FINAL
DESIGN ANALYSIS
LANDFILL 2 (FTC-006)
FORT CARSON, COLORADO

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Prepared by:
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Englewood, Colorado

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TABLE OF CONTENTS

Section **Page**

LIST OF TABLES ... iii

LIST OF FIGURES ... iii

LIST OF APPENDICES ... iii

LIST OF ACRONYMS ... iv

1.0 INTRODUCTION ... 1-1
1.1 OBJECTIVE ... 1-1
1.2 ORGANIZATION OF THE ENGINEERING DESIGN ... 1-1
1.3 SCOPE OF DESIGN ACTIVITIES ... 1-1
1.4 ORGANIZATION OF DESIGN ANALYSIS ... 1-2

2.0 SITE SETTING ... 2-1
2.1 GENERAL FACILITY INFORMATION ... 2-1
2.2 SITE DESCRIPTION ... 2-1
2.3 EVALUATION OF CORRECTIVE MEASURES ... 2-2

3.0 SUMMARY OF PREDESIGN ACTIVITIES ... 3-1
3.1 FIELD MAPPING ... 3-1
3.2 GEOPHYSICAL SURVEY ... 3-2
3.3 SOIL GAS SURVEY ... 3-3
3.4 GEOTECHNICAL FIELD INVESTIGATION ... 3-4
3.4.1 Drilling and Sampling Field Procedures ... 3-4
3.4.2 Waste Encountered in Borings ... 3-6
3.5 TRENCHING ... 3-6
3.5.1 Trenching Field Procedures ... 3-6
3.5.2 Waste Encountered in Trenches ... 3-7
3.6 GROUNDWATER MONITORING ... 3-8
3.7 SUMMARY OF HYDROGEOLOGIC CONDITIONS AT LANDFILL 2 ... 3-10

4.0 LANDFILL CAP DESIGN ... 4-1
4.1 DESIGN APPROACH TO LANDFILL 2 ... 4-1
4.2 REGULATORY REQUIREMENTS FOR CAPPING ... 4-2
4.2.1 Subtitle D Design Considerations ... 4-3
4.2.2 Subtitle C Design Considerations ... 4-4
4.3 CAP PROFILE OVERVIEW ... 4-5
4.3.1 Existing Cap ... 4-6
4.3.2 HELP Model Analysis of the Cap Profile ... 4-7
4.4 DETERMINATION OF CAP EQUIVALENCY ... 4-8
4.5 GEOTECHNICAL EVALUATION ... 4-8
4.5.1 Site Characterization and Geology ... 4-8
4.5.2 Geotechnical Laboratory Testing ... 4-10
4.5.3 Material Property Characterization ... 4-11
4.5.4 Settlement of Proposed Cover ... 4-11

4.5.5 Stability of Proposed Cover 4-12
4.6 SURFACE WATER MANAGEMENT SYSTEM 4-13
4.7 FINAL CAP EROSION 4-15
4.8 DEVELOPING CONTOURS OF LANDFILL FINAL GRADES 4-16
4.9 DETAIL DRAWINGS RELATED TO CAPPING THE LANDFILL 4-17
4.10 SITE ACCESS ROADS AND FENCING 4-17

5.0 COST ANALYSIS 5-1

6.0 SUMMARY OF DESIGN DRAWINGS 6-1

7.0 REFERENCES 7-1

LIST OF TABLES

Table No.	Title
1	Summary of Groundwater Sampling
2	Analytes Detected Above the State and Federal Water Quality Standards in Groundwater

LIST OF FIGURES

Figure No.	Title
1	Location of Geophysical Survey
2	Soil Gas Survey Results
3	Summary of Geotechnical Borings
4	Summary of Existing Cap Permeability Testing
5	Summary of Trenching
6	Analytes Above Drinking Water Standards
7	Water Table Elevation-6/21/95
8	Geologic Cross Sections

LIST OF APPENDICES

Appendix	Title
A	Geophysical Survey
B	Soil Boring Logs
C	Geotechnical Laboratory Testing Results
D	Construction Cost Estimate
E	HELP Modeling
F	Geotechnical Characterization and Settlement and Stability Calculations
G	Phone Memos/Frost Protection Reference
H	Analytical Groundwater Data
I	Pertinent Colorado Landfill Closure Requirements
J	Final Cap Erosion Calculations
K	Real Time Air Monitoring
L	Surface Water Calculations

LIST OF ACRONYMS

ASTM	American Society for Testing and Materials
CDPHE	Colorado Department of Public Health and Environment
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
cm/sec	Centimeters per Second
COD	Chemical Oxygen Demand
EPA	Environmental Protection Agency
Geo-Centers	Geo-Centers, Inc.
GPS	Global Positioning System
ID	Inside Diameter
mg/l	Milligrams per Liter
MHA	Maximum Horizontal Accelerations
MSL	Mean Sea Level
OD	Outside Diameter
PID	Photoionization Detector
POL	Petroleum, Oil, and Lubricants
ppm	Parts per Million
RCRA	Resource Conservation and Recovery Act
Rust	Rust Environment & Infrastructure
SVOC	Semivolatile Organic Compound
SWMU	Solid Waste Management Units
TOC	Total Organic Carbon
VOC	Volatile Organic Compound
μg/l	Micrograms per Liter
USACE	U.S. Army Corps of Engineers
USAEHA	U.S. Army Environmental Health Agency
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency

1.0 INTRODUCTION

1.1 OBJECTIVE

Rust Environment & Infrastructure (Rust) has been retained by the U.S. Army Corps of Engineers (USACE), Omaha District, to design a cap for Landfill 2 at Fort Carson.

1.2 ORGANIZATION OF THE ENGINEERING DESIGN

The engineering design includes four components which are prepared as separate documents as follows:

- Design Analysis, which provides the engineering design basis for capping the landfill;
- Technical Specifications, which provide legal and technical information for construction of the system;
- Design Drawings, which provide site location, site plan, and design details; and,
- Work Plan, which provides a summary of the Design Analysis and detailed procedures for construction.

This document serves as the Final Design Analysis as part of a 90% design package. The 90% design package includes the Final Design Analysis, final (90%) design drawings, and draft specifications. A 100% design will be prepared and submitted to the USACE using the criteria outlined above. USACE specifications are not included in the Design Analysis, but are presented as a separate document to accompany this 90% submittal. The 100% design will incorporate USACE comments and responses from the 90% engineering design package.

1.3 SCOPE OF DESIGN ACTIVITIES

The scope of work for this project generally consists of: (1) obtaining information related to the chemical characteristics of groundwater in the area of the landfill; (2) obtaining information to assist in the design of a landfill cap; and (3) performing actual design work for the landfill cap. This document presents the results of information gathered during field activities in support of the design of the landfill cap and subsequent design related efforts associated with the final (90%) design.

Field and laboratory work on this project consisted of performing the following tasks:

- A ground survey to establish elevation and coordinate control for subsequent areal survey work;
- An areal topographic survey to obtain 1 foot contours of the landfill;

- A geophysical survey to aid in determining the limits of the landfill;
- Field mapping of the limits of the landfill by walking the landfill's perimeter;
- A soil gas survey to assess the presence of landfill gas and assist in determining the limits of the landfill;
- Subsurface exploration through soil borings and trenches, and geotechnical soil testing to determine the extent of landfill materials and geotechnical properties; and
- Groundwater sampling and analysis at existing monitoring well locations and at direct push sampling locations.

Subsequent work has focused on assessing the field information and using it to assist in the design effort. This work has included:

- Defining the limits of the landfill to be capped;
- Reviewing regulatory requirements for capping;
- Performing HELP Model analysis of potential cap systems;
- Performing settlement and stability analysis of the landfill final grades;
- Performing final cap erosion calculations;
- Developing contours of landfill final grades; and
- Developing detail drawings related to capping the landfill.

1.4 ORGANIZATION OF DESIGN ANALYSIS

Section 2.0 of this Design Analysis provides background information. Section 3.0 presents results of the field and laboratory work which pertain to the cap design, and Section 4.0 presents discussion related to the design of the landfill cap. Section 5.0 provides a cost estimate. Finally, Section 6.0 provides a summary of drawings included in the final design drawing plan set.

2.0 SITE SETTING

2.1 GENERAL FACILITY INFORMATION

Fort Carson is located in east-central Colorado, adjacent to the eastern flank of the Rocky Mountain Front Range. The installation is approximately eight miles south of Colorado Springs and 40 miles north of Pueblo, and in its entirety occupies approximately 220 square miles. Fort Carson is an active military training installation for both weapons qualification and field training. The primary mission of Fort Carson is the training and readiness of all assigned and attached troops to ensure combat-readiness. Principal industrial operations at Fort Carson have been the repair and maintenance of vehicles and aircraft.

2.2 SITE DESCRIPTION

The Cantonment Area is bounded on the northeast by Interstate Highway 25, on the north by the Fort Carson Reservation boundary, and on the east by Colorado State Road 115. The site facility pertaining to this project is Landfill 2 (FTC-006), which is located east of the Cantonment Area, SE 1/4, Sec 15, T15S, R66W. The site was reportedly operated between 1960 and 1978 as a combined trench and fill landfill. The trenches were supposedly oriented perpendicular to the topographic slope. The types of waste reportedly received at the site include mixed loads of sanitary wastes, sludges, and waste petroleum, oil, and lubricants (POL).

The U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) reported that the water quality of a downgradient monitoring well showed evidence of leachate migrating from this site. This conclusion is supported by a report from the U.S. Army Environmental Health Agency (USAEHA) Geohydrologic Study in 1985 (Phase 2 Geohydrologic Study #38-26-0392-87, dated August 1985) which stated that the site contained elevated levels of Total Organic Carbon (TOC), Chemical Oxygen Demand (COD), nitrates and nitrites. It was concluded in a USAEHA, 1988 (Groundwater Quality Study #38-26-0897-89, Investigation of Closed Landfills, dated June and November 1988) evaluation report of Solid Waste Management Units (SWMUs) at Fort Carson that leachate generated from this site had apparently migrated to the groundwater. Therefore, this project was initiated to develop construction plans to cap the landfill.

The Part B Permit for Fort Carson (September 29, 1995) identifies two landfill SWMUs within the fenced landfill area evaluated in this Design Analysis as Landfill 2 (FTC-006). Sheet 17 of Map 9-8 of the Part B Permit identifies SWMU 2 - Landfill 2 as comprising the eastern most section of the fenced landfill area and SWMU 3 - Landfill 3 as comprising the western portion of the fenced landfill area, including the prominent side slope, which can be seen when reviewing the existing topography (see Sheet C-3 of the design drawings). SWMU 3 - Landfill 3 reportedly received the same type of waste materials as discussed above.

Recent interviews with Fort Carson personnel indicated that several grit/oil pits were located along the western edge of Landfill 2. The use of these pits was discontinued, and the grit/oil wastes were taken to the Grit/Oil Pit (SWMU 13) at Landfill 1. The grit/oil pits at Landfill 2 appear to have been completely covered by landfill materials and the cap for the landfill based on the trenching activities discussed in Section 3.5. The presence of these pits along the western portion of the landfill may explain the identification of two landfill SWMUs within the same fenced landfill area.

The pre-design investigations discussed in Section 3.0 identified one continuous landfill within the fence for Landfill 2. As a result, both of these SWMUs represent a single continuous landfill that is referred to as Landfill 2 in this Design Analysis and in the drawings.

2.3 EVALUATION OF CORRECTIVE MEASURES

Based on the historical groundwater sampling results, a corrective measure or series of corrective measures are required to address Landfill 2. In evaluating corrective measures for landfills, several conditions need to be considered in determining the effectiveness and implementability of various types of corrective measures. The heterogeneous nature of waste materials and the variable sizes of waste material make corrective measures based on excavation and treatment impracticable. In addition, the large volume of waste materials relative to the areal extent of the landfill, along with the variable sizes of waste material, make excavation and redisposal measures considerably more expensive and less implementable than in-place containment. In addition, the heterogeneous nature of landfill materials significantly reduces the effectiveness and implementability of corrective measures.

In-place containment, on the other hand, is a feasible, effective, and economical corrective measure. In-place containment prevents direct contact with waste materials; minimizes infiltration, leachate generation, and leaching of contaminants to groundwater; and controls surface water runoff. As a result, in-place containment is the appropriate technology for Landfill 2.

Sampling the waste material is not appropriate or necessary for evaluating corrective measures or designing an in-place corrective measure. Due to the heterogeneity of landfill waste materials, characterization beyond the general categorization provided by historical information can not be reasonably achieved. Instead, sampling activities to support the design efforts need to be focused on evaluating the effectiveness of the existing soil cover and the quality of the groundwater, which may be effected by landfill gas or leachate migration.

As a result, the evaluation of the existing cover at Landfill 2 is a major component of the predesign activities discussed in Section 3.0. The data gathered during these activities is evaluated in subsequent sections of this Design Analysis to determine if the existing cover provides adequate containment. If the existing cover is not adequate, the subsequent sections evaluate whether the existing cover should be removed and replaced, or upgraded to meet landfill closure requirements.

This Design Analysis focuses on the construction of a cap over the designated areas of the landfill since it is the initial phase of an in-place containment measure. The construction of the cap is being implemented as the first phase of a multi-phase remedy, and the groundwater quality will continue to be evaluated for two years after construction of a cap to determine if the follow-on phases of corrective measures are required such as a slurry wall or groundwater remediation system.

3.0 SUMMARY OF PREDESIGN ACTIVITIES

One of the fundamental pieces of information necessary to develop plans to cap a landfill is to establish the lateral limits of waste. In pursuit of this information, several field methods were utilized in an effort to delineate the boundary of the landfill, henceforth referred to as the "limit of waste". In conjunction with this effort, additional information was sought pertaining to the presence of landfill gas and the geotechnical characteristics which exist in soils forming the landfill and its foundation. The field methods used to help define the limit of waste and obtain information relative to assessing the presence of landfill gas and characterizing geotechnical soil parameters included:

- Field mapping;
- Geophysics;
- Soil gas sampling;
- Soil borings; and
- Trenching.

These field methods and the associated results are summarized in the following sections.

3.1 FIELD MAPPING

Prior to conducting the geophysical survey at the site, preliminary field mapping was performed to establish the approximate limit of waste. This was done in an effort to help expedite the geophysical survey work. Subsequent to the geophysical survey work, which will be discussed in the following section, additional field mapping was performed to further refine the limit of waste. Field mapping performed after the geophysics survey work was aided by the availability of site topography maps, which were prepared by Aero-metric Engineering, Inc. from air photos of the site taken on December 14, 1994. A copy of the topographic map of Landfill 2 (with 1 foot contours) is included in the Design Drawings as Sheet C-3.

Note that at Landfill 2, the limit of waste is generally expressed by changes in topography. For example, the western and southern limit of waste is delineated by a rather apparent transition in slope. However, areas located along the west portion of the site (between the western earthen perimeter channel and the topographic west toe of slope) and southwest portion of the site (between the existing fence along the south side of the site and the topographic south toe of slope) were recently identified by Fort Carson personnel (Jim Henderson) as possible grit/oil pit trench fills, and were

subsequently included within the limit of waste and designated for capping. However, the trenching performed to determine the limit of waste along the west and southwest portions of the landfill did not encounter waste materials typically associated with grit/oil pits.

Field mapping of the ridge along the north side of the landfill indicated the presence of end-dumped materials consisting of construction-demolition waste. Specifically, brick, concrete, and empty barrels were observed along the slope face. In addition, field mapping along the east side of the landfill identified waste east of the existing concrete channel.

In general, field mapping of the limits of waste was very effective at Landfill 2. Based on results of the field mapping effort, as well as observations made while drilling the soil borings (Section 3.4.2) and while performing the trenching (Section 3.5.2), the existing limit of waste encompasses approximately 98 acres. The limit of waste is illustrated on Sheet C-3 of the drawings.

3.2 GEOPHYSICAL SURVEY

The goal of the geophysical survey was to define, to the highest degree of accuracy possible, the location of the outer perimeter of the landfill, thereby determining the extent of landfill to be capped. Due to the fact that accurate records describing the lateral extent of the landfill were not available, the approach at the beginning of the survey was to conduct a series of perimeter surveys. A preliminary survey was to be carried out along what was estimated to be the outer perimeter of the landfill based upon historic records and field observations. Subsequent surveys were to be executed within the previous survey, approximately 25 feet radially *inward*, in areas where the edge of the landfill was not encountered. In areas where the survey traverse cut the boundary of the landfill, subsequent perimeter traverses were to pass approximately 25 feet radially *outward* from the previous traverse. This procedure was to be repeated at least four times around the landfill. However, the results of the preliminary survey were not able to differentiate between landfill materials and native soils, probably as a result of the large amount of soil mixed with waste materials, as encountered during drilling activities. Figure 1 presents the locations of the geophysical transects for Landfill 2.

A continuous wave electromagnetic sensor was deployed on each survey traverse. Geo-Centers, Inc. (Geo-Centers) of Newton Centre, Massachusetts conducted and interpreted the geophysical surveys. A Geonics EM31 was selected as the most appropriate sensor to detect the edge of the landfill, since

this device can detect changes in bulk conductivity of the subsurface caused by the existence of underground conductive bodies, buried metals, conductive fluids, etc. Geo-Centers deployed a new, state-of-the-art field data acquisition system which integrates the satellite based global positioning system (GPS) navigation technology with the EM31.

In general, the survey was not able to refine the boundaries of the landfill beyond the boundaries determined from field mapping efforts. Although some in-phase data appeared to correlate with observed metal at the surface, analysis of the data provided little information on identifying the limit of waste, probably as a result of the large amount of soil mixed with waste materials, as encountered during drilling activities. A copy of the geophysics report is enclosed with this Design Analysis as Appendix A.

3.3 SOIL GAS SURVEY

A soil gas survey was performed at Landfill 2 during May and June of 1995 to evaluate hydrogen sulfide, methane, and total organic vapor concentrations. The procedure used to collect the soil gas survey consisted of driving a gas sampler as discussed below:

- The steel tip was placed onto the end of a 5-foot hollow steel rod and the steel rod was driven into the soil;
- A slide hammer was attached to the steel rod and the steel rod was hammered into the soil to a 3.5- to 4.0-foot depth;
- A steel rod was pulled upward 2 to 3 inches towards the ground surface;
- A slide hammer was removed from the steel rod and a tygon tubing/tee assembly/sample vacuum bulb were attached;
- The tubing was filled with the soil gas using the vacuum bulb;
- The tygon tubing was attached to each instrument individually and the soil gas measured (methane, hydrogen sulfide, and total organic vapors); and
- The slide hammer was placed back onto the steel rod, and the steel rod was removed from the soil.

Additional monitoring included passive soil gas pressure measurement and applied vacuum measurement. These analyses were measured immediately after the methane, hydrogen sulfide and total organic vapor gas analyses at each location.

A total of 105 points were surveyed for Landfill 2 for landfill gas using the procedures described above. Results of the soil gas survey revealed small concentrations of methane and hydrogen sulfide

in localized areas of the landfill, as shown on Figure 2 of this Design Analysis. Concentrations of total organic vapors and hydrogen sulfide were below background levels. During the course of the survey work, personnel performing the survey did not observe odors typically associated with landfill gas. In addition, pressure measurements during the survey indicated no positive pressure at any sampling point. Although present at 13 survey locations, methane gas does not appear to be a problem at the landfill. The borings performed for the geotechnical investigation did not encounter large amounts of organic wastes (which produce methane), but did encounter large amounts of soil mixed with waste materials.

3.4 GEOTECHNICAL FIELD INVESTIGATION

The geotechnical field investigation for Landfill 2 consisted of drilling exploratory borings. The exploratory borings were performed in two phases. The first phase consisted of drilling 14 exploratory borings (SB-1 through SB-14) between June 15 and 19, 1995. This work was performed in order to gather information on the limit of waste, as well as geotechnical characteristics of existing cover soils and native materials. Boring locations for the first phase of drilling are shown on Figure 3 titled Summary of Borings, which is enclosed with this Design Analysis. The second phase consisted of drilling 29 exploratory borings (CVT-1 through CVT-29) through the existing cap between February 7 and 15, 1996. This work was performed in order to evaluate the soil type, thicknesses and permeabilities of the existing soil cap at Landfill 2. Boring locations for the second phase of drilling are shown on Figure 4 titled Summary of Existing Cap Permeability Testing, which is enclosed with this Design Analysis.

A discussion of the Landfill 2 exploratory drilling and sampling program is given in the following section. Logs of exploratory borings are presented in Appendix B.

3.4.1 Drilling and Sampling Field Procedures

A total of 43 borings were drilled for the geotechnical field investigation program at Landfill 2. All borings were advanced using 3 1/4-inch inside diameter (ID), 6-inch outside diameter (OD) hollow-stem augers drilled with a CME-75 or a CME-55 drill rig provided by Site Services, Inc. of Golden, Colorado. Subsurface materials were logged in detail by Rust's geologist and obtained by two methods:

(1) Drive sampling using split-spoon sampler; and
(2) Push sampling using Shelby tube samplers.

