ROCKY FLATS SITE
REGULATORY CONTACT RECORD

Purpose: Reportable Condition at the Original Landfill (OLF)

Contact Record Approval Date: October 21, 2013

Site Contact(s)/Affiliation(s): Scott Surovchak, U.S. Department of Energy (DOE); Rick DiSalvo, S.M. Stoller Corporation (Stoller); Linda Kaiser, Stoller; Jeremiah McLaughlin, Stoller

Regulatory Contact(s)/Affiliation(s): Carl Spreng, Colorado Department of Public Health and Environment (CDPHE); Vera Moritz, U.S. Environmental Protection Agency (EPA)

Date of Consultation Meeting: September 18, 2013

Consultation Meeting Participants: Carl Spreng, CDPHE; Vera Moritz, EPA; Scott Surovchak, DOE; John Boylan Stoller; Rick DiSalvo, Stoller; Linda Kaiser, Stoller

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Introduction: A rainfall event from September 9 through September 16, 2013, caused catastrophic flooding in northeastern Colorado. Based on preliminary data, the amount of rainfall received at the Rocky Flats Site during this event was at least 8 inches.

Because the event produced more than 1 inch of rainfall within a 24-hour period, the OLF cover and storm water management system were inspected after this storm event in accordance with the Rocky Flats Legacy Management Agreement (RFLMA) Attachment 2, Table 3, "Present and Original Landfill Inspection and Maintenance Requirements."

Localized surface cracking and differential settlement in the northeastern portion of the cover were noted during the inspection on September 16, 2013. In accordance with RFLMA Attachment 2, Section 6.0, "Action Determinations," DOE determined this was a reportable condition affecting the effectiveness of the OLF cover. Section 6.0 provides:

> When reportable conditions occur (except in the case of evidence of violation of institutional controls as described below), DOE will inform CDPHE and EPA within 15 days of receiving the inspection reports or validated data. Within 30 days of receiving inspection reports or validated analytical data documenting a reportable condition, DOE will submit a plan and a schedule for an evaluation to address the condition. DOE will consult as described in RFLMA Paragraph 11 to determine if mitigating actions are necessary. Final plans and schedules for mitigating actions, if any, will be approved by CDPHE in consultation with EPA. DOE is not, however, precluded from undertaking timely mitigation once a reportable condition has been identified.

Cracks with vertical displacement of up to approximately 2 feet and cracks up to approximately 0.5 feet wide were observed during the inspection. The cracking and settling extended through portions of Diversion Berms 4 and 5, and a minor depression was formed in the Diversion Berm 4 channel between the cracks. Figure 1 shows the general location of the observed cracks based on handheld GPS measurements.

