
*SURFACE CASING TOP: 2.9' ID (IN) 1.93 TYPE: N/A
*SURFACE SEAL TOP: 2.5' ID (IN) 1.93 TYPE: CEMENT
*PROTECTIVE CASING BOTTOM, ID (IN), TYPE: 1.93 SQUARE STEEL
*WELL PAD DIMENSIONS, TYPE: 3' X 3' SQUARE
*ADDS CASING FILL TOP: N/A BOTTOM: N/A TYPE: N/A
*STICKER ISOLATION CASING TOP: N/A BOTTOM: N/A TYPE: N/A
*STICKER ISOLATION ID (IN) N/A TYPE: N/A
*OTHER (E.G., ASEOIC) CASING TOP: N/A BOTTOM: N/A TYPE: N/A
*OTHER CASING ID (IN) N/A TYPE, PURPOSE: N/A
*CENTRALIZER(S) ID (IN) NUMBER USED: N/A TYPE: N/A
*CENTRALIZER(S) DEPTH(S) N/A
*GROUT TOP: N/A MEASURED DENSITY (LB/BLD): N/A TYPE: N/A
*GRANULAR BENTONITE TOP: N/A TYPE: N/A
*BENTONITE SEAL OR GRANULAR BENTONITE BOTTOM (+ FILTER PACK TOP) 0.2" TYPE: N/A BENTONITE PELLETS 0.2" FILTER PACK 0.2" TYPE: N/A BENTONITE PELLETS
*FILTER PACK TYPE: N/A SILT FREE SAND BRAND: N/A
*SURTACE CASING BOTTOM, ID (IN) SCREEN TOP: 4.6' TYPE: SCH. 40 PVC
*SCREEN ID (IN) 4.0" SILT SLAT SIZE (IN) 0.01 TYPE: SCH. 40 PVC
*SURTACE BOTTOM (+ SUMP TOP) 24.65' SUMP TYPE: THERMAL END CAP SCH. 40 PVC
*FILTER PACK BOTTOM (+ TACKPACK) 25.0' TACKPACK TYPE: N/A BENTONITE PELLETS SCH. 40 PVC
*SUMP BOTTOM (+ WELL COMPLETED DEPTH) 25.0' PILOT HOLE DIAMETER: 6.0" TYPE: SCH. 40 PVC
*TOTAL BOREHOLE DEPTH (+ PILOT HOLE AND BACKPACK BOTTOM) 28.0'

*REMARKS:* Routine well installation on 9/14/05. Top 2.9' of bentonite seal and protective casing installed on 9/14/05. Beaded well seal installed on 9/14/05. Completed by: F. J. 9/14/05

CHECKED BY: J. B. 9/14/05

SILTSTONE: Clayey Siltstone with trace to some sand in pockets (rip-up?), brownish yellow (10YR6/6) with some light gray (10YR7/1) mottling. Weak to moderate pervasive iron oxidation with some unoxidized mottling. Massive texture. Weak to moderately friable, trace roots. Slightly moist. Trace to some, very fine grained, sand.

CLAYSTONE: Silty Claystone, light brownish gray (10YR6/2). Decreased iron oxidation to trace. Strongly friable, crumbly, trace roots, slightly moist.

No recovery.

SILTSTONE: Clayey Siltstone, light yellowish brown (10YR6/4) to light brownish gray (10YR6/2). Weak pervasive iron oxidation from 2.0' to 2.1'. Massive texture, slightly moist. Increasing clay at base of interval. Moderately friable.

CLAYSTONE: Claystone with some silt, light brownish gray (10YR6/2). Trace weak iron oxidation, predominately along bedding planes (subhorizontal) and fracture surfaces. Trace white caliche stringers and blebs. Massive texture, moderately friable, slightly moist.

No recovery.