Drive sampling was performed using a 24-inch long, 1 3/8-inch ID and 2-inch OD standard penetration test split-spoon sampler driven by a 140 pound auto-hammer free falling from 30 inches, in accordance with American Society for Testing and Materials (ASTM) Method D1586. Split-spoon soil samples were retained in labeled plastic bags. Push sampling was performed using 3-inch OD by 30-inch long Shelby tubes handled in accordance with ASTM Method D1587. Following the collection of each Shelby tube sample, both ends were sealed with wax, any void space filled with silica sand, then both ends were taped and capped prior to transport from the drill site.

Boring SB-1 and borings SB-5 through SB-10, as well as borings CVT-1 through CVT-29, were located in areas where waste was anticipated for the purpose of evaluating the existing cover soils. Continuous sampling was conducted through cover material using Shelby tube samplers in fine materials (i.e. clays), and split-spoon samplers were driven through granular material such as clayey sand. Shallow borings were generally terminated as soon as waste was confirmed (usually two consecutive samples) and ranged in depth from 3 to 19 feet. Shallow borings rarely reached bedrock and were terminated when waste was not encountered.

Borings SB-2 through SB-4 and borings SB-11 through SB-14 were located in perimeter areas to investigate existing foundation conditions. The first 6 feet were sampled continuously and at 5-foot intervals thereafter, unless soft or loose soils were encountered. In this event, continuous samples were obtained until competent soil or bedrock was encountered. These borings, ranging in depth from 6 to 22.5 feet, were terminated approximately 5 feet into bedrock, or into soil that was either hard or dense. Where groundwater was encountered, such as boring SB-13, borings were usually allowed to remain open for approximately 24 hours to measure groundwater levels prior to grouting.

Soil cuttings from each boring were contained in labeled and sealed drums and remained onsite until removal by Fort Carson personnel. All borings were grouted to the surface via the Tremie method using bentonite grout slurry. Upon completion of drilling work at the landfill, the drill rig, augers and tools were decontaminated using a steam cleaner.

3.4.2 Waste Encountered in Borings

Waste was encountered in six of the fourteen borings performed during the first phase of the exploratory soil borings at Landfill 2. These included boring SB-1 and borings SB-6 through SB-10. Waste was not encountered in boring SB-5; however, given the location of the boring, waste is believed to exist in the general area of the boring. Waste was not encountered in borings SB-2 through SB-4, and borings SB-11 through SB-14. These borings were performed around the periphery of the landfill.

Waste was encountered in 19 of the 29 borings performed during the second phase of the exploratory soil borings at Landfill 2. However, given the location of the borings for the second phase of exploratory drilling, waste is believed to exist in the general area of all of the borings, as noted earlier.

Results and interpretation of information from the geotechnical field investigation pertaining to geotechnical calculations is presented in Section 4.5.1. Results of the drilling and testing performed for investigating the existing cap is presented in Section 4.5.2.

3.5 TRENCHING

Trenching was performed at Landfill 2 to assist in determining the limit of waste. Trenching activities were performed in February 1996. A total of 24 trenches (LF2-T01 through LF2-T24) were performed around the periphery of the landfill. Additional trenches (LF2-T02a, LF2-T02b, LF2-T03a, and LF2-T20a) were performed to further define the limit of waste near the southwest corner of Landfill 2, with trenches LF2-T02b and LF2-T03a performed with the intent to determine the thickness of the waste. Figure 5 provides the location of the trenches with a summary of the materials encountered in the trenches, as well as the interpreted limit of waste.

3.5.1 Trenching Field Procedures

The trenches were performed around the periphery of the landfill using a backhoe provided and operated by OHM Remedial Services, with observations and direction provided by a Rust field engineer. The trenches were typically extended from the exterior of the landfill toward the landfill interior, with trenching terminating once waste was encountered. Total depth for the trenches was reached after soil conditions indicated native material was encountered. Trenches were logged for color, soil type, moisture, and waste material encountered. Start and end points, as well as the limit

of waste for each trench were staked and surveyed, and Figure 5 reflects the surveyed trench information.

Trenches were continuously monitored using real time air monitoring for organic vapors using a Microtip photoionization detector (PID), air particulates using a Miniram, and hydrogen sulfide, carbon dioxide, and oxygen using a Gastech instrument. Real time air monitoring readings above background were not observed during trenching activities at Landfill 2. A copy of the real time air monitoring readings is included in Appendix K of this Design Analysis.

Soil cuttings in contact with waste from each trench were contained in labeled and sealed 55-gallon drums and remained onsite. Soil cuttings that were not in contact with waste were backfilled in the trench. Upon completion of each trench that encountered waste, the backhoe bucket was decontaminated. The decontamination procedures consisted of removing soil and debris with shovels and picks and placing materials into the 55-gallon drums.

3.5.2 Waste Encountered in Trenches

Waste was not encountered in trenches LF2-T08, LF2-T09, LF2-T11, LF2-T12, LF2-T14, and LF2-T15 performed at Landfill 2. Waste was encountered in all other trenches performed at Landfill 2. Top of waste was encountered at depths ranging from ground surface to 2.5 feet below existing grade. The total thickness of waste was determined in trenches LF2-T02b and LF2-T03a, with thicknesses of approximately 6 feet and 2 feet, respectively. The waste encountered generally consisted of mostly soil fill with glass, metal, wood, plastic, brick, concrete and paper mixed in. Figure 5 provides the location of the trenches with a summary of the materials found while trenching. Because of the length of LF2-T24, the trench was discontinuously trenched. Discontinuous trenching involved several 10-foot sections extending towards the exterior of the landfill until the limit of waste was encountered.

Results of the trenching work indicated that the limit of waste generally corresponded with the estimated limit of waste for the 30% Conceptual Design. However, the limit of waste was found to extend further north and further south along the western portion of the landfill. The revised grading plans submitted with this Design Analysis reflect adjustments made in capping or relocating waste associated with the revised footprint resulting from the trenching work.

3.6 GROUNDWATER MONITORING

In order to evaluate the potential impacts on groundwater quality at Landfill 2, existing monitoring wells were sampled and direct push groundwater samples were collected in May 1995 as part of the pre-design activities for Landfill 2. Additional groundwater sampling activities were performed in March 1996, including collecting seven direct push groundwater samples in the vicinity of FCMW-75 and FCMW-76. A total of six wells and seven direct push locations were sampled at Landfill 2. Groundwater samples could not be obtained from five of the twelve direct push sample locations installed. The groundwater sample locations including the direct push locations are illustrated on Figure 6 of the Design Analysis.

The direct push groundwater locations LF2DPW-1 through LF2DPW-5 were selected to provide better coverage between the existing monitoring well locations. The additional direct push locations LF2DPW-6 through LF2DPW-12 were selected to define the extent of metals detected in FCMW-75 and FCMW-76 and the volatile organic compounds (VOCs) detected in FCMW-76. The Landfill 2 groundwater monitoring locations also included sample locations at existing drainage swales to analyze the flows following the natural topography.

All direct push groundwater samples were collected using a hydraulic penetrometer rig, mounted on an all-terrain vehicle. One-inch diameter probing rods were attached to hardened steel expendable points which were hydraulically driven to just below the water table based on water level measurements from existing wells. Perforated Polyflow (polyethylene and polybutylene) tubing, perforated to correspond to the depth of the water-bearing zone, was inserted into the rod and screwed into the expendable point. The rods were then retracted to expose the perforations, allowing groundwater to flow into the tubing. A groundwater sample was then obtained with a peristaltic pump or an inertia valve. When auger refusal occurred prior to reaching groundwater, an additional attempt was made to collect a groundwater sample by moving a few feet away and repeating the procedure. Groundwater samples were not collected from the direct push sample locations: LF2DPW-1 and LF2DPW-5 due to access; LF2DPW-2 and LF2DPW-8 were dry; and LF2DPW-10 produced groundwater for volatile organic analysis only. Groundwater samples could not be collected from the direct push sampling locations: LF2DPW-1, LF2DPW-2, LF2DPW-5, LF2DPW-8, and LF2DPW-10 due to site accessability, drilling refusal, or subsurface conditions.

The six existing monitoring wells were purged prior to sampling to ensure that representative samples were collected. Prior to purging, the depth to groundwater was measured with an electric water level meter. Field parameters, pH, temperature, specific conductance, and turbidity, were measured at the start of purging and twice per casing volume removed. Purging of the existing monitoring wells generally continued until at least three well volumes were removed and until pH measurements stabilized to 0.2 pH units or a 10 percent variation around the mean of four successive pH measurements. The purge rates were reduced in order to minimize sample turbidity. In low yield wells, a single casing volume was removed, and the water level in the well was allowed to recover prior to sampling.

The groundwater samples from the existing wells and the direct push samples were analyzed for: VOCs using Method 8260; and semivolatile organic compounds (SVOCs) using Method 8270. The additional analytes tested for each groundwater monitoring point are listed in Table 1. In cases where the recovery of the well or direct push sample was not adequate to fill all of the sample containers, the containers were filled in the following order: VOCs; SVOCs; and metals.

Results of the groundwater analyses above drinking water standards are posted on Figure 6, and copies of the laboratory analytical data are presented in Appendix H. Metals (antimony and manganese) were detected above drinking water standards in groundwater from FCMW-75 and FCMW-76, located near the southern, downgradient edge of the landfill. Concentrations ranged from 0.014 to 0.022 milligrams per liter (mg/l) antimony and 4.8 to 6.8 mg/l manganese. Antimony was also detected in groundwater from FCMW-81 at a concentration of 0.021 mg/l. The additional direct push locations performed in March 1996 in the vicinity of FCMW-75 and FCMW-76 revealed levels of manganese at 1.2 mg/l in LF2DPW-9.

Chlorinated pesticides and herbicides were not detected in any of the samples analyzed during the predesign activities in May 1995 and the first quarterly sampling effort of February 1996 as listed in Table 1.

Organic compounds were detected only in groundwater from downgradient well FCMW-76 and the additional direct push samples LF2DPW-6, LF2DPW-7. The compound 1,2-dichloroethane was detected at a concentration of 2.9 micrograms per liter (μg/l), while 1,2 dichloropropane was

detected at a concentration of 3.8 μg/l in FCMW-76. Vinyl chloride was detected in LF2DPW-6 at 5.1 ug/l and in LF2DPW-7 at 14.0 ug/l. VOCs were also detected at or below the laboratory reporting limits but below drinking water standards at the LF2DPW- 6 location. These parameters consisted of benzene, ethylbenzene, toluene, and xylenes in addition to naphthalene. However, the direct push samples collected downgradient of well FCMW-76 (LF2DPW-9, LF2DPW-11) did not contain any organic compounds above drinking water standards.

A groundwater sample was collected for water quality parameters during the May 1995 sample effort from FCMW-73 (sample #LF2-WQ). Also during the February 1996 first Quarterly Groundwater sampling effort, groundwater was analyzed for water quality parameters from four wells downgradient of Landfill 2 (FCMW-70, FCMW-73, FCMW-74, FCMW-76) The furthest downgradient wells (see inset map on Figure 6) contained nitrates above the drinking water standards as indicated in previous sampling. However, none of the wells or direct push samples at the toe of the landfill contained nitrates above drinking water standards. The groundwater quality analytical results are listed in Table 2.

3.7 SUMMARY OF HYDROGEOLOGIC CONDITIONS AT LANDFILL 2

The groundwater elevation contour map based on water level measurements collected on June 21, 1995 are presented in Figure 7 and Drawing C-4. Water table contours appear to follow the slope of the top of Pierre Shale. The groundwater flow appears to be in a south-southeasterly direction with an approximate hydraulic gradient of 0.070. Previous hydrogeologic reports estimated the hydraulic conductivity, based on piezometer test data, to range from 1.22×10^{-6} centimeters per second (cm/sec) in FCMW-74 to 2.08×10^{-3} cm/sec in FCMW-75. The water table is generally below the bottom of the landfilled materials and often is located within the upper portions of the Pierre Shale (see cross sections A-A^1, B-B^1). A summary of general characteristics of geologic materials is presented below. Geologic cross sections are shown in Figure 8.

Cover Materials - The cover material is predominantly lean clay with sand and sandy lean clay, very stiff, brown to dark grayish-brown, moist, medium plastic, contains angular clasts of shale randomly oriented, and was probably derived locally from alluvium and the surrounding Pierre Shale. Cover material overlies both landfill waste, *in situ* alluvium and shale, and ranges in thickness from 2.7 feet in boring SB-1 to 15.0 feet in boring SB-7.

Waste/Landfill - Other than construction/demo waste types of fill, no organic or municipal type of material was observed at the landfill surface. Landfill waste material typically consists of equal parts "trash" and sandy lean clay. The sampled waste includes metal, wood, broken glass, plastic, plaster, rubber, decomposed organics, and paper, and is generally of low strength, from soft to firm, and varies from damp to moist. The thickness of landfill encountered ranged from a minimum 2.5-feet to 4-feet thick, although total thickness was not the scope of this investigation and was not determined.

Alluvium - The alluvium deposits encountered in Landfill 2 were located in the lower lying southeastern area of the fill (borings SB-12 and SB-13). The alluvium varied considerably, ranging from poorly graded sand to fat clay (SB-13, 0 to 17 feet), from soft to hard, and contained occasional interbeds of sandy lean clay. The thickness of alluvium and depth to bedrock ranged from 6 to 17 feet (SB-13, 0 to 17 feet). Perched water was encountered in SB-13 at 1.5 feet during drilling, and fell to 12.9 feet 24 hours after completion of drilling.

Colluvium - Colluvial deposits encountered in the northwestern fill area (borings SB-4 and SB-5) are generally sandy lean clay, stiff to hard, dry to moist, and of medium plasticity. Some deposits contained little subangular gravel (to 0.5 inch), along with small nodules (<0.1 inch) of salt-like deposits.

Pierre Shale - Bedrock underlying Landfill 2 consists of Pierre Shale. Where encountered during this study, this unit is roughly flat-lying (near horizontal bedding) and consists of severely weathered claystone which typically displays rock-like qualities as very soft and plastic with thinly laminated bedding (<0.1 inch). Heavy iron-oxide staining occurs in both the groundmass and along the fracture/bedding surfaces. Vertical fractures/joints, heavily iron-oxide stained, were noted in boring SB-11 where claystone is exposed at the surface. Although relic rock texture is recognizable, the severely weathered claystone is best described by its soil-like qualities as lean to fat clay with sand, where sand content varies. The unit generally occurs as hard, damp to moist, predominantly clay with medium plasticity, occasional interbeds of fine sand, and appears tight and competent. The claystone underlying the various surficial units was encountered at the surface (SB-11) and to a depth of 8 feet (SB-12). Groundwater was not encountered in the claystone.

4.0 LANDFILL CAP DESIGN

The capping of Landfill 2 requires several key items to be addressed in the design. First, waste existing along the perimeter of the landfill, in particular, along the northern limit of the landfill, appears to be end-dumped surficial waste. To limit the size of the landfill cap and reduce potential construction capping problems associated with the steepness of some of the areas, excavation and relocation of waste existing along the landfill periphery will be considered. Second, portions of the centrally located 43 acre area with existing in-place cap will require improvement to achieve the required thickness and permeability. Third, the existence of a concrete lined surface water channel at the landfill offers the opportunity to utilize this structure and limit the construction of new surface water channels. In addition to limiting new channel construction, Fort Carson personnel have expressed an interest in preserving the channel to the extent reasonable and possible. And fourth, the presence of possible grit/oil pit trench fills along west and south portions of the landfill may require additional capping area, where appropriate. To develop a cap system to meet the environmental regulations and address the items listed above, the proposed excavation and final grades have been modified to accommodate the various areas of the landfill.

4.1 DESIGN APPROACH TO LANDFILL 2

The focus of the design was to develop a cap system and grading plan which accommodated the requirements outlined above. In the course of establishing the limit of waste in predesign activities, areas of the landfill which would present a significant operational problem in placing and compacting a landfill cap, and areas that would aid in limiting the area of new cap construction, were identified. These areas were targeted for waste relocation to the interior of the landfill, and included the eastern areas outside of the existing concrete lined perimeter surface water channel, the slope north of the surface water collection channel in the northern part of the site, and the southwest corner of the site between the topographic south toe of the landfill and the southern earthen channel.

Preference to maintain the current surface water management system also governed the limits of the landfill cap in the east and north of the site. In the north, the entire northern face has been designed to relocate waste to the interior of the landfill, thereby allowing the construction of a new perimeter surface water run-on control channel at the toe of the northern slope. This new channel will connect hydraulically to the existing concrete lined surface water control channel along the eastern perimeter

of the landfill. As discussed in Section 3.5, the extent of waste was confirmed by the installation of 24 exploratory trenches. The intent of limiting the cap to these areas will allow for the construction of a landfill cap that will meet specifications and provide a surface water control system that will adequately control surface water run-on and run-off without impact to the landfill cap.

As previously noted, areas located along the west and southwest portions of the site (between the western earthen perimeter channel and the topographic west toe of slope) and southwest portion of the site (between the existing fence along the south side of the site and the topographic south toe of slope) were identified by Fort Carson personnel as possible grit/oil pit trench fills. During a meeting with Colorado Department of Public Health and Environment (CDPHE) on September 18, 1995, the CDPHE (Edgar Ethington) agreed in concept to capping these areas. However, trenching performed to determine the limit of waste along the west and southwest portions of the landfill did not encounter waste materials typically associated with grit/oil pits. Thus, no special capping area has been assigned for grit/oil pits.

The cap design also includes utilizing the existing cap. The existing cap consists of an area of approximately 43 acres within the central portion of the landfill. Areas of the existing cap deemed insufficient will require reworking. The following sections provide discussions related to cap design.

4.2 REGULATORY REQUIREMENTS FOR CAPPING

The requirements for establishing the landfill cap profile were based upon the review of the following regulations, technical guidance documents, and seminar publications:

- State of Colorado, CDPHE, "Regulations Pertaining to Solid Waste Disposal Sites and Facilities", 6 CCR 1007-2;
- State of Colorado, CDPHE, "Regulations Pertaining to Hazardous Waste Disposal Sites and Facilities", 6 CCR 1007-3;
- U.S. Environmental Protection Agency (EPA), Technical Guidance Document, "Quality Assurance and Quality Control for Waste Containment Facilities";
- U.S. EPA, Seminar Publication, "Design and Construction of Resource Conservation and Recovery Act (RCRA)/Comprehensive Environmental Response Compensation and Liability Act (CERCLA) Final Covers"; and

- U.S. EPA, Technical Guidance Document, "Final Covers on Hazardous Waste Landfills and Surface Impoundments".

4.2.1 Subtitle D Design Considerations

The requirements for a landfill cap under the Colorado Subtitle D regulations require a final cap that meets or exceeds a minimum of 5 percent slope. The Colorado Subtitle D regulations further state that a variation from the 5 percent minimum may be acceptable if a demonstration of adequacy is provided. This is consistent with a recent meeting with the State of Colorado (Ron Florina), as well as a follow-up telephone conference with Ron Florina (see Notes of Telephone Conversation provided in Appendix G), in which Rust was informed that the State would be flexible in considering a flatter final grade slope, provided final grades ensure and promote surface drainage off the landfill and avoid ponding of surface water. The use of flatter slopes is further supported by EPA document 625/4-91/025/ titled "Design and Construction of RCRA/CERCLA Final Covers", which states on page 3 that "Final slopes of the cover should be uniform and at least 3 percent, and should not allow erosion rills or gullies to form."

Colorado Subtitle D regulations also require that the final cap be comprised of the following components.

For a soil final cover:

- An infiltration layer consisting of a minimum 18 inches of earthen material that has a permeability of less than or equal to the permeability of any bottom liner system or natural subsoils present, or a permeability no greater than $1x10^{-5}$ cm/sec, whichever is less; and
- An erosion layer of earthen material a minimum 6 inches in thickness that is capable of sustaining native plant growth.

For a composite final cover:

- A foundation layer to be comprised of a minimum 6-inch soil layer, located immediately above the refuse, to provide a suitable foundation for placement of the geomembrane; and,
- The barrier layer shall consist of a geomembrane which has a minimum 30-mil thickness and displays properties adequate for its intended purpose.

A copy of the landfill closure section of the Colorado Subtitle D regulations is enclosed in Appendix I.

4.2.2 Subtitle C Design Considerations

Both Federal and Colorado Subtitle C regulations (Subpart N - 264.310), which are presented in Appendix I, require that a final cap must be placed over the landfill as part of the closure of the landfill and that the cap must meet the following design criteria:

- Provide long-term minimization of migration of liquids through the closed landfill;
- Function with minimum maintenance;
- Promote drainage and minimize erosion or abrasion of the cap;
- Accommodate settling and subsidence so that the cover's integrity is maintained; and
- Have a permeability less than or equal to the permeability of any bottom liner system of natural subsoils present.