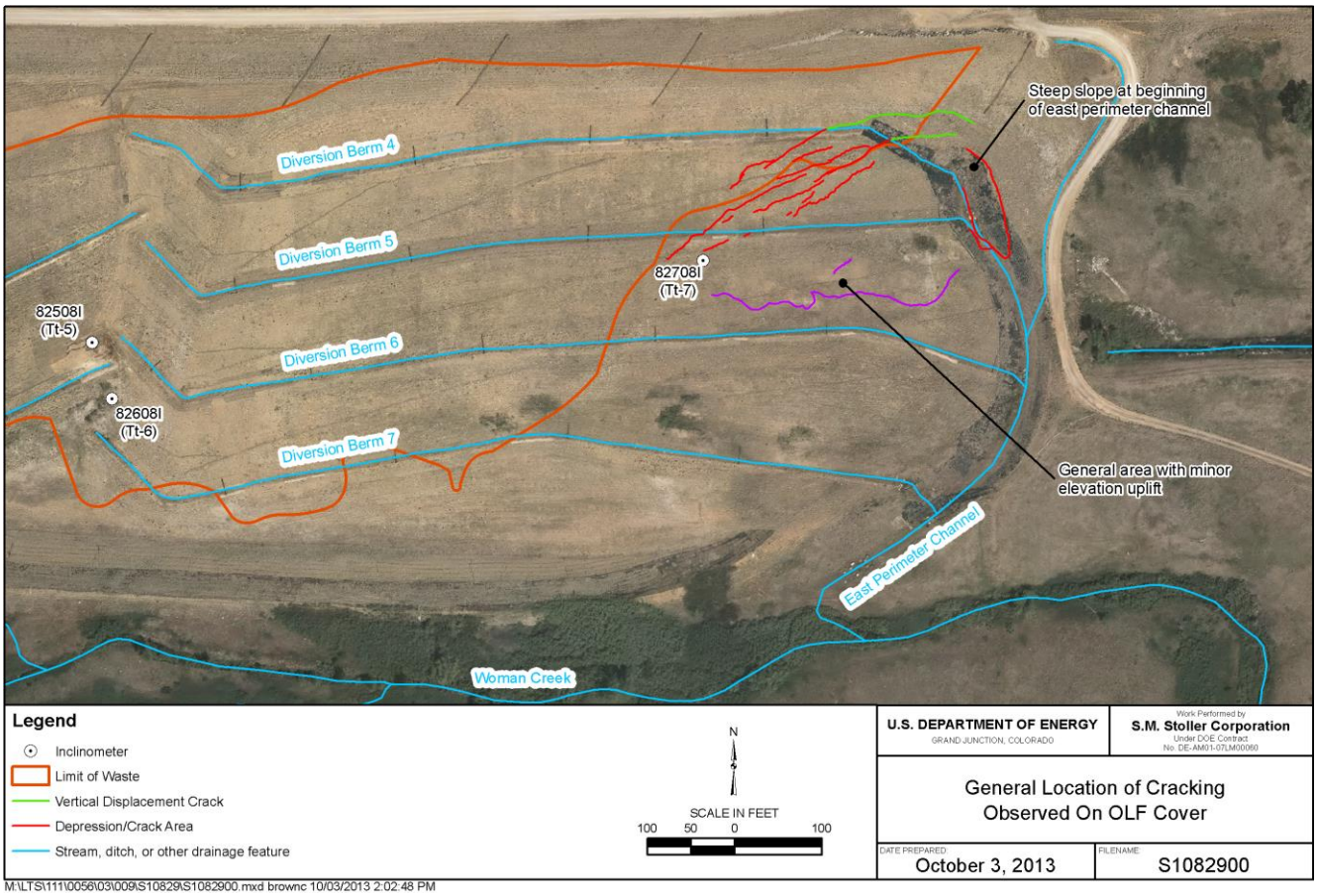

Figure 1. General Location of Cracking Observed on OLF Cover

DOE informed CDPHE and EPA of the cracking on the northeast side of the OLF on September 17, 2013. DOE, CDPHE, and EPA personnel toured the area on September 18 to start the consultative process to develop a proposed course of action.

Background: Minor surface cracking north of the beginning of the East Perimeter Channel (EPC) was noted in August 2010. A qualified geotechnical engineer evaluated the observed cracking in August 2010 and in September 2011. The evaluations concluded that, based on the proximity and shape of the cracks, they appeared to be related to the abrupt slope change at the beginning of the EPC. The geotechnical engineer recommended in 2010 that the cracks be monitored for expansion and be filled and tamped to prevent infiltration of precipitation as part of routine maintenance. This routine maintenance has been performed since that time. The condition of the observed cracking has also been noted on the OLF monthly inspection reports.

This repair methodology is (1) consistent with the conclusions and recommendations in the June 2008 geotechnical investigation report, which is discussed in Contact Record 2008-07, and (2) related to localized instability cracking on the northwest side of the OLF observed in 2007. The new cracking on the northeast side of the OLF appears similar to the cracking that was previously observed and repaired on the northwest side.

The geotechnical engineer's recommendation was reiterated after observation of the area in 2011, and no significant expansion of the cracking was observed until the September 16, 2013, inspection. The 2008 geotechnical investigation concluded for the northwest side OLF instability that a weak clay layer containing organic materials at or near the bedrock contact appeared to be a weak interface area. Modeling predicted small-scale instability due to percolating moisture that lubricates this weak interval. It is likely that the northeast side OLF instability is also associated with the effects of moisture from this precipitation event.

