FINAL
LANDFILL MONITORING AND MAINTENANCE PLAN
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
ORIGINAL LANDFILL

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

February 13, 2006

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LIST OF ACRONYMS AND ABBREVIATIONS

CCR	Colorado Code of Regulations
CDPHE	Colorado Department of Public Health and Environment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DOE	U.S. Department of Energy
DQO	data quality objective
EPA	U.S. Environmental Protection Agency
H	horizontal
IDW	investigation-derived waste
IM/IRA	Interim Measure/Interim Remedial Action
IMP	Integrated Monitoring Plan
LHSU	lower hydrostratigraphic unit
ml	milliliter
mph	miles per hour
OLF	Original Landfill
QA	quality assurance
QC	quality control
Plan	Monitoring and Maintenance Plan
RCRA	Resource Conservation and Recovery Act
RFCA	Rocky Flats Cleanup Agreement
RFETS	Rocky Flats Environmental Technology Site
RL	reporting limit
SOP	Standard Operating Procedure
SVOC	semivolatile organic compound
UHSU	upper hydrostratigraphic unit
V	vertical
VOC	volatile organic compound

1.0 INTRODUCTION

1.1 PURPOSE

This Monitoring and Maintenance Plan (Plan) has been prepared for the Original Landfill (OLF) (Individual Hazardous Substance Site 115 and 196) at the Rocky Flats Environmental Technology Site (RFETS) and is designed to meet the following objectives:

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

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

3. Describe the features necessary to prevent run-on and runoff from eroding or otherwise damaging the final cover (Section 5.0).

Revisions to the plan will be submitted to the Rocky Flats Cleanup Agreement (RFCA) parties for review and endorsement and also documented in the Annual Original Landfill Monitoring Report.

Under the Final Interim Measure/Interim Remedial Action (IM/IRA) for the Original Landfill (U.S. Department of Energy [DOE] 2005a), a 2-foot-thick soil cover was selected to address closure of the Original Landfill. 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.

1.2 FACILITY LOCATION AND UNITS

RFETS is a government-owned facility formerly used for the fabrication of miscellaneous weapons components for national defense. The 6,550-acre site is located in Jefferson County, Colorado, approximately 16 miles northwest of Denver (Figure 1-1). The Original Landfill is located south of the RFETS Industrial Area on a south-facing hill slope north of Woman Creek (Figure 1-2).

1.3 SITE OPERATIONS

The Original Landfill was used to dispose of solid sanitary and construction debris wastes generated at the Rocky Flats Plant from 1952 to 1968 (DOE 1988). The landfill was not designed or operated as an engineered landfill. Aerial photographs indicate that the landfill was operated as an area fill (DOE 1994). Waste was merely dumped in the area vertically below and just south of the southern edge of the alluvial pediment on which the RFETS Industrial Area is located. The waste disposal area lies north of Woman Creek. The waste was generally spread over the south-facing hillside, serving to fill in the area below the pediment edge. No liner or other collection barrier was installed between the waste and the existing surfaces (DOE 2006).

Waste placed within the Original Landfill is contaminated and commingled with hazardous constituents, including organic compounds and metals at levels greater than action levels and/or applicable standards. Additional information can be found in the IM/IRA for the Original Landfill (DOE 2006).

2.0 SITE PHYSICAL DESCRIPTION

This section describes the physical conditions at the Original Landfill site, such as topography, hydrology, climate and precipitation, hydrogeology, and site features, which include the final cover, the buttress fill, the stormwater management system, the Resource Conservation and Recovery Act (RCRA) groundwater monitoring network, and the surface water monitoring locations.

2.1 TOPOGRAPHY

The final topography of the Original Landfill is as shown on the post-construction survey (Figure 2-1). Slopes are as follows:

- Soil cover slope – 18 percent;
- Top of buttress fill slope – 2-5 percent;
- Buttress fill (south) sideslope – 3 horizontal (H):1 vertical (V);
- Perimeter channel sideslope – generally 3H:1V; and
- Perimeter channel slopes – approximately 12 percent.

2.2 HYDROLOGY

The Original Landfill is located within the Woman Creek drainage. Diversion berms have been constructed on the soil cover to minimize surface water overland flow and divert run-on and run-off to the perimeter channels. The perimeter channels divert the surface water south of the landfill to below the buttress fill. Below the buttress fill, the perimeter channel slopes decrease, and flow encounters rock outfalls that dissipate the flow energy and allow the surface water to return to overland or sheet flow between the buttress fill and Woman Creek.

2.3 CLIMATE AND PRECIPITATION

RFETS 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 reach 75 miles per hour (mph). 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 Original Landfill, groundwater flows predominantly within the upper hydrostratigraphic unit (UHSU). The UHSU is composed of materials that include the quaternary Rocky Flats Alluvium, colluvium, Valley Fill Alluvium, and weathered claystone bedrock. Unweathered bedrock claystones are included as part of the lower hydrostratigraphic unit (LHSU). Groundwater elevations typically vary seasonally less than 5 feet, mostly in

response to direct precipitation recharge in wetter periods and evapotranspiration in warmer months. Water levels above the weathered bedrock range from 0 to 5 feet along Woman Creek; below the bedrock in the east-central waste area; 5 to 10 feet in the central waste area; 0 to 5 feet in the western waste area; and from 10 to more than 40 feet above the bedrock north of the Original Landfill (DOE 2006).

Natural groundwater seeps were discovered during construction of the soil cover and perimeter channels. Several seeps were mitigated with a subsurface drain to the buttress sub-drain. The buttress sub-drain was constructed beneath the buttress fill to prevent buttress saturation. This drainage layer directs water to the south of the buttress into the Valley Fill Alluvium.

2.5 SITE FEATURES

Site features included in the monitoring program at the Original Landfill include the final cover, the buttress fill, the stormwater management system, the RCRA groundwater monitoring network, and the surface water sampling locations. Construction included regrading of the site to consistent slopes. This included regrading the waste and placement of clean imported soil gradefill material. A minimum of 2-feet of Rocky Flats Alluvium soil cover was placed within the limit of waste. Monitoring procedures are provided in subsequent sections.

2.5.1 Final Cover

The final cover of the Original Landfill includes a 2-foot-thick Rocky Flats Alluvium soil cover that was constructed over both the regraded surface and the buttress fill. The 2-foot-thick soil cover was constructed within the limit of waste and does not extend to the perimeter channels. Surface soil between the limit of waste and the perimeter channels is also Rocky Flats Alluvium, but was placed as regrade material.

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

2.5.2 Buttress Fill

The buttress fill is an approximately 20-foot-high, 1,000-foot-long soil mass placed at the toe of the Original Landfill (Figure 2-1). The compacted soil for the buttress fill was continuously tested for compaction and moisture content to meet design specifications. A sub-drain lies beneath the buttress fill and consists of drainage rock covered with a geotextile separation layer. The sub-drain is located below the surface and cannot be visually inspected. The buttress fill was constructed over the sub-drain with engineered fill compacted in 1-foot lifts.

2.5.3 Stormwater Management System

2.5.3.1 Introduction

The stormwater management plan is presented in Appendix D of the Original Landfill Design Submittal (Earth Tech, Inc. 2005). This appendix presents the results of calculations used to

determine the stormwater run-on and runoff volumes to adequately design the diversion berms and perimeter channels. The stormwater management structures are designed to the 100-year, 24-hour storm event and include capacity to handle a 1,000-year, 24-hour storm event.

2.5.3.2 Applications

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

- Protect the land surface from erosion (Section 2.5.3.3),
- Manage run-on and runoff (Section 2.5.3.4), and
- Inspect and maintain the erosion and stormwater management practices (discussed in Section 3.0).

In the long term, the system is designed as an erosion control system so sediment control will not be necessary since limited sediment will be generated. In the short term, sediment will be controlled with temporary erosion lining and check dams (GeoRidge®).

2.5.3.3 Erosion Control

At the Original Landfill, stormwater management features have been designed with erosion control features to limit both short-term erosion and long-term erosion. Erosion control is any practice that protects soil surfaces and prevents the soil particles from being detached by rainfall or wind. Following construction, the soil cover was covered with both straw mulch and a spray-on erosion control medium called Flexterra™. The diversion berms and upper slope portions of the buttress fill are lined with temporary erosion mat. The diversion berms included temporary check dams (GeoRidge®) to limit sediment transport. These measures will limit short-term erosion until vegetation is established. The check dams may be removed at the end of the 2006 growing season if the vegetation is well established. The perimeter channels and lower sideslope of the buttress are lined with permanent erosion mat. Rock outfalls are present at the diversion berm outfalls to the perimeter channel outfalls to prevent scouring. All areas have been seeded to aid in long-term erosion protection.

2.5.3.4 Run-on and Runoff Control

The stormwater management system is designed to collect, route, and discharge storm water run-on and runoff. Run-on stormwater is conveyed from upper portions of the Original Landfill as overland flow and then enters either the diversion berms or perimeter channels. Runoff enters the perimeter channel from overland flow on the cover and from the diversion berms constructed on the cover.

2.5.4 RCRA Groundwater Monitoring Network

Four RCRA monitoring wells will be used for groundwater monitoring at the Original Landfill as discussed in Section 4.0. These wells will be monitored in accordance with the RFETS

Integrated Monitoring Plan (IMP), FY2005 (DOE 2005a). Of the four wells, one is upgradient and three are downgradient of the Original Landfill.

2.5.5 Surface Water Monitoring

Surface water monitoring will be conducted at two locations, one upgradient and one downgradient of the Original Landfill. Sampling locations and procedures are discussed in Section 4.0.

During construction, intermittent seeps were discovered and remedied if necessary. Seep inspection is required and is discussed in Section 3.3.

3.0 FINAL COVER AND STORMWATER MANAGEMENT SYSTEM INSPECTION AND MONITORING

This section outlines the inspection and monitoring program to be undertaken at the Original Landfill to ensure that the integrity of the cover is not compromised and continues to function as designed. Inspection and monitoring tasks will include monitoring subsidence/consolidation, slope stability, soil cover, vegetation, and stormwater management structures so that any potential maintenance actions can be taken in a timely manner. In the event that actions are needed that go beyond routine maintenance and such actions require engineering design, the RFCA parties will be notified and consulted regarding proposed actions.

3.1 INSPECTION PROCEDURES

In accordance with the IM/IRA (DOE 2006), site inspections of the area will be conducted on a periodic basis following construction of the final cover, with the following exceptions:

- The site shall be inspected within two days after a storm event of one inch or more of rain in a 24-hour period;
- The site shall be inspected within two days after significant melt of a 10-inch or more snow storm assuming 10 inches of snow is equivalent to one inch of water; and
- The vegetation shall be inspected on a monthly basis from April to September and quarterly the rest of the year for the first two growing seasons following initial seeding (2006 and 2007).

Monthly inspections will be conducted for the one year. After one year the frequency of inspections may change based on the data collected and discussions among the Rocky Flats Cleanup Agreement (RFCA) parties. It is anticipated that quarterly inspections will continue for four additional years and the inspection program will be evaluated at the first Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) review.

Inspections will be performed by qualified personnel and reviewed by a competent professional. Site inspections will be performed using a prescribed form containing a checklist of items that documents the evaluation of site conditions. The inspection form is included 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 Original Landfill Monitoring Report. If deficiencies are discovered that require immediate attention, the RFCA parties will be notified.

3.2 SUBSIDENCE / CONSOLIDATION

Subsidence and consolidation at the Original Landfill largely depend on how well the waste was compacted when placed, thickness of the waste, age, and waste 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, compaction, thickness, and moisture content. Differential settlement across the landfill may create cracks on the surface, which would allow precipitation to infiltrate more easily.

Differential settlement can also change the topography of the landfill and create areas on the surface where ponding of water can occur – this is particularly important regarding the 2-foot high drainage berms that run across the Original Landfill. 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. Therefore, cover subsidence or consolidation is less of a concern than is waste subsidence.

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 landfill surface or other indicators of differential settlement. Subsidence/consolidation at the Original Landfill will be monitored by visually inspecting the surface of the landfill cover for cracks, depressions, and sinkholes. Visual inspections will involve traversing the landfill to gain perspective on regions of the landfill, i.e., every square foot of the landfill is not inspected. In addition, the seven diversion berm flow lines will be traversed to look for sloughing or differential settling that could change the flow line slope or berm height. Eight settlement monuments will also be installed at locations agreed upon by the RFCA parties as shown on Figure 3-1 (Original Landfill Inspections). For each monument location (A-F on Figure 3-1), the calculated settlement from the final design (Figure 3-1a) will be used to compare with measured settlement. Monuments G and H have no calculated settlement values. The monuments will be monitored quarterly for the first year and annually thereafter, subject to field conditions and monitoring results. Areas of observed differential settlement, including ponding will be staked, photographed, measured, and located on the landfill site map prior to any maintenance action. Control Point 1001 will be maintained as the control for surveying the Original Landfill.

3.2.2 Maintenance Action 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. Replacement soil will be Rocky Flats Alluvium as was used in the construction derived from or near the Site. 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 Original Landfill site map.

Settlement plate data will be tabulated and the measured settlement will be compared to the anticipated settlement calculated in the final design. After settlement plate locations are finalized, a specific calculation will be done for each location. Should measured settlement exceed 30% of the calculated maximum settlement and be expressed as differential settlement, the area will be photographed, located on the Original Landfill site map, repaired and reported on the inspection forms. Should the measured settlement exceed 90% 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 geotechnical engineer's evaluation will be reported to the RFCA parties. The area(s) where maintenance actions have taken place will be specifically inspected and reported during the inspections of the cover to monitor any continued subsidence. If differential settlement or localized subsidence appears to be substantial and likely to influence the integrity of the existing cover and surface water

drainage over the Original Landfill, the RFCA parties will be consulted and maintenance actions will be taken to mitigate these concerns (e.g. areas of ponding water on the cover).

3.3 SLOPE STABILITY

A landfill 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 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 with buttress fill 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 Original Landfill footprint but within the general area of the landfill, the area of the inspection will be expanded to include these areas.

3.3.1 Monitoring Locations and Procedures

Slope stability at the Original Landfill will be monitored by visually inspecting the cover, the stormwater diversion berms, the perimeter channel sideslopes, and the buttress fill sideslope for signs of cracks, evidence of block failure, seeps, and evidence of rotational failure. The inspection will categorize the observed cracking. Visual inspection will involve traversing the slope to gain a perspective of the entire slope. Specific attention will be provided to areas where small seeps occurred at the surface of the OLF during construction. These areas are shown on the figure in Appendix A. Any areas where a surface seep is identified will be photographed, marked, located on the Landfill site map and monitored for signs of slope instability. Areas that are identified during the inspections as potential slope stability concerns will be photographed, located on the Landfill 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 flow will be taken to prevent surface water from entering the cracked area. If further monitoring indicates a continued stability concern, a qualified geotechnical engineer will be consulted.

3.3.2 Maintenance Action 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 OLF that would likely compromise the remedy. The maintenance actions will include, but not be limited to, regrading affected areas, filling areas, maintaining positive drainage of surface water, seep drain construction, and regrading steep sections to achieve side slopes no greater than 4H:1V. Areas where maintenance actions have taken place will be closely monitored for further slope stability concerns. The RFCA parties will be notified and consulted if inspections show continued slope stability concerns in an area of the OLF closure.

3.4 SOIL COVER

The cover system at the Original Landfill is designed 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 soil cover is performing in accordance with the design and the Original Landfill system as a whole continues to meet performance objectives.

