DOE–LM/1545–2007

Rocky Flats Site

Original Landfill Geotechnical Investigation/ Engineering Work Plan

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Work Performed Under DOE Contract No. DE–AC01–02GJ79491
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Original Landfill – Geotechnical Investigation/Engineering Work Plan

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

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Attachment 1 Test Pit and Boring Rationale

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1.0 General

1.1 Introduction

This work plan presents geotechnical engineering investigative services for geotechnical analysis of localized areas of slope instability at the Original Landfill (OLF) located at the U.S. Department of Energy (DOE) Rocky Flats Site.

1.2 Background

DOE is managing the Legacy Management (LM) Program to provide operations and maintenance at the Rocky Flats Site. S.M. Stoller (Stoller) is the Technical Assistance Contractor for the DOE Office of Legacy Management. The Site is maintained by Stoller's office in Westminster, Colorado.

The OLF was used between 1952 and 1968. Accurate and verifiable records of the wastes placed in the landfill are not available. However, approximately 74,000 cubic yards of sanitary waste and construction debris were disposed in the OLF. These types of wastes likely included relatively small quantities of organics, paint and paint thinner, oil, pesticides, and cleaners. Commonly used organics from 1952 to 1968 may have included trichloroethene (TCE), carbon tetrachloride, tetrachloroethene (PCE), petroleum distillates, 1,1,1-trichloroethane, dichloromethane, and benzene. In the 1960s, the landfill may have received polychlorinated biphenyl (PCB) wastes such as carbonless copy paper, transformer and vacuum pump cleanup paper and rags, small capacitors, and fluorescent light bulbs. Metals such as beryllium, lead, and chromium may also have been placed in the landfill. There is no information indicating that the OLF was used for routine disposal of radioactive material or other hazardous substance waste streams. However, some waste contaminated with radioactive material, most notably wastes from buildings where depleted uranium (DU) operations were conducted, were disposed in the OLF. In addition, in 1965, 60 kilograms (kg) of DU were placed in the landfill after the DU, which was left on a pallet, reportedly ignited on a flatbed truck. The DU was probably covered with soil to extinguish the fire. Efforts were later made to retrieve the DU, but only 40 kg were recovered. Further removal of DU in contaminated surface soil was completed in August 2004 leaving surface soil activities below the action levels.

A raw water treatment plant filter backwash pond was also located within the OLF footprint, and probably abandoned without any backwash sludge removal by 1964. The effluent from the water treatment plant was discontinuous and probably made up of filter backwash, filter pre-wash, sludge blowdown, and other discharges from the water treatment process. It contained filterable solids removed from the raw water, as well as chemical flocculants (aluminum sulfate or lime) and residual chlorine.

During the OLF final closure construction activities, initial air monitoring confirmed that airborne radioactivity was not a hazard, and Level D personal protective equipment (PPE) was subsequently used during the work.

Under the Final Interim Measure/Interim Remedial Action (IM/IRA) for the OLF (DOE 2005a), a 2-foot-thick soil cover was selected to address closure of the OLF. To enhance the slope stability of the landfill, the existing slopes were regraded prior to placement of the soil cover, and

a buttress fill was installed at the toe of the landfill. The remedial action also included installation of perimeter drainage channels and cover diversion berms to control surface water run-on and runoff around the landfill cover. Construction was completed in September 2005, with the final regulatory walk-down occurring on September 12, 2005.

Settlement cracks, differential settlement, subsidence in drainage channels, and seeps that created saturated areas or direct surface flows on the cover or near the buttress toe have been found on inspections, which triggered the need for a geotechnical investigation to determine if these conditions are likely to influence the integrity of the existing cover and surface water drainage over the OLF. Previous geotechnical engineering studies, slope stability analyses, groundwater modeling, and geologic investigation have been conducted on the site, and the remedy decision documents provide the objectives and implementation requirements for the OLF remedy.