The localized instability observed in 2008 in the northwest side of the OLF was addressed by adding fill to reduce the depth of the West Perimeter Channel (WPC), regrading the relatively steep side slopes of portions on the WPC, and adding additional drainage features to reduce potential water infiltration. This work, done in 2008, along with routine maintenance to address minor surface cracking by smoothing and tamping cracks to fill any openings, appears to be successful.

Discussion: The "Maintenance Action Activities" subsections in Section 3.2, "Subsidence and Consolidation"; Section 3.3, "Slope Stability"; Section 3.4, "Soil Cover"; and Section 3.6, "Stormwater Management Systems," of the *Original Landfill Monitoring and Maintenance Plan* (OLF M&M Plan) are relevant to development of a plan and schedule to address the new reportable condition.

The goals of the maintenance actions that are or may be required after further evaluation by a qualified geotechnical engineer are as follows:

- To eliminate the potential for ponding and to correct the slope of the surface
- To address any potential slope failure that would likely compromise the remedy
- To maintain the minimum soil cover thickness and diversion-berm design heights
- To remove and relocate eroded soils (if necessary)
- To remove blockages in diversion berm channels, repair any channel disturbances, and replace temporary erosion control mats

In general, the new maintenance actions may include, but are not limited to, regrading affected areas, filling areas, maintaining positive drainage of surface water, constructing seep drains, and regrading steep EPC slopes to achieve side slopes grade of no greater than 4 horizontal:1vertical. If soil is needed, Rocky Flats Alluvium (RFA) is to be used.

Prior to the September 2013 precipitation event, diversion berm height maintenance had been planned to begin on September 23, 2013. This work involves adding RFA to the tops of those portions of the diversion berms that, due to minor settling of the berms over time, do not meet the minimum height

requirements. Generally, measurements show that most portions needing adjustment are low by an inch or two, but the planned maintenance approach is to add RFA to the berm tops in 6-inch lifts, compact the lifts, seed the added RFA, and cover the added RFA with erosion matting.

The minimum diversion berm heights were calculated (based on modeling) to be sufficient to convey the runoff from a 100-year/24-hour storm event to the perimeter channels, with additional height (freeboard) based on a projected 1,000-year/24-hour storm event. Inspections of the OLF during and after the precipitation event demonstrated that the diversion berms were more than adequate to convey the runoff without causing significant water level elevations in the berm channels. It appeared that runoff collected and conveyed by the diversion berms was approximately 6 to 10 inches deep in the berm channels. The fast moving water did cause some erosion and gullying at the ends of several diversion berms where they joined the perimeter channels. However, there was no evidence of any significant erosion of the OLF cover or the perimeter channels or loss of existing vegetation from run on and runoff.

Based on these observations, it appears that, except for the northeast side of the OLF, the storm water management systems performed very well and that these features are robust. The RFLMA parties agreed that the planned berm-height maintenance can be delayed until DOE can compare performance of the diversion berms in relation to this event and then evaluate a possible modification to the minimum berm-height criteria.

Previous instances of localized instability and cracking have been successfully addressed by (1) regrading and filling cracks to maintain the integrity of the cover and (2) adding drainage features to minimize infiltration of precipitation. Since such repair activities involve the use of construction machinery, any needed berm-height maintenance can be performed at the same time as the repair activities.

Initial Response: Initial mitigation steps were undertaken by DOE to minimize the potential for infiltration of precipitation. Initial steps included (1) regrading the differential displacement cracks to seal the openings using the RFA from the adjacent area and (2) filling minor cracks by smoothing and tamping the surrounding surface. Erosion mats were placed over the regraded area. This work was completed on September 20, 2013. This area will be inspected weekly and any continuation of the cracking will be filled by smoothing out and tamping the surface as needed.