3.4.1 Monitoring Locations and Procedures

Monitoring of the soil cover at the Original Landfill will include the following:

- Visually inspecting the soil cover for erosion or deposition areas;
- Visually inspecting the soil cover for signs of burrowing animals;
- Visually inspecting previously identified seep areas and noting any new ones that may have developed; and
- Visually inspecting the diversion berms, diversion berm outfalls, and the perimeter channels for erosion rills or excessive deposition. Particular attention and appropriate measurements will occur regarding the design parameters (Specification 01310-0976) for the diversion berms of 2 feet high minimum and a gradient of at least 2% with the primary focus being the performance objective of the berms.

Visual inspection will involve traversing the slope to gain a perspective of the entire area. Signs of rill and gully erosion will be photographed, marked with stakes, measured and located on the landfill site map and reported on the inspection form. Additionally, areas of observed soil deposition will also be photographed, marked, measured, and located on the landfill site map and reported on the inspection form. If visual inspections of the diversion berms indicate a departure from the design parameters, the height and gradient will be measured. Measurement of the berm height and drainage gradient will occur at least annually until the CERCLA review, at which time the need and frequency will be assessed.

3.4.2 Maintenance Action Activities

If monitoring indicates significant loss of soil over time, maintenance actions will be taken. If any section of gully is greater than 6-inches deep, maintenance actions will be implemented. Maintenance actions will include, but not be limited to soil replacement and regrading the affected areas to maintain the minimum design soil cover thickness and removing and relocating eroded soils (if necessary). The regraded areas will be vegetated per design criteria to prevent further erosion. Erosion control measures will be implemented to prevent further erosion of cover soils, (e.g., erosion control mat, revegetation), if necessary. The amount of soil used to fill areas of erosion will be estimated, recorded, and reported in the quarterly monitoring report. The RCRA parties will be notified and consulted if soil erosion concerns persist. Areas of soil deposition that hinder the flow of surface water in a stormwater channel will be removed to maintain the designed channel configuration of at least 2% grade and flow capacity as well as a

berm height of 2 feet. Maintenance of these areas will also be documented and reported in the quarterly report.

3.5 VEGETATION

Vegetation is important to long-term erosion protection for the cover, the upper portion of the buttress sideslope, and the diversion berms. Permanent erosion mat has been placed in the perimeter channels and the lower portion of the buttress sideslope; nevertheless, vegetation is important to reinforcing the erosion mat and providing long-term protection. For short-term protection, Flexterra™ and crimped straw have been placed on the cover, and temporary erosion mat, which has a 2 to 3 year life span, has been placed on the diversion berms and upper buttress fill sideslope. In addition, check dams have been placed in the diversion berms. Vegetation inspections will ensure that vegetation is established properly and will be consistent with the Rocky Flats, Colorado, Site Revegetation Plan (DOE 2005b) and the Rocky Flats, Colorado, Site Vegetation Management Plan (DOE 2005c).

3.5.1 Monitoring Locations and Procedures

Vegetation at the Original Landfill will be monitored by visual inspection on a monthly basis from April to September and quarterly for the rest of the year for the first two growing seasons following initial seeding (2006 and 2007), and only quarterly after that. Monthly inspections will help identify problematic weeds that can grow quickly and potential drought conditions that can adversely affect young vegetation. The vegetation will be monitored by traversing the cover and visually inspecting for the health of the grasses and for unwanted vegetation such as weeds or deep-rooting trees. Particular attention will be focused on the berms, channels and buttress sideslope. The percentage of weeds versus grass on the cover will be estimated. At least one of the inspections during the spring/summer months must be conducted by a competent person capable of identifying weed species known in the area. If, after the first growing season, the Flexterra and mulch have eroded and vegetation is sparse, maintenance action will be necessary on the cover. If, after two growing seasons, the temporary erosion mat in the diversion berms and upper buttress fill sideslope has degraded and vegetation is sparse (The design documents assumed a vegetation density in these areas of at least 75% after two full growing seasons. This "vegetation density" is equivalent to "a good stand of unmowed grass"), maintenance action will also be necessary.

3.5.2 Maintenance Action Activities

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

- Localized reseeding of the soil cover;
- Spot herbicide applications;
- Reseeding;
- Reapplication of temporary erosion controls; and

- Removal of deep-rooting trees and repair of the area.

The maintenance of the cover vegetation will be consistent with the Site Revegetation Plan (DOE 2005b). The RFCA parties will be notified and consulted should an area consistently show vegetation concerns.

3.6 STORMWATER MANAGEMENT STRUCTURES

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

- Reduce flow onto the landfill (run-on controls);
- Reduce overland flow on the landfill;
- Collection and transport of runoff from the Original Landfill; and
- Limit transport of sediment from the disturbed areas to off-site drainage ways.

Existing stormwater controls at the Original Landfill include the following (Figure 2-1):

- Diversion berms 1 through 7;
- Diversion berm outfalls 1 through 7;
- Diversion berm temporary check dams (GeoRidge®);
- West perimeter channel;
- East perimeter channel;
- West perimeter channel outfall;
- East perimeter channel outfall;
- Permanent erosion mat-lined lower buttress fill sideslope;
- Vegetation/temporary erosion mat-lined upper buttress fill sideslope; and
- Temporary, naturally degradable, straw waddles between the diversion berms for additional erosion control.

Details of each type of structure are included on Figure 3-2.

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, breaches in the diversion berms, subsidence, burrowing animals, and blockage. Signs of potential problems include, but are not limited to, ponding water, gullying, sediment build-up, and depressions.

The perimeter channel lining and temporary diversion berm lining will be inspected for evidence of damage, displacement, undermining, scour, or deterioration. Repairs will be made to re-stabilize the channel in accordance with the design specifications. Permanent and temporary erosion control mat lining on the buttress fill sideslope 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 noted during the inspection. The temporary check dams placed perpendicular to the flow lines of the berms will be inspected for excessive sediment and removed after vegetation is established. Riprap in the diversion berm and perimeter channel outfalls will be inspected for integrity and excessive sediment.

3.6.2 Maintenance Action 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.

Routine maintenance of the surface water controls will include removing any blockages, filling eroded areas, replacing erosion control mat, or repairing other disturbances as necessary. In the case of permanent erosion control mat repairs, they will be conducted in accordance with the manufacturer's specifications or equivalent matting will be used. Sediment may be removed periodically 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. Should areas of stormwater management continually show evidence of concern, the RFCA parties will be notified and consulted.

3.6.3 Institutional Controls

Institutional controls are used to control access and restrict activities at the Original Landfill to ensure the effectiveness of the engineered controls and the monitoring systems. Inspection at the Original Landfill will look for evidence that the institutional controls were violated 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 for any purpose other than the accelerated action;

- Damage or removal of any signage or groundwater monitoring wells at the Original Landfill; and
- Evidence of unauthorized entry.

A checklist of these items is included on the inspection form found in Appendix A.

3.6.4 Condition of Monitoring Points

All established monitoring locations, such as groundwater wells, 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.

3.6.5 Site Conditions

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

3.6.6 Reporting and Record Keeping

Inspection forms and findings will be included in the Annual Original Landfill Monitoring Reports discussed in Section 6.0. These annual reports will be submitted to the U.S. Environmental Protection Agency (EPA) and the Colorado Department of Public Health and Environment (CDPHE).

4.0 GROUNDWATER MONITORING PLAN

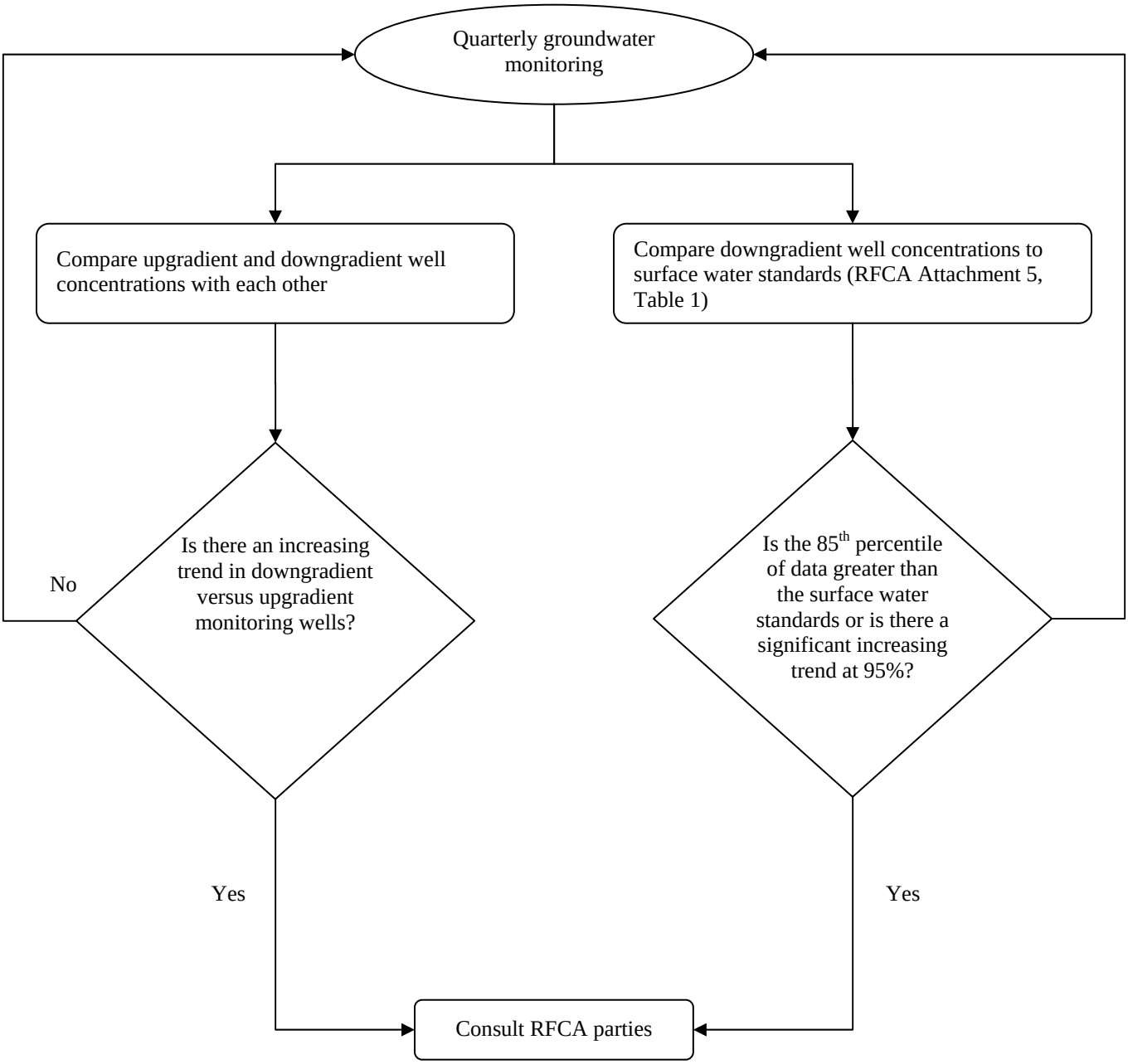
This section presents the groundwater monitoring plan for the Original Landfill during the post-closure period. The plan establishes consistent monitoring locations and frequencies for the monitoring period.

4.1 PURPOSE AND REQUIREMENTS

The Original Landfill groundwater monitoring plan has been implemented to determine groundwater quality impacts of the Landfill (DOE 2006). The groundwater monitoring system was implemented under the IMP (DOE 2005a) in accordance with 6 CCR Regulations 1007-3, 265.90[d]. Groundwater monitoring results will be used to evaluate upgradient versus downgradient groundwater quality at the Original Landfill. Downgradient groundwater will also be compared to surface water standards (RFCA Attachment 5, Table 1).

4.2 DATA QUALITY OBJECTIVES

Detailed data quality objective (DQO) information can be found in Section 3.3 of the IMP. Groundwater monitoring wells at the Original Landfill are categorized as RCRA monitoring wells under the IMP and undergo a certain decision statement, as outlined in Section 3.3.9.4 of the IMP. The following flowchart will be used to guide the decision statement:


Quarterly groundwater monitoring
Compare upgradient and downgradient well concentrations with each other
Compare downgradient well concentrations to surface water standards (RFCA Attachment 5, Table 1)
Is there an increasing trend in downgradient versus upgradient monitoring wells?
No
Is the 85th percentile of data greater than the surface water standards or is there a significant increasing trend at 95%?
Yes
Yes
Consult RFCA parties

4.3 WELL LOCATIONS

Well locations have been chosen in compliance with the IMP (DOE 2005) and include a total of four RCRA groundwater monitoring wells (Figure 4-1). Locations were selected and approved by both CDPHE and EPA. Of these, one is upgradient, and three are downgradient of the Original Landfill.

Upgradient monitoring wells include well P416589. Downgradient monitoring wells include wells 80005, 80105, and 80205. Monitoring well details are summarized in Table 4-1. Boring logs are included in Appendix B.

4.4 GROUNDWATER QUALITY SAMPLE PARAMETERS

Groundwater samples will be submitted for laboratory analysis for the following EPA-approved methods, in accordance with the IM/IRA (DOE 2006):

- SW-846 Method 8260B – Volatile Organic Compounds (VOCs)
- SW-846 Method 6010B – Metals (including uranium)
- SW-846 Method 7470A – Mercury
- SW-846 Method 8270C – Semivolatile Organic Compounds (SVOCs)

The analytical results of these methods for those analytes listed in Table 2 of RFCA Attachment 5 will be reported (See Appendix C).

4.5 SAMPLING PROCEDURES SUMMARY

Groundwater sampling will be conducted in accordance with RFETS Standard Operating Procedures (SOPs). The following sections summarize the groundwater sampling procedures that will be used to monitor groundwater conditions at the Original Landfill. Details include groundwater level measurements, conventional groundwater purging and sampling procedures, quality control (QC) field samples, decontamination procedures, and investigation-derived waste (IDW) management.

4.5.1 Groundwater Level Measurement

Water levels are measured to determine groundwater flow patterns, water level fluctuations, and the volume of water in a well for the calculation of purge volumes prior to sampling. Because this plan requires measuring water levels from a group of monitoring wells for hydrologic evaluation, such measurements will be conducted as a complete round, separate from any sampling efforts. The four RCRA monitoring wells will be included during water level measurements. Water levels will be measured in accordance with RFETS SOPs.

4.5.2 Conventional Groundwater Purging and Sampling

Monitoring wells will be purged before samples are withdrawn to prevent collection of non-representative stagnant water in a well. Well purging will be sufficient to increase the likelihood that the water collected is representative of the groundwater within the formation around the well. All purging and sampling operations will be conducted in accordance with RFETS SOPs.

4.5.3 Quality Control Field Samples

During implementation of the field sampling program, field quality assurance (QA)/QC samples will be collected to assess the reproducibility of the field collection techniques, the quality of preservation techniques and sample bottles, and the effectiveness of field decontamination procedures. QA/QC procedures will be conducted in accordance with RFETS SOPs.

4.5.4 Decontamination

Equipment used in monitoring and sampling must be properly decontaminated. Decontamination must effectively eliminate the potential for cross-contamination between sampling locations and must be conducted using the appropriate materials to prevent the introduction of external contaminants (such as phosphate from detergents, aromatic hydrocarbons from motor vehicles, or oil and grease from dirty hands). Decontamination procedures will be conducted in accordance with RFETS SOPs.

4.5.5 Investigation-Derived Waste

IDW that will accumulate during groundwater monitoring includes decontamination and purge water. The management of IDW will be conducted in accordance with RFETS SOPs.

4.6 LABORATORY PROCEDURES SUMMARY

Analytical methodologies and reporting limits (RLs), data reporting procedures, laboratory QA/QC procedures, laboratory data validation and contractor validation procedures will be conducted in accordance with EPA-approved methods. Groundwater samples will be submitted to an EPA-approved analytical laboratory for the analyses listed in Section 4.4.