2.0 Work Plan

2.1 General Conditions

2.1.1 Roles and Responsibilities

Work under this subcontract is being performed in accordance with the existing Stoller / Geotechnical Subcontractor subcontract documents including the *Rocky Flats Site, Original Landfill-Geotechnical Investigation/Engineering Statement of Work* (SOW) dated August 3, 2007. Roles of responsibility for performing the Geotechnical Investigation are as follows:

Geotechnical Subcontractor	Stoller
Determine site investigation requirements.	Acquire drilling subcontractor.
Perform geophysical survey.	Acquire trenching subcontractor.
Provide geotechnical oversight by individual with Rad Worker II and Hazardous Waste 24 hr. training.	Provide Site Safety Supervisor oversight.
Acquire lab services.	Provide Rad-con support.
Perform the function of an OSHA Competent Person for test pits excavation.	Provide Rad-Worker II training.
Collect, manage, and transport geotechnical samples.	

Stoller will be responsible for coordinating and overseeing the activities of the drilling and excavating subcontractors as related to site work, access, and contractual issues. The geotechnical subcontractor will oversee the drilling, excavating, and sampling activities. All subcontractors will be responsible for performing their work in accordance with the applicable health and safety requirements (see Section 3).

2.1.2 Access, Erosion Control, and Ecological Controls

The *Erosion Control Plan for Rocky Flats Property Central Operable Unit*, July 2007 (ECP) applies to this work, and ECP Section 7.0, “Best Management Practices,” must be considered in conducting the field work.

Erosion controls have been installed on the OLF in accordance with the *Final Landfill Monitoring and Maintenance Plan Rocky Flats Environmental Technology Site Original Landfill* (M&M Plan), February 13, 2006, will be maintained under the direction of Stoller during the conduct of the work, and will be repaired/replaced as necessary after completion of the test pit excavation and bore hole work.

No vehicle or other excavation or drilling equipment traffic or stockpiling of excavation materials or other disturbance is allowed in Preble's meadow jumping mouse habitat areas outside of the disturbance footprint created in the construction of the cover (OLF disturbance footprint), which will be marked by Stoller prior to the field work. The ECP Section 7.0, "Best Management Practices" shall also be followed, as directed by Stoller. The ECP Section 7.1, "General Measures and Best Management Practices to Protect the Preble's Mouse," includes the measures and conditions to protect the Preble's mouse.

Vehicle and equipment access routes to and from the work area will be directed by Stoller. No disturbance of the wetlands along Woman Creek, which are outside of the OLF disturbance footprint, is allowed. In particular, test pits TTP-3 and TTP-9 and drill location TT-8 are of special concern, and the equipment access and set-up locations will be agreed upon with Stoller.

2.2 Work Plan

2.2.1 Project Goals

The goal of the investigation is to provide information to implement the M&M Plan, February 13, 2006, to maintain the cover to ensure the integrity of the cover is not compromised and that it continues to function as designed. This information will be used to develop any recommended changes to the M&M Plan and for design of any recommended repairs to the cover. Specifically, the goals will be:

- To review site geology and previous geologic, groundwater, geotechnical, and construction reports that have been completed and are available for the OLF and in the immediate area;
- To perform field and laboratory investigation to characterize the site from a geotechnical perspective, and identify and investigate potential causes of the slope instability and/or settlement that has occurred on the OLF;
- To investigate areas where seepage is occurring from the slope at the OLF; and
- To prepare a geotechnical engineering report summarizing the investigation, presenting the results of laboratory testing and geotechnical engineering analysis. The work will be performed by and/or under the direct supervision of a Professional Geologist and a Geotechnical Engineer registered in Colorado, and will present opinions, conclusions, and recommendations for mitigating the seepage, slope instability, and settlement issues that have been observed at specified locations within the OLF. The report will include recommendations for mitigative alternatives that can be implemented, depending on the results of the analysis and DOE/Stoller preferences. DOE/Stoller's review will consider alternatives and recommendations provided and make recommendations for implementation.