In an EPA guidance document (530-SW-89-047) titled "Final Covers on Hazardous Waste Landfills and Surface Impoundments", EPA has developed a recommended cap profile for Subtitle C landfills. In this document, EPA acknowledges that the recommended cap profile is only guidance and that alternative cap designs are acceptable providing that the alternative design adequately achieves the regulatory requirements and provides equivalent performance to the recommended design. The EPA proposed cap profile consists of the following layers:

- Infiltration layer consisting of a minimum 2 feet of earthen material that has a permeability of less than or equal to the permeability of any bottom liner system or natural subsoils present;
- A geosynthetic liner with a minimum 30-mils thickness;
- An infiltration collection layer consisting of 12 inches minimum of granular material or consisting of a geosynthetic drainage layer; and
- A protective soil cover layer a minimum 24-inches thick and consisting of miscellaneous soils and capable of sustaining vegetative growth.

The final slope to be considered under Subtitle C design regulations is at least 3 percent according to EPA guidance (Section 4.2.1). However, the State of Colorado has indicated in several meetings (see Notes of Conversations provided in Appendix G) that a flatter slope would be considered provided that it ensures surface water drainage and avoids ponding of surface water. As discussed in Section 4.3, one cap design was evaluated which achieves the Subtitle C regulations and provides equivalent performance as the EPA proposed cap design based on the semi-arid climate and availability on cap materials.

4.3 CAP PROFILE OVERVIEW

Given the observed make-up of the waste in Landfill 2, which is composed principally of soil fill, municipal waste, and construction/demolition fill, coupled with the potential presence of hazardous waste materials, the landfill cap design will consider both Subtitle D and Subtitle C regulations.

The landfill cap being proposed for Landfill 2 is an enhanced version of the soil cap required by the State of Colorado Subtitle D regulations in order to achieve Subtitle C regulations and guidance. The cap being proposed takes the prescribed minimum profile required by the Subtitle D regulations, and increases the final cap profile by adding an additional 6 inches of low permeable soil and providing for protection from freeze/thaw effects. The proposed cap components consist of the following:

- A frost protection layer consisting of a minimum 30-inch thickness of miscellaneous soils with a permeability of $5x10^{-5}$ cm/sec or less; and
- A barrier layer consisting of cohesive soils with an in-place permeability of $5x10^{-7}$ cm/sec or less and placed at a minimum thickness of 24 inches.

The permeability of the soils immediately below the landfill range between $2.08x10^{-3}$ cm/sec to $1.22x10^{-6}$ cm/sec. These soil permeabilities were determined when monitoring wells FCMW-75 and FCMW-74 were installed at Landfill 2. Permeability values were determined using slug testing as reported in "Final RCRA Facility Assessment for Fort Carson, Colorado Springs, Colorado" (Science Applications International Corporation, May 1994). The use of a barrier layer with a permeability of $5x10^{-7}$ cm/sec exceeds the requirements of both Colorado Subtitle C and D regulations, which require a cap barrier layer with a permeability of less than or equal to the permeability of any bottom liner system or natural subsoils presents.

The frost protection layer is being recommended for the soil cap because studies have shown that freeze/thaw cycles cause an increase in hydraulic conductivity of one to two orders of magnitude in barrier layers. It is essential that the soil barrier layer being recommended for Landfill 2 be protected from the effects of freeze/thaw by the addition of a 30-inch thick layer of soil above it. The Colorado Springs Building Department indicates that the design frost depth is 30 inches for the area (see copy of phone memo in Appendix G). This value is supported by reference information also presented in Appendix G. In addition, the larger thickness of the frost protection layer will reduce the potential for erosion damage by allowing a stronger stand of vegetation to be established.

The cap profile discussed above will be utilized for those portions of the landfill that will receive relocated waste from perimeter areas, or areas which are regraded to provide adequate slope. After relocating landfill materials within the SWMU boundary, the revised limit of waste would decrease to 70 acres. The area of the landfill that will receive new cap equals approximately 33 acres. The remaining 43 acres of the landfill will consist of existing cap or reworked existing cap; however, the existing cap profile and reworked areas will both meet the criteria discussed above. The following sections present evaluations of the existing cap and the proposed clay/soil cap.

4.3.1 Existing Cap

Since the project approach was to use existing final cover where possible, borings (SB-1 through SB-14) were performed in June 1995 with the partial intent to obtain some initial information as to if a sufficient soil cap may already exist at the site. Results of permeability testing performed on several samples from these borings indicated that the existing soil cover meet the cap requirements outlined earlier. As a follow-up effort to further document the limits of existing cap which met the appropriate permeability and thickness criteria, a grid system to verify the thickness and permeability of actual cover soils in-place was developed. The grid system was based on the State of Colorado "Guidance Recommendations for Construction Quality Control Testing of Liner and Final Cover Barrier Layer Components for Solid Landfill Waste", which states that the recommended frequency of permeability tests is one test for every 5,000 cubic yards of barrier layer material. Based on the approximate 43-acre area of existing cover to be checked, and considering a barrier layer thickness of 2 feet, 29 additional soil borings were drilled within the 43 acre area, yielding a boring grid system with test locations spaced about 250 feet apart.

This second phase of drilling to perform the cap verification test borings (CVT-1 through CVT-29) was used in conjunction with the initial phase of drilling to identify those areas which have suitable cap, as well as those areas which will require reworking. The location of the cap verification test borings with their respective permeability test results are shown on Figure 4. This figure also shows the interpreted boundaries of cap which were considered suitable, or which need to be reworked. Permeability results are also presented in Attachment 1 of Appendix C, and copies of the boring logs are presented in Appendix B.

In summary, 12 of 29 of the cap verification test borings were considered within the criteria of an acceptable soil cover. Note that there was insufficient or poor quality soil material to conduct permeability testing on samples obtained from borings CVT-5 and CVT-17. Based on the test results, as well as the thickness of soil cover encountered, there is an area of approximately 18 acres which is considered acceptable, and 25 acres of the existing cap that will need to be reworked. Reworking will take the form of either regrading and constructing the standard soil cap, or reworking the existing soils to the thicknesses and specifications of the standard soil cap. Figure 4 delineates the areas and the associated approach to each area, and the design drawings provide further detail of the specific areas and the associated work. It is further anticipated that the areas to be reworked may require the addition of clay material to ensure the required minimum thickness of the cap layers are present; however, based on the thickness and type of existing soils present, the work should generally be limited to reworking the existing soils which are appropriate in type, but which were not placed with adequate moisture and compaction required to develop the required permeabilities.

Finally, the use of onsite (Fort Carson) borrow soil has been clarified, and some clay and general soil fill borrow sites have been identified. The grading plan has been designed with minimum 5 percent grades. As will be discussed in Section 4.5, these construction slopes are expected to provide a minimum of 3 percent slope after settlement has occurred.

4.3.2 HELP Model Analysis of the Cap Profile

In order to verify the adequacy or equivalency of the proposed landfill cap in preventing precipitation infiltration, the EPA HELP Model - Version 3.04 was used to simulate a 30-year post-closure period. The results of the HELP Modeling are presented in Appendix E of this Design Analysis report. Furthermore, a 100-year, 24-hour storm event was manually inputted in the precipitation input file to further test the proposed landfill cap. Results of the HELP Modeling indicate that the infiltration through the proposed cap, as well as the existing cap (in areas passing permeability testing), is negligible. The soil cap will adequately prevent any infiltration into the landfill. In addition, the infiltration rates for the EPA-recommended Subtitle C cap are negligible, documenting that the proposed caps are equivalent.

4.4 DETERMINATION OF CAP EQUIVALENCY

The proposed cap design achieves the regulatory requirements established in both Federal and State regulations (Subpart N - 264.310). As discussed in Appendix E, the cap design for Landfill 2 provides long-term minimization of migration of liquids through the closed landfill. In addition, the evaluation of design grades and settlement indicates that the cap design is adequate to promote drainage, minimize erosion, and can accommodate settling and subsidence to maintain the integrity of the cap. As discussed in Section 4.3, the permeability of the proposed cap is less than the permeability of the underlying soils, thereby achieving the State and Federal regulations. The proposed cap design is designed to function with minimum maintenance.

The proposed cap provides equivalent performance to the EPA-recommended Subtitle C cap. As discussed in Appendix E, the proposed cap prevents infiltration and minimizes long-term migration of liquids through the landfill equally, as well as the EPA-recommended Subtitle C cap based on estimated infiltration rates from the HELP model analyses in Appendix E. In addition, the maintenance requirements and ability to accommodate settlement are the same for the proposed design for Landfill 2 and the proposed Subtitle C cap in EPA guidance.

4.5 GEOTECHNICAL EVALUATION

A geotechnical evaluation of Landfill 2 was conducted using the information gathered during the field investigation, as well as available published data and soil property correlations. The geotechnical evaluation for the design focused on analyzing the landfill for potential settlement to ensure the proposed final grades meet the minimum slope requirements following cap construction, and evaluating slope stability conditions. Present topography, location of exploratory borings, cross sections A-A' through G-G' and proposed final cap elevations are shown in Figures F-1 and F-2, respectively. The following sections summarize work associated with the geotechnical laboratory testing and subsequent geotechnical engineering analysis.

4.5.1 Site Characterization and Geology

Section 3.7 provides a discussion of the geological units present at Landfill 2, and the following paragraphs present the geotechnical properties of the various materials encountered at Landfill 2.

Cover Materials - The cover material is predominantly lean clay with sand and sandy lean clay, very stiff, brown to dark grayish-brown, moist, medium plastic, contains angular clasts of shale randomly oriented, and was probably derived locally from alluvium and the surrounding Pierre Shale. Cover material overlies landfill waste, *in situ* alluvium and shale, and ranges in thickness from 3 feet in boring CVT-17 to 15.0 feet in boring SB-7. As previously noted, partially exposed debris, such as concrete rubble and crushed drums, was observed in the northern and eastern limits of the landfill.

Waste/Landfill - Other than construction/demolition waste types of fill, no organic or municipal type of material was observed at the landfill surface. Landfill waste material typically consists of equal parts "trash" and sandy lean clay. The sampled waste includes metal, wood, broken glass, plastic, plaster, rubber, decomposed organics, and paper, and is generally of low strength, from soft to firm, and varies from damp to moist. The thickness of landfill material encountered ranged from a minimum 2.5-feet to 4-feet thick, although total thickness was not the scope of this investigation and was not determined. The majority of landfill samples were screened with the organic vapor analyzer and measured 0 parts per million (ppm), although in several borings organic vapors were detected up to a maximum of 68 ppm (boring SB-10, sample number SB10-8).

Alluvium - The alluvium deposits encountered in Landfill 2 were located in the lower lying southeastern area of the fill (Boring Nos. SB-12 and SB-13). The alluvium varied considerably, ranging from poorly graded sand to fat clay (SB-13, 0 to 17 feet), from soft to hard, and contained occasional interbeds of sandy lean clay. The thickness of alluvium and depth to bedrock ranged from 6 to 17 feet (SB-13, 0 to 17 feet). Perched water was encountered in SB-13 at 1.5 feet during drilling, and fell to 12.9 feet 24 hours after completion of drilling.

Colluvium - Colluvial deposits encountered in the northwestern fill area (Boring Nos. SB-4 and SB-5) are generally sandy lean clay, stiff to hard, dry to moist and of medium plasticity. Some deposits contained little subangular gravel (to 0.5 inch), along with small nodules (<0.1 inch) of salt-like deposits.

Pierre Shale - Bedrock underlying Landfill 2 consists of Pierre Shale. Where encountered during this study, this unit is roughly flat-lying (near horizontal bedding) and consists of severely weathered

claystone which typically displays rock-like qualities as very soft and plastic with thinly laminated bedding (<0.1 inch). Heavy iron-oxide staining occurs in both the groundmass and along the fracture/bedding surfaces. Vertical fractures/joints, heavily iron-oxide stained were noted in Boring SB-11, where claystone is exposed at the surface. Although relic rock texture is recognizable, the severely weathered claystone is best described by its soil-like qualities as lean to fat clay with sand, where sand content varies. The unit generally occurs as hard, damp to moist, predominantly clay with medium plasticity, occasional interbeds of fine sand, and appears tight and competent. The claystone underlying the various surficial units was encountered at the surface (SB-11) to a depth of 8 feet (SB-12). Groundwater was not encountered in the claystone.

A summary of general characteristics of geologic materials is presented in Table F-1. Cross sections A-A' through G-G' showing interpreted subsurface conditions are presented in Figures F-3 through F-9, respectively; cross-section locations are shown on a reduced site plan, Figure F-2. Approximate thickness of existing fill and native foundation soils overlying bedrock (Pierre Shale) are summarized in Table F-2 (Sheets 1 and 2).

4.5.2 Geotechnical Laboratory Testing

Laboratory testing was conducted to evaluate index and engineering properties of selected specimens of geologic materials. Testing included existing cover soils (fill) and native materials (e.g., alluvium, colluvium, and Pierre Shale), as well as potential borrow soils for the proposed landfill cap (from Landfill Borrow Area No. 1). Waste materials were not tested for either geotechnical engineering or environmental properties.

The index property/soil classification program included testing for natural water content, dry density, grain size distribution, moisture content - dry density relationship (compaction), and Atterberg limits. The engineering property evaluation program included undrained shear strength and permeability (hydraulic conductivity) testing. Soil and/or waste compressibility testing was not part of our scope of work, but rather, appropriate parameters were obtained from reference sources as noted in the settlement calculations in Appendix F. A report on the laboratory testing program and test results is presented in Appendix C.

4.5.3 Material Property Characterization

Soil properties for engineering evaluations were primarily based on the result of the geotechnical field investigation and the laboratory test program described in Section 4.5.2. Available subsurface material data collected as part of this investigation, including standard penetrati test blow count, dry unit weight, fines fraction (percent passing standard sieve #200), Atterberg limits, and moisture content are plotted versus depth and included in Attachment 1 of Appendix F. Published data on correlations between various (sought) engineering properties and other (available) soil parameters were also used to supplement the field and laboratory investigation, particularly regarding compressibility and shear strength of soil and waste materials are also included in Attachment 1 of Appendix F. A summary of geotechnical properties of fill and native materials is presented in Appendix F (Tables F-3(a) and F-3(b)).

4.5.4 Settlement of Proposed Cover

In general, the type, method of placement or deposition, and age of materials directly affect compressibility of materials. Thickness and compressibility of materials in turn affect estimated settlements of the proposed final cap. Consequently, evaluation of limits of fill (horizontal as well as vertical extent) is an important part of settlement evaluations.

These characteristics are summarized in Tables F-1, F-2, and F-3. Most critical elements of the settlement evaluation were considered to be existing fill materials, e.g. waste and soil cover materials. To assess the effect of uncertainties in the thickness and compressibility of waste materials, an estimate was made of their expected upper bound.

Estimated settlements at boring locations SB-1 through SB-14 are shown in Table F- 4(a) of Appendix F. Because of long-term settlement characteristics of both waste and onsite clayey soils (such as existing soil cover, alluvium and colluvium), estimated settlements were evaluated for both short- and long-term conditions. Short-term settlement includes the construction period (for addition of about 4.5 feet of cap fill) and roughly one year after construction. Long-term settlement includes a period of approximately 15 years after construction. Settlements after 15 years are expected to be negligible.

Based on calculations for this design submittal, the pre-settlement design grades will provide enough slope on the landfill to maintain a minimum 3 percent post-settlement slope (see Table F(b) of Appendix F). As noted in Section 4.2 of this Design Analysis report, 3 percent is the minimum slope per EPA guidance documents, and is anticipated to be acceptable given performance of settlement calculations to ensure sufficient post-settlement slope. An evaluation of the estimated settlements indicates that the proposed cap surface gradient will provide adequate drainage after the expected settlements.

4.5.5 Stability of Proposed Cover

In general, slope stability depends on various factors including the subject slope gradient, subsurface soil stratigraphy, groundwater conditions, static and transient external loading, type and properties of various materials (e.g. unit weight and shear strength) for the anticipated drainage and loading conditions.

In the case of Fort Carson Landfill No. 2 (FTC-006), cover slope gradients are anticipated to vary between 5 to 25 percent, depending on the location (see Table F-5). Interpreted landfill stratigraphy for Cross-Section F-F', shown in Figure F-8 (Appendix F), was selected for the slope stability evaluation. This section assumes the following materials:

Material/Layer No.	Description
[1]	A 2.5-foot-thick soil cover and frost protection layer (SC/FP);
[2]	A 2.0-foot-thick barrier layer (BL);
[3]	About 4 to 10 feet of pre-existing soil cover and additional fill soils (F_m);
[4]	On the order of 10 to 20 feet of pre-existing and relocated waste materials;
[5]	On the order of 5 to 15 feet of Quaternary alluvium (Q_{al}) and/or residual soils (RS), overlying bedrock; and,
[6]	Pierre Shale (PS) below approximate elevation 5,820 to 5,870 feet mean sea level (MSL) at the southern and northern edges of the landfill, respectively, outcropping on slopes north of Landfill No. 2.

Location of Section F-F' is shown in Figure F-2. At this location, groundwater elevation is estimated to range from south to north, from approximately 5,810 to 5,870 feet above MSL, or about 10 to 20 feet below present grade.

No ground surface loads are anticipated to result from potential future use of the landfill, and consequently, no static ground surface loads were considered to act on the proposed cover for this evaluation.

An evaluation of potential seismic loading indicated that maximum horizontal accelerations (MHA) in rock have a 90 percent probability of not exceeding approximately 5 percent of gravity in 250 years, as shown in Figure F-10 (Appendix F).

Shear strength of clayey materials, such as proposed barrier layer, residual, and alluvial soils were selected based on published correlations with other (available) soil index properties and parameters. A limited number of laboratory tests on pre-existing fill/cover soils were also available, including triaxial compression (ICU and UU) tests, shown in Figures C-11 and C-12 (Appendix C).

PCSTABL5M slope stability software was used to conduct the stability analyses after inputting the appropriate profile and soil parameter information. Because of the relatively small driving forces resulting from gentle cover surface gradients and minor external static loads, computed static stability factors of safety were, in all analyzed cases, greater than 1.5, which is typically required as a minimum for static long-term loading conditions (Naval Facilities Engineering Command, Design Manual 7.1 titled "Soil Mechanics", page 7.1-329, enclosed in Appendix F). Figures F-11 and F-12 of Appendix F show material properties and typical results of our slope stability computations; downward pointing arrows indicate beginning and end of trial failure surfaces with lowest safety factor.

For seismic conditions, a yield acceleration value (K_y) in excess of approximately 0.5 gravity (g) was computed using the procedure developed by Makdisi and Seed (1978); K_y is the value of horizontal (pseudo-static) forces causing a factor of safety of unity (1.0). For this value of K_y, and the estimated values of MHA, seismically-induced permanent deformations were negligible.

4.6 SURFACE WATER MANAGEMENT SYSTEM

The State of Colorado Subtitle D Regulations require that permanent surface water diversion structures remaining after closure of the landfill shall control run-on and run-off from the 100-year, 24-hour storm event.

The surface water management system for Landfill 2 will consist of permanent structures designed to adequately convey run-on and run-off from a 100-year, 24-hour storm event. The permanent structures consist of existing segments of concrete channel, diversion berms, downslope channels, and earthen diversion channels. See Drawing C-10 for locations of these permanent structures and Appendix L for design calculations. A majority of the drainage from the landfill cap flows towards an existing earthen perimeter channel along the south side of the landfill. The channel does not discharge to any other drainage feature in the area. The drainage that flows into the existing concrete channel eventually discharges into a low lying area at the southeast corner of the landfill, and also does not drain to any other drainage feature in the vicinity of the landfill. If desired, in the future it may be possible to design structures to route the run-off away from the south perimeter channel to existing drainage features.

As mentioned above, portions of an existing concrete diversion channel will continue to be used for purposes of routing run-on and run-off from the site. The concrete channel was designed by the USDA Natural Resource Conservation Service (previously named Soil Conservation Service) in La Junta, Colorado and constructed in the Fall of 1992. The channel is trapezoidal in cross section having a 3 foot bottom width, 1.25:1 (h:v) sideslopes, and varies in depth from 2 feet to 4 feet. Copies of the original design calculations and plans are included in Appendix L. The condition of the concrete channels was inspected for cracking and it was determined that most of the channel is in good condition. A few locations have developed cracks and will need to be repaired.

A diversion channel is proposed to collect run-off from the steeper portions of cap along the northern portion. The channel will be trapezoidal in cross section and will have dimensions as shown in the design drawings. The diversion channel will tie into an existing concrete channel along the eastern side of the landfill, and also tie into an existing perimeter ditch on the west side of the landfill.