Sample results are reported according to laboratory analytical method SOPs 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.

4.7 DATA EVALUATION AND REPORTING

Groundwater monitoring results will be included in the Annual Original Landfill Monitoring Report~~s~~ discussed in Section 6.0. Groundwater monitoring will be conducted on a quarterly basis at the Original Landfill.

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5.0 SURFACE WATER MONITORING PLAN

As part of Original Landfill post-closure monitoring, surface water will be monitored at both upgradient and downgradient locations. This section presents the monitoring plan to determine whether surface water standards are met.

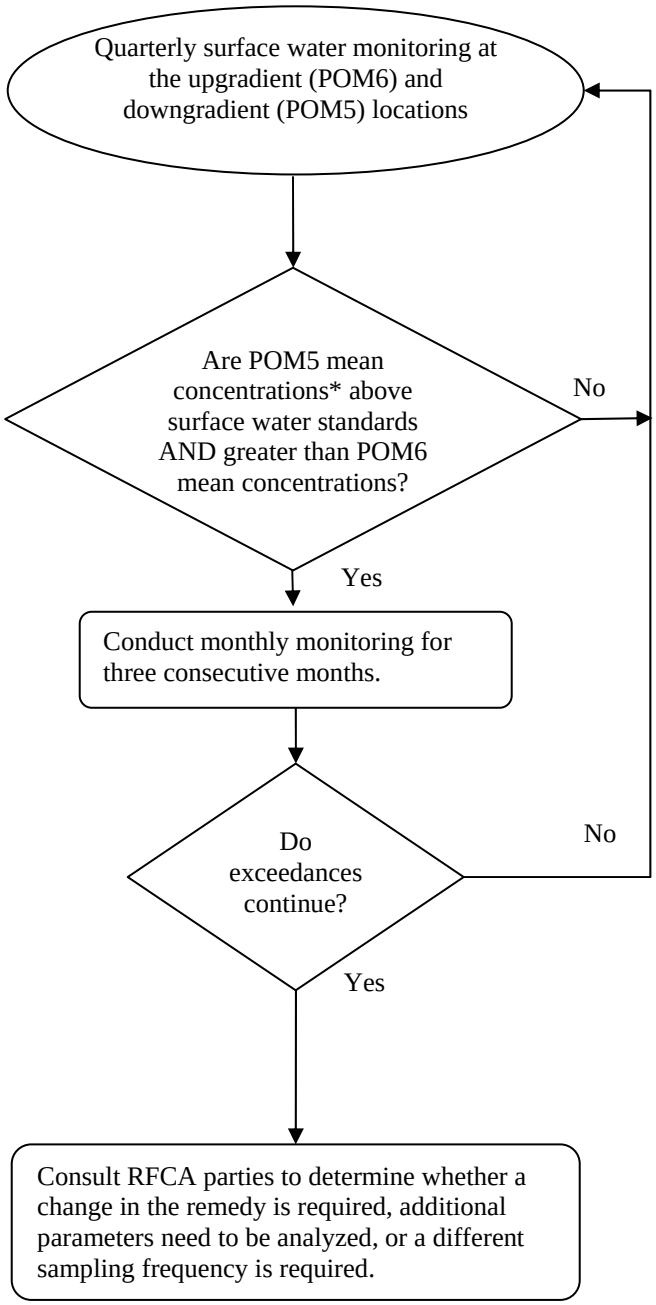
5.1 PURPOSE AND REQUIREMENTS

The Original Landfill surface water monitoring plan has been implemented to determine surface water quality impacts of the Original Landfill (DOE 2006). Applicable surface water standards are listed in the RFCA, Attachment 5, Table 1.

As detailed in the IM/IRA, monitoring requirements will consist of quarterly monitoring until the first CERCLA review. A validated exceedance of a surface water standard and value in the downstream station that is at least 50% greater than in the upstream station will trigger monthly monitoring for three consecutive months. Continued exceedances during the three-month period will trigger consultation between the RFCA parties to determine whether a change in the remedy is required, additional parameters need to be analyzed, or a different sampling frequency is required.

5.2 DATA QUALITY OBJECTIVES

Surface water monitoring DQO information can be found in the IMP, Section 2 (DOE 2005a). The following flowchart will be used to guide the decision statement.



*Mean concentration is the arithmetic average of individual results for the quarter

5.3 SAMPLE LOCATIONS

Sampling for water quality will be conducted at the two locations shown on Figure 4-1, POM5 (downgradient) and POM6 (upgradient)

5.4 SURFACE WATER SAMPLE PARAMETERS

Surface water samples will be submitted for laboratory analysis in accordance with the IM/IRA (DOE 2006) for the following EPA-approved method:

- SW-846 Method 8260B –VOCs
- SW-846 Method 6010B – Metals
- SW-846 Method 7470A – Mercury
- Alpha Spectrometry – Isotopic Uranium

The analytical results of these methods for those analytes listed in Table 1 of RFCA Attachment 5 will be reported.

5.5 SAMPLING PROCEDURES SUMMARY

The following sections detail the sampling procedures that will be used to monitor surface water. QC field samples, decontamination procedures, sample identification, and sample handling procedures are identical to those of the groundwater sampling.

Sampling Procedures

Surface water at the two locations will be sampled by directly placing a collection device or using a pond sampler device. The pond sampler can be purchased or easily fabricated with the following parts:

- One 250-milliliter (ml) polypropylene beaker (laboratory supply store);
- Adjustable clamp sized for 250-ml beakers (laboratory supply store);
- Aluminum telescoping tube equipped with bolt holes (swimming supply store); and
- Nuts/bolts to attach clamp to telescoping tube (hardware store).

Water from the sampler device will be poured directly into the sample containers. The device must be decontaminated in accordance with Section 4.5.4 between samples.

5.6 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 analyses in Section 5.4.

5.7 REPORTING AND SCHEDULING

Surface water sampling results will be included in the Annual Original Landfill Monitoring Report discussed in Section 6.0. Surface water monitoring will be conducted on a quarterly basis at the Original Landfill.

6.0 REPORTING AND CONTACT INFORMATION

6.1 REPORTING

The complete Annual Original Landfill Monitoring Report, including inspection results, repairs, groundwater monitoring data, and surface water monitoring data if applicable, will be submitted to the RFCA parties. Any maintenance action activities will be detailed in the report. If serious conditions occur at any time requiring immediate attention, the RFCA parties will be notified immediately. The Annual Original Landfill Monitoring Report will include at a minimum:

- Monthly vegetation inspection forms for the first two growing seasons;
- All inspection forms/reports for the year;
- Notations of problems, maintenance action(s) taken, and maintenance or repairs as a result of the inspections;
- Any deviations from the Original Landfill Monitoring and Maintenance 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 surface water results and associated qualifiers;
- Figures with groundwater monitoring points and location(s) of problems and/or repairs; and
- Groundwater and surface water sampling forms.

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

6.2 CONTACT INFORMATION

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

Scott Surovchak/Department of Energy
Rocky Flats Office of Legacy Management
12101 Airport Way, Unit A
Broomfield, CO 80021-2583
303-966-3551

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7.0 REFERENCES

Earth Tech, Inc., 2005, Final Design Analysis, Accelerated Action Design for the Original Landfill. May.

DOE, 1988, Remedial Investigation and Feasibility Study Plans for Low Priority Sites, Volume I – Site Descriptions, Groupings and Prioritization, June.

DOE, 1994, Technical Memorandum No. 15, Addendum to Final Phase I RFI/RI Work Plan, Amended Field Sampling Plan, Volume 2, Woman Creek Priority Drainage, Rocky Flats Plant, Golden, Colorado, May.

DOE, 2006, Final Interim Measure/Interim Remedial Action for the Original Landfill, Rocky Flats Environmental Technology Site, Golden, Colorado, Minor Modification, January.

DOE, 2005a, RFETS Integrated Monitoring Plan FY2005, Revision 1, Background Document; Rocky Flats Environmental Technology Site, Golden, Colorado, September.

DOE, 2005b, Rocky Flats, Colorado, Site Revegetation Plan, Rocky Flats Office of Legacy Management; Broomfield, Colorado, September

DOE, 2005c, Rocky Flats, Colorado, Site Vegetation Management Plan, Rocky Flats Office of Legacy Management, Broomfield, Colorado, December.

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TABLES

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TABLE 4-1
GROUNDWATER MONITORING WELLS
ORIGINAL LANDFILL

Well ID	Type	Installation Date	Screen Length (feet)	Borehole Depth (feet bgs)	Well Diameter (inches)	Depth to Top of Screen (feet bgs)	Depth to Bedrock (feet bgs)
P416589	upgradient	9/14/89	4	36.5	2	27.05	30.50
80005	downgradient	8/9/05	15	21.0	2	5.80	7.10
80105	downgradient	8/8/05	15	20.1	2	4.95	7.50
80205	downgradient	8/10/05	15	19.8	2	4.75	8.35

Notes:
bgs below ground surface

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FIGURES

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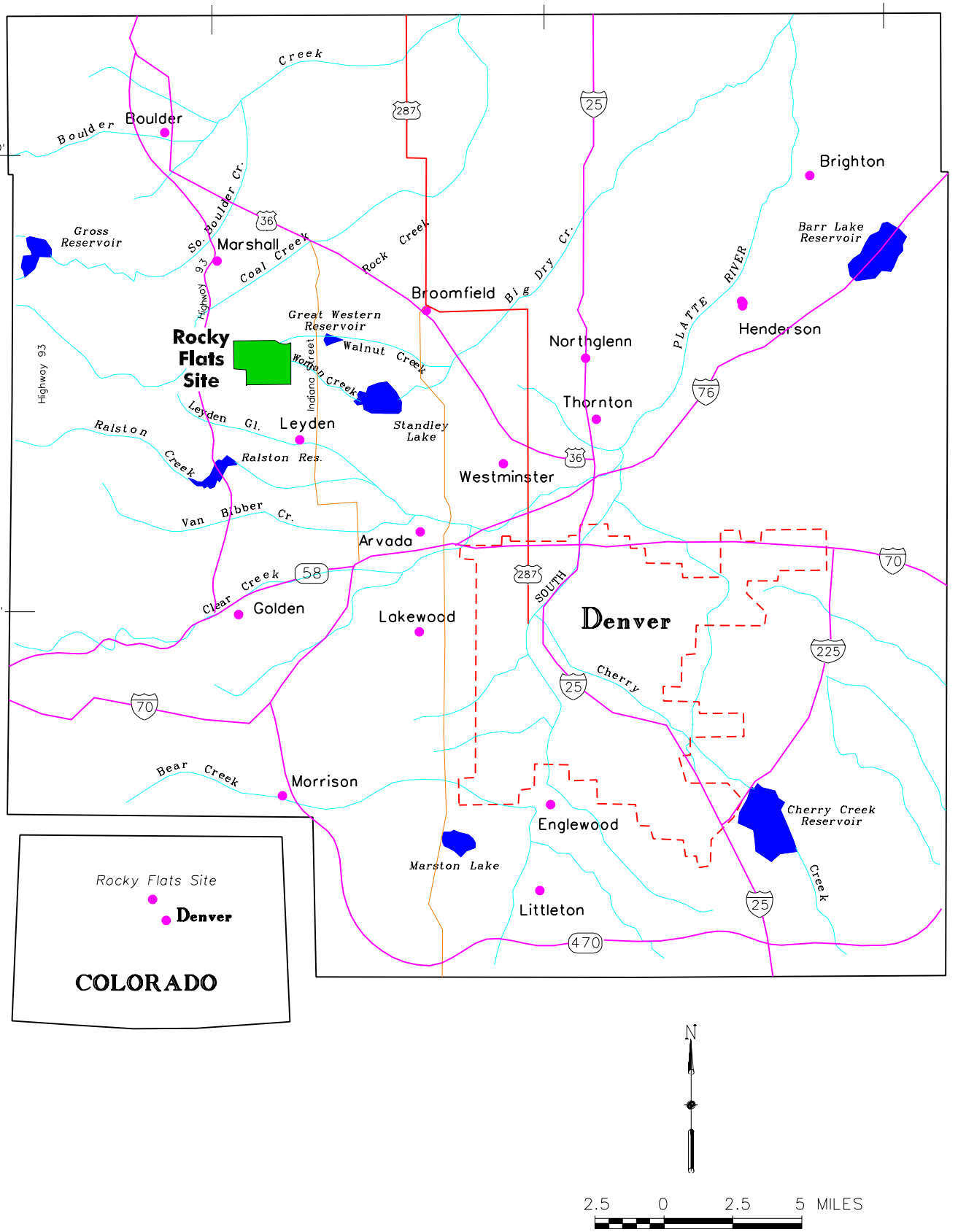

DATE: 12/8/2004

CAD FILE: GROUP\CAD\ROCKY_FLATS\NEWDESIGN_2004\PLFMM\LOCATION.DGN

EARTH TECH

FIGURE 1–1

LOCATION MAP

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

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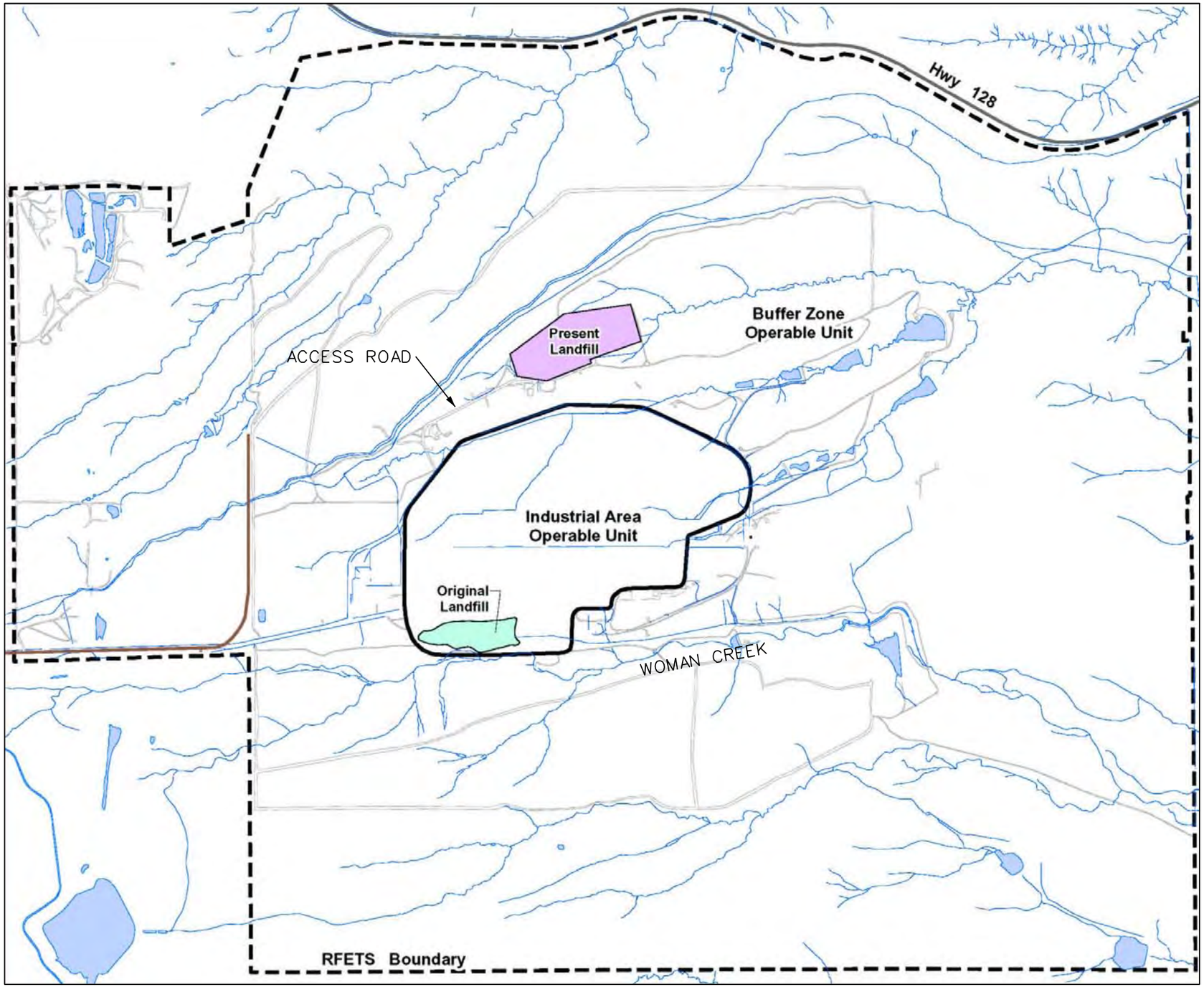
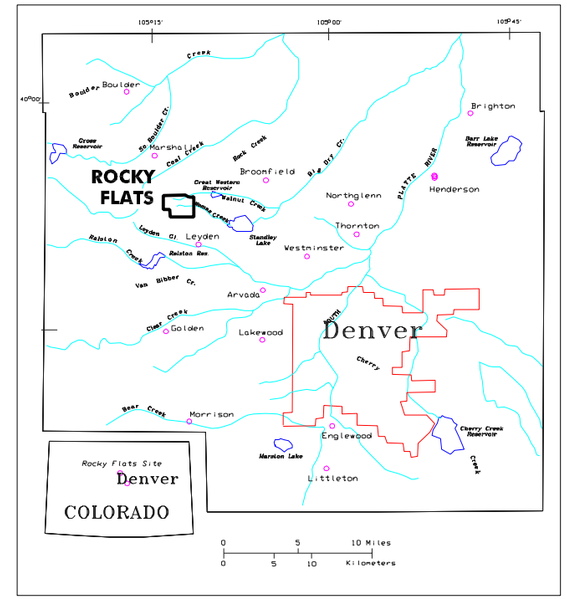