The investigation will provide information and recommendations regarding the following M&M Plan implementation areas:

- Section 3.2, “Subsidence/Consolidation”—The normal maintenance activity for differential settlement is to place additional soil and regrade the affected area to eliminate the potential for ponding and to correct the slope of the surface.
- Section 3.3, “Slope Stability”—Maintenance actions will be taken to address any potential slope failure that would likely compromise the remedy. Areas where maintenance actions have taken place will be closely monitored for further slope stability problems.
- Section 3.4, “Soil Cover”—Maintenance actions will include, but not be limited to, soil replacement and regrading the affected areas to maintain the minimum design soil cover thickness (minimum 2 foot cover over the extent of the waste) and removing and relocating eroded soils (if necessary). Maintain the designed channel configuration of at least 2 percent grade (average) and flow capacity as well as a berm height of 2 feet.
- Section 3.6, “Stormwater Management Structures”—Maintenance will be performed if the existing stormwater management structures are not adequately controlling surface water run-on and runoff.

2.2.2 OLF Areas to be Addressed

The areas to be specifically addressed are all in and adjacent to the OLF. Figure 1 shows the OLF, including topography, salient features of the area, and approximate locations of proposed borings and test pits. The areas are described below:

- West Side Settlement: An area of instability located in the west central part of the OLF. Recent scarps, bulging, and seepage have been observed and may coincide with deep-seated instability reported previously in a previous geotechnical investigation (Earth Tech 2004).
- East Side Settlement: Localized failures, subsidence, or potential slide features that transect slope berms and associated channels, such as a 300-foot-long curvilinear feature in the eastern portion of the OLF.
- West Channel Side Slope Failure: Steepened sideslopes in the western channel where localized failures have occurred. These may be coincident with historically unstable areas shown on pre-landfill aerial topography. This area may also coincide with an area that was over-excavated during previous construction.
- East Channel Side Slope Failure: Localized side slope failure on the east drainage channel.
- Seep Areas: Areas within the slope where seepage is either occurring or does occur intermittently, including Seep No. 8 at the base of the slope near the eastern terminus of the OLF buttress.