A large portion of the concrete channel collects run-off from areas below the diversion channel noted above. Run-off collected flows toward the east and into a proposed section of diversion channel that is trapezoidal in cross section. The diversion channel flows in a southeast direction along the edge of proposed new final cap and discharges into the existing concrete channel.

Diversion berms will also be used to divert surface water run-off from the landfill cap. The berm locations are shown on the design drawings. The berms form a triangular cross section with the final cap and were located to decrease slope lengths, and thus, reduce erosion. Once surface water run-off is intercepted by the diversion berm it is routed to a downslope channel or existing drainage ditch.

Downslope channels are formed by two parallel berms spaced equally apart creating a trapezoidal shaped cross section. They are used to transport collected run-off as quickly as possible off of the final cap and discharge into main collection channels, such as the concrete channel and south perimeter channel. See the design drawings for locations and sizes.

To further reduce erosion loss within the proposed drainage features, temporary and permanent channel/ditch linings will be required. Drawing C-10 shows locations where these will be needed. A permanent lining, such as Enkamat, is required in areas of high shear stress due to steep slopes and high velocities. A temporary lining, such as Excelsior Blanket, is necessary to provide erosion protection while vegetation is being established.

In addition to the permanent structures to control surface water run-on and run-off, temporary structures are proposed to further control the amount of erosion loss from the final cap. The temporary features include silt fencing, straw bale check dams, and straw bale sediment barriers. These structures will be installed, as required to minimize sediment transport, during construction of the landfill cap and will remain in place until vegetation has been re-established on the landfill cap and within permanent earthen channels.

4.7 FINAL CAP EROSION

Analysis of the final cap using the Revised Universal Soil Loss Equation developed by the Soil Conservation Service indicates that soil loss from a typical acre of the landfill can be expected to be on the order of approximately 0.24 tons/acre/year to 0.96 tons/acre/year. These estimates account for the use of diversion berms and diversion channels to decrease the slope length which decreases the amount of erosion. The final cap was broken up into seven zones which were based on locations of existing and proposed drainage structures. The erosion loss analysis for each zone is presented in Appendix J of this Design Analysis.

4.8 DEVELOPING CONTOURS OF LANDFILL FINAL GRADES

Contours for the landfill were developed based on an assumed 4.5-foot thick final cap. In areas where the existing cap is to be reworked, the current contours were left intact. In areas where relocated waste is to be placed and capped, a minimum final slopes of 5 percent and maximum final slopes of 25 percent were used with a final cap thickness of 4.5 feet over all waste fill material.

Grades along the north side of the site were developed to promote collection of surface water runon, prior to the runon moving over areas of capped waste. This required the excavation of existing waste on the steep slopes in the northern part of the site. The final grades along this slope reflect the excavation of approximately 3 feet of material to remove waste which appears surficial in nature. The final grades generally mimic the existing grades along the north slope, although some smoothing of irregular contours was performed.

Waste existing along the east side of the site (east of the concrete lined perimeter channel) has been designated for excavation and relocation to the interior of the landfill. In addition to the north and east areas, waste along the perimeter of the landfill at the southeast and southwest corners of the landfill is also designated for relocation. Several areas within the interior of the landfill require regrading to develop positive drainage, and the waste excavated from perimeter areas will be used as grade fill to achieve bottom of barrier layer grade. In the event that more waste volume is encountered in the excavation areas than fill volume is allotted in the interior areas, the grades within the interior area, which are designed at 5 percent, may be raised in elevation to allow for the placement of the additional volume. Note that all areas to receive relocated waste will be capped with the standard cap profile.

Sheet C-9 of the design drawings depicts final grade landfill cap contours and areas with existing cover. Sheet C-8 of the design drawings depicts the top of the final cap barrier layer, and Sheet C-7 of the design drawings depicts final excavation grade contours for waste relocation areas after removal of the waste. Grades were not provided for all areas to have surficial waste removed; however, the design drawings do designate that the these areas are to be graded to provide for positive drainage, and be subsequently seeded. Finally, cross sections through the landfill cover and waste relocation areas are provided on Sheet C-16.

4.9 DETAIL DRAWINGS RELATED TO CAPPING THE LANDFILL

A number of details were developed for this design. The details include the soil cap profile, final cap tie-in at the edge of the existing ditches and channels, and final cap tie-in along the southern boundary of the landfill. Details have also been developed for cap tie-in at proposed ditches and channels. In addition, a number of details are provided for construction of the permanent surface water control structures. Several details are also included which are related to temporary erosion control structures. These detail drawings are included in the drawing plan set.

4.10 SITE ACCESS ROADS AND FENCING

Site access will be controlled by using the existing gates. Temporary roadways will be established by the construction subcontractor as necessary for access for cap construction. No permanent roadways other than the existing site access roads are proposed for the landfill.

Landfill 2 is currently enclosed within a fence. This fence is to be removed in areas requiring work, and is to be replaced after construction work is completed. No additional fencing is proposed for the landfill.

5.0 COST ANALYSIS

Table D-1 of Appendix D presents the costs associated with capping Landfill 2 based on using onsite soils. The final cap configuration utilized in this cost estimate consists of:

- Clay/Soil Cap: 2-feet of compacted cohesive soils with a permeability equal to or less than $5x10^{-7}$ cm/sec; 2.5 feet of soil cover/frost protection layer; and general fill required to bring the landfill to grade.

The cost for each component of the final cap is as follows:

Cut/fill to reach subgrade	$848,683
Clay/soil Cap (new cap)	$1,860,041
Clay/soil Cap (reworked cap)	$658,529
Seeding, erosion/drainage control (new and reworked cap areas; does not include seeding 18 acres of existing cap)	$185,120
Fencing	$10,691
Construction Quality Assurance/Quality Control (QA/QC)	$251,606
Total Cost	$3,814,670

Some general assumptions related to the above costs are as follows:

1. Haul distance for new cap barrier layer soils and frost protection layer soils is about 5 miles round trip.

2. Areas of the existing cap to be reworked will have approximately 5.5 feet excavated. It is assumed that approximately 1 foot of excavated material will not be the appropriate soil type, and thus will be used for subgrade fill below the reworked cap. It is further assumed that the remaining 4.5 feet of material to be reworked is adequate barrier soil and frost protection soil material.

3. Construction QA/QC cost is based upon the estimate put together by Rust, and encompasses efforts for new cap and reworking existing cap.

4. Costs reflect overhead and fee. Costs were adapted from the negotiated construction contract under Delivery Order No. 19-TERC 1. Project management and health/safety costs are not included in the total cost.

The associated cost breakdown for each alternative identified above is presented in Appendix D of this Design Analysis. In summary the cost per acre to construct a cap utilizing onsite borrow sources for the profile outlined above is $73,359 per acre. This value is based on final capping 52 acres: 70

acres final limit of waste less 18 acres of existing cap. Note that the existing limit of waste encompasses 98 acres, and the above costs reflect relocation of waste prior to capping.

6.0 SUMMARY OF DESIGN DRAWINGS

The following text provides a summary of the drawings included in the plan set. A brief explanation as to the rationale for including the drawings is provided.

C-1 **Regional, Vicinity, and Location Maps:** This drawing shows the relative location of Fort Carson to Denver and Colorado Springs, and road access to the landfill. In addition, this sheet contains the index for the plan set.

C-2 **Legend & Symbols:** This drawing presents standard symbols in legend format which are used throughout the plans.

C-3 **Existing Conditions with Subsurface Exploration Locations:** This drawing contains the existing contours as per the December 14, 1994 photo date. This sheet also depicts the limit of waste based on field mapping observations and interpretation of conditions following subsurface exploration work which consisted of borings and trenches.

C-4 **Water Table Elevation 6/21/95:** This sheet shows groundwater contours for the date indicated. This sheet is being included in the plan set since excavation is being performed at the site as part of construction associated with waste relocation.

C-5 **Monitoring Well Abandonment and Installation Plan:** This drawing designates which of the existing wells are to be decommissioned and abandoned prior to construction activities at the landfill. In addition, this drawing identifies the location of proposed monitoring wells to be installed after cap construction activities.

C-6 **Cap Plan:** This drawing depicts the location of the existing cap, the area to be reworked, areas of consolidation and fill, and areas to have surficial waste removed.

C-7A, B, C, D **Excavation and Fill Grades:** These drawings depict the excavation and fill grades required to reach top of subgrade or bottom of cap barrier layer. Due to the size of the landfill, four sheets are provided for clarity.

C-8A, B, C, D **Top of Final Cap Barrier Layer:** These drawings depict the top of the low permeable cap barrier layer. Due to the size of the landfill, four sheets are provided for clarity.

C-9A, B, C, D **Final Grades:** These drawings illustrate final grade contours after relocation of waste and construction of the final cap. Due to the size of the landfill, four sheets are provided for clarity.

C-10 **Location of Erosion Protection:** This drawing depicts the location and type of erosion protection to be used after final grades are reached, and surface water ditches and channels are in place.

C-11 **Final Cap and Tie-in Details:** This drawing contains details of the final cap profiles, as well as details of how the final cap is to tie into structures at the landfill's boundary. Details of permanent surface water control structures are provided.

C-12,C-13,C-14 **Channel Tie-in Details:** These drawings contain details of the transitions between earthen channel and the existing concrete channel.

C-15 **Details:** This sheet contains details of permanent as well as temporary erosion controls to be used, a detail of a typical decontamination pad, and a detail of a typical pull post assembly and corner post assembly.

C-16 **Landfill Cross Sections:** This sheet provides cross sections through the landfill depicting the existing topography, as well as the final grades and the cap.

7.0 REFERENCES

Environmental Protection Agency. "Final Covers on Hazardous Waste Landfills and Surface Impoundments."

Science Applications International Corporation. May 1994. Final RCRA Facility Assessment for Fort Carson, Colorado Springs.

U.S. Army Environmental Health Agency (USAEHA). August 1985. Phase 2 Geohydrologic Study #38-26-0392-87.

USAEHA. June and November 1988. Groundwater Quality Study #38-26-0897-89, Investigation of Closed Landfills.

TABLES

TABLE 1
SUMMARY OF GROUNDWATER SAMPLING, LANDFILL 2
FORT CARSON, COLORADO

Groundwater Sample	Date Sampled	Analytes Tested
LF2DPW3	06/23/95	8260 - Volatile Organic Compounds 8270 - Semivolatile Organic Compounds 8080 - Chlorinated Pesticides 353 - Nitrate + Nitrite 7060 - Arsenic 7421 - Lead 7470 - Mercury 7740 - Selenium 6010 - ICP Metals
LF2DPW4	06/23/95	8260 - Volatile Organic Compounds 8270 - Semivolatile Organic Compounds
LF2DPW6	03/21/96	8260 - Volatile Organic Compounds 8270 - Semivolatile Organic Compounds 354.1 - Nitrite 353.2 - Nitrate + Nitrite 7060 - Arsenic 7421 - Lead 7470 - Mercury 7740 - Selenium 6010 - ICP Metals
LF2DPW7	03/21/96	8260 - Volatile Organic Compounds 8270 - Semivolatile Organic Compounds 354.1 - Nitrite 353.2 - Nitrate + Nitrite 7060 - Arsenic 7421 - Lead 7470 - Mercury 7740 - Selenium 6010 - ICP Metals
LF2DPW9	03/22/96	8260 - Volatile Organic Compounds 8270 - Semivolatile Organic Compounds 354.1 - Nitrite 353.2 - Nitrate + Nitrite 7060 - Arsenic 7421 - Lead 7470 - Mercury 7740 - Selenium 6010 - ICP Metals
LF2DPW10	03/25/96	8260 - Volatile Organic Compounds
LF2DPW11	03/22/96	8260 - Volatile Organic Compounds 353.2 - Nitrate + Nitrite
LF2DPW12	03/22/96	8260 - Volatile Organic Compounds 8270 - Semivolatile Organic Compounds 353.2 - Nitrate + Nitrite

TABLE 1
SUMMARY OF GROUNDWATER SAMPLING, LANDFILL 2
FORT CARSON, COLORADO

Groundwater Sample	Date Sampled	Analytes Tested
FCMW-62	01/29/96	8080 - Chlorinated Pesticides 8150 - Chlorinated Herbicides 8260 - Volatile Organic Compounds 8270 - Semivolatile Organic Compounds 6010 - ICP Metals 7041 - Antimony 7060 - Arsenic 7421 - Lead 7470 - Mercury 7740 - Selenium 7841 - Thallium 9012 - Cyanide 160.1 - Total Dissolved Solids 160.2 - Total Suspended Solids 300.0 - Chloride 310.1 - Alkalinity, Hyd 353.2 - Nitrate + Nitrite 405.1 - Biochemical Oxygen 410.4 - Chemical Oxygen 415.1 - Total Organic Carbon
FCMW-68	01/29/96	8080 - Chlorinated Pesticides 8150 - Chlorinated Herbicides 8260 - Volatile Organic Compounds 8270 - Semivolatile Organic Compounds 6010 - ICP Metals 7041 - Antimony 7060 - Arsenic 7421 - Lead 7470 - Mercury 7740 - Selenium 7841 - Thallium 9012 - Cyanide 160.1 - Total Dissolved Solids 160.2 - Total Suspended Solids 300.0 - Chloride 310.1 - Alkalinity, Hyd 353.2 - Nitrate + Nitrite 405.1 - Biochemical Oxygen 410.4 - Chemical Oxygen 415.1 - Total Organic Carbon

TABLE 1
SUMMARY OF GROUNDWATER SAMPLING, LANDFILL 2
FORT CARSON, COLORADO

Groundwater Sample	Date Sampled	Analytes Tested
FCMW-70	01/30/96	8080 - Chlorinated Pesticides 8150 - Chlorinated Herbicides 8260 - Volatile Organic Compounds 8270 - Semivolatile Organic Compounds 6010 - ICP Metals 7041 - Antimony 7060 - Arsenic 7421 - Lead 7470 - Mercury 7740 - Selenium 7841 - Thallium 9012 - Cyanide 160.1 - Total Dissolved Solids 160.2 - Total Suspended Solids 300.0 - Chloride 310.1 - Alkalinity, Hyd 353.2 - Nitrate + Nitrite 405.1 - Biochemical Oxygen 410.4 - Chemical Oxygen 415.1 - Total Organic Carbon
FCMW-73	05/10/95	8260 - Volatile Organic Compounds 8270 - Semivolatile Organic Compounds 8080 - Chlorinated Pesticides 300 - Nitrate 353 - Nitrate + Nitrite 7041 - Antimony 7060 - Arsenic 7412 - Lead 7740 - Selenium 7841 - Thallium 7470 - Mercury 6010 - ICP Metals
FCMW-73 (LF2-WQ)	05/10/95	160.1 - Total Dissolved Solids 300.0 - Chloride 310.1 - Alkalinity, Hyd 353.2 - Nitrate + Nitrite 405.1 - Biochemical Oxygen 410.4 - Chemical Oxygen 415.1 - Total Organic Carbon

TABLE 1
SUMMARY OF GROUNDWATER SAMPLING, LANDFILL 2
FORT CARSON, COLORADO

Groundwater Sample	Date Sampled	Analytes Tested
FCMW-73	01/30/96	8080 - Chlorinated Pesticides 8150 - Chlorinated Herbicides 8260 - Volatile Organic Compounds 8270 - Semivolatile Organic Compounds 6010 - ICP Metals 7041 - Antimony 7060 - Arsenic 7421 - Lead 7470 - Mercury 7740 - Selenium 7841 - Thallium 9012 - Cyanide 160.1 - Total Dissolved Solids 160.2 - Total Suspended Solids 300.0 - Chloride 310.1 - Alkalinity, Hyd 353.2 - Nitrate + Nitrite 405.1 - Biochemical Oxygen 410.4 - Chemical Oxygen 415.1 - Total Organic Carbon
FCMW-74	05/10/95	8260 - Volatile Organic Compounds 8270 - Semivolatile Organic Compounds 8080 - Chlorinated Pesticides 300 - Nitrate 353 - Nitrate + Nitrite 7041 - Antimony 7060 - Arsenic 7412 - Lead 7740 - Selenium 7841 - Thallium 7470 - Mercury 6010 - ICP Metals

TABLE 1
SUMMARY OF GROUNDWATER SAMPLING, LANDFILL 2
FORT CARSON, COLORADO

Groundwater Sample	Date Sampled	Analytes Tested
FCMW-74	01/30/96	8080 - Chlorinated Pesticides 8150 - Chlorinated Herbicides 8260 - Volatile Organic Compounds 8270 - Semivolatile Organic Compounds 6010 - ICP Metals 7041 - Antimony 7060 - Arsenic 7421 - Lead 7470 - Mercury 7740 - Selenium 7841 - Thallium 9012 - Cyanide 160.1 - Total Dissolved Solids 160.2 - Total Suspended Solids 300.0 - Chloride 310.1 - Alkalinity, Hyd 353.2 - Nitrate + Nitrite 405.1 - Biochemical Oxygen 410.4 - Chemical Oxygen 415.1 - Total Organic Carbon
FCMW-75	05/09/95	8260 - Volatile Organic Compounds 7041 - Antimony 7060 - Arsenic 7412 - Lead 7740 - Selenium 7841 - Thallium 7470 - Mercury 6010 - ICP Metals
FCMW-75	05/10/95	8270 - Semivolatile Organic Compounds 8080 - Chlorinated Pesticides 300 - Nitrite 353 - Nitrate + Nitrite
FCMW-76	05/09/95	8260 - Volatile Organic Compounds 8270 - Semivolatile Organic Compounds 8080 - Chlorinated Pesticides 300 - Nitrate 7041 - Antimony 7060 - Arsenic 7412 - Lead 7740 - Selenium 7841 - Thallium 7470 - Mercury 6010 - ICP Metals

TABLE 1
SUMMARY OF GROUNDWATER SAMPLING, LANDFILL 2
FORT CARSON, COLORADO

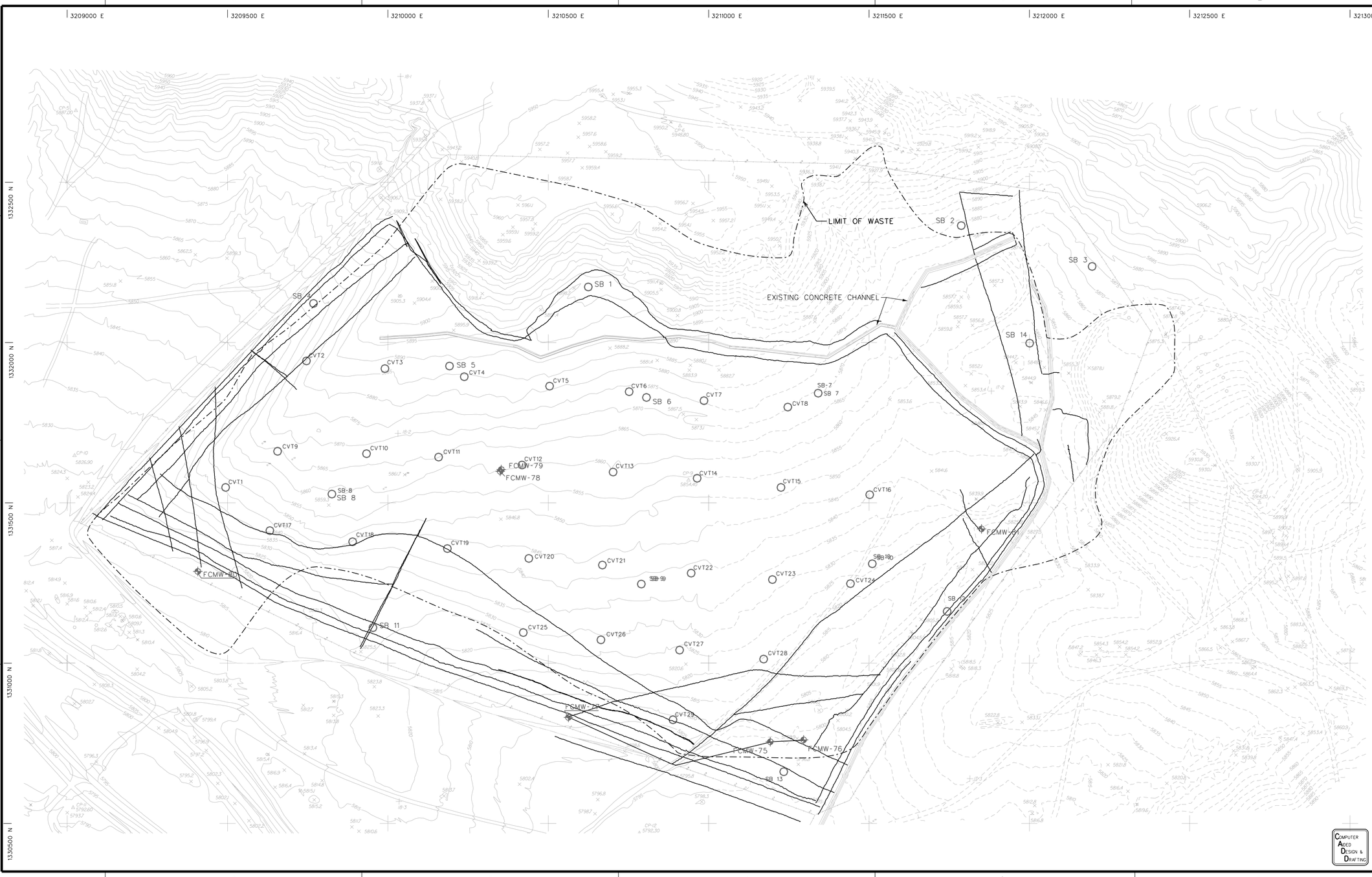
Groundwater Sample	Date Sampled	Analytes Tested
FCMW-76	01/30/96	8080 - Chlorinated Pesticides 8150 - Chlorinated Herbicides 8260 - Volatile Organic Compounds 8270 - Semivolatile Organic Compounds 6010 - ICP Metals 7041 - Antimony 7060 - Arsenic 7421 - Lead 7470 - Mercury 7740 - Selenium 7841 - Thallium 9012 - Cyanide 160.1 - Total Dissolved Solids 160.2 - Total Suspended Solids 300.0 - Chloride 310.1 - Alkalinity, Hyd 353.2 - Nitrate + Nitrite 405.1 - Biochemical Oxygen 410.4 - Chemical Oxygen 415.1 - Total Organic Carbon
FCMW-81	05/09/95	8260 - Volatile Organic Compounds 8270 - Semivolatile Organic Compounds 8080 - Chlorinated Pesticides 300 - Nitrate 7041 - Antimony 7060 - Arsenic 7412 - Lead 7740 - Selenium 7841 - Thallium 7470 - Mercury 6010 - ICP Metals