N

EARTH TECH

FIGURE 1–2

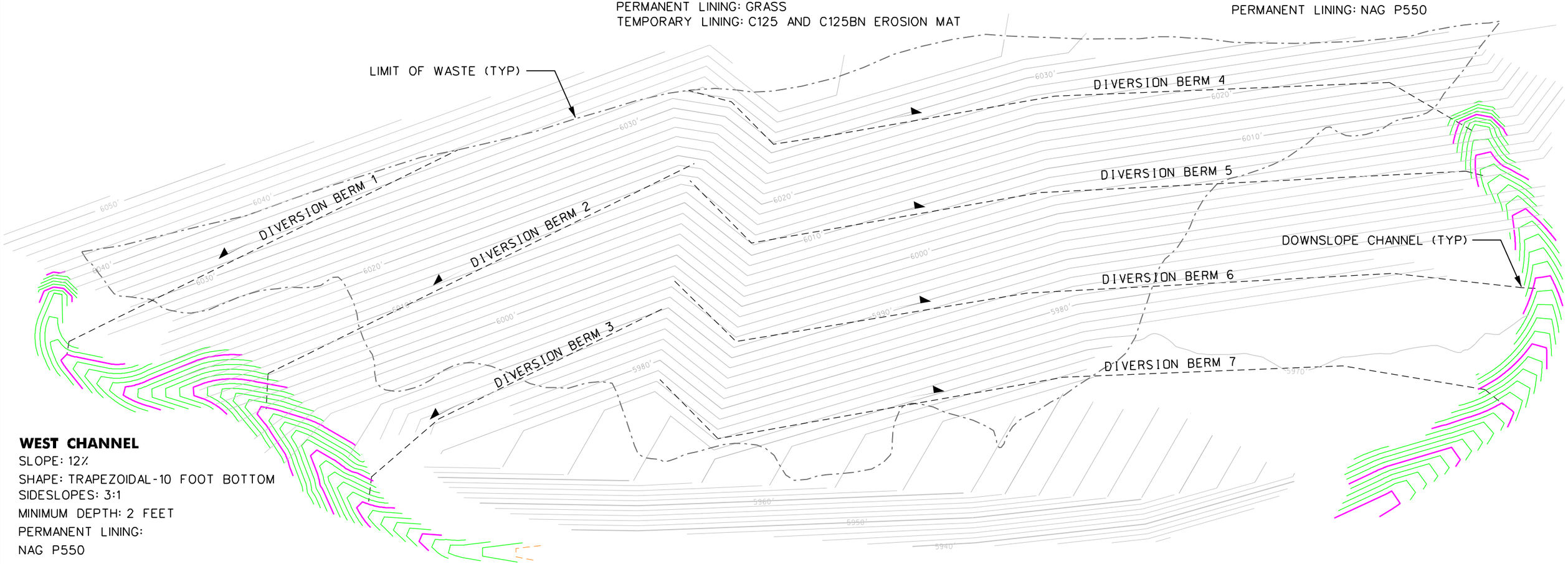
ORIGINAL LANDFILL SITE MAP

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

L:\GROUP\CAD\ROCKY_FLATS\OLF_805Figs\HaulRte1.dgn DATE: 8/23/05

DIVERSION BERMS 1,2,3,4,5,6,7
SLOPE: 2%
SHAPE: TRIANGULAR
HEIGHT: 3 FEET
PERMANENT LINING: GRASS
TEMPORARY LINING: C125 AND C125BN EROSION MAT

EAST CHANNEL
SLOPE: 12%
SHAPE: TRAPEZOIDAL-18 FOOT BOTTOM
SIDESLOPES: 3:1 TO 4:1
MINIMUM DEPTH: 2 FEET
PERMANENT LINING: NAG P550



WEST CHANNEL
SLOPE: 12%
SHAPE: TRAPEZOIDAL-10 FOOT BOTTOM
SIDESLOPES: 3:1
MINIMUM DEPTH: 2 FEET
PERMANENT LINING:
NAG P550

N

60 0 60 120 FEET

LEGEND
- - - - DIVERSION BERM
CHANNEL
— · — · LIMIT OF WASTE

E A R T H T E C H

FIGURE 2-1

ORIGINAL LANDFILL COVER

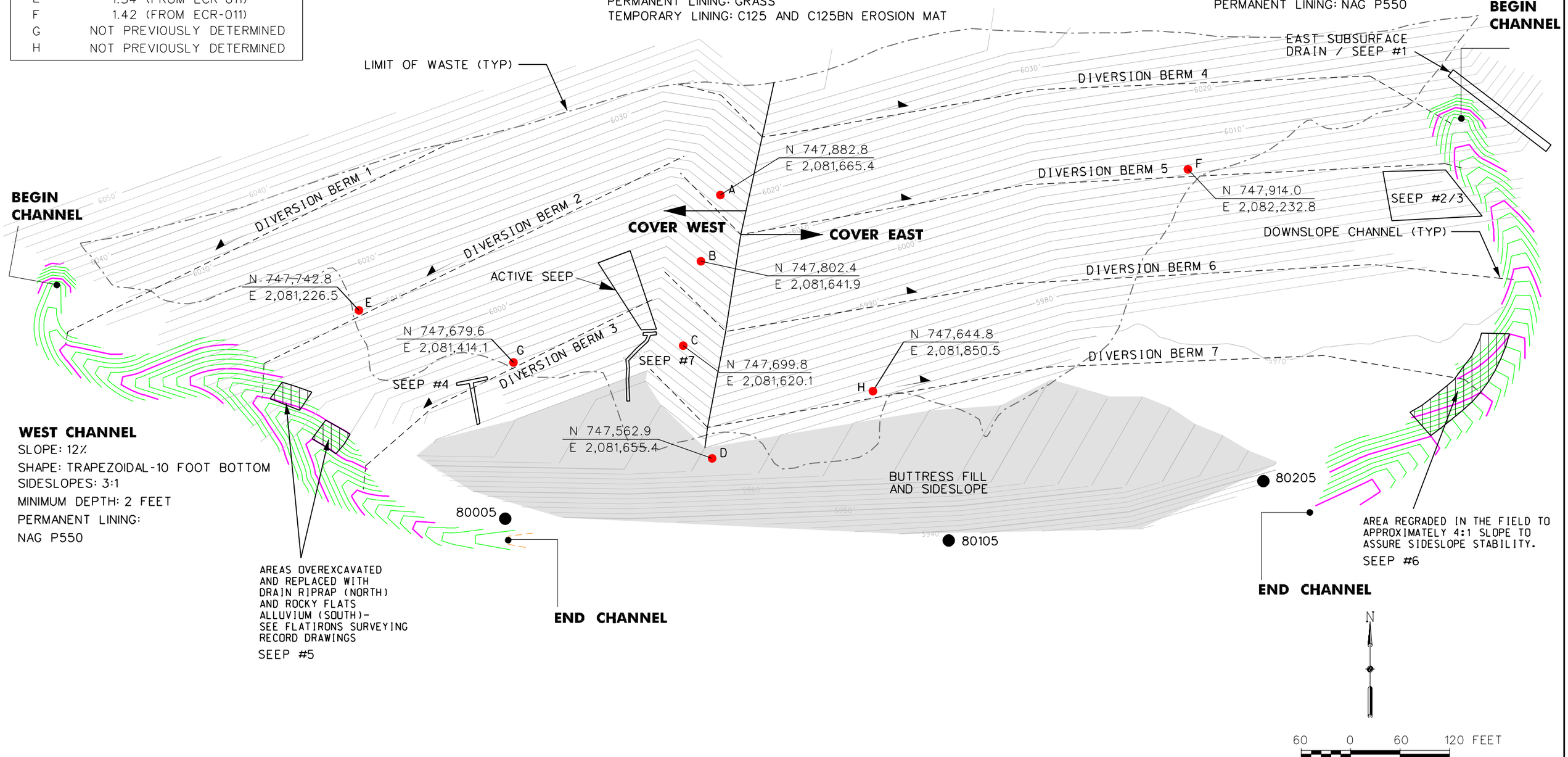
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

L\GROUP\CAD\ROCKY_FLATS\OLF_805Figs\Surfrev2.dgn DATE: 12/8/04

POINT	CALCULATED SETTLEMENT (FT)
A	2.86
B	2.54
C	1.45
D	1.99
E	1.34 (FROM ECR-011)
F	1.42 (FROM ECR-011)
G	NOT PREVIOUSLY DETERMINED
H	NOT PREVIOUSLY DETERMINED

DIVERSION BERMS 1,2,3,4,5,6,7
SLOPE: 2%
SHAPE: TRIANGULAR
HEIGHT: 3 FEET
PERMANENT LINING: GRASS
TEMPORARY LINING: C125 AND C125BN EROSION MAT

EAST CHANNEL
SLOPE: 12%
SHAPE: TRAPEZOIDAL-18 FOOT BOTTOM
SIDESLOPES: 3:1 TO 4:1
MINIMUM DEPTH: 2 FEET
PERMANENT LINING: NAG P550



WEST CHANNEL
SLOPE: 12%
SHAPE: TRAPEZOIDAL-10 FOOT BOTTOM
SIDESLOPES: 3:1
MINIMUM DEPTH: 2 FEET
PERMANENT LINING:
NAG P550

AREAS OVEREXCAVATED AND REPLACED WITH DRAIN RIPRAP (NORTH) AND ROCKY FLATS ALLUVIUM (SOUTH)- SEE FLATIRONS SURVEYING RECORD DRAWINGS
SEEP #5

LEGEND
- DIVERSION BERM
- CHANNEL
- LIMIT OF WASTE
- GROUNDWATER MONITORING WELL
- SETTLEMENT MONITORING LOCATION

EARTH TECH

FIGURE 3-1
ORIGINAL LANDFILL INSPECTIONS
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

L:\GROUP\CAD\ROCKY_FLATS\OLF_805Figs\fig3-1new.dgn DATE: 2/07/06

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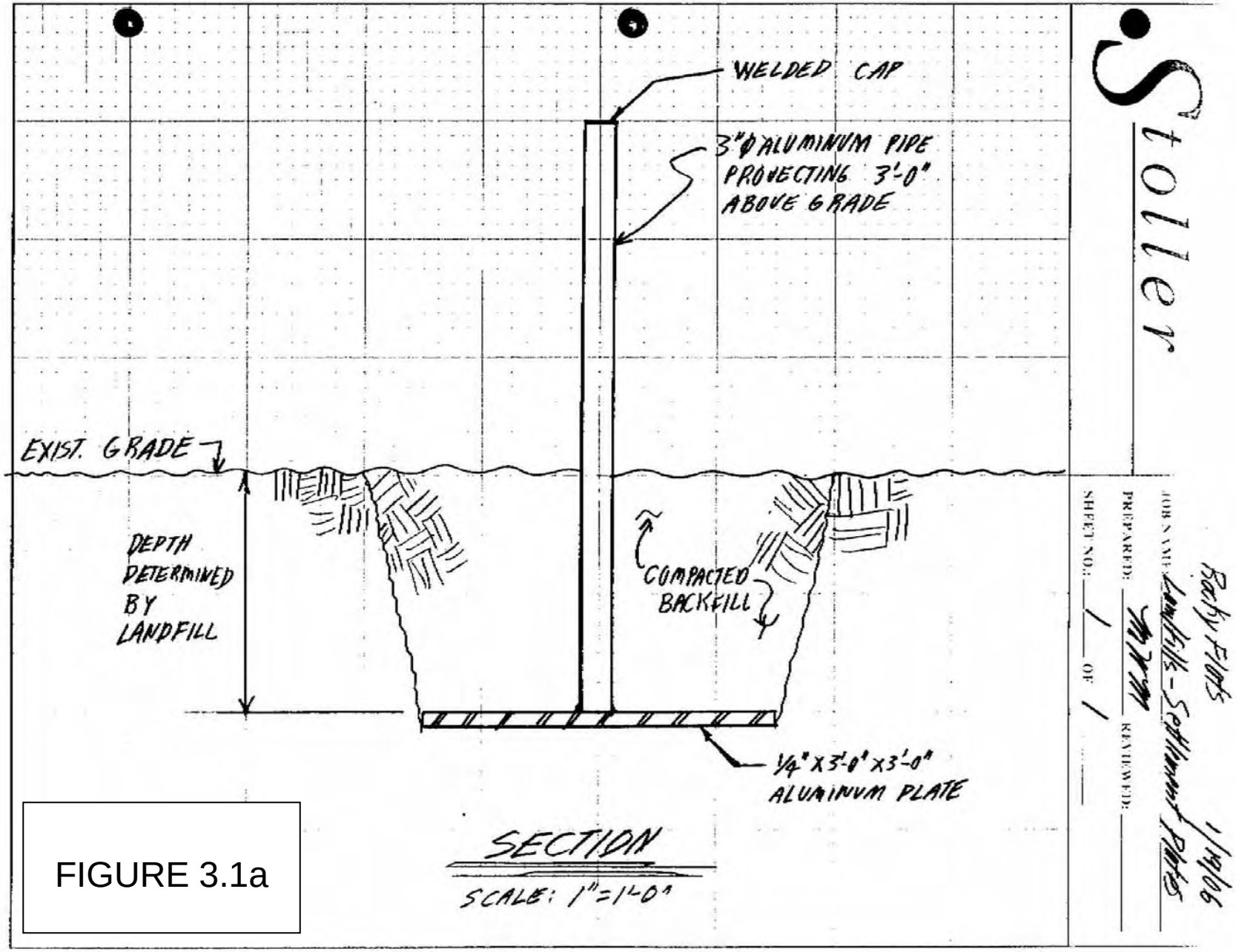
WELDED CAP
3"Ø ALUMINUM PIPE PROJECTING 3'-0" ABOVE GRADE
EXIST. GRADE
DEPTH DETERMINED BY LANDFILL
COMPACTED BACKFILL
1/4" X 3'-0" X 3'-0" ALUMINUM PLATE
SECTION
SCALE: 1"=1'-0"
Stoller
JOB NAME: Lowell Hill - Schlumpf Plots
PREPARED:
REVIEWED:
SHEET NO: 1 OF 1
Rocky Flats
1/19/06