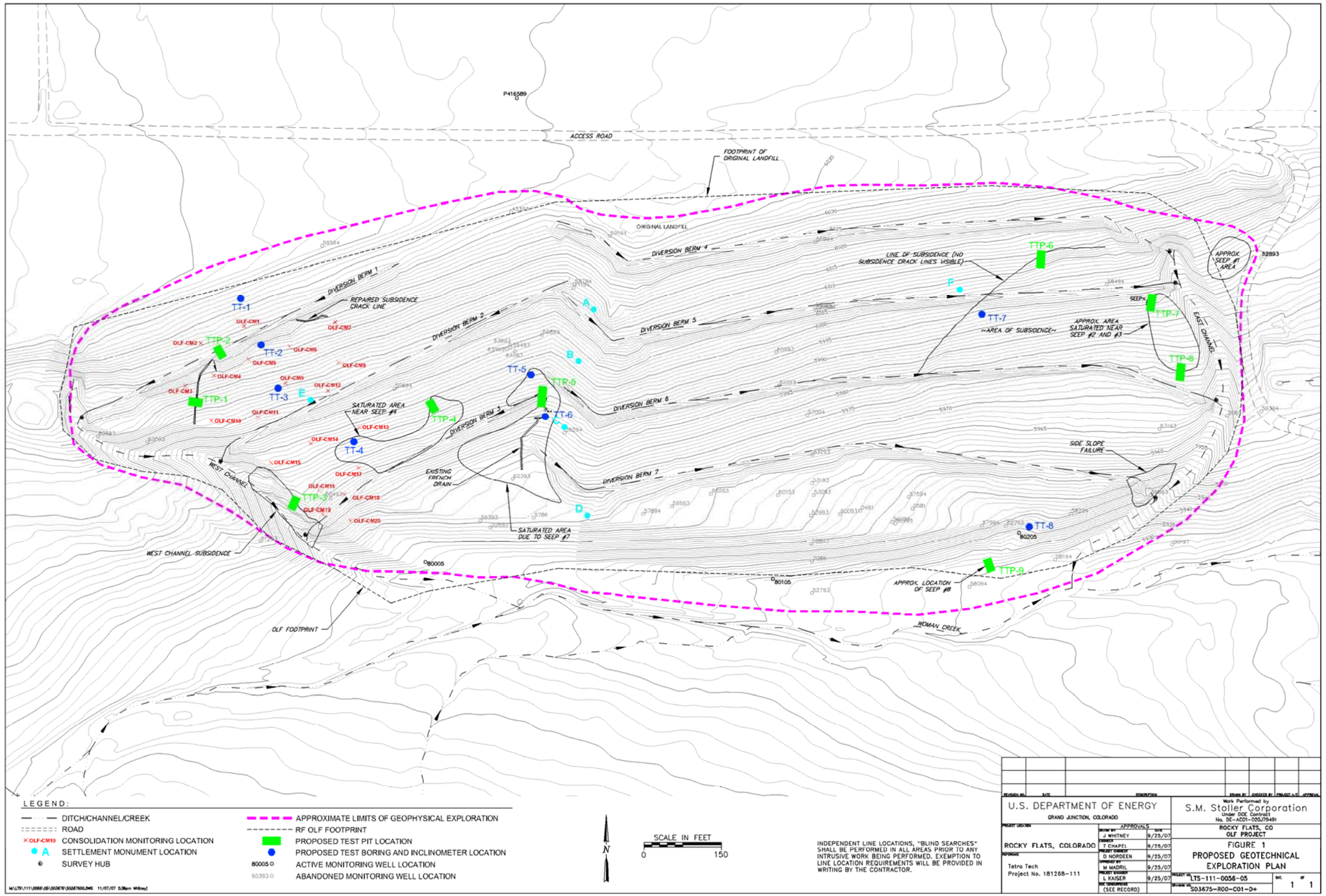

Figure 1. Proposed Geotechnical Exploration Plan

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2.2.3 Work Plan Specifics

Specifics of the work plan are as follows:

Task 1—Literature Search & Document Review

The Geotechnical Subcontractor will conduct a literature search and review of documents from previous work at the site. DOE and Stoller will provide documents contained in the Rocky Flats records requested for the review. Items to be reviewed will include: previous slope stability studies, historical aerial photographs, published and internal (DOE and Stoller) geologic mapping and cross sections, previous groundwater studies, survey data, laboratory test data, final construction reports approved by the Construction Quality Assurance Engineer, and geotechnical engineering reports. This work will be conducted prior to the commencement of field work, during the contractor procurement process.

Task 2—Field Work, Phase 1: Geophysical Survey

A geophysical survey will be completed to assist in determining the thickness and extent of waste present at the OLF. Based on the information available, it is anticipated that the seismic refraction and the high-resolution resistivity (HRR) will be the most appropriate geophysical methods for this investigation. It is assumed that the waste will be located within approximately 30 feet of the ground surface. The geometry (source, geophone, electrode spacing, and line lengths) of the seismic and HRR field investigations will be maximized to map the presence of the lenticular waste deposit. Preliminary results will be evaluated in the field to determine if other methods should be considered. The results of this survey will be summarized in a section of the geotechnical engineering report. The report will present data, interpretation, and significant findings. Findings will be used to guide drilling and potholing activities, described below. It is assumed that this field work will take approximately 2 days to complete. This work will be the first phase of the field work.