TABLE 2
ANALYTES DETECTED ABOVE THE STATE AND FEDERAL WATER QUALITY STANDARDS IN GROUNDWATER
LANDFILL 2
FORT CARSON, COLORADO

Site ID	Sample Date	Number	Analyte	Result	Units	State/Federal Water Quality Standard	Units
FCMW-62	01/29/96	6010	Manganese	2.3	mg/L	0.05	mg/L
		353.2	Nitrate plus Nitrite as N	113	mg/L	10	mg/L
		300.0	Chloride	415	mg/L	250	mg/L
		300.0	Sulfate	10200	mg/L	250	mg/L
FCMW-68	01/29/96	6010	Manganese	1.5	mg/L	0.05	mg/L
		353.2	Nitrate plus Nitrite as N	182	mg/L	10	mg/L
		300.0	Chloride	752	mg/L	250	mg/L
		300.0	Sulfate	9010	mg/L	250	mg/L
FCMW-70	01/30/96	6010	Manganese	16.7	mg/L	0.05	mg/L
		300.0	Chloride	365	mg/L	250	mg/L
		300.0	Sulfate	30100	mg/L	250	mg/L
FCMW-73	01/30/96	353.2	Nitrate plus Nitrite as N	119	mg/L	10	mg/L
		300.0	Chloride	353	mg/L	250	mg/L
		300.0	Sulfate	11500	mg/L	250	mg/L
FCMW-74	01/30/96	6010	Manganese	8.3	mg/L	0.05	mg/L
		353.2	Nitrate plus Nitrite as N	118	mg/L	10	mg/L
		300.0	Chloride	761	mg/L	250	mg/L
		300.0	Sulfate	28700	mg/L	250	mg/L
FCMW-76	01/30/96	6010	Manganese	5.3	mg/L	0.05	mg/L
		353.2	Nitrate plus Nitrite as N	0.14	mg/L	10	mg/L
		300.0	Chloride	210	mg/L	250	mg/L
		300.0	Sulfate	12200	mg/L	250	mg/L

Notes:
NA No State or Federal Water Quality Standard available.

FIGURES



LEGEND

FCMW-81	LOCATION OF EXISTING MONITORING WELL
SB 7	LOCATION OF GEOTECHNICAL BORING
CVT16	LOCATION OF CAP VERIFICATION TEST BORING
	EM-31 TRAVERSE
	SURVEY CONTROL POINT
	LIMIT OF WASTE

N

NOTES:

1. HORIZONTAL COORDINATES ARE MODIFIED STATE PLANE COORDINATES COLORADO CENTRAL ZONE BASED ON NAD83 WITH A DATUM ADJUSTMENT FACTOR OF 1.00026853 ELEVATIONS SHOWN ARE MEAN SEA LEVEL NAVD88 CONTROL BY MONTGOMERY-PHILLIPS, INC.

DATE OF PHOTOGRAPHY: DECEMBER 14, 1994

PHOTO SCALE: 1:3600'

SCALE: 1 INCH = 200 FEET
100' 0 100'

$$ – THINK VALUE ENGINEERING – $$

Revisions

Symbol	Descriptions	Date	Approved

EARTH TECH
MOUNTAIN DIVISION

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
OMAHA, NEBRASKA

Designed by: ES
Drawn by: PB
Checked by: MY
Reviewed by: JE
Submitted by:

FIGURE 1 – DESIGN ANALYSIS

LOCATION OF GEOPHYSICAL SURVEY
LANDFILL No.2 (FTC-006)

Plot Scale Ratio: AS SHOWN
Design File: LF2FIG1.DGN
Date: JUNE 2000
Sheet reference number:
Spec. No.:
Drawing Code:
Contract No.: DACW 45

COMPUTER AIDED DESIGN & DRAFTING

LEGEND

SG-5 ● SOIL GAS SAMPLING LOCATION

△ SURVEY CONTROL POINT

—·—·— LIMIT OF WASTE

N

NOTES:

1. HORIZONTAL COORDINATES ARE MODIFIED STATE PLANE COORDINATES COLORADO CENTRAL ZONE BASED ON NAD83 WITH A DATUM ADJUSTMENT FACTOR OF 1.00026853 ELEVATIONS SHOWN ARE MEAN SEA LEVEL NAVD88 CONTROL BY MONTGOMERY-PHILLIPS, INC.

   DATE OF PHOTOGRAPHY: DECEMBER 14, 1994

   PHOTO SCALE: 1:3600'

2. SOIL GAS SAMPLING LOCATIONS SG-4, SG-37, SG-68, SG-98, SG-104 THROUGH SG-109, AND SG-112 WERE NOT PERFORMED.

3. HYDROGEN SULFIDE AND VOLATILE ORGANIC COMPOUNDS WERE NOT DETECTED IN ANY SOIL GAS SAMPLE.

SCALE: 1 INCH = 200 FEET
100' 0 100'

$$ – THINK VALUE ENGINEERING – $$

Revisions

Symbol	Descriptions	Date	Approved

EARTH TECH
MOUNTAIN DIVISION

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
OMAHA, NEBRASKA

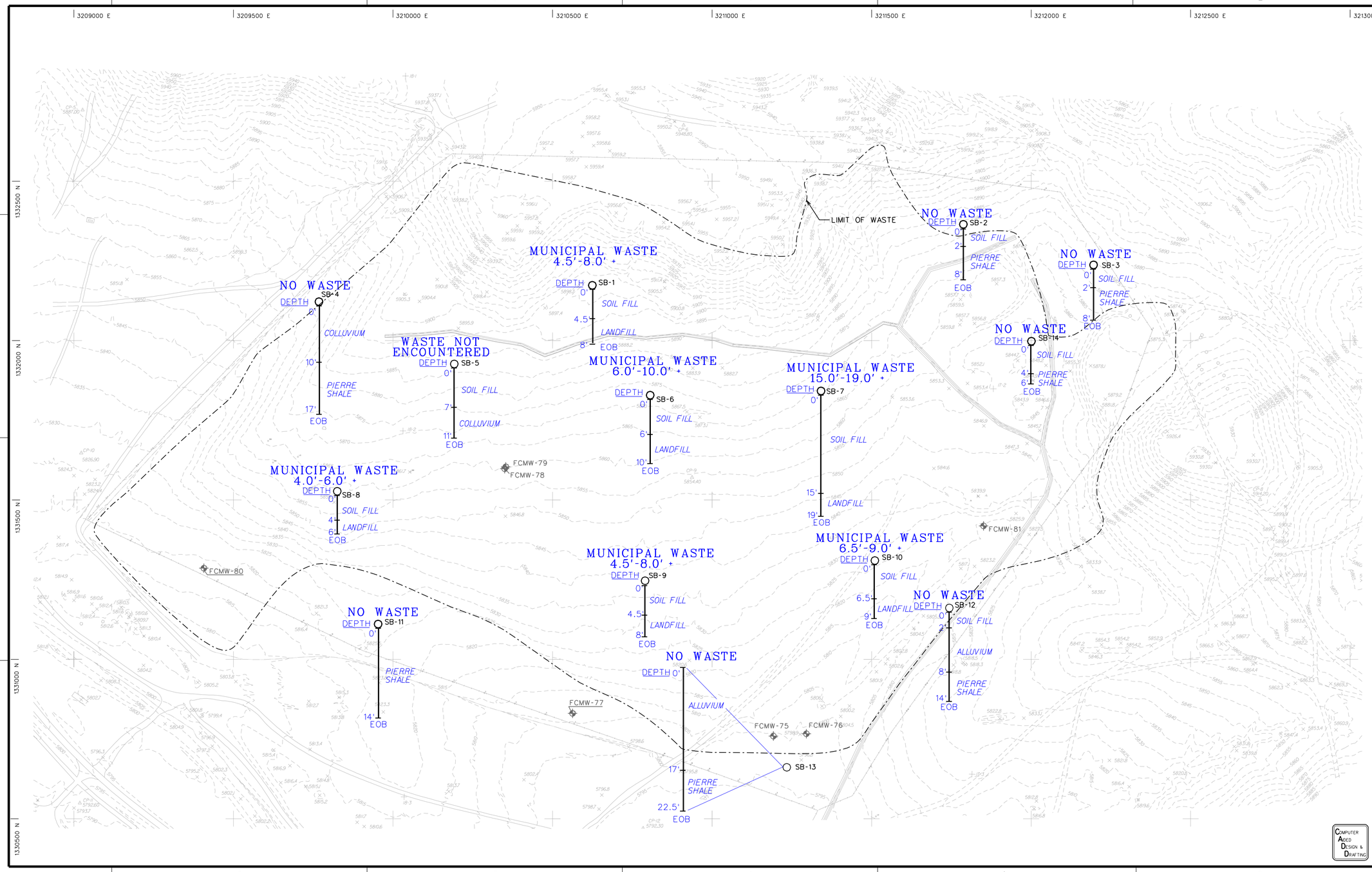
Designed by: ES
Drawn by: AS
Checked by: MY
Reviewed by: JE
Submitted by:

FIGURE 2 – DESIGN ANALYSIS

SOIL GAS SURVEY RESULTS
LANDFILL No.2 (FTC-006)

Plot Scale Ratio: AS SHOWN
Design File: LF2FIG2.DGN
Date: JUNE 2000
Spec. No.:
Drawing Code:
Contract No.: DACW 45
Sheet reference number:

COMPUTER AIDED DESIGN & DRAFTING



LEGEND

FCMW-81	LOCATION OF EXISTING MONITORING WELL
SB-3	LOCATION OF GEOTECHNICAL BORING
EOB	END OF BORING
-·-·-	LIMIT OF WASTE
△	SURVEY CONTROL POINT

N

NOTES:

1. HORIZONTAL COORDINATES ARE MODIFIED STATE PLANE COORDINATES COLORADO CENTRAL ZONE BASED ON NAD83 WITH A DATUM ADJUSTMENT FACTOR OF 1.00026853 ELEVATIONS SHOWN ARE MEAN SEA LEVEL NAVD88 CONTROL BY MONTGOMERY-PHILLIPS, INC.

   DATE OF PHOTOGRAPHY: DECEMBER 14, 1994

   PHOTO SCALE: 1:3600'

2. SOIL BORINGS WERE SURVEYED BY MONTGOMERY PHILLIPS, INC. IN JULY, 1995

3. SOIL BORINGS CVT-1 THROUGH CVT-29 WERE DRILLED TO EVALUATE THE THICKNESSES, SOIL TYPES AND PERMEABILITIES OF THE EXISTING CAP, AND ARE SHOWN IN FIGURE 4.

SCALE: 1 INCH = 200 FEET
100' 0 100'

$$ – THINK VALUE ENGINEERING – $$

Revisions

Symbol	Descriptions	Date	Approved

EARTH TECH
MOUNTAIN DIVISION

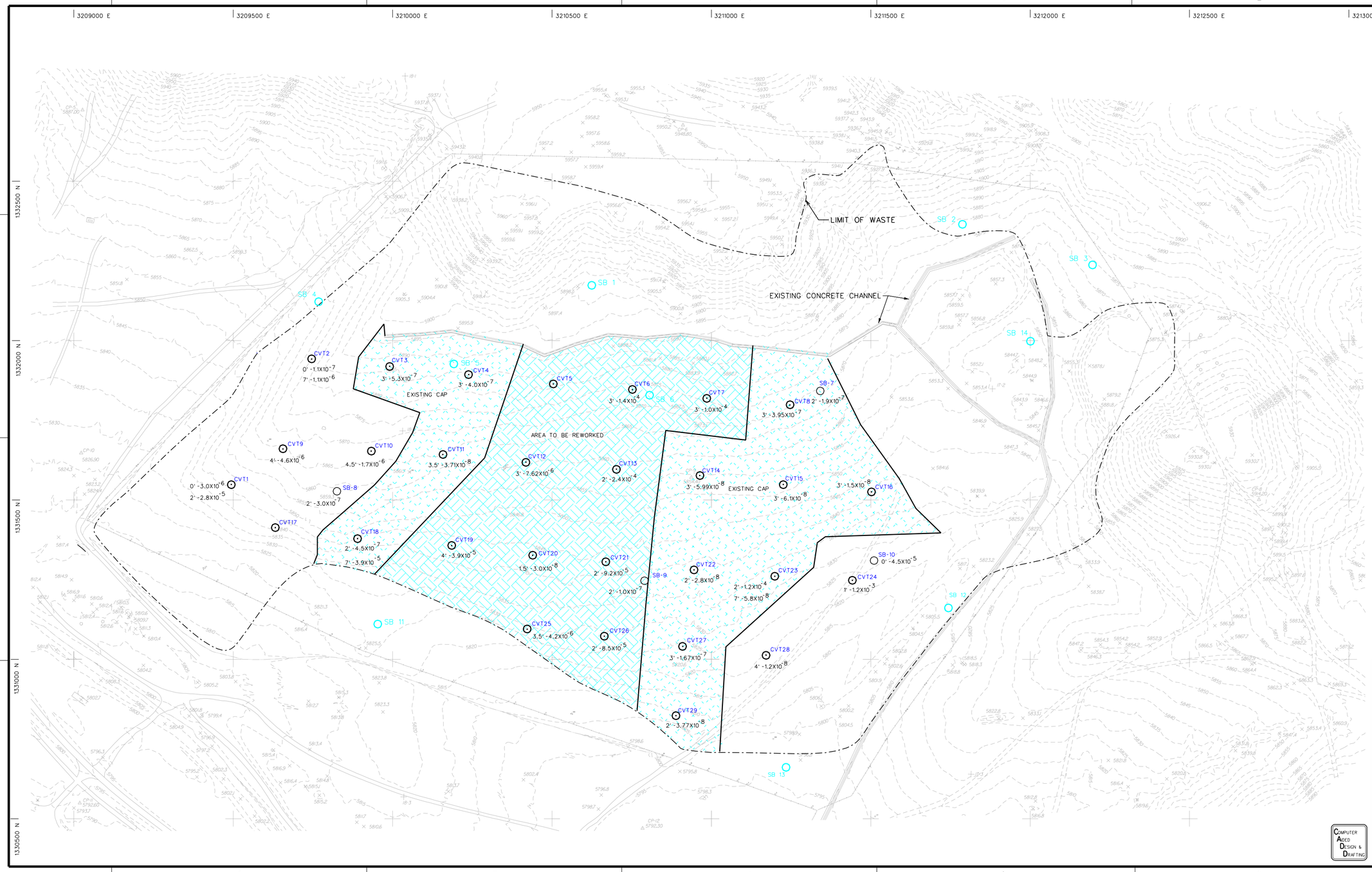
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
OMAHA, NEBRASKA

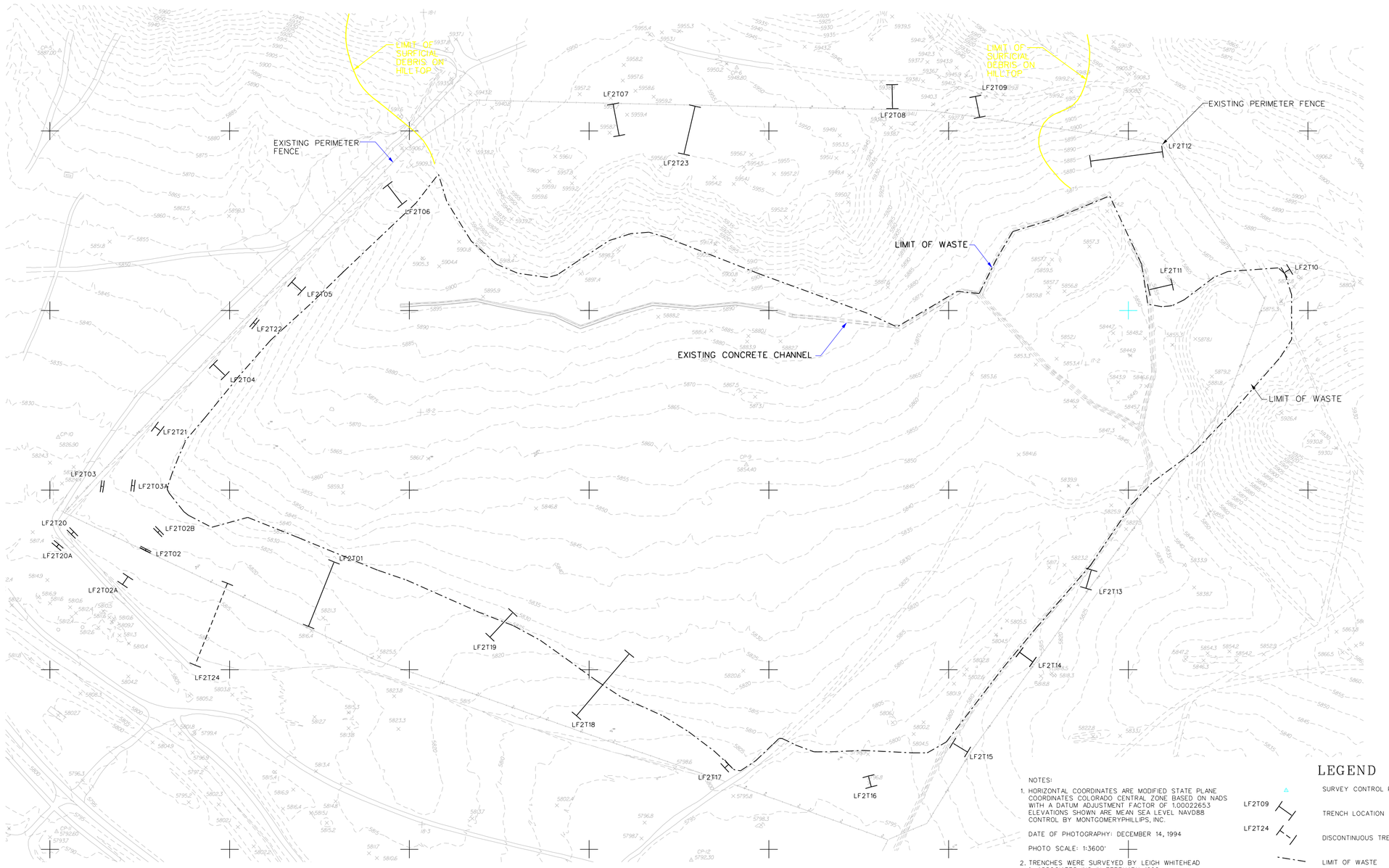
Designed by: MW
Drawn by: AS
Checked by: MY
Reviewed by: JE
Submitted by:

FIGURE 3 – DESIGN ANALYSIS
SUMMARY OF GEOTECHNICAL BORINGS
LANDFILL No.2 (FTC-006)

Plot Scale Ratio: AS SHOWN
Date: JUNE 2000
Design File: LF2FIG3.DGN
Sheet reference number:
Spec. No.:
Drawing Code:
Contract No.: DACW 45