A qualified geotechnical engineer and Stoller engineering staff visited the OLF on September 24, 2013, to view the affected area, to provide recommendations for additional near term repairs, and to assist in developing a plan and schedule to address the conditions.

EPA and CDPHE concurred with the initial mitigation steps outlined above and with the need for additional work to maintain positive drainage in the Diversion Berm 4 channel.

The cracks with vertical displacement running through Diversion Berm 4 created a slight depression about 50 feet long in the berm channel. The depression prevents positive storm water drainage. This was temporarily corrected by installing perforated drain pipe and drain rock in the channel to convey runoff and to prevent ponding in this channel.

The work is subject to the *Rocky Flats Legacy Management Agreement*, Attachment 2, Section 4.0, "Institutional Controls" (ICs). The work involves an authorized response action on the OLF cover, which is subject to IC 6, shown in Table 1.

Table 1. Institutional Controls

IC 6	Digging, drilling, tilling, grading, excavation, construction of any sort (including construction of any structures, paths, trails or roads), and vehicular traffic are prohibited on the covers of the Present Landfill and the Original Landfill, except for authorized response actions.
	Objective: Ensure the continued proper functioning of the landfill covers. **Rationale:** This restriction helps ensure the integrity of the landfill covers.

The initial response information in this contact record demonstrates that the objective and rationale of IC 6 will be met.

Evaluation Plan and Schedule: The evaluation of localized instability and recommendations by a qualified geotechnical engineer is included in Attachment 1.

Drawings of the proposed grading and additional drainage features and an estimate of the time needed to complete the repairs to the OLF cover will be submitted by November 25, 2013, for CDPHE review and approval, as required under RFLMA. The schedule for completing the repairs will be dependent upon CDPHE's review and any changes that are required for DOE to obtain CDPHE approval of the final design.

In accordance with RFLMA, DOE is not prohibited from taking any mitigating actions it deems necessary while the evaluation and design is being completed. The RFLMA Parties shall use the consultative process to discuss DOE's mitigating actions as necessary. DOE will document mitigating actions in e-mail or other written correspondence, and will provide summaries of the actions taken in RFLMA quarterly or annual reports of site surveillance and maintenance activities.

Resolution: CDPHE concurs with DOE's conduct of the initial response work described above. The work meets the objective and rationale of IC 6.

CDPHE, after consultation with EPA, approves the plan and schedule for evaluation.

DOE will provide information regarding the outcome of further consultation related to this reportable condition and the progress of the evaluation in RFLMA quarterly and annual reports.

Closeout of Contact Record: This contact record will be closed when the construction is completed, post-construction reseeding has been performed, and post-construction erosion controls are in place.

Approval: Carl Spreng, CDPHE, approved this contact record.

Contact Record Prepared By: Rick DiSalvo

Distribution:
Carl Spreng, CDPHE
Scott Surovchak, DOE
Linda Kaiser, Stoller
Rocky Flats Contact Record File

Attachment 1

Geotechnical Engineer Technical Memorandum

TETRA TECH

Technical Memorandum

To:	Mr. Rick DiSalvo Mr. Melvin Madril, PE Mr. Stephen Pitton	From:	Thomas A. Chapel, CPG, PE
Company:	S.M. Stoller Corporation	Date:	October 10, 2013
Re:	Rocky Flats OLF Berm 4 Grading and Drainage	Project No.:	114-181750

This memorandum summarizes Tetra Tech's observations, opinions, and recommendations regarding recent soil movement near Berm 4 at the Original Land Fill (OLF) area within the Rocky Flats Environmental Technology Site (RFETS). Minor cracking and localized slope distress have been observed occasionally in the area of Berm 4 since approximately 2010 (see Tetra Tech's 2010 memorandum). Cracks were also noted during a walk down in September 2011. Similar movements have been observed elsewhere on and adjacent to the OLF.