Task 3—Field Work, Phase 2: Test Pits and Bore Holes

After the literature review and geophysical survey, LM and Geotechnical Subcontractor/Stoller will make a joint site visit to identify/refine test pit and boring locations. Test pits and borings are described below. Attachment 1 provides excavation and boring specific detail and rationale.

Test Pits

Nine test pits are proposed and shown on the attached Figure 1. The main purposes of the test pits will be to investigate subsurface conditions as indicated below and shown on Figure 1:

- TTP-9: in the vicinity of Seep #8 and to the extent permitted by volume of seepage;
- TTP-7, TTP-8: in an area of what has become a large potential settlement area (west of the main dirt road into the valley bottom);
- TTP-6: along the head of a broad settlement area in the eastern portion of the OLF;

- TTP-1 and TTP-2: in areas of the western slump where multiple slide surfaces have been previously mapped;
- TTP-4 and TTP-5: in a central area where instability, wet soils have been observed, and a gravel subdrain for Seep #7 may exist;
- TTP-6: in the alignment of a previous buried outfall pipe; and
- TTP-3: where a potential slide surface intersects the western channel.

The test pits should provide important visual indications of the shear zone(s) and potential multiple slide planes suggested by previous mapping. The pits should be excavated prior to drilling exploratory borings because they may provide information that will suggest additional sample locations or changes to the boring locations or depths. Trenches are intended to penetrate through potential slide planes or previously mapped slide planes and into underlying soils and/or weathered bedrock. Depths are expected to be 5 to 10 feet below the existing ground surface based on preliminary review of previous geotechnical logs (see Earth Tech 2004 report). Bulk samples of materials encountered will be collected for classification testing, comparison with boring samples and core. Laboratory testing, including particle size tests, Atterberg limits, Proctor testing, and remolded shear strength tests are anticipated.

Pits will be excavated and sloped or benched to meet Occupational Safety and Health Administration (OSHA) compliance criteria for safe entry into excavations if entry becomes necessary. Water encountered in the excavation process will be handled in accordance with procedures established by Stoller. Waste may be encountered in these pits and strict adherence to health and safety protocols as established by Stoller will be an important consideration. Health and safety, sampling, and scanning procedures are addressed in more detail in Section 3.1. Based on results from literature search and documents review and field consultation with Stoller, locations and numbers of test pits may be adjusted in the field. The pit excavations will be observed and lithology logged by the Geotechnical Subcontractor's Senior Geologist with trained Stoller support personnel. The Geotechnical Subcontractor's Geotechnical Engineer will visit the site at the beginning of the excavations and periodically during the operations to observe conditions and monitor progress. It is anticipated that three site visits will be required.

Based on an assumed rate of excavation of two test pits per day, this task is expected to be completed in 5 to 10 working days (45 to 90 hours).

<u>Borings</u>

Eight geotechnical borings are proposed and shown on the attached Figure 1. The borings are needed to obtain comparatively high quality and undisturbed samples for laboratory testing, to determine depth to water at critical areas, and/or to look for deep-seated failure planes within the bedrock. Inclinometers will be installed in each of the borings to monitor current and future movement of the slide masses as well as to provide a method to document and measure future performance of the slopes. Holes will penetrate comparatively unweathered bedrock. Total depth of each hole is expected to be approximately 30 feet. Sonic drilling techniques would provide greatest sample and data integrity; if not available, hollow stem auger and a CME continuous sampler should be used to obtain samples of each boring. Samples should be collected continuously from surface to total depth. Water encountered in the borings or used in the drilling process will be handled in accordance with procedures established by Stoller. Waste may be

encountered in the borings and strict adherence to health and safety protocols as established by Stoller will be an important consideration. Sample screening and handling, and handling of investigation derived waste is described in Section 3.1.

An all terrain, tractor mounted drill rig will be required to negotiate the OLF terrain and off-road conditions in a safe manner. It is estimated that during a typical 10-hour work day, one 30-foot boring can be drilled and sampled, inclinometer casing can be installed and grouted, and an initial inclinometer reading can be taken from the previous day's inclinometer installation. Therefore, an estimate of 8 days will be required for the drilling phase.