CLAYSTONE: Claystone with some silt, pale brown (10YR6/3) with some gray (10YR5/1) mottling. Weak pervasive iron oxidation from...
<table>
<thead>
<tr>
<th>Depth (Ft)</th>
<th>Lithology</th>
<th>Logs</th>
<th>Well or Piezometer Construction and Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.0'</td>
<td>CLAYSTONE: Claystone with some silt, gray (10YR5/1) to grayish brown (10YR5/2). Weak iron oxidation along bedding planes. Massive texture, weak to moderately friable, slightly moist.</td>
<td></td>
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<tr>
<td>6.0'</td>
<td>No recovery.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.0'</td>
<td>CLAYSTONE: Claystone, gray (10YR6/1), predominately unoxidized. Faint undulating bedding planes visible. Trace black organic stringers throughout. Weak to moderately friable. Slightly moist.</td>
<td></td>
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</tr>
<tr>
<td>8.0'</td>
<td>No recovery.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.0'</td>
<td>CLAYSTONE: Claystone, gray (10YR6/1), predominately unoxidized. Faint undulating bedding planes visible. Trace black organic stringers throughout. Weak to moderately friable, slightly moist.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.0'</td>
<td>No recovery.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.0'</td>
<td>CLAYSTONE: Claystone, gray (10YR6/1), predominately unoxidized. Faint undulating bedding planes visible. Trace black organic stringers throughout. Weak to moderately friable, slightly moist. Trace iron oxidation stringers from 10.3' - 10.5'.</td>
<td></td>
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</tr>
<tr>
<td>12.0'</td>
<td>CLAYSTONE: Claystone, brown (10YR5/3), slight color change. Faint laminations (bedding planes) visible with trace to some black organic stringers on planes. Trace to some iron oxidation stringers along bedding planes and fracture surfaces. Weak to moderately friable, slightly moist.</td>
<td></td>
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</tr>
<tr>
<td>13.0'</td>
<td>CLAYSTONE: Claystone, gray (10YR5/1 to 10YR6/1). Weak iron oxidation along bedding planes at 11.6' and from 12.2' to 13.0'. Fissile and moderately friable, slightly moist. Iron oxidation along fracture surfaces, especially from 11.6' to 11.8' and 12.2' to 13.0'.</td>
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</table>

**Note:**
- **Screen, Sch 40-PVC, 2 in. ID., 0.010 in. slots**
- **Elev (Ft)**
- **Depth (Ft)**
- **Lithology**
- **Logs**
- **Well or Piezometer Construction and Materials**
SILTSTONE: Clayey Siltstone to silty claystone, pale brown (10YR6/3) to light brownish gray (10YR6/2). Weak iron oxidation on sub-horizontal bedding planes (approximately 4 to 6 iron-oxidized bedding planes per foot) and fracture surfaces. Trace black organic stringers. Notable iron oxidation coating 80 deg fracture from 18.9' to 19.2'. Color of iron oxidation is strong brown (7.5YR5/6). Iron oxidation on 20 deg fracture from 19.5' to 19.6'. Moisture decreasing to trace. Occasional iron oxidation-replaced organic debris fragments. Some intervals to silty claystone, but predominately clayey siltstone.

SILTSTONE: Clayey Siltstone to silty claystone, gray (10YR5/1). Notable color change. Decrease iron oxidation to trace as minor fracture coating. Massive texture, moderately friable. Increase moisture to slightly moist.
CLAYSTONE: Claystone with some silt, yellowish brown (10YR5/6) and gray (10YR5/1). Weak iron oxidation mottled throughout. Iron oxide coating ~80 deg fracture at 22.9’. Moderate pervasive iron oxidation from 23.7’ to 23.8’. Moderately friable from 23.1’ to 24.0’, corresponding with increased moisture zone. Slightly moist from 22.7’ to 23.1’, moist from 23.1’ to 24.0’.

CLAYSTONE: Claystone with trace silt, gray (10YR5/1) to light brownish gray (10YR6/2). Decreased iron oxidation to trace along bedding planes and fracture surfaces. Massive textured, moderately friable. Clay-rich (no silt) from 24.0’ to 24.2’ and slightly darker color (dark gray: 10YR4/1). Moist, decreasing to very slightly moist from 24.2’ to 26.0’. Fissile between 24.5’ and 25.7’. Trace black organic material.

CLAYSTONE: Claystone, grayish brown (10YR5/2). Massive texture, weakly friable. Iron oxidation along internal fractures at 26.3’ and 27.0’. Very slightly moist.

CLAYSTONE: Claystone, dark gray (10YR4/1). Notable color change. Fissile and friable, trace moisture.

No recovery.
<table>
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<tr>
<th>Elev (Ft)</th>
<th>Well or Piezometer Construction and Materials</th>
<th>Depth (Ft)</th>
<th>Unified Soils Classification or Rock Type</th>
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Elev (Ft): 5929, 5928, 5927, 5926, 5925, 5924, 5923, 5922

GP: Gravel (fill), pea gravel (1/4" diameter, subrounded to subangular), composed of granite and quartzite. Poorly graded, dry.

CL: Clay with trace sand and gravel, grayish brown (10YR5/2) to gray (10YR5/1). Re-worked claystone. Thin black organic stringers common, moist.

SC/CL: Gravely, Sandy Clay to clayey, gravely sand, strong brown (7.5YR5/6). Imported fill (Qalrf). 60% clay, medium plasticity, 30% sand (medium grained to coarse grained, subrounded to subangular), 10% gravel (1/4" diameter, subrounded to subangular), very moist.