Such cracking and associated movement were evaluated as part of a geotechnical engineering investigation conducted by Tetra Tech for S. M. Stoller in 2008. Results of that investigation were published in a report titled Rocky Flats Original Landfill Geotechnical Investigation Report, dated June 4, 2008. The investigation included site visits and "walk downs", geophysical seismic and resistivity surveys, test excavations, exploratory borings, laboratory testing, slope stability modeling, and engineering analyses. The report concluded that the distress generally includes small-scale, localized slump features that typically originate in a comparatively weak, native clay layer that underlies the OLF. During extreme precipitation events or prolonged periods of wet weather, surface water penetrates the cover and shallow soil deposits, reducing the stability of the shallow subsurface. Computer modeling indicated that large scale, global failure of the OLF slopes is unlikely.

Recommendations in the geotechnical report included a range of possible measures that could be implemented to mitigate the localized distress. In accordance with approved procedures, S.M. Stoller selected a method of hand tamping soil in and adjacent to cracks to reduce water infiltraton in distressed areas. This measure seems to have been successful, because little movement has been noted by S.M. Stoller during periods of typical precipitation that occurred between 2010 and the recent heavy and prolonged precipitation event.

RECENT EVENTS

During the period September 11 through September 13, 2013, rainfall of historic proportions fell in the vicinity of the OLF. Shortly after that event S.M. Stoller conducted a walk down of the OLF and observed several curvilinear cracks near the eastern terminus of Berm 4. The most significant of these cracks was located upslope from the area where Berm 4 outfalls into the East Perimeter Channel (EPC), and was on the order of 200 feet long with up to approximately two feet of downward displacement on the downhill side of the crack. Informal measurements of the crack depth indicated it progressed more than 18 inches below the ground surface and had a width of two to three inches. S.M. Stoller mapped the cracks, then filled them in by hand and using lightweight construction equipment to prevent additional surface water and precipitation from entering the cracks.

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On September 24, S.M. Stoller and Tetra Tech met and walked the OLF to examine the ground, specifically the eastern portion of Berm 4 and nearby areas. At the time of our visit, no new movement was visible after the crack described above had been repaired. Traces of minor additional cracks were visible and had a similar alignment to the larger crack described above.

As a result of the crack and displacement described above, a segment of Berm 4 is now lower than adjacent segments of Berm 4, which may impact the ability of Berm 4 to convey the needed surface water volume in the event of future precipitation events similar in magnitude to those that occurred in September 2013. Further, the lower segment of channel will hold water and cause increased surface water infiltration in the distressed area.

Any condition that results in an increase in water in the shallow subsurface will contribute to instability of the slope. Localized failures can be expected under these conditions. We do not believe that a broad-scale, global failure of the OLF slope is more likely at this time than was predicted during the previous study. Recommendations to mitigate the localized instability of the eastern portion of the OLF are described below.

RECOMMENDATIONS

We recommended a phased approach to repair, monitor, and mitigate the localized instability observed in the vicinity of Berm 4. Items 1 and 2 are considered immediate and short-term measures; items 3 and 4 are longer-term engineering remedies. In order of implementation, we suggest the following:

1. **Monitor the distress.** Frequency of observations of the OLF should be increased to approximately weekly in the short term to look for evidence of additional movement of the existing cracks or development of new distress. If or as distress is observed, cracks should continue to be filled in accordance with existing procedures. New cracks should be mapped if or as they occur. This process has been used successfully in other parts of the OLF. The repair methodology is consistent with the conclusions and recommendations in Tetra Tech's geotechnical investigation report dated June 4, 2008, and with the recommendations described in our Technical Memorandum dated August 10, 2010.

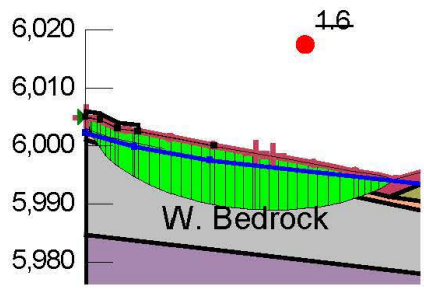
2. **Evaluate and repair Berm 4.** In its current condition, Berm 4 will hold water in the distressed area should additional precipitation and runoff occur. Ponding water in this area will exacerbate the instability and could result in additional or accelerated movement of localized, marginally stable zones. This condition should be repaired as soon as practical to reduce the risk of additional movement.