Drilling and sampling operations and inclinometer casing installation will be observed, samples collected and lithology logged by the Geotechnical Subcontractor's Senior Geologist, a Rad Worker II and OSHA HAZWOPER trained individual. Field observations of water levels from test borings may suggest the installation of pneumatic piezometers on the outside the inclinometer casings would provide useful long-term information. The Geologist or Geotechnical Engineer will provide direction for piezometer installation based on field conditions during the investigation and subsequent consultation with Stoller/LM. The Geotechnical Engineer will visit the site at the beginning of the drilling and periodically during the operations to observe conditions and monitor the progress. It is anticipated that three site visits will be required.

Based on results from literature search and documents review and field consultation with Stoller, locations and number of borings may be adjusted in the field.

Task 4—Laboratory Testing and Analyses

Samples will be scanned by Stoller to meet health and safety requirements and to identify the need for special sample handling or procedures. Samples will be examined by the geotechnical engineer and geologist. Samples will be selected for classification, strength, and consolidation testing. Shear strength parameters (cohesion and friction angle) for in-situ slope stability conditions will be determined using direct shear and/or triaxial testing methods on the comparatively undisturbed samples. Samples will be correlated with bulk samples obtained from the test pits, and shear strength tests will be performed at differing moisture and density conditions to provide suitable parameters for the geotechnical analyses described below. Specifics regarding the type and number of tests anticipated are presented in the attached fee estimate.

Laboratory testing will be performed by Advanced Terra Testing (ATT), 833 Parfet Street, Lakewood, CO 80215 (303-232-8308). ATT is licensed by the Colorado Department of Public Health and Environment to handle, store, and test hazardous and radioactive materials (License No. Colo. 896-01, Amendment No. 4).

Triaxial testing is variable and dependant on sample characteristics. The testing schedule in this case could be further impacted by the presence of hazardous or radioactive materials. However, it is estimates the laboratory testing will be completed approximately 4 weeks after completion of the drilling.

Task 5—Slope Stability and Geotechnical Analyses

Slope stability analyses will be performed using Slope/W software by Geoslope International, Inc. Minimum factors of safety will be determined for the existing condition (based on existing survey data and slope configuration). Iterative analyses will be performed to evaluate safety factors under differing slope, water, and soil conditions. Comparative analyses will be performed using analytical methods employed in the previous, PC STABL analysis. Proposed design alternatives will be evaluated to determine factors of safety for mitigative measures proposed. Geotechnical engineering analyses will be conducted to identify critical factors on the site that are causing or contributing to the apparent slope instability and/or settlement. If large strain consolidation analysis is indicated by the field exploration, such methods will be employed.

Geotechnical analysis will be performed by a staff geotechnical engineer under the direction of the geotechnical engineer. It is anticipated this task will begin concurrently with the laboratory testing and will be complete approximately two weeks after final laboratory test data are available.

Task 6—Geotechnical Engineering Report

An engineering report will be prepared that describes the investigation, presents summaries of as well as all raw field and laboratory results, results of the analyses and review, calculations, and all other pertinent data. Recommendations for mitigative measures and design details will be included, where appropriate. The report will be prepared under the responsible charge of a certified Professional Geologist and a Professional Engineer registered in Colorado. A draft geotechnical engineering report will be submitted for review by Stoller approximately 3 weeks after completion of the laboratory testing.

2.2.4 Outside Services

Stoller will contract with outside services for equipment to perform the site investigation such as a backhoe for excavating and a suitable drill rig and equipment. Stoller's Geotechnical Subcontractor will provide equipment specifications and any other information necessary from which Stoller can develop an SOW for those services. The Geotechnical Subcontractor will provide geophysical survey equipment. A summary of services to be provided by Stoller and the Geotechnical Subcontractor is provided in Section 2.1.