COMPUTER AIDED DESIGN & DRAFTING


3209000 E
3209500 E
3210000 E
3210500 E
3211000 E
3211500 E
3212000 E
3212500 E
3213000 E
1332500 N
1332000 N
1331500 N
1331000 N
1330500 N
LIMIT OF WASTE
EXISTING CONCRETE CHANNEL
EXISTING CAP
AREA TO BE REWORKED
SB 1
SB 2
SB 3
SB 4
SB 5
SB 6
SB-7
SB-8
SB-9
SB-10
SB 11
SB 12
SB 13
SB 14
CVT1
0' -3.0X10^-6
2' -2.8X10^-5
CVT2
0' -1.1X10^-7
7' -1.1X10^-6
CVT3
3' -5.3X10^-7
CVT4
3' -4.0X10^-7
CVT5
CVT6
3' -1.4X10^-4
CVT7
3' -1.0X10^-4
CVT8
2' -1.9X10^-7
3' -3.95X10^-7
CVT9
4' -4.6X10^-6
CVT10
4.5' -1.7X10^-6
CVT11
3.5' -3.71X10^-8
CVT12
3' -7.62X10^-6
CVT13
2' -2.4X10^-4
CVT14
3' -5.99X10^-8
CVT15
3' -6.1X10^-8
CVT16
3' -1.5X10^-8
CVT17
CVT18
2' -4.5X10^-7
7' -3.9X10^-5
CVT19
4' -3.9X10^-5
CVT20
1.5' -3.0X10^-8
CVT21
2' -9.2X10^-5
2' -1.0X10^-7
CVT22
2' -2.8X10^-8
CVT23
2' -1.2X10^-4
7' -5.8X10^-8
CVT24
1' -1.2X10^-3
CVT25
3.5' -4.2X10^-6
CVT26
2' -8.5X10^-5
CVT27
3' -1.67X10^-7
CVT28
4' -1.2X10^-8
CVT29
2' -3.77X10^-8
SB-10
0' -4.5X10^-5
LEGEND
3' -3.95X10^-7
PERMEABILITY VALUE IN CENTIMETERS PER SECOND (CM/SEC)
DEPTH OF SAMPLE
LIMIT OF WASTE
SB-7
LOCATION OF GEOTECHNICAL BORING
CVT8
LOCATION OF CAP VERIFICATION BORING TEST
EXISTING CAP
AREA OF EXISTING CAP TO BE REWORKED
N
NOTES:
1. HORIZONTAL COORDINATES ARE MODIFIED STATE PLANE COORDINATES COLORADO CENTRAL ZONE BASED ON NAD83 WITH A DATUM ADJUSTMENT FACTOR OF 1.00026853 ELEVATIONS SHOWN ARE MEAN SEA LEVEL NAVD88 CONTROL BY MONTGOMERY-PHILLIPS, INC.
DATE OF PHOTOGRAPHY: DECEMBER 14, 1994
PHOTO SCALE: 1:3600'
2. SOIL BORINGS CVT1 THROUGH CVT29 WERE SURVEYED BY LEIGH WHITEHEAD & ASSOCIATES, INC. IN FEBRUARY, 1996.
3. SOIL BORINGS SB1 THROUGH SB14 WERE SURVEYED BY MONTGOMERY PHILLIPS, INC. IN JULY, 1995.
4. BECAUSE OF INSUFFICIENT SOIL COLLECTED FROM CVT17 AND CVT5, PERMEABILITY TESTS COULD NOT BE CONDUCTED.
SCALE: 1 INCH = 200 FEET
100' 0 100'
COMPUTER AIDED DESIGN & DRAFTING
$$ – THINK VALUE ENGINEERING – $$
Revisions
Symbol
Descriptions
Date
Approved
EARTH TECH
MOUNTAIN DIVISION
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
OMAHA, NEBRASKA
Designed by: MF
Drawn by: PB
Checked by: MY
Reviewed by: JE
Submitted by:
FIGURE 4 – DESIGN ANALYSIS
SUMMARY OF EXISTING CAP PERMEABLILITY TESTING
LANDFILL No.2 (FTC-006)
Plot Scale Ratio: AS SHOWN
Date: JUNE 2000
Design File: LF2BORNG.DGN
Sheet reference number:
Spec. No.:
Drawing Code:
Contract No.: DACW 45



NOTES:

1. HORIZONTAL COORDINATES ARE MODIFIED STATE PLANE COORDINATES COLORADO CENTRAL ZONE BASED ON NAD5 WITH A DATUM ADJUSTMENT FACTOR OF 1.00022653 ELEVATIONS SHOWN ARE MEAN SEA LEVEL NAVD88 CONTROL BY MONTGOMERYPHILLIPS, INC.

   DATE OF PHOTOGRAPHY: DECEMBER 14, 1994

   PHOTO SCALE: 1:3600'

2. TRENCHES WERE SURVEYED BY LEIGH WHITEHEAD & ASSOCIATES, INC. IN FEBRUARY, 1996.

LEGEND

- SURVEY CONTROL POINT
- LF2T09 — TRENCH LOCATION
- LF2T24 — DISCONTINUOUS TRENCH
- LIMIT OF WASTE

CAD FILE: L:\WORK\29188\CAD\FTCARSON\LF2\LANDFL

SUMMARY OF TRENCHING

Trench No.	Landfill Material Encountered	Depth Waste Encountered (feet)	Trench Depth (feet)	Soil Conditions
LF2T01	paper, foil, plastic, pop can	1.0	5.0	2' to 4' of clay over weathered shale
LF2T02	brick, asphalt, concrete, metal, rubber	1.0	2.0	clay to at least 2'
LF2T02a	metal, plastic, brick	1.0	3.0	2' of clay over weathered shale
LF2T02b	wood, metal, brick, asphalt, plastic	1.0 - 7.0	8.5	7' of clay with silt and sand over alluvium
LF2T03	cans, concrete, plastic, metal pieces	2.5	4.0	3' of clay over weathered shale
LF2T03a	wood, plastic, metal	0.0 - 2.0	5.0	2' of clay over weathered shale
LF2T04	concrete, wood	1.0	4.0	clay (colluvium) to at least 4'
LF2T05	plastic, wood, rubber	1.5	4.0	clay (colluvium) to at least 4'
LF2T06	wood, cloth, cans, metal	2.0	4.0	weathered shale changing to clay fill near limit of waste
LF2T07	cloth, can, plastic rubber	1.0	6.0	2' of clay with sand over weathered shale
LF2T08	not encountered		2.0	weathered shale
LF2T09	not encountered		2.0	1.5' of clay over weathered shale
LF2T10	ash, glass, metal brick	0.5 - 1.5	5.0	2' of clay with sand over clay (alluvium)
LF2T11	not encountered		2.0	weathered shale
LF2T12	not encountered		3.0	02' of clay with sand over weathered shale
LF2T13	ash, wood, metal, concrete	0.5 - 1.0	3.0	weathered shale
LF2T14	not encountered		3.0	1' of clay over weathered shale
LF2T15	not encountered		2.5	1' of clay over weathered shale
LF2T16	ash, wood, paper	2.5	5.0	2' of clay with sand over clay (alluvium)
LF2T17	wood, plastic, metal	1.0	4.0	2' of clay over clay (alluvium)
LF2T18	wood, plastic, metal	2.5	8.0	3' of clay with sand over clay (alluvium)
LF2T19	concrete	1.0	8.0	3' to 8' of clay and reworked shale over clay (alluvium)
LF2T20	coal, wood	2.0	5.0	3' of clay and sand over clay (alluvium)
LF2T20a	coal	0.0 - 2.0	3.0	2' of clay with sand over weathered shale
LF2T21	rubber, plastic, glass, metal, ash	2.0 - 4.0	4.0	1' to 4' of clay with sand over weathered shale
LF2T22	paper, metal, concrete, boards	0.0 - 3.0	5.0	2' of clay with sand over weathered shale
LF2T23	plastic, metal, glass, paper	1.0 - 2.0	4.0 to 6.0	1' to 6' of clay with sand and sand over weathered shale
LF2T24	concrete, asphalt	1.0 - 2.0	2.5 to 7.0	1' of reworked shale over weathered shale changing to 2' to 3' of clay and sand over clay (alluvium)

$$ – THINK VALUE ENGINEERING – $$

Revisions

Symbol	Descriptions	Date	Approved

EARTH TECH

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
OMAHA, NEBRASKA

Designed by: AS
Drawn by: AS
Checked by: MY
Reviewed by: JE
Submitted by:

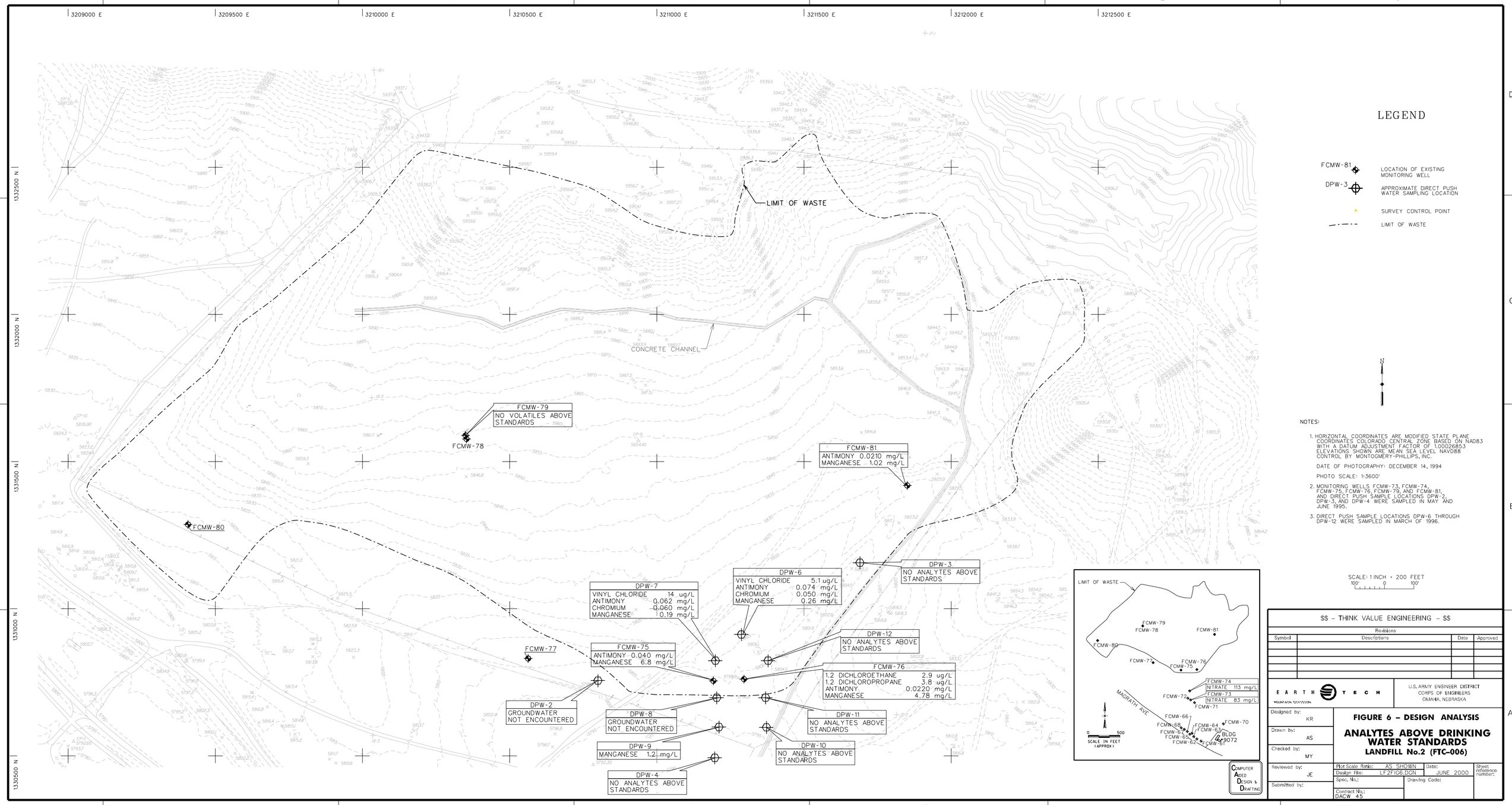
FIGURE 5 DESIGN ANALYSIS

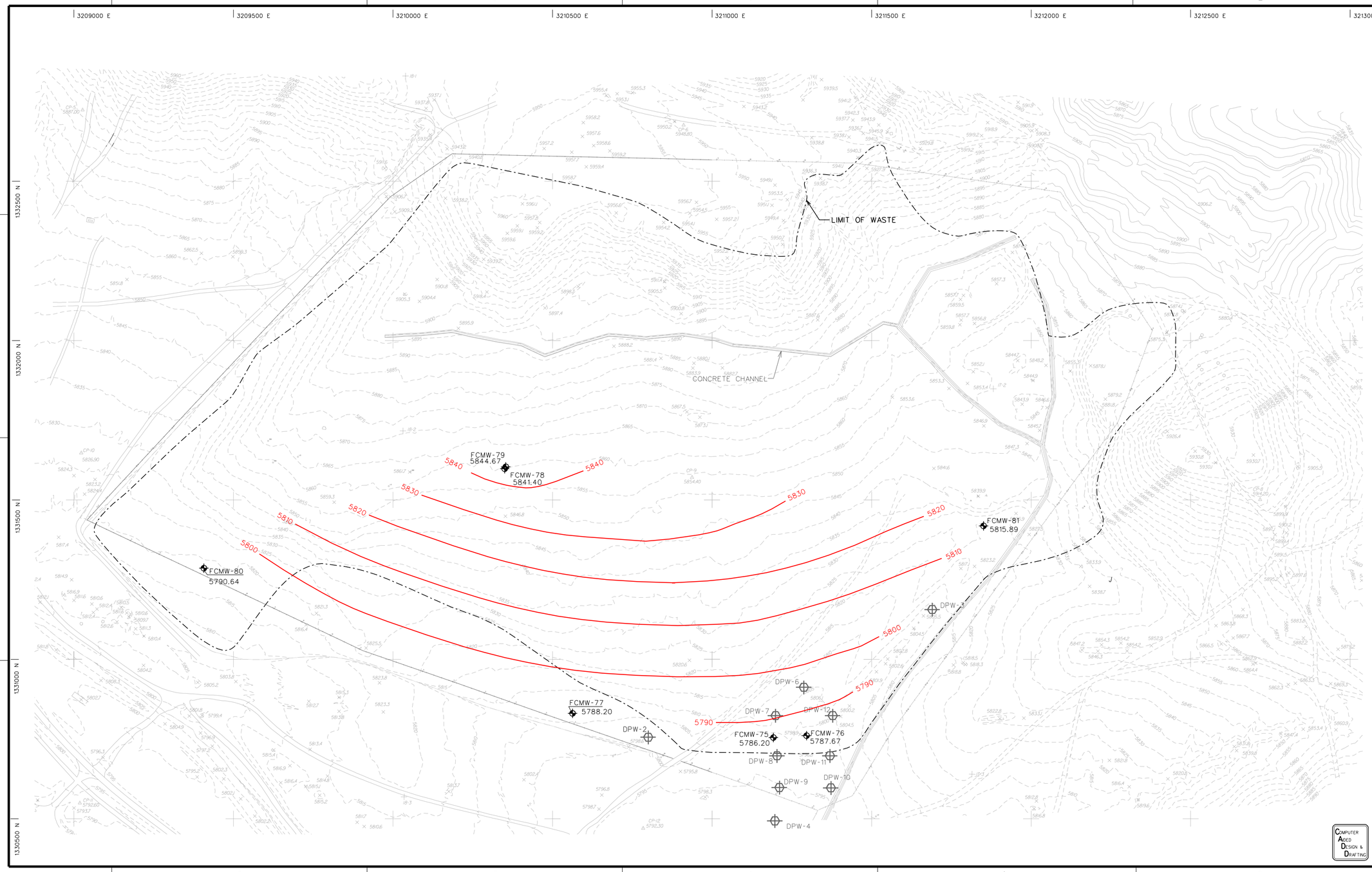
SUMMARY OF TRENCHING

LANDFILL No.2 (FTC-006)

Plot Scale Ratio: AS SHOWN
Design File: LF2TRNC1.DGN
Date: JUNE 2000
Spec. No.:
Drawing Code:
Contract No.: DACW 45
Sheet reference number:

COMPUTER AIDED DESIGN & DRAFTING


3209000 E
3209500 E
3210000 E
3210500 E
3211000 E
3211500 E
3212000 E
3212500 E
1332500 N
1332000 N
1331500 N
1331000 N
1330500 N
LIMIT OF WASTE
CONCRETE CHANNEL
FCMW-79
NO VOLATILES ABOVE STANDARDS
FCMW-78
FCMW-81
ANTIMONY 0.0210 mg/L
MANGANESE 1.02 mg/L
FCMW-80
DPW-3
NO ANALYTES ABOVE STANDARDS
DPW-6
VINYL CHLORIDE 5.1 ug/L
ANTIMONY 0.074 mg/L
CHROMIUM 0.050 mg/L
MANGANESE 0.26 mg/L
DPW-7
VINYL CHLORIDE 14 ug/L
ANTIMONY 0.062 mg/L
CHROMIUM 0.060 mg/L
MANGANESE 0.19 mg/L
DPW-12
NO ANALYTES ABOVE STANDARDS
FCMW-77
FCMW-75
ANTIMONY 0.040 mg/L
MANGANESE 6.8 mg/L
FCMW-76
1,2 DICHLOROETHANE 2.9 ug/L
1,2 DICHLOROPROPANE 3.8 ug/L
ANTIMONY 0.0220 mg/L
MANGANESE 4.78 mg/L
DPW-2
GROUNDWATER NOT ENCOUNTERED
DPW-8
GROUNDWATER NOT ENCOUNTERED
DPW-11
NO ANALYTES ABOVE STANDARDS
DPW-9
MANGANESE 1.2 mg/L
DPW-10
NO ANALYTES ABOVE STANDARDS
DPW-4
NO ANALYTES ABOVE STANDARDS
LEGEND
FCMW-81 LOCATION OF EXISTING MONITORING WELL
DPW-3 APPROXIMATE DIRECT PUSH WATER SAMPLING LOCATION
SURVEY CONTROL POINT
LIMIT OF WASTE
N
NOTES:
1. HORIZONTAL COORDINATES ARE MODIFIED STATE PLANE COORDINATES COLORADO CENTRAL ZONE BASED ON NAD83 WITH A DATUM ADJUSTMENT FACTOR OF 1.0002685.3 ELEVATIONS SHOWN ARE MEAN SEA LEVEL NAVD88 CONTROL BY MONTOGMERY-PHILLIPS, INC.
DATE OF PHOTOGRAPHY: DECEMBER 14, 1994
PHOTO SCALE: 1:3600'
2. MONITORING WELLS FCMW-73, FCMW-74, FCMW-75, FCMW-76, FCMW-79, AND FCMW-81, AND DIRECT PUSH SAMPLE LOCATIONS DPW-2, DPW-3, AND DPW-4 WERE SAMPLED IN MAY AND JUNE 1995.
3. DIRECT PUSH SAMPLE LOCATIONS DPW-6 THROUGH DPW-12 WERE SAMPLED IN MARCH OF 1996.
SCALE: 1 INCH = 200 FEET
100' 0 100'
LIMIT OF WASTE
FCMW-79
FCMW-78
FCMW-81
FCMW-80
FCMW-77
FCMW-76
FCMW-75
FCMW-74
NITRATE 11.3 mg/L
FCMW-73
NITRATE 8.3 mg/L
FCMW-72
FCMW-71
MAGRATH AVE
FCMW-66
FCMW-68
FCMW-64
FCMW-70
FCMW-63
FCMW-62
FCMW-65
BLDG 9072
FCMW-67
FCMW-61
N
0 500
SCALE IN FEET (APPROX)
COMPUTER AIDED DESIGN & DRAFTING
$$ – THINK VALUE ENGINEERING – $$
Revisions
Symbol
Descriptions
Date
Approved
EARTH TECH
MOUNTAIN DIVISION
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
OMAHA, NEBRASKA
Designed by: KR
Drawn by: AS
Checked by: MY
Reviewed by: JE
Submitted by:
FIGURE 6 – DESIGN ANALYSIS
ANALYTES ABOVE DRINKING WATER STANDARDS
LANDFILL No.2 (FTC-006)
Plot Scale Ratio: AS SHOWN
Date: JUNE 2000
Design File: LF2FIG6.DGN
Spec. No.:
Drawing Code:
Contract No.: DACW 45
Sheet reference number:



LEGEND

FCMW-81	LOCATION OF EXISTING MONITORING WELLS
DPW-3	APPROXIMATE DIRECT PUSH WATER SAMPLING LOCATION
	SURVEY CONTROL POINT
	LIMIT OF WASTE
5810	WATER ELEVATION CONTOUR 6/21/95

N

NOTES:

1. HORIZONTAL COORDINATES ARE MODIFIED STATE PLANE COORDINATES COLORADO CENTRAL ZONE BASED ON NAD83 WITH A DATUM ADJUSTMENT FACTOR OF 1.000026853 ELEVATIONS SHOWN ARE MEAN SEA LEVEL NAVD88 CONTROL BY MONTGOMERY-PHILLIPS, INC.