FIGURE 3.1a

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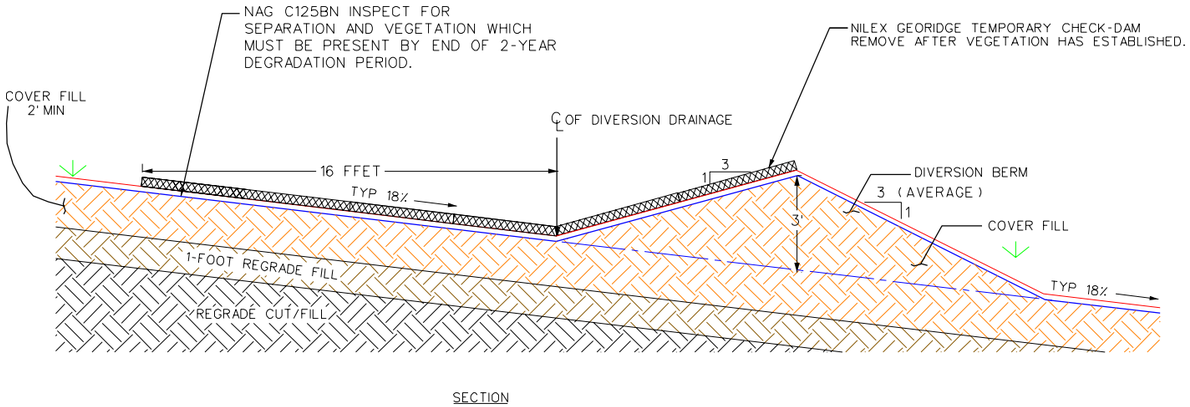
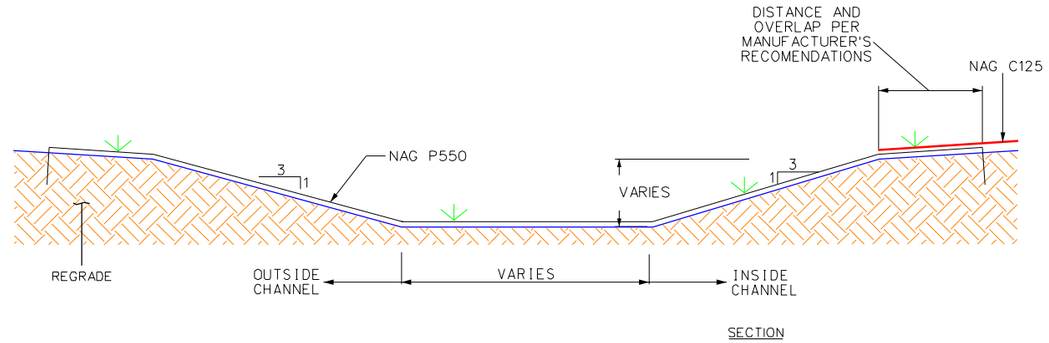


NOTE: IN AREAS OUTSIDE OF THE WASTE "FOOTPRINT" COVER SOIL MAY BE LESS THAN 2' (IN TRANSITION AREAS) OR NO COVER SOIL

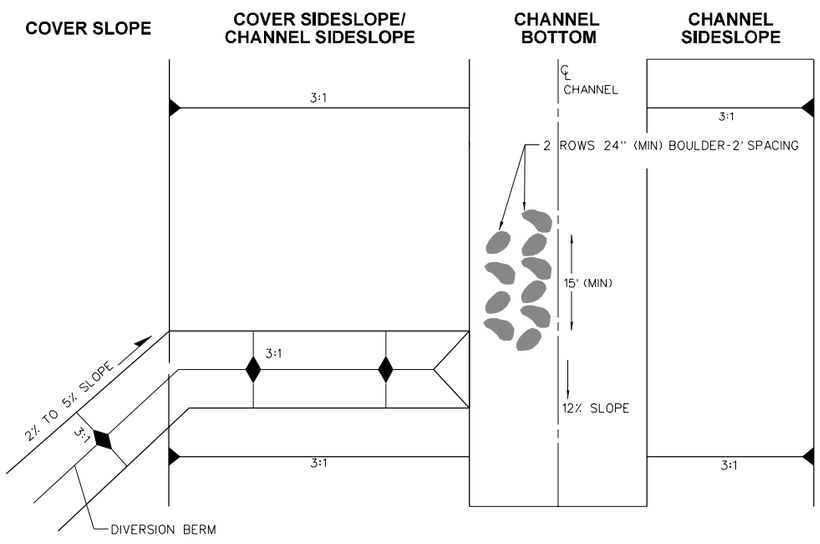
DIVERSION BERM (SECTION)

NTS



PERMANENT/GRASS-LINED CHANNEL DETAIL (SECTION)

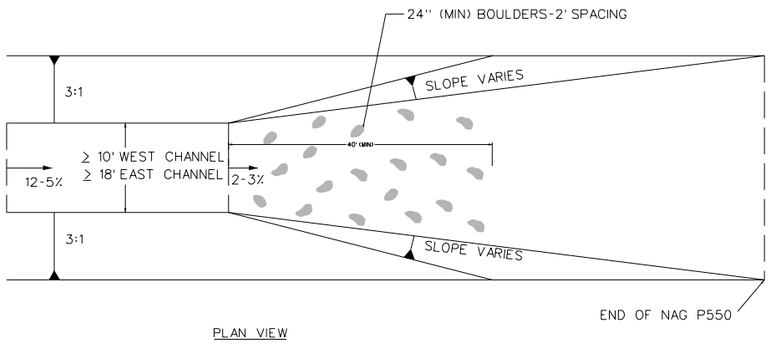
NTS



NOTE: NAG P550 EROSION MAT ON CHANNEL BOTTOM, CHANNEL SIDESLOPES, DOWNSLOPE CHANNEL BOTTOM, AND DOWNSLOPE CHANNEL SIDESLOPES.

DOWNSLOPE CHANNEL TRANSITION FROM DIVERSION BERM TO CHANNEL (PLAN VIEW)

NTS



END CHANNEL (PLAN VIEW)

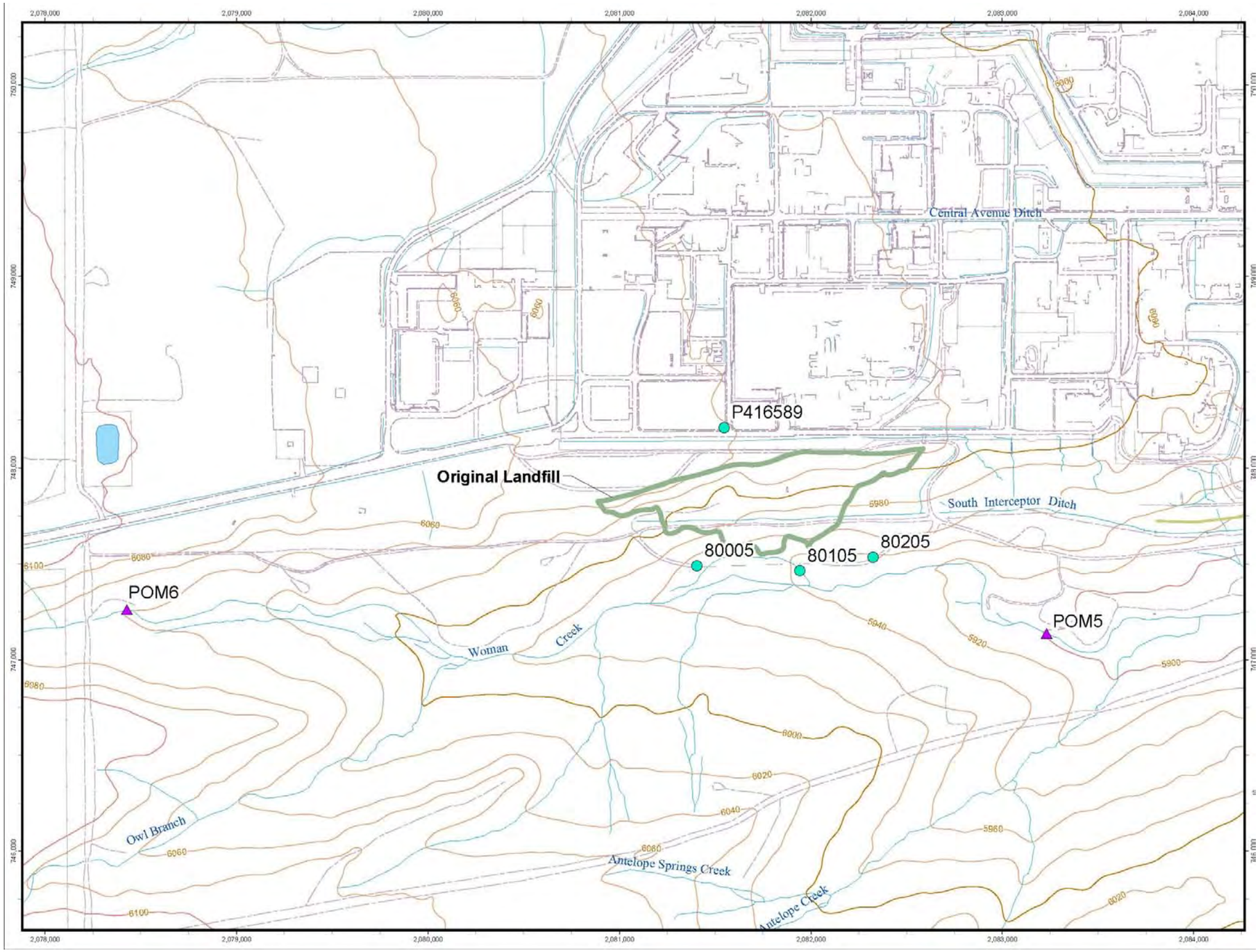
NTS

E A R T H T E C H

FIGURE 3–2

ORIGINAL LANDFILL STORMWATER MANAGEMENT STRUCTURE DETAILS

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO



N

250 0 250 500 FEET

E A R T H T E C H

FIGURE 4–1

ORIGINAL LANDFILL GROUNDWATER AND SURFACE WATER MONITORING

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

L\GROUP\CAD\ROCKY_FLATS\OLF_805Figs\GwSurf.dgn DATE: 8/26/05

APPENDIX A

ORIGINAL LANDFILL – MONITORING AND MAINTENANCE PROGRAM INSPECTION FORM

ORIGINAL LANDFILL – MONITORING AND MAINTENANCE PROGRAM

INSPECTION FORM

INSPECTOR: _____ DATE: _____TIME:_____REVIEWED BY:_____

TEMPERATURE: _____ WEATHER CONDITIONS: _____ REVIEW DATE:_____

METEOROLOGICAL STATION LOCATION: _____

SUBSIDENCE / CONSOLIDATION

REGION	EVIDENCE OF CRACKS?	EVIDENCE OF DEPRESSIONS?	EVIDENCE OF SINK HOLES?	EVIDENCE OF PONDING?	OTHER (DESCRIBE BELOW)
COVER – WEST	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	
COVER – EAST	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	
BUTTRESS FILL	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	
DIVERSION BERM 1	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	
DIVERSION BERM 2	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	
DIVERSION BERM 3	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	
DIVERSION BERM 4	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	
DIVERSION BERM 5	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	
DIVERSION BERM 6	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	
DIVERSION BERM 7	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	

Settlement Plates on Top of cover to be inspected for integrity.
During Year 1, they will be surveyed quarterly, and annually thereafter.

Integrity intact?
☐ Yes ☐ No

MAINTENANCE REQUIRED / COMMENTS/PHOTO LOG

_____

_____

_____

SLOPE STABILITY

REGION	EVIDENCE OF SEEPS?	EVIDENCE OF BLOCK OR CIRCULAR FAILURE?	EVIDENCE OF SEEPS?	OTHER? (DESCRIBE BELOW)
COVER – WEST	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	
COVER – EAST	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	
BUTTRESS FILL SIDESLOPE	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	
WEST PERIMETER CHANNEL SIDESLOPES	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	
EAST PERIMETER CHANNEL SIDESLOPES	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	
COVER SEEPS (IF PRESENT)	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	
			☐ Yes ☐ No	
			☐ Yes ☐ No	

MAINTENANCE REQUIRED / COMMENTS/PHOTO LOG

SOIL COVER

REGION	EVIDENCE OF SOIL DEPOSITION OR EROSION?	EVIDENCE OF EROSION RILLS/GULLIES?	EVIDENCE OF BURROWING ANIMALS?	OTHER (DESCRIBE BELOW)
COVER – WEST	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	
COVER – EAST	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	
BUTTRESS FILL	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	
BUTTRESS FILL SIDESLOPE	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	

MAINTENANCE REQUIRED / COMMENTS/PHOTO LOG

VEGETATION

REGION	CONDITION OF GRASS	UNWANTED VEGETATION PRESENT*?	PERCENTAGE OF GRASS VERSUS BARE GROUND?	PERCENTAGE OF UNWANTED VEGETATION?
COVER- WEST		☐ Yes ☐ No		
COVER - EAST		☐ Yes ☐ No		
DIVERSION BERM 1		☐ Yes ☐ No		
DIVERSION BERM 2		☐ Yes ☐ No		
DIVERSION BERM 3		☐ Yes ☐ No		
DIVERSION BERM 4		☐ Yes ☐ No		
DIVERSION BERM 5		☐ Yes ☐ No		
DIVERSION BERM 6		☐ Yes ☐ No		
DIVERSION BERM 7		☐ Yes ☐ No		
WEST PERIMETER CHANNEL		☐ Yes ☐ No		
EAST PERIMETER CHANNEL		☐ Yes ☐ No		
UPPER BUTTERESS FILL SIDESLOPE		☐ Yes ☐ No		
LOWER BUTTRESS FILL SIDESLPOE		☐ Yes ☐ No		

* Unwanted vegetation includes weeds and deep-rooting trees.

MAINTENANCE REQUIRED / COMMENTS/PHOTO LOG

STORMWATER MANAGEMENT STRUCTURES

CHANNELS / LINING

STRUCTURE	EVIDENCE OF EXCESSIVE EROSION, GULLYING, SCOUR, OR UNDERMINING?	EVIDENCE OF SETTLEMENT/ SUBSIDENCE OR DEPRESSIONS?	EVIDENCE OF BREACHING OR BANK FAILURE?	EVIDENCE OF BURROWING ANIMALS?	EVIDENCE OF SEDIMENT BUILD-UP OR OTHER BLOCKAGE?	EVIDENCE OF LINING DETERIORATION, HOLES, RIPS, OR SEPARATION?	EVIDENCE OF LINING DISPLACEMENT?
DIVERSION BERM 1	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No
DIVERSION BERM 2	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No
DIVERSION BERM 3	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No
DIVERSION BERM 4	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No
DIVERSION BERM 5	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No
DIVERSION BERM 6	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No
DIVERSION BERM 7	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No
CHECK DAMS	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No
WEST PERIMETER CHANNEL	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No
EAST PERIMETER CHANNEL	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No

OTHER DEFICIENCIES?