3.0 Health and Safety/Environmental Compliance/QA and Project Requirements.

Requirements stated in the Rocky Flats OLF Geotech Investigation SOW dated August 3, 2007, shall apply to this work.

3.1 Investigation Derived Materials and Sample Screening

Based on the experience during the closure work, hazards posed by the excavation of test pits and drilling work are related to suspect low levels of hazardous substance contamination. The excavation and drilling work will be performed in accordance with the Stoller job specific work control procedures developed in accordance with STO 2, *Health and Safety Manual* and STO 11, *Environmental Management Program Implementation Manual*. A radiological control technician will be present to conduct surveys for proper characterization and control of samples and investigation materials and to perform free release surveys of personnel and equipment, as necessary.

Although some test pit and bore hole locations are from outside the waste footprint, for consistency, all investigation derived materials shall be managed as described below.

The material excavated from the test pits will be controlled and staged at the respective excavation sites in a manner to prevent the release of the excavated potentially contaminated soils and residual waste removed from under the 2-foot-thick soil cover layer. Waste material will be placed on impervious material, such as plastic sheets, with small berms (e.g., 2 × 4s) under the impervious material to limit run on/runoff, and covered with impervious material in a manner to prevent wind or water erosion and run on/runoff from the waste.

The clean soil cover layer will be staged separately from the lower waste material. Excavated waste materials will be returned to the test pits and then covered with the soil cover materials upon completion of the test pit evaluation. Following placement, the clean soil cover layer shall have a minimum thickness of 2 feet; while unlikely, additional clean soil (meeting the requirements of the OLF M&M Plan) shall be obtained to satisfy this requirement if necessary. It is anticipated that test pits will remain open for a short period (i.e., on the order of less than 24 hours), except one or more designated test pits <u>within the waste footprint</u> will remain open, appropriately covered, to receive the bore hole waste before being closed.

All bore hole waste will be collected and staged near the bore hole location, using impervious material, berming and covering as described for the test pits, and subsequently placed into the test pit(s) reserved for this waste. Prior to placing the material in the test pit(s), bore hole cores may be stored for a short period in a designated location at the OLF or another on site location, such as the east shed (so evaluations may be done out of the weather), for subsequent evaluation. Stored cores will be properly controlled, again using impervious material, berming and covering as described for the test pits, to prevent release of the cored material during storage. The volume of this bore hole waste is expected to be small in comparison to the test pit size. After completion of the bore hole work, the test pit used for placing the bore hole material will be closed as described above.

Used PPE shall also be collected and disposed in the test pit(s) within the waste footprint. PPE shall be bagged, and the bags shall be compacted as much as practicable to minimize air pockets. These wastes should be disposed in the bottom of the appropriate test pit(s) to allow the maximum amount of soil covering them. Excavation backfill will be compacted by placing the material in lifts not to exceed 12 inches of loose material and tamping it using the backhoe/trackhoe bucket to reduce potential settlement and infiltration of surface water. The potential for excess material causing soil mounding exists and additional clean fill cover material shall be used to obtain the required final 2 feet of clean cover thickness over the waste. It is assumed that with time settlement will restore the surface to near existing conditions. The surface of the backfilled excavation will be rough-graded using the backhoe/loader bucket to blend with the surrounding ground surface.

Samples will be properly packaged for shipment to the analytical laboratory or laboratories selected for this work. Samples will be administratively controlled in accordance with Stoller analytical sample procedures until custody is given to the geotechnical investigation personnel for shipment to the laboratory. The laboratories shall be properly permitted and/or licensed to receive these samples.