No recovery.

SC/CL: Gravely, Sandy Clay to clayey, gravely sand, strong brown (7.5YR4/6). Imported fill (Qalrf). Very similar to interval from 0.4' to 0.8'. 65% clay, medium plasticity, 20 - 25% sand (medium grained to coarse grained, subangular to subrounded), 10 - 15% gravel (1/8" - 1/4" diameter, subrounded, predominately granite and quartzite), saturated, but not flowing.

No recovery.

SC/CL: Gravely, Sandy Clay to clayey, gravely sand, strong brown (7.5YR4/6). Imported fill (Qalrf). Very similar to interval from 2.0' to
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<td>2.9'</td>
<td>60% clay, medium plasticity, 25% sand (medium grained to coarse grained, subangular to subrounded), 15% gravel (1/4&quot; - 1/2&quot; diameter, subangular, composed of granite, quartzite, and schist), saturated.</td>
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<td>3.0'</td>
<td>GP: Gravel with trace sandy clay, strong brown (7.5YR4/6) clay. Appears to be pea-gravel (possible slough). Gravel (1/4&quot; - 3/4&quot; diameter, subrounded to subangular), poorly graded. Moisture decreases from saturated to moist.</td>
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<td>GC/CL: Gravelly, Sandy Clay and shattered quartzite cobbles mixture. 45% gravelly, sandy clay, light brown (7.5YR6/4) with 55% shattered cobbles (1/2&quot; to 1-1/2&quot; diameter, angular), moist.</td>
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<td>5.0'</td>
<td>GC/CL: Sandy Clay/Gravel mixture, strong brown (7.5YR5/6) clay. 60 - 70% gravel and cobbles, 20 - 30% clay (medium plasticity), 5 - 10% sand (coarse grained, subangular). Shattered quartzite cobbles from 8.4' to 8.6' (2&quot; diameter) and from 9.2' to 9.5' (2&quot; - 3&quot; diameter). Moist.</td>
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<tr>
<td>6.0'</td>
<td>GC/CL: Sandy Clay/Gravel mixture, strong brown (7.5YR5/6). 50% clay (medium plasticity), 30% gravel (1/8&quot; - 3/4&quot; diameter, subangular), ~20% sand (coarse grained), moist. Quartzite cobbles (1&quot; - 2&quot; diameter) at 11.2' and 11.7'.</td>
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<td>14</td>
<td>CLAYSTONE: TOP OF BEDROCK. Silty Claystone (weathered bedrock), grayish brown (10YR5/2) with some yellowish brown (10YR5/6) mottling. Massive texture, firm and cohesive. Weak to moderately friable. Weak iron oxidation mottled throughout. Trace black organic material. Moist. Bedrock contact estimated at 12.5’. Estimated by drilling conditions and changes in penetration. No recovery.</td>
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<td>15</td>
<td>CLAYSTONE: Silty Claystone, iron oxidized, yellowish brown (10YR5/4), grading to gray (10YR5/1) at base of interval. Moderate pervasive iron oxidation from 16.0’ to 16.3’, then decreasing at base. Massive texture, weak to moderately friable. Saturated from 16.0’ to 16.2’, decreasing to moist from 16.2’ to 16.3’.</td>
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<td>17</td>
<td>CLAYSTONE: Claystone with silt, grayish brown (10YR5/2) with some yellowish brown (10YR5/6) mottling. Decreasing overall iron oxidation to weak, mottled. Firm, weakly friable, moist. Black organic stringers common. Faint bedding visible. No recovery.</td>
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<tr>
<td>19</td>
<td>CLAYSTONE: Claystone, light brownish gray (10YR6/2) to gray (10YR6/1). Massive texture, firm/dense. Trace overall iron oxidation. Weak iron oxidation from 21.7’ to 22.0’. Trace black organic stringers. Moisture decreases to slightly moist. No recovery.</td>
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<td>CLAYSTONE: Claystone, gray (10YR5/1) to dark gray (10YR4/1).</td>
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**LOG OF BORING NUMBER:**

73105

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CL: Clay with silt, trace gravel, and trace sand, brown (7.5YR4/3). Medium plasticity and firm. Trace to 3% disseminated caliche. Trace roots. Schist cobble (3/4" diameter, subangular) at 0.3'. Slightly moist to moist.

No recovery.

CL: Clay with silt, trace gravel, and trace sand, brown (7.5YR4/4 to 7.5YR4/2). Medium plasticity and firm. Same as interval from 0.0' to 1.5'. Slightly moist.