MAINTENANCE REQUIRED / COMMENTS/PHOTO LOG

STORMWATER MANAGEMENT STRUCTURES (CONTINUED)

OUTFALLS

CHECK EACH STRUCTURE FOR EXCESSIVE EROSION AND SEDIMENT DEPTH. IF SEDIMENT DEPTH IS COMPROMISING THE DESIGN CHARACTERISTICS, REMOVE SEDIMENT.

STRUCTURE	CONDITION / SEDIMENT DEPTH
DIVERSION BERM OUTFALL 1	
DIVERSION BERM OUTFALL 2	
DIVERSION BERM OUTFALL 3	
DIVERSION BERM OUTFALL 4	
DIVERSION BERM OUTFALL 5	
DIVERSION BERM OUTFALL 6	
DIVERSION BERM OUTFALL 7	
WEST PERIMETER CHANNEL OUTFALL	
EAST PERIMETER CHANNEL OUTFALL	
FRENCH DRAIN OUTFALL (SID)	

OTHER DEFICIENCIES?

MAINTENANCE REQUIRED / COMMENTS/PHOTO LOG

"RUN-ON" CONTROL

AREA	ADVERSELY AFFECTING OLF?		
NORTH OF THE ORIGINAL LANDFILL	☐ Yes	☐ No	COMMENT:
WEST OF THE WEST PERIMETER CHANNEL	☐ Yes	☐ No	COMMENT:
EAST OF THE EAST PERIMETER CHANNEL	☐ Yes	☐ No	COMMENT:
NORTH OF WOMAN CREEK	☐ Yes	☐ No	COMMENT:

MAINTENANCE REQUIRED

INSTITUTIONAL CONTROLS

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

OTHER DEFICIENCIES/PHOTO LOG

ACTION ITEMS

DEFICIENCY	DATE NOTED	ACTION	DATE COMPLETED	COMMENTS

INSPECTOR SIGNATURE: _____ DATE: _____

REVIEWER SIGNATURE: _____ DATE:_____

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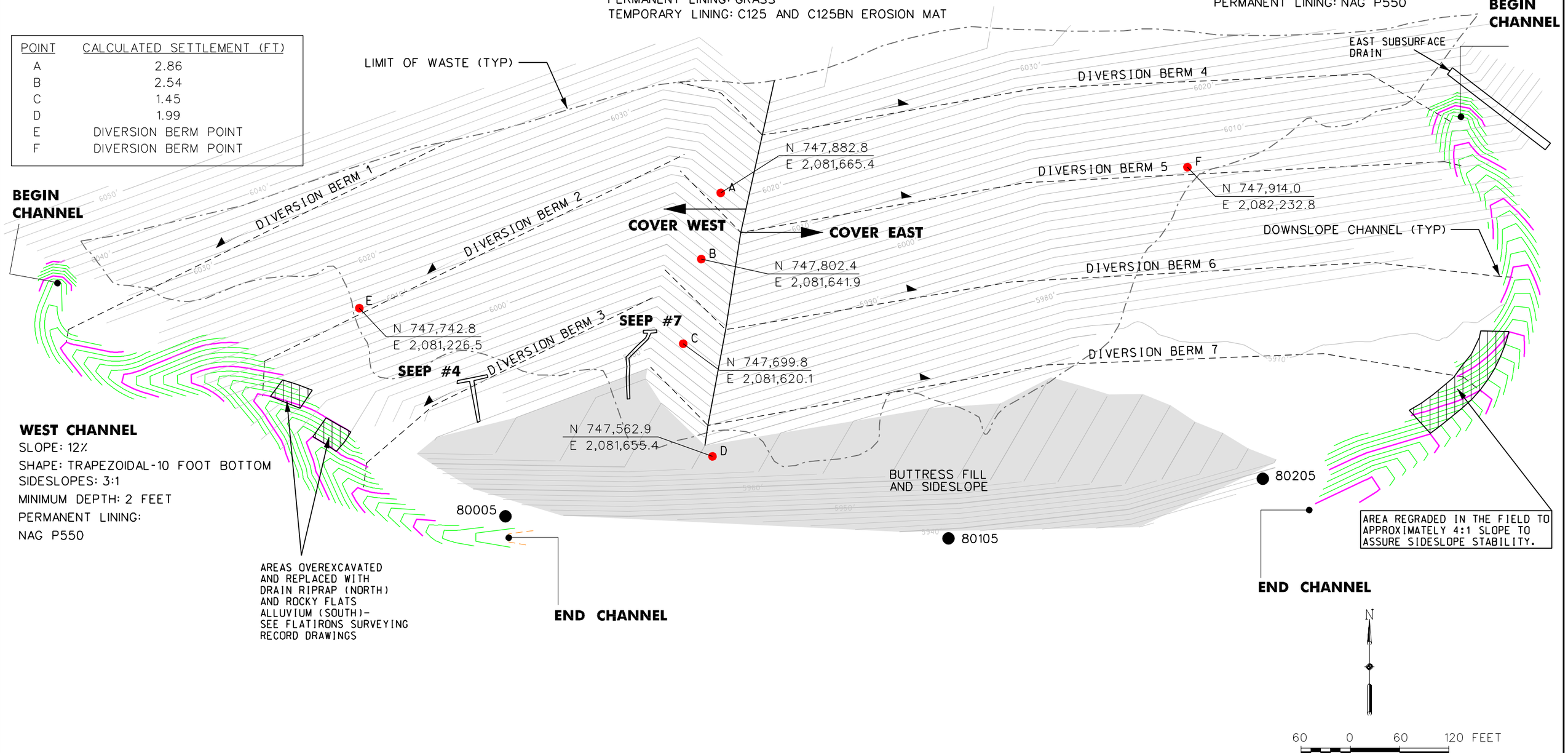
DIVERSION BERMS 1,2,3,4,5,6,7
SLOPE: 2%
SHAPE: TRIANGULAR
HEIGHT: 3 FEET
PERMANENT LINING: GRASS
TEMPORARY LINING: C125 AND C125BN EROSION MAT

EAST CHANNEL
SLOPE: 12%
SHAPE: TRAPEZOIDAL-18 FOOT BOTTOM
SIDESLOPES: 3:1 TO 4:1
MINIMUM DEPTH: 2 FEET
PERMANENT LINING: NAG P550

POINT	CALCULATED SETTLEMENT (FT)
A	2.86
B	2.54
C	1.45
D	1.99
E	DIVERSION BERM POINT
F	DIVERSION BERM POINT



WEST CHANNEL
SLOPE: 12%
SHAPE: TRAPEZOIDAL-10 FOOT BOTTOM
SIDESLOPES: 3:1
MINIMUM DEPTH: 2 FEET
PERMANENT LINING:
NAG P550

AREAS OVEREXCAVATED AND REPLACED WITH DRAIN RIPRAP (NORTH) AND ROCKY FLATS ALLUVIUM (SOUTH)- SEE FLATIRONS SURVEYING RECORD DRAWINGS

LEGEND
- DIVERSION BERM
- CHANNEL
- LIMIT OF WASTE
- GROUNDWATER MONITORING WELL
- SETTLEMENT MONITORING LOCATION

E A R T H T E C H

FIGURE 3-1
ORIGINAL LANDFILL INSPECTIONS
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

L\GROUP\CAD\ROCKY_FLATS\OLF_805Figs\fig3-1new.dgn DATE: 1/12/06

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APPENDIX B

GROUNDWATER WELL BORING LOGS / CONSTRUCTION SUMMARIES

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STATE PLANE COORDINATE		TOTAL DEPTH (FT) 36 5	GROUND ELEVATION (FT)	6041.20	OLD WELL NUMBER	P260-89	LOG OF BORING NUMBER
NORTH:	748211	AREA: PLANT	CASING DIAMETER (IN)	2-3/8 O.D.	GEOLOGIST	SPC	P416589
EAST	2081546	LOCATOR NUMBER: I8	BOREHOLE DIAMETER (IN)	7 25	DATE DRILLED	09/14/89	

REMARKS: Hollow Stem Auger Weston Log

GEOTECHNICAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE	PERCENT RECOVERY	RECOVERY/ INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
										Asphalt
					6041	0			SM	Silty Sand - olive gray (5 Y 4/1), non-stratified F g. to v c g sand Trace gravel, poor sorting, sub-angular, quartzose, granite Dense, moist
	P76089002			2.00 /2.00	6040	1			CL	Gravelly Sandy Clay - olive black (5 Y 2/2), mod. brown (5 YR 3/4), mod reddish brown (10 R 4/6), non-stratified F g to v c g sand 1 cm to 4 cm gravel, poor sorting, sub-angular, quartzose. Very stiff, low plasticity, moist
	P76089003									
					6039	2			CL	Gravelly Sandy Clay - same as above, no olive black
									CL	Gravelly Sandy Clay - same as above. Varicolored, with grayish red (5 R 4/2), light brown (5 YR 5/6) Trace cobbles
	P76089004			1.40 /2.00	6038	3				
					6037	4			SC	Gravelly Clayey Sand - light brown (5 YR 5/6), pale yellowish brown (10 YR 6/2), non-stratified F g. to v c.g sand, 1 cm to 7 cm gravel, some silt, trace cobbles, poor sorting, sub-angular, quartzose Low to no plasticity, dense, moist
	P76089006									
	P76089007			1.10 /2.00	6036	5				
					6035	6			SC	Gravelly Clayey Sand - same as above Calcareous in part
	P76089008			1.20 /2.00	6034	7				
					6033	8			SC	Gravelly Clayey Sand - same as above, as indicated by cuttings
				0.00 /2.00	6032	9				
						10				

STATE PLANE COORDINATE		TOTAL DEPTH (FT) 36.5	GROUND ELEVATION (FT)	6041.20	OLD WELL NUMBER:	P260-89	LOG OF BORING NUMBER
NORTH	748211	AREA: PLANT	CASING DIAMETER (IN)	2-3/8 O.D	GEOLOGIST	SPC	P416589
EAST	2081546	LOCATOR NUMBER I8	BOREHOLE DIAMETER (IN)	7.25	DATE DRILLED	09/14/89	

REMARKS: Hollow Stem Auger Weston Log.

CHEMICAL SAMPLE DEPTH / GEOTECHNICAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE (0% 50% 100%)	PERCENT RECOVERY (0% 100%)	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
				0.00/1.00	6031	10			SC	Gravelly Clayey Sand - same as above, as indicated by cuttings.
				0.00/1.00	6030	11			SC	Gravelly Clayey Sand - same as above, as indicated by cuttings.
	P260891214 P260891216			1.50/2.00	6029 6028	12 13			SC	Gravelly Clayey Sand - banded, varicolored, mod red (5 R 5/4), pale reddish brown (10 R 5/4), light brown (5 YR 5/6), dark yellowish orange (10 YR 6/6), yellowish gray (5 Y 7/2), non-stratified F g to v c g sand, some gravel, some silt, poor sorting, sub-angular, quartzose. Low plasticity, iron staining, calcareous 0.5 cm. lense of Silty Clay, dense to med dense, damp.
	P260891415			0.40/0.70	6027	14			SC	Gravelly Clayey Sand - same as above, with scattered cobbles.
				0.00/1.30	6026	15			NO SAMPLE	NO SAMPLE.
	P260891618 P260891620			1.30/2.00	6025 6024	16 17			SC	Gravelly Clayey Sand - same as above Increased clay content
	P260891820			0.90/2.00	6023 6022	18 19			SM	Gravelly Silty Sand - same as above Light brown (5 YR 5/6), light olive gray (5 Y 6/1) Some clay, quartzose.
						20				

STATE PLANE COORDINATE		TOTAL DEPTH (FT) 36 5	GROUND ELEVATION (FT)	6041 20	OLD WELL NUMBER:	P260-89	LOG OF BORING NUMBER:
NORTH:	748211	AREA: PLANT	CASING DIAMETER (IN)	2-3/8 0.0	GEOLOGIST	SPC	P416589
EAST	2081546	LOCATOR NUMBER I8	BOREHOLE DIAMETER (IN)	7 25	DATE DRILLED	09/14/89	

REMARKS: Hollow Stem Auger Weston Log

CHEMICAL SAMPLE DEPTH / GEOTECHNICAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE	PERCENT RECOVERY	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
					6021	20			SC	Gravelly Clayey Sand - same as above Light brown (5 YR 5/6), pale yellowish orange (10 YR 8/6), pale reddish brown (10 R 5/4), banded No cobbles
	P6092022			2.00 /2.00	6020	21				
	P6092024									
					6019	22			SC	Gravelly Clayey Sand - same as above Trace cobbles, quartzose to granites
	P6092224			0.90 /2.00	6018	23				
					6017	24			SC	Gravelly Clayey Sand - same as above, with very thin lenses (3 cm.) of very Silty Sand at 25.3' to 25.4'
	P6092426			1.60 /2.00	6016	25				
	P6092428				6015	26			CL	Gravelly Sandy Clay - same as above
							01/16/90		CL	Sandy Clay - pale reddish brown (10 R 5/4), dark yellowish orange (10 YR 6/6), light olive gray (5 Y 6/1), mottled, non-stratified V f g to f g sand. Some silt, very stiff, med plasticity, damp
	P6092628			2.00 /2.00	6014	27				
							09/14/89		SC	Clayey Sand - mod. reddish brown (10 R 4/6), light brown (5 YR 5/6), non-stratified F g to c g sand, some silt, poor sorting, sub-angular Iron staining, low plasticity, dense, damp
					6013	28				
	P6092830			1.40 /2.00	6012	29			SM	Silty Sand - same as above Some clay Trace of gravel, no plasticity, wet
	P6092831					30				

STATE PLANE COORDINATE		TOTAL DEPTH (FT) 36.5	GROUND ELEVATION (FT)	6041.20	OLD WELL NUMBER:	P260-89	LOG OF BORING NUMBER:
NORTH:	749211	AREA: PLANT	CASING DIAMETER (IN)	2-3/8 O.D.	GEOLOGIST:	SPC	P416589
EAST	2081546	LOCATOR NUMBER: I8	BOREHOLE DIAMETER (IN)	7.25	DATE DRILLED	09/14/89	

REMARKS: Hollow Stem Auger Weston Log.