DATE OF PHOTOGRAPHY: DECEMBER 14, 1994

PHOTO SCALE: 1:3600'

SCALE: 1 INCH = 200 FEET
100' 0 100'

$$ – THINK VALUE ENGINEERING – $$

Revisions

Symbol	Descriptions	Date	Approved

EARTH TECH
MOUNTAIN DIVISION

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
OMAHA, NEBRASKA

Designed by: JG
Drawn by: VG
Checked by: MY
Reviewed by: JE
Submitted by:

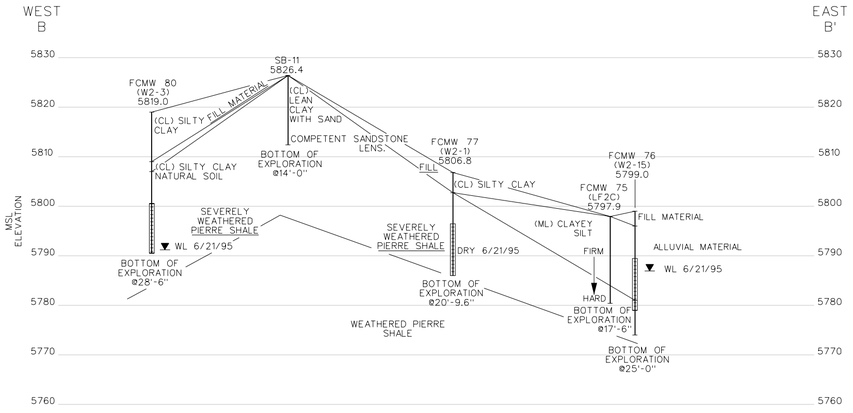
FIGURE 7 – DESIGN ANALYSIS

WATER TABLE ELEVATION 6/21/95

LANDFILL No.2 (FTC-006)

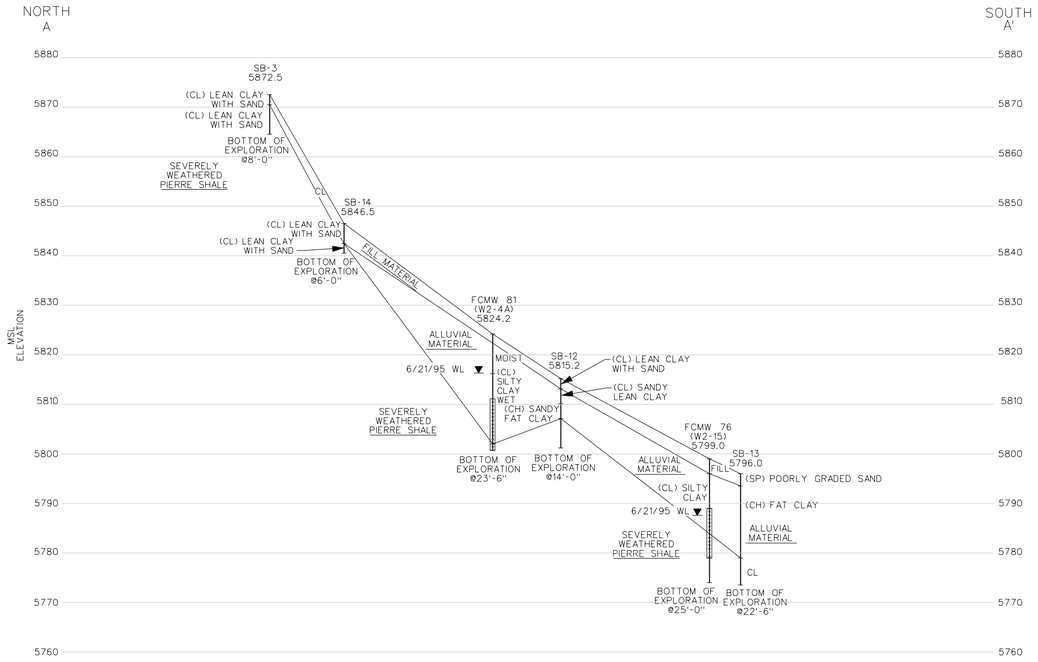
Plot Scale Ratio: AS SHOWN
Design File: LF2FIG7.DGN
Date: JUNE 2000
Spec. No.:
Drawing Code:
Contract No.: DACW 45
Sheet reference number:

COMPUTER AIDED DESIGN & DRAFTING



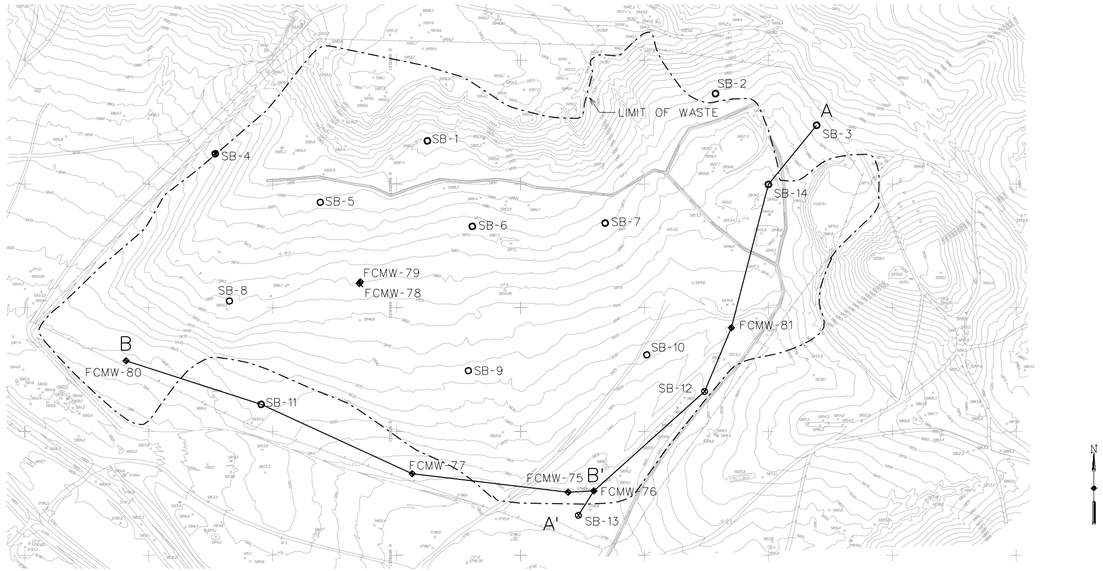
SECTION B-B'

VERTICAL SCALE: 1" = 20'
HORIZONTAL SCALE: 1" = 400'



SECTION A-A'

VERTICAL SCALE: 1" = 20'
HORIZONTAL SCALE: 1" = 400'



KEY PLAN

$$ – THINK VALUE ENGINEERING – $$

Revisions

Symbol	Descriptions	Date	Approved

EARTH TECH
MOUNTAIN DIVISION

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
OMAHA, NEBRASKA

Designed by: JG
Drawn by: VG
Checked by: MY
Reviewed by: JE
Submitted by:

FIGURE 8 – DESIGN ANALYSIS

GEOLOGIC CROSS SECTIONS
LANDFILL No.2 (FTC-006)

Plot Scale Ratio: AS SHOWN
Date: JUNE 2000
Design File: LF2GEOX.DGN
Spec. No.:
Drawing Code:
Contract No.: DACW 45
Sheet reference number: .

COMPUTER AIDED DESIGN & DRAFTING

APPENDIX A
GEOPHYSICAL SURVEY

FINAL REPORT

Fort Carson Landfill Survey

GC-FR-95-2853

Prepared for

RUST ENVIRONMENTAL & INFRASTRUCTURE
6143 So. Willow Drive, Suite 200
Englewood, CO 80111-5123

Prime Contract No. DACW45-93-D-0007

Prepared by

GEO-CENTERS, INC.
7 Wells Avenue
Newton Centre, MA 02159

November 1, 1995

GEO-CENTERS, INC.

1.0 SUMMARY

A series of non-intrusive geophysical surveys were conducted by GEO-CENTERS, INC. at three different landfill sites at Fort Carson, Colorado for the purpose of delineating the spatial extent of waste disposal.

GEO-CENTERS deployed its new portable surface geophysics surveying system to cover the three landfills. This device is an automated survey system which integrates GPS navigation technology with various geophysical sensors. This combination allows for rapid, high-density surveying. The selected geophysical sensor was a continuous wave electromagnetic sensor which is sensitive to spatial variations in the bulk conductivity of subsurface materials. After some lengthy discussion between GEO-CENTERS and Rust staff members, the EM sensor was selected, specifically the EM31. Consideration was given to: documented site geology, the suspected buried materials, the large area to be covered, the terrain and vegetation cover; and the use of the data in concert with the results of exploratory trenching and soil borings.

The EM surveys were successfully conducted at the three sites on Fort Carson. A very large amount of data was collected at the three sites, in total nearly 23 linear miles of data were collected at a data density of better than 1 linear foot. All data were reviewed in the field by GEO-CENTERS and Rust personnel for optimization of subsequent deployments.

Upon completion of the survey, the data were reduced and interpreted. This process culminated in the identification of several areas with slightly elevated bulk ground conductivity. Most of the significant anomalies observed in the continuous wave electromagnetic measurements and at these sites, however, could be correlated with utilities, metal fences, or metallic debris observed at the surface. The magnitude and spatial distribution of other variations observed in the terrain conductivity at these sites provide insufficient data for delineating landfilled waste materials without additional corroborating data. These results seem consistent with samples collected in soil borings drilled subsequent to this survey which revealed only traces of waste materials intermixed with native soils. Exploratory trenching was not performed.

2.0 OVERVIEW

GEO-CENTERS, INC. was contracted by Rust Environmental & Infrastructure to perform a geophysical survey of three separate sites located on Fort Carson, Colorado. These sites were used over the last decades in a variety of ways for the disposal of a wide range of materials and will be discussed separately below. Each landfill site contained different and unique issues which made the survey strategy for each of the surveys specific to the site. The goal of each of the three surveys remained the same however to determine the spatial extent of the landfill.

Landfill Descriptions

Landfill 6 - This site is located in the west end of the Cantonment Area of the Fort, west of Wetzel Street and north of Ellis Street. The site is approximately 11 acres in extent and reportedly contains a landfill which was operated between 1942 and 1946. It was suspected that the landfill was approximately 8 acres in extent and contained refuse placed in trenches which may have been compacted and covered by bulldozers. The landfill was suspected to contain construction debris, mixed sanitary waste, sludge and waste petroleum, oil, and lubricants (POL). Anecdotal evidence suggested that the landfill may be significantly smaller in size.

Landfill 2 - The largest of the three landfills covering over 140 acres, this site is located east of the Cantonment Area. The site was operated between 1960 and 1978 as a combined trench and landfill. Some of the cover material was hauled to the site from other sites on Fort Carson. The type of waste reportedly received at this site included mixed loads of sanitary wastes, sludge, and waste POL.

Landfill 5 - This site is located in the northeast corner of the Cantonment Areas and covers approximately 60 acres. The site was reportedly operated between 1946 and 1956, in an unknown mode of operation. The types of waste reportedly received at the site include construction debris, mixed sanitary waste POL, waste from a horse barn and coal cinders and ash.

Characterization Strategy

Each of the three separate landfill sites represents a different type of characterization problem: Landfill 6 represents a "search survey" where the location of a potentially small landfill lies within a larger site; Landfill 2 represents a "landfill extent survey" where the gross location of the landfill is obvious, but the specific location of the perimeter is in question; and Landfill 5 is a "complex site survey" where a subsurface picture of a complicated site is desired.

The expected contents of the landfills range from horse manure and household waste to waste POL and construction debris. The physical composition of the expected buried contaminants dictated the deployment of a geophysical sensor designed to measure variations in subsurface electrical properties. GEO-CENTERS decided to deploy its portable GPS navigated geophysical mapping technology at the site. This system, fully described in Section 3, was outfitted with the Geonics EM31, a ground conductivity sensor.

The EM31 deployment strategy was designed to maximize coverage at each of the sites. As the Chronology of activities indicates, 3 days were allocated for the collection of geophysical data at the 3 separate landfill sites.

Landfill 6 - As a "landfill search" survey, the Landfill 6 site deployment strategy was designed to cover the entire area suspected to contain the landfill. This is best accomplished by surveying a series of parallel lines, separated by the minimum offset which allows for complete coverage in the allocated time. An offset of 20 feet was used to cover the 24 parallel line required to survey the site. 24 lines were planned, each of length approximately 1000 feet, to produce 27579 linear survey feet at the site (5.22 miles). The station spacing along each line is determined by the speed at which the operate walks, and is down-sampled to a final sample spacing of 1 foot (see Technology Description below). 137,900 data points were collected at Site 6.

Landfill 2 - As a "landfill extent survey" the goal was to delineate the boundary of the landfill periphery. The gross location of the landfill is known and is obvious from its topographic expression. The developed survey strategy was twofold; first, a series of surveys would be carried out around the landfill boundary at progressively greater radii, and second, a series of perpendicular lines, transverse to the lines around the landfill would be completed. These two data sets would be used to calibrate the signature of the landfill and delineate its spatial extent. The large size of the landfill (over 140 acres), and the limited amount of time allocated to perform the task (1 day) limited the number of scheduled perimeter and transverse line. The perimeter lines are approximately 2,500 feet in length and the transverse lines 100 feet.

Landfill 5 - Due to the expected complexity of the subsurface at this landfill, this site required a "complex site survey". In this case the goal was to acquire as much information possible about the subsurface conductivity through surveying around the perimeter of the site as well as throughout the entire body of the site. Again, the tight schedule limited the ability to provide "complete" coverage. To mitigate this effect, GEO-CENTERS implemented a strategy of in-the-field processing, where the data could be viewed and assessed preliminarily immediately after acquisition. This field information could be used to adjust subsequent survey deployments thereby maximizing the effectiveness of the operation.

3.0 DESCRIPTION OF TECHNOLOGY

GEO-CENTERS deployed the backpack version of the STOLS geophysical survey system. This portable system (Figure 1) is design for the rapid collect of geophysical data, and is positioned on-the-fly via the Global Positioning System (GPS).

System Design - The system is designed to allow for the deployment of a wide variety of sensors, including: magnetometers, gradiometers, continuous wave electromagnetic sensors, pulsed induction sensors, and ground penetrating radar. At Fort Carson the system was outfitted with the Geonics EM31 continuous wave electromagnetic sensor, sometimes referred to as a ground conductivity sensor.

The system is controlled by an embedded PC which collects data on an internal hard drive. The device provides a variety of audio tones to indicate various states of operation (logging data, pause, data download, etc.). After the user completes a survey, the system is umbilicated to a host PC for automated data retrieval.

Global Positioning System (GPS) - The integration of the GPS navigation subsystem adds a tremendous degree deployment flexibility to the deployment of surface geophysical sensors. GEO-CENTERS was incorporated a Trimble differential GPS based on the SSE 4000 receiver series. This device allows for the realtime collection of position data with a mean accuracy of approximately 30 cm. This position accuracy has been thoroughly tested and verified by GEO-CENTERS in a rigorous land-navigation simulation study.

The GPS system is highly robust and reliable. No errors, dropouts, or limitation to GPS navigation were encountered during the Fort Carson operation. The only special consideration required at Fort Carson was in the placement of RF repeaters at Landfill 2 and Landfill 5. These communication relays are needed to ensure constant, uninterrupted reception on the roving GPS unit of the differential corrections broadcast by the base-station system.

Continuous Wave EM - Electromagnetic sensors are used in cases where anomalous electrical properties in the subsurface are suspected. Such anomalies can be caused by the presence of electrically conductive materials such as iron, steel, copper, etc. or from the anomalous concentration and quality of groundwater associated with changes in soil porosity and permeability conditions caused during trenching or burial of debris.

The Geonics EM31 was selected as the best single sensor available to delineate buried wastes at these sites (see above). The EM31 (Figure 1) is an active sensor comprised of a 10 foot long coil. This active sensor is a continuous source of electromagnetic waves, which are transmitted into the soil. Further, the coil functions as a receiver of the secondary magnetic fields induced by the transmitted signal. These secondary fields can be related to estimates of subsurface ground conductivity. The EM sensor was selected over a magnetometer due to the lack of historical evidence that landfill contents were comprised of ferromagnetic materials (iron and steel). Since many of the suspected landfill components were believed to

be sludge, and construction debris, the EM conductor sensor was thought to be superior to a magnetometer.

The EM31 sensor has two output modes: the quadrature mode provides estimates of the bulk ground conductivity below the sensor, and are provided in units of millisiemens per meter (mS/m). The In-Phase mode is a measure of the ratio of the secondary and primary magnetic fields (received versus transmitted) and is provided in parts per thousand (ppt). This mode is used as a metal detector, as it is sensitive to the presence of very highly conductive materials.

Operational Issues -The use of this system has several operation advantages to conventional geophysical systems. The rate of surveying can be greatly increased with respect to conventional techniques due to the use of the GPS technology. GPS make obsolete the use laying out of grid lines, which is a significant component to traditional surveys. With GPS the absolute position of the sensor is always known with a horizontal position accuracy of approximately 30 cm. This feature, along with automatic data logging at 1 or 10 samples per second, allows for rapid coverage of a site. At Fort Carson, GEO-CENTERS covered nearly 23 linear traverse miles in 21 hours of surveying. Immediate on-site display of traverse and anomaly data allows for effective optimization of subsequent deployments. GEO-CENTERS brought in-the-field processing capability to the Fort Carson deployment. In addition to PC based data display packages, a UNIX workstation was established in a rental van on-site (Figure 2). Immediately after each survey all data were verified and reviewed.

Landfill 6 - The EM31 sensor was calibrated to a zero reading in the quadrature phase mode at the north end of the site. Two traverses were made to determine the electromagnetic signature of the site. These traverses indicated that the north end of the site showed much higher signal strength than the southern half. The sensor sensitivity scale was set to 300 millimhos per meter.

Landfill 5 - Using the fact that the northern end of the site had higher signatures than the southern half, the quadrature and phase were calibrated to a zero reading at the southern end of the site for a better range of values over the whole site. The sensor sensitivity scale was set to 300 millimhos per meter.

Landfill 2 - The EM31 was calibrated to set a zero reading for the quadrature and phase outside the area fence prior to acquiring data. A preliminary walkabout of the site inside the fence confirmed that the calibration provided a good range of readings. A preliminary data set was acquired along a traverse outside the fenced area to determine a base level against which the interior measurements could be referenced. The sensor sensitivity scale was set to 300 millimhos per meter.

4.0 DISCUSSION

The three landfill surveys at Fort Carson were carried out between December 12th and December 15th, 1994.

Site 6

Tuesday, December 13
24 traverses, approximately 8 meters apart, approximately 300 m long
11 °F
Set up over on corner of Warren St and Ellis St
Surveyed from 7:30 to 11 AM.
137,900 points, 8.4 km

Figure 3 is an aerial photograph of the site provided to GEO-CENTERS by Rust in which the traverses are overlaid on the image. The image is oriented with north to the top.

To the north, there are extremely high values as the edges of the surveyed area was reached (see Figure 4). There is a further indent of high conductivity in the northeast corner corresponding to opposite side of the road going downhill at that point. Viewing this data image and comparing it to the photo in Figure 3 shows the relative placement of the data to the surface features.

In Figure 5, the in-phase measurements, showed a source of the high conductivity in the north edge of the site due to a line of high conductivity under the north edge of the uphill slope. This correlates with the location of buried reinforced concrete sewer pipe. Within the site, there is a southerly trending high which shows the location of a buried natural gas utility line. No clear delineations of a smaller area landfill within this site is easily evident in this data although it may simply be masked by the extremely high values in the north washing out other signal variations.

Photocopies of utility maps provided assistance in the data interpretation. Profiles of the acquired data relative to a common base level, are included in Appendix A.

Site 2

Tuesday, December 13 - Wednesday, December 14, 1994
40 traverses, 4 perimeter surveys around the landfill and a series of 15 calibration traverses
20 °F
Set up over benchmark east of the landfill.
Surveyed from 1 PM to 5 PM on 12/13, 9 AM to 12 AM 12/14
240,520 points, 13.9 km

Figure 6 is an aerial photograph of the site provided to GEO-CENTERS by Rust with the traverses overlaid on the image. The image is oriented with east to the top.