Attachment 1

Test Pit and Boring Rationale

Boring/ Excavation	Anticipated Depth (ft)[a]	Completion Stratum	Purpose/Objective	Location rationale	Other
TT-1	30	unweathered, undifferentiated Arapahoe/Laramie Fm bedrock	penetrate through the slide mass, failure planes, and weathered bedrock zone to obtain samples. Samples serve 2 purposes: (1) provide visual evidence of the distressed and intact zones; and (2) provide high quality, comparatively undisturbed samples of each stratum for triaxial, direct shear, and consolidation testing	Above disturbed area	inclinometer installation above current distress to monitor future performance
TT-2/TTP-1/TTP-2	30/10/10	soil below slide plane(s) and/or unweathered, undifferentiated Arapahoe/Laramie Fm bedrock	determine depth/nature of failure; identify and correlate failure plane	in "evacuation[b] zone" of disturbed area	inclinometer installation in scarp area to monitor current/future performance
TT-3	30	unweathered, undifferentiated Arapahoe/Laramie Fm bedrock	characterize conditions between evacuation zone and deposition[c] zone of apparent circular slide mass	below/between disturbed areas	inclinometer installation in central failure area to monitor current/future performance
TT-4/ TTP-4	30/10	soil below slide plane(s) and/or unweathered, undifferentiated Arapahoe/Laramie Fm bedrock	explore cause and location of previous distress; compare locations at different ends of the seep[d] area and in "deposition zone"	in "saturated" area; will show water current water level stratigraphically in deposition zone; may clarify involvement of waste in previous failure	inclinometer installation within potential distress area and current seep to monitor current and future performance
TT-5/TT-6/TTP-5	30/30/10	soil below slide plane(s) and/or unweathered, undifferentiated Arapahoe/Laramie Fm bedrock	evaluate presence of multiple slide masses at different levels as reported by Earthtech (2004); investigate water level and relationship to existing drain	within pre-landfill drainage; should show water and slide plane relationship	inclinometer installation in current failure areas to monitor future performance
TT-7/TTP-6	30/10	soil below slide plane(s) and/or unweathered, undifferentiated Arapahoe/Laramie Fm bedrock	evaluate consolidation vs slope failure for this area	in disturbed area; TTP-6 is in an area where a previous outfall pipe was located according to historical plans	inclinometer installation at approximate upper end of failure zone to monitor present future performance

Boring/ Excavation	Anticipated Depth (ft)[a]	Completion Stratum	Purpose/Objective	Location rationale	Other
TT-8	30	unweathered, undifferentiated Arapahoe/Laramie Fm bedrock	evaluate/characterize conditions in the buttress above seep 8	Above seep 8 area and in the buttress area; should also provide information from the native gravel outfall that was intended to drain the slope	inclinometer installation to monitor future performance
TTP-9	10	native soil below gravel layer	evaluate/characterize overburden, gravel lense, and underlying stratum	investigate causes of seep 8	
TTP-3	10	soil below slide plane	determine extent of failure depth and relationship with prior sub-excavation	in area of localized slope failures	
TTP-7, TTP-8	10	soil below slide plane	observe source of seep water and soil conditions in associated strata	at upper and lower limits of visible seepage and north of location of former South Interceptor Ditch	investigate potential source of water collection due to differences caused by the prior interceptor

Notes:
[a]Surface expressions of instability suggest shallow failures (approx. 10 feet). Boring depths (30 feet) will verify initial assumptions of shallow failure but does not preclude the potential for deeper failures.
[b]The evacuation zone is defined as the area at the upper end of a circular failure where the mass pulls away from surrounding soil. Frequently a scarp is made apparent in this zone.
[c]A deposition zone is that which is near the toe of a slide where material collects. Frequently a bulge, or hummocky appearance to the ground surface is apparent in this area.
[d]The presence of water is a clue that is expected but is not the only clue or a necessary clue. Also expected are soil alteration, fracturing, and distortion in the zone where sliding has occurred. If there is no evidence of sliding, that is also good information and provides evidence to suggest consolidation issues or other unknowns that will be further investigated through the drilling/sampling program.