CHEMICAL SAMPLE DEPTH / GEOTECHNICAL SAMPLE DEPTH	SAMPLE NUMBER	SAMPLE GRAIN SIZE	PERCENT RECOVERY	RECOVERY/INTERVAL	DATUM (FT)	DEPTH (FT)	WELL OR PIEZOMETER CONSTRUCTION	LITHOLOGY	UNIFIED SOILS CLASSIFICATION OR ROCK TYPE	DESCRIPTION
					6011	30			SM:	Silty Gravelly Sand - same as above
	P260893032			2.00 /2.00	6010	31			CLAYSTONE	Top of Bedrock Yellowish gray (5 Y 7/2), dusky yellowish orange (10 YR 6/6), mottled, blocky, med. high plasticity, weathered, oxidized, med. hard, damp, minor silty sand laminations
	P260893234				6009	32			CLAYSTONE	Same as above
	P260893135			0.20 /2.00	6008	33				
	P260893436			0.40 /1.00	6007	34			CLAYSTONE	Same as above - silty Trace sand, med plastic
					6006	35			CLAYSTONE	Same as above - some silt to silty
	P260893537			1.50 /1.50	6005	36				
					6004	37				TD = 36.5'
					6003	38				
					6002	39				
						40				

STATE PLANE COORDINATES AREA: GRND ELEV. (FT): 5957.54 CASING DIA (IN): 2"
NORTH: 747489.979 TOTAL DEPTH (FT): 21.0 BH DIA. (IN): 8"
EAST: 2081404.042 COMPLETION DATE: 8/9/05 GRID LOCATOR:
PROJECT: Original Landfill GEOLOGIST: E. Warp
REMARKS:
Routine well installation

LOG OF BORING NUMBER: 80005

Elev (Ft)	Well or Piezometer Construction and Materials	Depth (Ft)	Lithology	Unified Soils Classification or Rock Type	Lithologic Description
5961					
	Protective Casing, Steel, 6 in. ID.	3			
	Casing, Sch 40-PVC, 2 in. ID.				
5960		2			
5959		1			
5958		0			GC/CL: Gravelly, Sandy Clay with silt, brown (7.5YR4/4). 8 - 10% gravel (1/8" - 1/4" diameter, subangular to subrounded, composed of granite, schist, and quartzite). ~8% sand (coarse grained, subrounded to subangular). Clay has medium plasticity. Moist. 1" to 1-1/2" diameter cobbles of quartzite and granite at 0.4'.
5957		1			CL: Clay with trace gravel and sand, dark brown (7.5YR3/2). ~3 - 5% gravel (1/8" - 1/2" diameter, subangular), ~3 - 5% sand. Clay has medium plasticity. Shattered quartzite cobble at 0.6'. Roots at base of interval. Moist.
5956	Hydrated Bentonite Chips	2			CL: Clay with trace gravel and trace sand, brown (10YR4/3) with dark yellowish brown (10YR4/6) mottling. Possibly re-worked claystone with gravel and sand. Weak iron oxidation mottled throughout and disseminated at base. Trace roots. Moist.
5955		3			No recovery.
					CL: Clay with trace gravel and trace sand, same as interval from 0.8' to 1.3'. Moist.
5954		4			GP: Gravel/Cobbles, schist and quartzite cobbles (3/4" - 2" diameter, subangular) with gravel (1/4" - 1/2" diameter, subangular, composed of amphibolite (?)). Gravel is greenish gray (GLEY5/1).
					No recovery
5953					GC/CL: Sandy, Gravelly Clay with silt, dark brown (7.5YR3/2) clay matrix with ~30% gravel (1/4" - 3/4" diameter, subangular, composed of quartzite and schist). 5 - 10% sand (coarse grained,

Elev (Ft)	Well or Piezometer Construction and Materials	Depth (Ft)	Lithology	Unified Soils Classification or Rock Type	Lithologic Description
					subangular to subrounded). Clay has medium plasticity. Moist. Shattered cobbles (1" - 2" diameter) at base of interval from 4.6' to 4.8'.
5952	Filter Pack, 16/40 Silica Sand	5			SC/CL: Silty, Sandy Clay with some gravel, brown (7.5YR4/3 to 7.5YR4/4). Sand and gravel increase at base of interval. ~35% sand from 5.1' to 5.4', sand is coarse grained, subangular. ~25% gravel (1/4" - 1/2" diameter, subangular) from 5.1' to 5.4'. Moist. Possibly fluvial in origin (?)
		6			No recovery.
5951	Screen Sch 40-PVC, 2 in ID, 0.010 in slots				
		7			SC/CL: Silty, Sandy Clay with some gravel, same as interval from 4.8' to 5.4'. Moist.
5950					SILTSTONE: TOP OF BEDROCK. Clayey Siltstone with some fine grained sand. Bedrock is gray (10YR6/1) with abundant yellowish brown (10YR5/6) mottling. Siltstone interbedded with claystone and fine grained sandy lenses. Some caliche as stringers and blebs throughout interval. Strong pervasive iron oxidation from 8.5' to 8.7' with ironstone fragments. Moist.
		8			
5949					
		9			
5948					SILTSTONE: Sandy Siltstone, grayish brown (10YR5/2) with light yellowish brown (10YR6/4) iron oxidation mottled throughout. Abundant very fine grained sand in siltstone. Friable. Caliche along internal bedding at 10.7'. Decreasing moisture to slightly moist.
		10			
5947					
		11			SILTSTONE: Clayey, Sandy Siltstone, yellowish brown (10YR5/6) with gray (10YR6/1) and light brownish gray (10YR6/2) mottling. Clayey lenses at 10.9' and from 11.65' to 11.8'. Black organic stringers associated with clayey lenses. Interval is friable and slightly fissile. Rip-up clasts common. Small healed fracture (45 deg) with iron oxidation at 11.95'. Abundant very fine grained sand from 11.2' to 11.4'. Slightly moist.
5946					
		12			
5945					SILTSTONE: Clayey Siltstone, yellowish brown (10YR5/6) with gray (10YR5/1) mottling from 12.4' to 13.0'. Color changes to brown (10YR5/3) from 13.0' to 14.0'. Decreasing very fine grained sand to trace. Black organic stringers common from 13.0' to 14.0'. Interval is competent, yet weak to moderately friable. Rip-up clasts common. Weak to moderate iron oxidation throughout. Slightly moist.
		13			
5944					
		14			

Elev (Ft)	Well or Piezometer Construction and Materials	Depth (Ft)	Lithology	Unified Soils Classification or Rock Type	Lithologic Description
5943					CLAYSTONE: Claystone with trace silt, gray (10YR5/1) with grayish brown (10YR5/2) and yellowish brown (10YR5/4) mottling. Weak to moderate pervasive iron oxidation. Some black organic stringers. Interval is firm and dense. Decreased moisture to very slightly moist.
		15			
5942					
		16			
5941					
		17			CLAYSTONE: Claystone, un-weathered, dark gray (2.5Y4/1) to gray (2.5Y5/1). Trace iron oxidation along internal fractures from 16.8' to 17.0', and at 17.0'. Interval is highly fissile and friable. Dry.
5940					
		18			
5939					
		19			No recovery.
5938					
		20			CLAYSTONE: Claystone, un-weathered, dark gray (2.5Y4/1). Dense and firm, weakly fissile, dry.
5937	Threaded End Cap - Sump, Sch				
		21			

STATE PLANE COORDINATES AREA:
NORTH: 747463.414
EAST: 2081942.494
PROJECT: Original Landfill
REMARKS:
Routine well installation

GRND ELEV. (FT): 5939.29
TOTAL DEPTH (FT): 20.15
COMPLETION DATE: 8/8/05
GEOLOGIST: E. Warp

CASING DIA (IN): 2"
BH DIA. (IN): 8"
GRID LOCATOR:

LOG OF BORING NUMBER: 80105

Elev (Ft)	Well or Piezometer Construction and Materials	Depth (Ft)	Lithology	Unified Soils Classification or Rock Type	Lithologic Description
5942	Protective Casing, Steel, 6 in ID. Casing, Sch 40-PVC, 2 in. ID	3			
5941		2			
5940		1			
5939		0			GC/CL: Gravel/Sandy Clay with silt mixture. Imported Qalrf fill. Strong brown (7.5YR4/6). 20 - 25% gravel (1/8" - 1" diameter, subrounded to subangular), predominately quartzite with less schist and granite. 20% sand (coarse grained, subangular to subrounded). Clay has medium plasticity. Dark brown (7.5YR3/2) clay lense from 0.4' to 0.5'. Disseminated caliche, tiny white specks common throughout interval. Moist.
5938		1			No recovery.
5937		2			GC/CL: Gravel/Sandy Clay with silt mixture, same as interval from 0.0' to 1.2'. Moist.
5936	Hydrated Bentonite Chips	3			No recovery
5935	Filter Pack, 16/40 Silica Sand	4			CL: Gravelly, Sandy Clay, dark brown (7.5YR3/2). Distinct color change. ~10% sand (coarse grained, subangular), 5 - 8% gravel (1/8" - 1/2" diameter, subrounded to subangular). Trace to some

Elev (Ft)	Well or Piezometer Construction and Materials	Depth (Ft)	Lithology	Unified Soils Classification or Rock Type	Lithologic Description
					organic material (woodchips). Medium to high plasticity, very moist. Color change may indicate prior ground surface (before fill added).
		5			GC/CL: Gravelly, Sandy Clay, dark gray (7.5YR4/1) to brown (7.5YR4/4). ~30% sand (coarse grained, subangular), 20 - 25% gravel (1/8" to 1-1/2" diameter, subrounded to subangular). Possible fluvial deposit. Well graded, poorly sorted, very moist.
5934	Screen, Sch 40-PVC, 2 in ID. 0.010 in. slots				
		6			CL: Silty Clay. Re-worked bedrock. Light gray (10YR6/2) with brownish yellow (10YR6/6) mottling. Weak iron oxidation mottling. Trace caliche. [Very poor recovery, clay has been extruded like a "ribbon" due to a clogged cutting shoe.] Very moist.
5933					No recovery.
		7			CL: Silty Clay. Re-worked bedrock. Light gray (10YR7/1) with some light yellowish brown (10YR6/4) iron oxidation mottling. Trace alluvial clastics indicate not yet bedrock.
5932					CL: Clay with trace to some sand, gravel, and silt. Dark grayish brown (10YR4/2) with some light brownish gray (10YR6/2). 3 - 5% gravel (1/8" - 1/4" diameter), 3 - 5% sand (coarse grained, subangular). Weak to moderate iron oxidation mottled throughout. Very moist.
		8			SILTSTONE: TOP OF BEDROCK. Clayey Siltstone, gray (10YR6/1) with yellowish brown (10YR6/4) iron oxidation mottled throughout. Very subtle bedrock contact. [Very poor recovery, cutting shoe is clogged causing siltstone to appear "ribboned" in sample tube.] Very moist.
5931					No recovery.
		9			CLAYSTONE: Claystone, gray (10YR5/1) with yellowish brown (10YR5/6) mottling. Caliche blebs and stringers common throughout. Weak iron oxidation mottling. Massive texture. Moderately friable. Notable decrease in moisture to slightly moist.
5930					
		10			CLAYSTONE: Claystone, very dark gray (10YR3/1) to gray (10YR5/1). Massive texture. Abundant black organic stringers from 10.4' to 10.6'. Very rare caliche stringers. Moderately friable. No iron oxidation. Slightly moist.
5929					
		11			
5928					
		12			CLAYSTONE: Claystone, grayish brown (10YR5/2). Weak pervasive iron oxidation. Trace caliche blebs. Trace black organic material. Weakly friable. Organics or trace iron oxidation along internal fractures at 12.3', 12.6', and 13.4'. Decreased moisture to very slightly moist.
5927					
		13			
5926					

Elev (Ft)	Well or Piezometer Construction and Materials	Depth (Ft)	Lithology	Unified Soils Classification or Rock Type	Lithologic Description
		14			
5925					SILTSTONE: Clayey Siltstone, light brownish gray (10YR6/2) with some light yellowish brown (10YR6/4) iron oxidation mottling throughout. Massive texture. Weakly friable. Trace black organic stringers. Trace iron oxidation on minor internal fractures at 15.1', 15.5', 15.8', and 16.3'. Trace moisture. Occasional rip-up clasts.
		15			
5924					
		16			
5923					
					No recovery.
		17			
5922					CLAYSTONE: Claystone, dark gray (10YR4/1) to very dark gray (10YR3/1). Very fissile, friable, and dry. Abundant black carbonaceous material from 18.0' to 18.5'.
		18			
5921					
		19			
5920					No recovery. Reamed with augers from 19.0' to 20.15'. Did not sample this interval.
		20	Threaded End Cap Sump. Sch 40-PVC		

STATE PLANE COORDINATES AREA: GRND ELEV. (FT): 5938.52 CASING DIA (IN): 2"
NORTH: 747535.636 TOTAL DEPTH (FT): 20.0 BH DIA. (IN): 8"
EAST: 2082324.443 COMPLETION DATE: 8/10/05 GRID LOCATOR:
PROJECT: Original Landfill GEOLOGIST: E. Warp
REMARKS:
Routine well installation

LOG OF BORING NUMBER: 80205

Elev (Ft)	Well or Piezometer Construction and Materials	Depth (Ft)	Lithology	Unified Soils Classification or Rock Type	Lithologic Description
5942	Protective Casing, Steel, 6 in ID.	4			
	Casing, Sch 40-PVC, 2 in. ID	3			
5941		2			
5940		1			
5939		0			
5938		1		GC/CL	GC/CL: Gravel/Sandy Clay with silt, strong brown (7.5YR4/6). 15 - 25% gravel (1/8" - 3/4" diameter, subrounded to subangular, predominately quartzite and granite). 20 - 25% sand (coarse grained, subangular). Clay has medium plasticity. Moist from 0.0' to 1.0'. Saturated, but not flowing, from 1.0' to 1.5'.
5937		2		CL	CL: Silty Clay with trace sand and trace gravel, dark brown (7.5YR3/2) with some yellowish brown (10YR5/4) mottling. Clay has medium plasticity. Granite clast (3/4" diameter, angular) at 1.7'. Saturated, but not flowing.
					No recovery
5936		3			CL: Clay with trace silt, trace gravel, and trace sand, brown (7.5YR4/3) from 2.0' to 2.2', yellowish brown (10YR5/4) to dark yellowish brown (10YR4/4) from 2.2' to 4.0'. Appears to be re-worked claystone bedrock (?). Interval is firm and dense but pliable due to moisture. Trace black organic stringers. Trace caliche blebs at base of interval. Roots and twigs common throughout. Gravel (1/4" - 1/2", subrounded) from 3.4' to 3.6', and at base of interval. Decreased moisture to very moist.
5935	Bentonite Chips	4			

Elev (Ft)	Well or Piezometer Construction and Materials	Depth (Ft)	Lithology	Unified Soils Classification or Rock Type	Lithologic Description
5934	Filter Pack. 16/40 Silica Sand; Screen, Sch 40-PVC, 2 in ID., 0.010 in. slots	4			CL: Clay (re-worked claystone), gray (10YR5/1) with trace yellowish brown (10YR5/6) mottling. Roots common throughout interval. Trace caliche blebs. Caliche stringer with iron oxidation halo at 5.1'. Slight color change from 5.9' to 6.7' to light brownish gray (10YR6/2) with faint mottling. Decreased moisture to moist.
5933		5			
5932		6			
		7			No recovery.
5931					CL: Clay with trace gravel (probably re-worked claystone), grayish brown (10YR5/2). Roots common. Soft and pliable. Saturated, free water from 7.6' to 8.0'. Gravel (1/2" diameter, subrounded) at 7.6' with trace iron oxidation in clay surrounding gravel clast.
5930		8			GC/CL: Gravelly Clay, dark brown (7.5YR3/3) with some strong brown (7.5YR5/6) iron oxidation at 8.15'. Strongly fractured and crumbly. 20 - 25% gravel (1/4" - 3/4" diameter, subrounded to subangular). Composition of gravel (?) - possible conglomerate, coated with iron oxide and manganese oxide. Interval is saturated with free water.
5929		9			CLAYSTONE: TOP OF BEDROCK. Claystone (bedrock) - possibly re-worked. Grayish brown (10YR5/2) to gray (10YR5/1) with minor yellowish brown (10YR5/6) mottling. Roots common. Trace caliche stringers. Interval competent from 8.35' to 9.0'; friable from 9.0' to 9.45'. Distinct decrease in moisture to very moist, further decreasing to moist at base.
5928		10			CLAYSTONE: Claystone, grayish brown (10YR5/2) to gray (10YR5/1) with trace brownish yellow (10YR6/8) iron oxidation mottling throughout. Massive texture. Interval is moderately friable. Slightly moist.
5927		11			
		12			No recovery.
5926					CLAYSTONE: Claystone, pale brown (10YR6/3). Massive texture. Trace iron oxidation along bedding planes. Silty lense (~1/8" thick) with iron oxidation at 13.8'. Firm and dense. Decreased moisture to very slightly moist. Trace silt at 12.5' and below.
		13			