GC/CL: Sandy Gravel/Clay mixture, brown (7.5YR4/4). ~75% sandy gravel and ~25% clay. Gravel (1/4" - 1" diameter, subangular to subrounded, predominately quartzite). Sand (coarse grained, subangular). Weak iron oxidation disseminated throughout clay and as coating on 1/4" gravel clasts. Trace disseminated caliche. 2" diameter quartzite cobble at 2.4'. Shattered quartzite cobble from 3.0' to 3.2'. Poor recovery due to cobbles. Slightly moist.

No recovery.

CL: Sandy, Gravelly Clay, brown (7.5YR4/4). 5 - 10% gravel (1/4" - 1/2" diameter, subrounded to subangular, predominately quartzite). 5 - 7% sand (coarse grained, subangular). Clay has medium...
plasticity. Moisture increases from slightly moist to moist.

CLAYSTONE: TOP OF BEDROCK. Claystone, grayish brown (10YR5/2) to gray (10YR5/1). Firm/dense. Black organic stringers common on undulating bedding planes. 1/4" caliche lens at base of interval. Sharp basal contact, color change. Moist.

CLAYSTONE: Claystone, iron-oxidized/weathered, yellowish brown (10YR4/6). Moderate to strong pervasive iron oxidation. Moderately friable. 1/4" caliche lens at top of interval and as blebs throughout. Moist.


CLAYSTONE: Claystone, iron oxidized/weathered, yellowish brown (10YR5/6 to 10YR5/4). Weak pervasive iron oxidation. Weak to moderately friable. Trace white caliche stringers. Thin caliche lens at 6.8'. Slightly moist.

CLAYSTONE: Claystone, grayish brown (10YR5/2). Decreased iron oxidation to trace as stringers. Moderately friable. Massive texture. Slightly moist.


CLAYSTONE: Claystone, gray (10YR5/1). Decreased iron oxidation to trace. Massive texture, firm yet weakly friable. Trace black organic stringers throughout. Black organic lens (1/8" thick) at 11.2'. Trace iron oxidation stringers from 11.2' to 12.0'. Moisture decreases to very slightly moist. Hard, cryptocrystalline calcareous clast (~3/8") at 9.9'.

CLAYSTONE: Claystone, gray (10YR6/1). Massively texture, dense/firm, weakly friable. Trace to some iron oxidation. Abundant black organic material from 12.8' to 13.0'. Very slightly moist.

CLAYSTONE: Claystone with silt, gray (10YR6/1). Massive texture as above interval from 12.0' to 13.3'. Un-oxidized bedrock. Trace black organic stringers. Firm/dense. Thin caliche lens along
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CLAYSTONE: Silty Claystone, gray (10YR6/1). Weak iron oxidation along horizontal bedding planes. Predominately massive texture, firm/dense. Trace black organic stringers and blebs. Weak to moderate pervasive iron oxidation from 17.3' to 17.7'. Near-vertical fracture (~80 deg) from 18.9' to 19.5' with iron oxide coating. 1/4" horizontal lense of carbonate (druse) at 19.7'. Interval slightly moist. Occasional sandy intervals at 17.1', and from 17.6' to 17.7'. Claystone interval from 18.8' to 19.1'. Rip-up clasts, iron oxide-replaced organic debris present. Sand is very fine grained to fine grained.

CLAYSTONE: Claystone, gray (10YR5/2). Weak iron oxidation as stringers and along bedding planes. Black organic material along bedding planes. Possible manganese oxide associated with iron oxidation along bedding and fracture surfaces. Dense/firm. Slightly moist.

CLAYSTONE: Claystone, gray (10YR6/1 to 10YR5/1). Trace weak iron oxidation as stringers and along bedding/fracture surfaces. Iron oxidation as fracture (~50 deg) coating at 22.6'. Interval weak to moderately friable. Massive texture. Slightly moist.

Internal bedding plane at 13.7'. Very slightly moist.
CLAYSTONE: Claystone, dark gray (10YR4/1). Firm/dense. Trace iron oxidation along bedding planes/fracture surfaces. Bedding planes are faintly visible. Trace black organic material along bedding and as clasts (to 1/2" diameter). Slightly moist from 23.1' to 24.2', decreases to trace moisture from 24.2' to 30.4'. Weak pervasive iron oxidation from 29.1' to 29.3'.

CLAYSTONE: Claystone, un- (iron) oxidized/un-weathered, very dark gray (10YR3/1). Distinct color change. Firm and dense. Trace iron oxidation stringers from 31.8' to 31.9'. Sub-horizontal, undulating bedding faintly visible. Black organic material common along bedding planes and as clasts (to 1/2" diameter). Trace moisture.