   We have considered two alternative, short-term methods for reducing the occurrence of standing water in this area. Fill could be placed on the berm and in the channel invert to raise the lower portion so that positive drainage will occur across the zone. This alternative adds additional weight to the cracked area which tends to decrease the stability. Using previous slope stability models that we constructed as part of our geotechnical engineering evaluation, Tetra Tech simulated a wet condition and placement of additional fill by increasing the water level in the model and adding a surcharge to the ground surface at the failure plane. The surcharge applied approximates a two-foot layer of Rocky Flats Alluvium placed at the upper portion of the failure zone. Figure 1 (below) illustrates these conditions. Figure 1(a) shows the slope and localized failure with no surcharge, but with an elevated water level. The model calculated a minimum factor of safety (FoS) of 1.6, with failure occurring in the upper portion of the weathered claystone bedrock. Figure 1(b) shows the effect of adding a two-foot layer of fill as a surcharge. The calculated minimum FoS dropped

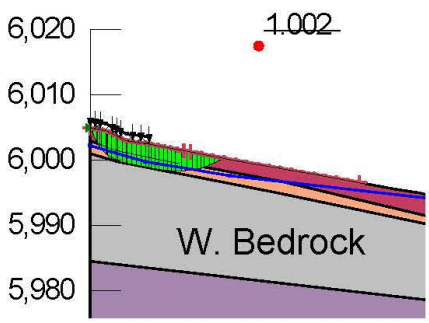
to 1.002 and the failure is predicted to occur in the organic layer at the surface of the weathered bedrock. These results indicate that the slope is marginally stable and on the verge of failure following the addition of two feet of fill. Because a localized, minor failure did actually occur when the water level increased, but without an additional surcharge, the model results may actually under-predict the potential risk of additional failures if surcharge is added.

Figure 1. Slope Stability Model Results

(a) Elevated water table, no surcharge.



(b) Elevated water table and a surcharge approximating a two foot fill in the upper portion of the failure zone.



Another alternative that would appear to have a lower risk for decreasing stability of the area is the construction of a temporary drain in the invert of Berm 4 to convey water from the low segment eastward to the outfall. This could be a trench and flexible drain pipe constructed such that the upper end of the drain is at the downstream end of the low segment and the drain outfall is at the eastern end of Berm 4 or in the EPC. This drain could be removed when longer term remedies have been designed and constructed (see below).

3. **Trench Drains and EPC Grading**. To improve drainage within the channels of Berms 4 through 7, thus decreasing the risk of future localized failures, a shallow trench drain could

be designed and constructed in the invert of each of the berms. Details would need to be designed, but the concept involves a trench excavated approximately one foot wide by one foot deep from a location upstream of the distressed area to the channel outfall in the EPC. This concept was used on some channels on the west side of the OLF, and it appears to have been successful in reducing the cracking and localized slope failures in that area.

The upstream terminus of the EPC includes a steep "headwall" that is adjacent to berm 4 at its east end. The steep slopes of this headwall may contribute to slope instability of the areas upslope from the EPC. The EPC should be re-graded to reduce the slopes to 3H:1V or shallower. This should be possible by placing approximately 5 feet of fill at the toe of the existing headwall and by "laying back" the existing slope at the upper end, generally on the north and east over a small area. The capacity of the EPC must be maintained and should be verified as part of the hydraulic analysis described below.

4. **Hydraulic Modeling and Design Review.** Because of the recent record setting precipitation and flood events, there is an opportunity to evaluate rainfall intensity and other hydrologic data at the OLF to evaluate the berm height in order to protect the area from damage due to future events. The analysis would require an engineer to obtain and review the daily precipitation records from Rocky Flats. A statistical analysis would be performed on the data to compare the rainfall event that occurred the week of September 11, 2013 to the projected period of record. This could be evaluated against previous recommendations for berm height along the drainage channels at the OLF to determine the actual level of protection that exists for the berms.