Elev (Ft)	Well or Piezometer Construction and Materials	Depth (Ft)	Lithology	Unified Soils Classification or Rock Type	Lithologic Description
5925					
		14			CLAYSTONE: Claystone, gray (10YR5/1) to dark gray (10YR4/1). Massive textured. Trace iron oxidation along bedding planes (sub-horizontal). Disseminated caliche coating from 15.2' to 15.8' along vertical fracture with iron oxidation. Interval weakly friable. Trace black organic stringers. Decreased moisture to trace.
5924					
		15			
5923					
		16			
5922					
		17			
5921					
		18			CLAYSTONE: Claystone, dark gray (10YR4/1) to very dark gray (10YR3/1). Massive texture. Moderately fissile and friable. No iron oxidation. Trace moisture to dry.
5920					
		19			
5919					
		20	Conical Threaded End Cap - Sump, Sch 40-PVC		

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APPENDIX C

LIST OF ANALYTES

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RFCA Attachment 5 Analytes by Method - Surface Water

Method 353.2 - Nitrate

Analyte	CAS Reference Number	Notes
Nitrate	14797-55-8	

Method 7470A - Hg

Analyte	CAS Reference Number	Notes
Mercury, total	7439-97-6	

Method 6010B - Metals

Analyte	CAS Reference Number	Notes
Aluminum, dissolved	7429-90-5	
Antimony, total recoverable	7440-36-0	
Arsenic, total recoverable	7440-38-2	
Barium, total recoverable	7440-39-3	
Beryllium	7440-41-7	
Boron, total	7440-42-8	
Cadmium, dissolved	7440-43-9	
Chromium, Total Recoverable	7440-47-3	6010B chromium (total recoverable; 7440-47-3) compared to Cr III (16065-83-1) in RFCA
Copper, dissolved	7440-50-8	
Lead, dissolved	7439-92-1	
Manganese	7439-96-5	
Nickel, dissolved	7440-02-0	
Selenium	7782-49-2	
Silver, dissolved	7440-22-4	
Thallium	7440-28-0	
Zinc, dissolved	7440-66-6	

Method 8260B - VOCs

Analyte	CAS Reference Number	Notes
Acetone	67-64-1	
Acrolein	107-02-8	
Acrylonitrile	107-13-1	
Benzene	71-43-2	
Bromodichloromethane	75-27-4	
Bromoform [Tribromomethane]	75-25-2	
Bromomethane [Methyl Bromide]	74-83-9	
2-Butanone [Methylethyl ketone]	78-93-3	
Carbon disulfide	75-15-0	
Carbon tetrachloride	56-23-5	
Chlorobenzene	108-90-7	
Chloroethane	75-00-3	
Chloroform [Trichloromethane]	67-66-3	
Chloromethane [Methyl chloride]	74-87-3	
Chlorodibromomethane	124-48-1	8260B chlorodibromomethane compared to RFCA dibromochloromethane (same CAS)
1,2-Dibromo-3-chloropropane	96-12-8	
1,2-Dichlorobenzene	95-50-1	
1,3-Dichlorobenzene	541-73-1	
1,4-Dichlorobenzene	106-46-7	
1,1-Dichloroethane	75-34-3	
1,2-Dichloroethane	107-06-2	
1,1-Dichloroethene	75-35-4	
1,2-Dichloroethene (cis)	156-59-2	
1,2-Dichloroethene (trans)	156-60-5	
1,2-Dichloropropane	78-87-5	
trans- 1,3-Dichloropropene	10061-02-6	8260B for CAS# 10061-02-6; compare to RFCA 1,3-dichloropropylene (542-75-6)
Ethylbenzene	100-41-4	
Ethylene dibromide [1,2-Dibromomethane]	106-93-4	
Hexachlorobutadiene	87-68-3	
Hexachloroethane	67-72-1	
Methylene chloride [Dichloromethane]	75-09-2	
4-Methyl-2-pentanone [Isopropoacetone]	108-10-1	

Naphthalene	91-20-3	
Nitrobenzene	98-95-3	
Nitrosodibutylamine N	924-16-3	
Styrene	100-42-5	
1,1,2,2-Tetrachloroethane	79-34-5	
Tetrachloroethene	127-18-4	
Toluene	108-88-3	
1,2,4-Trichlorobenzene	120-82-1	
1,1,1-Trichloroethane	71-55-6	
1,1,2-Trichloroethane	79-00-5	
Trichloroethene	79-01-6	
Vinyl chloride	75-01-4	
o-xylene	95-47-6	8260B for o- (95-47-6), m- (108-38-3), p- (106-42-3); compare sum to RFCA xylene (total) (1330-20-7
m-xylene	108-38-3	8260B for o- (95-47-6), m- (108-38-3), p- (106-42-3); compare sum to RFCA xylene (total) (1330-20-7
p-xylene	106-42-3	8260B for o- (95-47-6), m- (108-38-3), p- (106-42-3); compare sum to RFCA xylene (total) (1330-20-7

Method 8270C - SVOCs

Analyte	**CAS Reference Number**	**Notes**
Acenaphthene	83-32-9	
Acenaphthylene	208-96-8	
Aldrin	309-00-2	
Anthracene	120-12-7	
Benzidine	92-87-5	
alpha-BHC	319-84-6	
beta-BHC	319-85-7	
gamma-BHC [Lindane]	58-89-9	
Benzo(a)anthracene	56-55-3	
Benzo(a)pyrene	50-32-8	
Benzo(b)fluoranthene	205-99-2	
Benzo(g,h,i)perylene	191-24-2	
Benzo(k)fluoranthene	207-08-9	
Butylbenzylphthalate	85-68-7	

Carbofuran	1563-66-2	
Chlordane	57-74-9	8270C for chlordane (57-74-9); compared to RFCA cis-chlordane (5103-71-9)
bis(2-Chloroethyl)ether	111-44-4	
bis(2-Chloroisopropyl)ether	108-60-1	8270C for 108-60-1, which is a.k.a. "bis(2-…", compare to RFCA CAS# 39638-32-9
4-Chloro-3-methylphenol	59-50-7	
2-Chloronaphthalene	91-58-7	
2-Chlorophenol	95-57-8	
Chrysene	218-01-9	
4,4-DDD	72-54-8	
4,4-DDE	72-55-9	
4,4-DDT	50-29-3	
Demeton-S	126-75-0	8270C for 126-75-0 (demeton-S) and 298-03-3 (demeton-O); compare sum to RFCA demeton (8065-48-3)
Demeton-O	298-03-3	8270C for 126-75-0 (demeton-S) and 298-03-3 (demeton-O); compare sum to RFCA demeton (8065-48-3)
Dibenzo(a,h)anthracene	53-70-3	
Di-n-butylphthalate	84-74-2	
3,3-Dichlorobenzidine	91-94-1	
2,4-Dichlorophenol	120-83-2	
Dieldrin	60-57-1	
Diethylphthalate	84-66-2	
2,4-Dimethylphenol	105-67-9	
Dimethylphthalate	131-11-3	
4,6-Dinitro-2-methylphenol	534-52-1	
2,4-Dinitrophenol	51-28-5	
2,4-Dinitrotoluene	121-14-2	
2,6-Dinitrotoluene	606-20-2	
Dinoseb	88-85-7	
1,2-Diphenylhydrazine	122-66-7	
Endosulfan I	959-98-8	8270C for endosulphan I (959-98-8); compare to RFCA endosulphan alpha (95-99-88)
Endosulfan II	33213-65-9	8270C for endosulphan II (33213-65-9); compare to RFCA endosulphan beta (3321-36-59)
Endosulfan sulfate	1031-07-8	
Endrin (technical)	72-20-8	

Endrin aldehyde	7421-93-4	
bis(2-Ethylhexyl)phthalate	117-81-7	
Fluoranthene	206-44-0	
Fluorene	86-73-7	
Azinphos-methyl	86-50-0	8270C for Azinphos-Methyl (86-50-0); compare to guthion (86-50-0) in RFCA
Heptachlor	76-44-8	
Heptachlor epoxide	1024-57-3	
Hexachlorobenzene	118-74-1	
Hexachlorocyclopentadiene	77-47-4	
Indeno(1,2,3-cd)pyrene	193-39-5	
Isophorone	78-59-1	
Malathion	121-75-5	
Methoxychlor	72-43-5	
2-Methylphenol [o-Cresol]	95-48-7	
Mirex	2385-85-5	
Nitrophenol 4	100-02-7	
Nitrosodiethylamine N	55-18-5	
Nitrosodimethylamine N	62-75-9	
n-Nitrosodiphenylamine	86-30-6	
n-Nitrosodipropylamine	621-64-7	
Nitrosopyrrolidine N	930-55-2	
Parathion	56-38-2	
Pentachlorobenzene	608-93-5	
Pentachlorophenol	87-86-5	
Phenanthrene	85-01-8	
Phenol	108-95-2	
Pyrene	129-00-0	
1,2,4,5-Tetrachlorobenzene	95-94-3	
Toxaphene	8001-35-2	
2,4,6-Trichlorophenol	88-06-2	

RFCA Attachment 5 Analytes by Method - Groundwater

Method 353.2 - Nitrate

Analyte	CAS Reference Number	Notes
Nitrate	14797-55-8	

Method 7470A - Hg

Analyte	CAS Reference Number	Notes
Mercury, total	7439-97-6	

Method 6010B - Metals

Analyte	CAS Reference Number	Notes
Aluminum	7429-90-5	
Antimony	7440-36-0	
Arsenic	7440-38-2	
Barium	7440-39-3	
Beryllium	7440-41-7	
Cadmium	7440-43-9	
Chromium (total)	7440-47-3	
Cobalt	7440-48-4	
Copper	7440-50-8	
Lead (dissolved)	7439-92-1	
Lithium	7439-93-2	
Manganese	7439-96-5	
Molybdenum	7439-98-7	
Nickel	7440-02-0	
Selenium	7782-49-2	
Silver	7440-22-4	
Strontium	7440-24-6	
Thallium	7440-28-0	
Tin	7440-31-5	
Uranium	7440-61-1	

Vanadium	7440-62-2	
Zinc	7440-66-6	

Method 8260B - VOCs

Analyte	CAS Reference Number	Notes
1,1,1-Trichloroethane	71-55-6	
1,1,2,2-Tetrachloroethane	79-34-5	
1,1,2-Trichloroethane	79-00-5	
1,1-Dichloroethane	75-34-3	
1,1-Dichloroethene	75-35-4	
1,2,4-Trichlorobenzene	120-82-1	
1,2-Dibromo-3-chloropropane	96-12-8	
1,2-Dichlorobenzene	95-50-1	
1,2-Dichloroethane	107-06-2	
1,2-Dichloroethene (total)	75-35-4	
1,2-Dichloropropane	78-87-5	
1,3-Dichlorobenzene	541-73-1	
1,4-Dichlorobenzene	106-46-7	
2-Butanone [Methylethyl ketone]	78-93-3	
4-Methyl-2-pentanone	108-10-1	
Acetone [c]	67-64-1	
Benzene	71-43-2	
Bromodichloromethane	75-27-4	
Bromoform [Tribromomethane]	75-25-2	
Bromomethane [Methyl bromide]	74-83-9	
Carbon disulfide	75-15-0	
Carbon tetrachloride	56-23-5	
Chlorobenzene	108-90-7	
Chloroethane	75-00-3	
Chloroform [Trichloromethane]	67-66-3	
Chloromethane [Methyl chloride]	74-87-3	
cis-1,3-Dichloropropene	10061-01-5	
Chlorodibromomethane	124-48-1	8260B chlorodibromomethane compared to RFCA dibromochloromethane (same CAS)
Ethylbenzene	100-41-4	

Hexachlorobutadiene	87-68-3	
Hexachloroethane	67-72-1	
Methylene chloride [Dichloromethane]	75-09-2	
Naphthalene	91-20-3	
Nitrobenzene	98-95-3	
Styrene	100-42-5	
Tetrachloroethene	127-18-4	
Toluene	108-88-3	
trans-1,3-Dichloropropene	10061-02-6	
Trichloroethene	79-01-6	
Vinyl acetate	108-05-4	
Vinyl chloride	75-01-4	
o-xylene	95-47-6	8260B for o- (95-47-6), m- (108-38-3), p- (106-42-3); compare sum to RFCA xylene (total) (1330-20-7
m-xylene	108-38-3	8260B for o- (95-47-6), m- (108-38-3), p- (106-42-3); compare sum to RFCA xylene (total) (1330-20-7
p-xylene	106-42-3	8260B for o- (95-47-6), m- (108-38-3), p- (106-42-3); compare sum to RFCA xylene (total) (1330-20-7

Method 8270C - SVOCs

Analyte	CAS Reference Number	Notes
2,4,5-Trichlorophenol	95-95-4	
2,4,6-Trichlorophenol	88-06-2	
2,4-Dichlorophenol	120-83-2	
2,4-Dimethylphenol	105-67-9	
2,4-Dinitrophenol	51-28-5	
2,4-Dinitrotoluene	121-14-2	
2,6-Dinitrotoluene	606-20-2	
2-Chloronaphthalene	91-58-7	
2-Chlorophenol	95-57-8	
2-Methylnaphthalene	91-57-6	
2-Methylphenol	95-48-7	
2-Nitroaniline	88-74-4	
3,3-Dichlorobenzidine	91-94-1	
4,4-DDD	72-54-8	

4,4-DDE	72-55-9	
4,4-DDT	50-29-3	
4,6-Dinitro-2-methylphenol	534-52-1	
4-Chloroaniline	106-47-8	
4-Methylphenol	106-44-5	
4-Nitrophenol	100-02-7	
Acenaphthene	83-32-9	
Aldrin	309-00-2	
alpha-BHC	319-84-6	
Anthracene	120-12-7	
Aroclor-1016	12674-11-2	
Aroclor-1221	11104-28-2	
Aroclor-1232	11141-16-5	
Aroclor-1242	53469-21-9	
Aroclor-1248	12672-29-6	
Aroclor-1254	11097-69-1	
Aroclor-1260	11096-82-5	
Benzo(a)anthracene	56-55-3	
Benzo(a)pyrene	50-32-8	
Benzo(b)fluoranthene	205-99-2	
Benzo(k)fluoranthene	207-08-9	
Benzoic Acid	65-85-0	
Benzyl Alcohol	100-51-6	
beta-BHC	319-85-7	
bis(2-Chloroethyl)ether	111-44-4	
bis(2-Chloroisopropyl)ether	108-60-1	8270C for 108-60-1, which is a.k.a. "bis(2-…", compare to RFCA CAS# 39638-32-9
bis(2-Ethylhexyl)phthalate	117-81-7	
Butylbenzylphthalate	85-68-7	
Chrysene	218-01-9	
Dibenzo(a,h)anthracene	53-70-3	
Dibenzofuran	132-64-9	
Dieldrin	60-57-1	
Diethylphthalate	84-66-2	
Dimethylphthalate	131-11-3	
Di-n-butylphthalate	84-74-2	
Endosulfan I	959-98-8	

Endosulfan II	33213-65-9	
Endosulfan sulfate	1031-07-8	
Endrin (technical)	72-20-8	
Fluoranthene	206-44-0	
Fluorene	86-73-7	
gamma-BHC [Lindane]	58-89-9	
Chlordane	57-74-9	8270C for chlordane (57-74-9); compared to RFCA gamma-chlordane (12789-03-6)
Heptachlor	76-44-8	
Heptachlor epoxide	1024-57-3	
Hexachlorobenzene	118-74-1	
Hexachlorocyclopentadiene	77-47-4	
Indeno(1,2,3-cd)pyrene	193-39-5	
Isophorone	78-59-1	
Methoxychlor	72-43-5	
n-Nitrosodiphenylamine	86-30-6	
n-Nitrosodipropylamine	621-64-7	
Pentachlorophenol	87-86-5	
Phenol	108-95-2	
Pyrene	129-00-0	
Toxaphene	8001-35-2	