In the data images, Figures 7 and 8, the quadrature and in-phase information is shown in gray scale. The traverses surround and invade the area of interest. The most significant feature in these images is the high values in the in-phase data (Figure 8) which correlate spatially with visible outcroppings of metal at the surface, in the southeast corner of the site as well as along the eastern side.

Site 5

Wednesday, December 14, 1994 - Thursday, December 15, 1994
Traverses, perimeter surveys around the landfill and a series of calibration traverses
11 °F
Set up over benchmark, south of the landfill.
Surveyed from 2 PM to 5 PM on 12/14, 9 AM to 3 PM 12/15
299,148 points, 14.3 km

Figure 9 is an aerial photograph of the site provided to GEO-CENTERS by Rust with the traverses overlaid on the image. The image is oriented with east toward the top.

In the data images, Figures 10 and 11, the quadrature and in-phase data are displayed in gray tone. The quadrature in this area shows the most variation of all the sites but with inconclusive results. The high values corresponds largely to known surface metal artifacts such fences or metal buildings or to shallow ground water next to the river. The high values along the river are not constant either although this may have been due to topographical considerations (e.g., the higher values correspond to areas where the edge of the river was reached (see Figure 12) while the lows roughly correspond to the cliffs that were followed on the southeast side of the river.

Precipitates were observed alongside the cut banks of the creeks. These salts may be the cause of some of the elevated conductivity readings in those areas. The cut banks appear to be native with no obvious landfill materials present.

The in-phase data shows the provenance of these high values even more clearly, easily delineating the lines run along the metal fences to the north of the site. The high values to the east roughly correspond to some metal structures around that end of the site. The anomalously high values directly south-central of the site, are significant but do not clearly delineate an edge of the landfill either.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The three sites were surveyed and high quality electromagnetic data, both quadrature and in-phase were acquired, processed, and plotted in gray tone. The resulting data images, when compared visually with aerial photos of the sites with the data traverses overlaid, do not yield clear images of landfill edges. These geophysical survey data were then used to select locations for exploratory trenching.

The proposed trench locations are located on large maps for each of the 3 sites which also show the locations of the traverses, topography, and surface features. These maps were delivered previously under separate cover.

Figure 1

GEO-CENTERS, INC.

Figure 2

GEO-CENTERS, INC.

03820 P1 rev 9-15-95

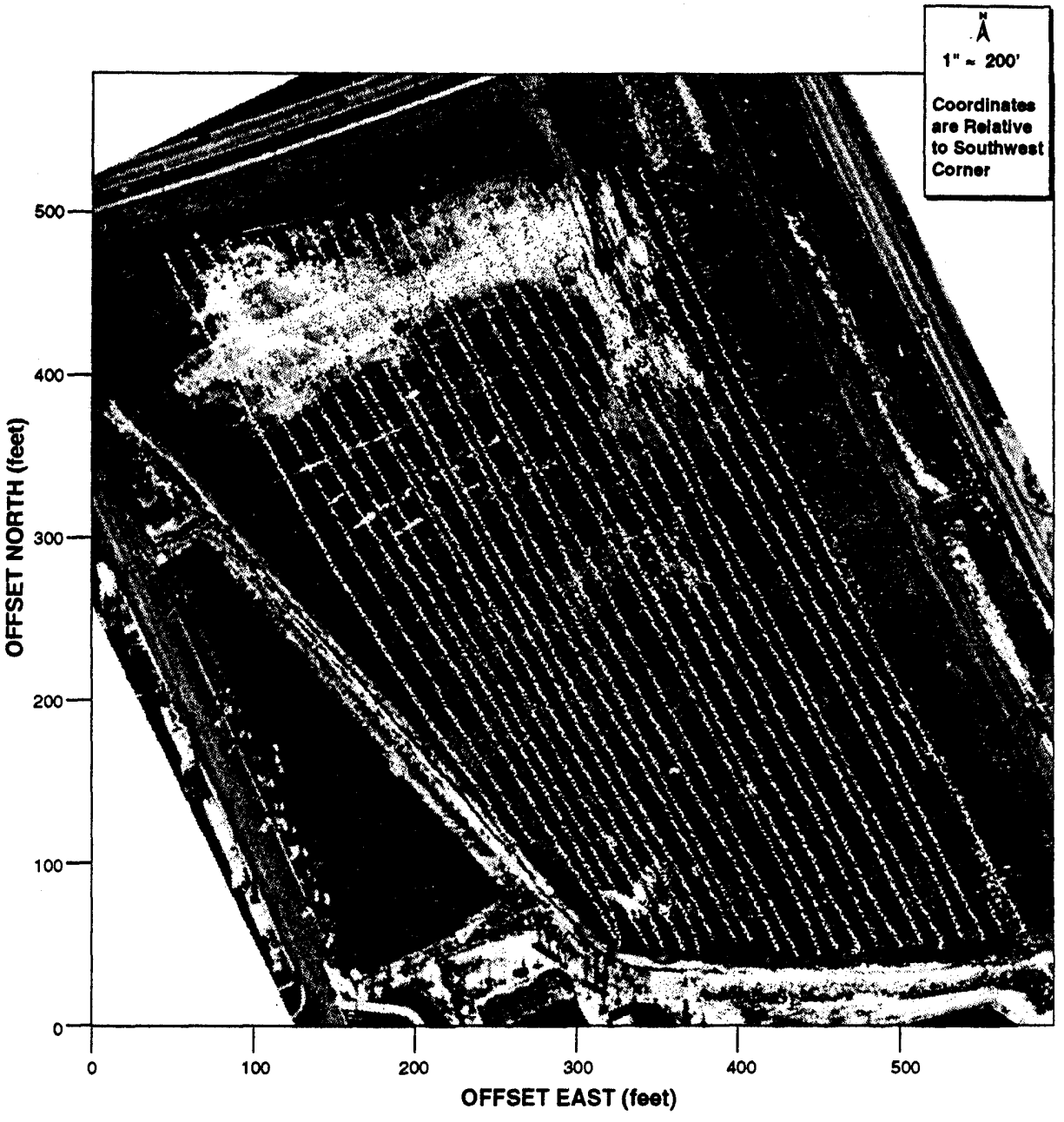


Figure 3. Landfill Site 6

GEO-CENTERS, INC.

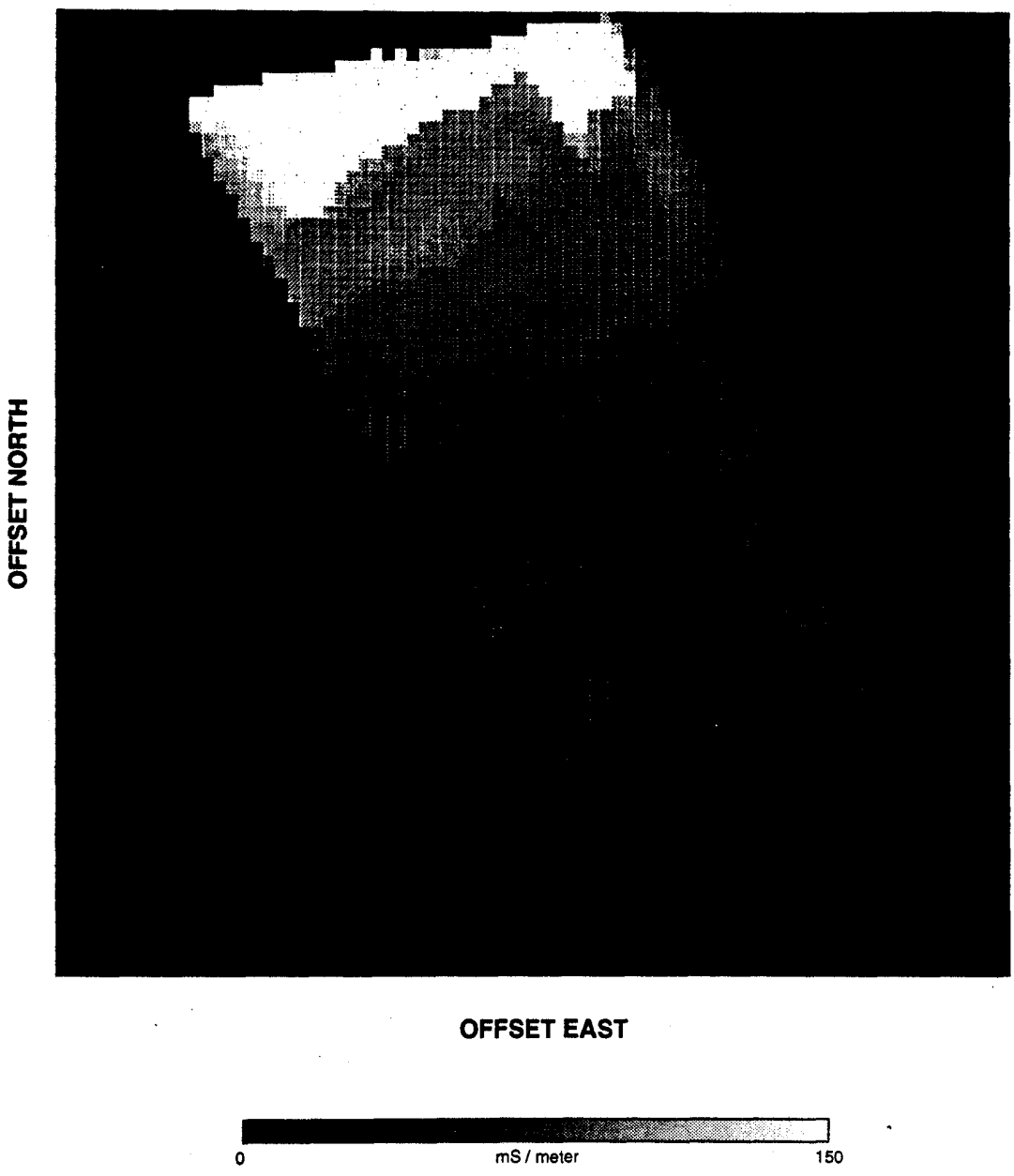


Figure 4. Site 6; 5x5 Grid, Quadrature (A) 0 150

GEO-CENTERS, INC.

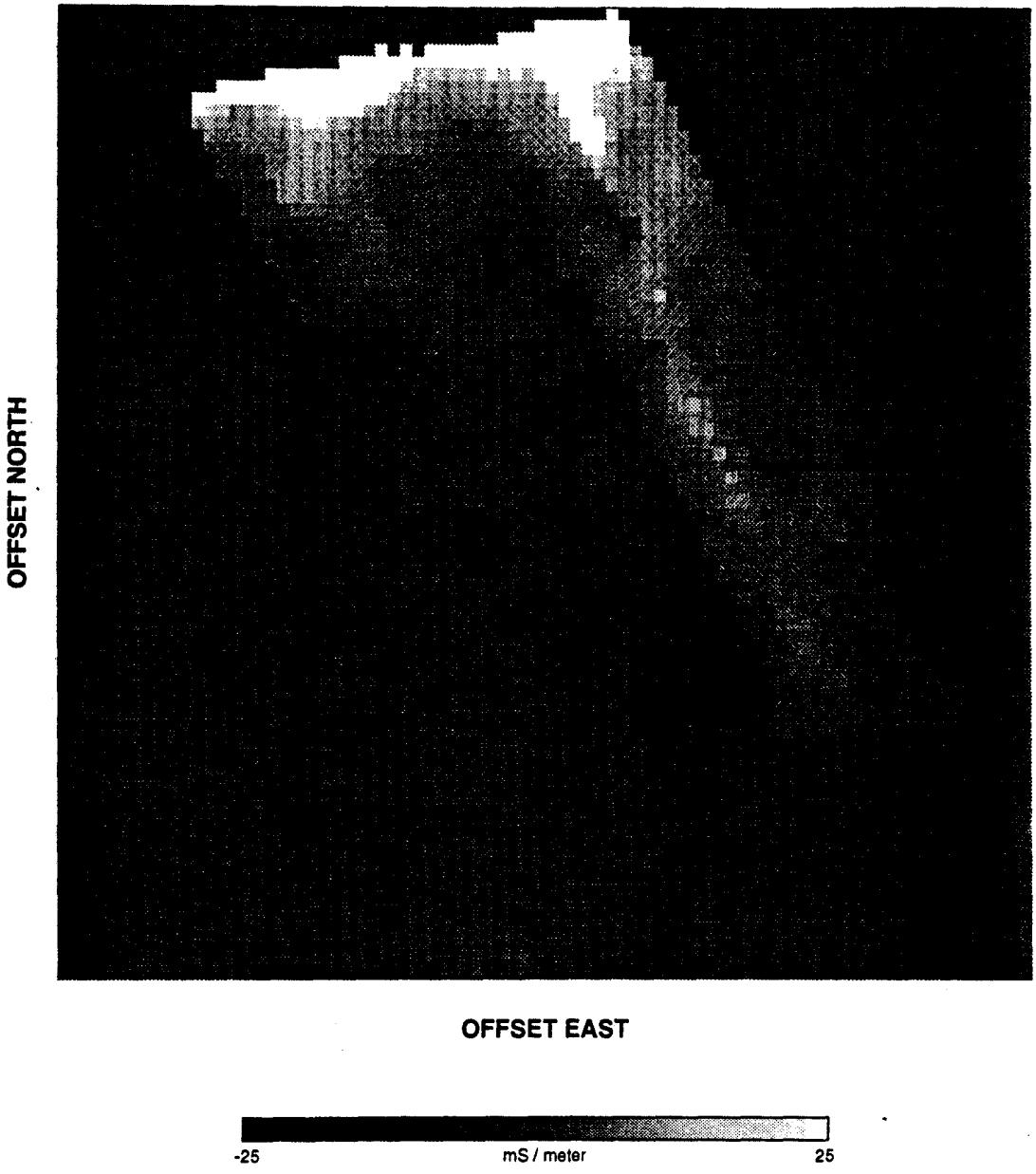


Figure 5. Site 6; 5x5 Grid, Phase (B) -25 25

GEO-CENTERS, INC.

03820 P3 rev 9-15-95

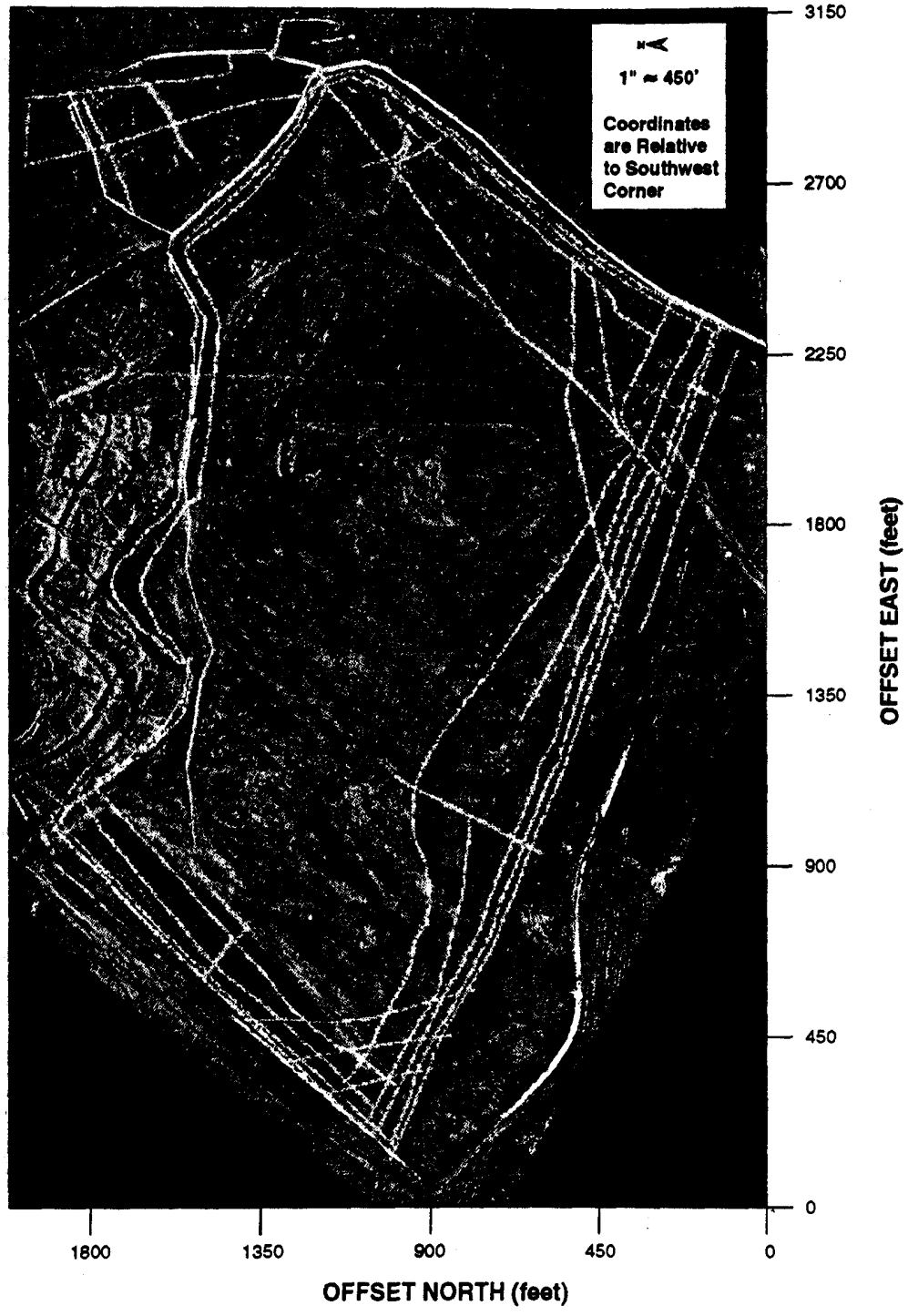


Figure 6. Landfill Site 2

GEO-CENTERS, INC.

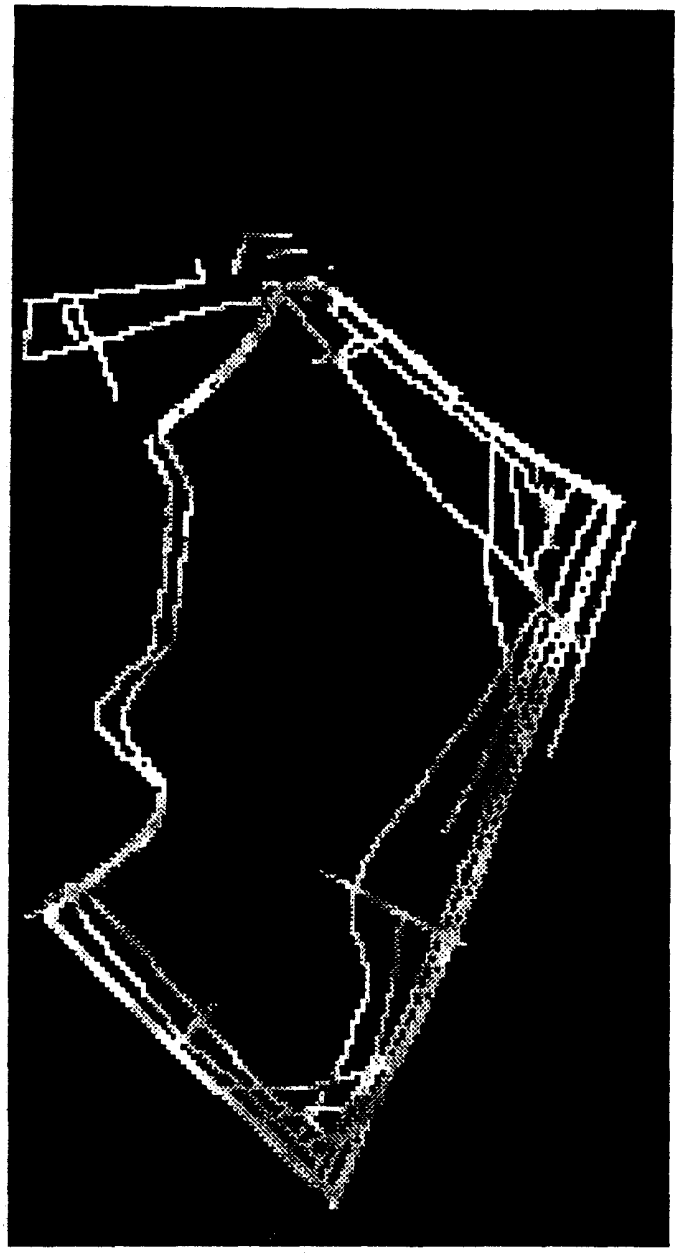


Figure 7. Site 2; 5x5 Grid, Quadrature (A) 0 100

GEO-CENTERS, INC.

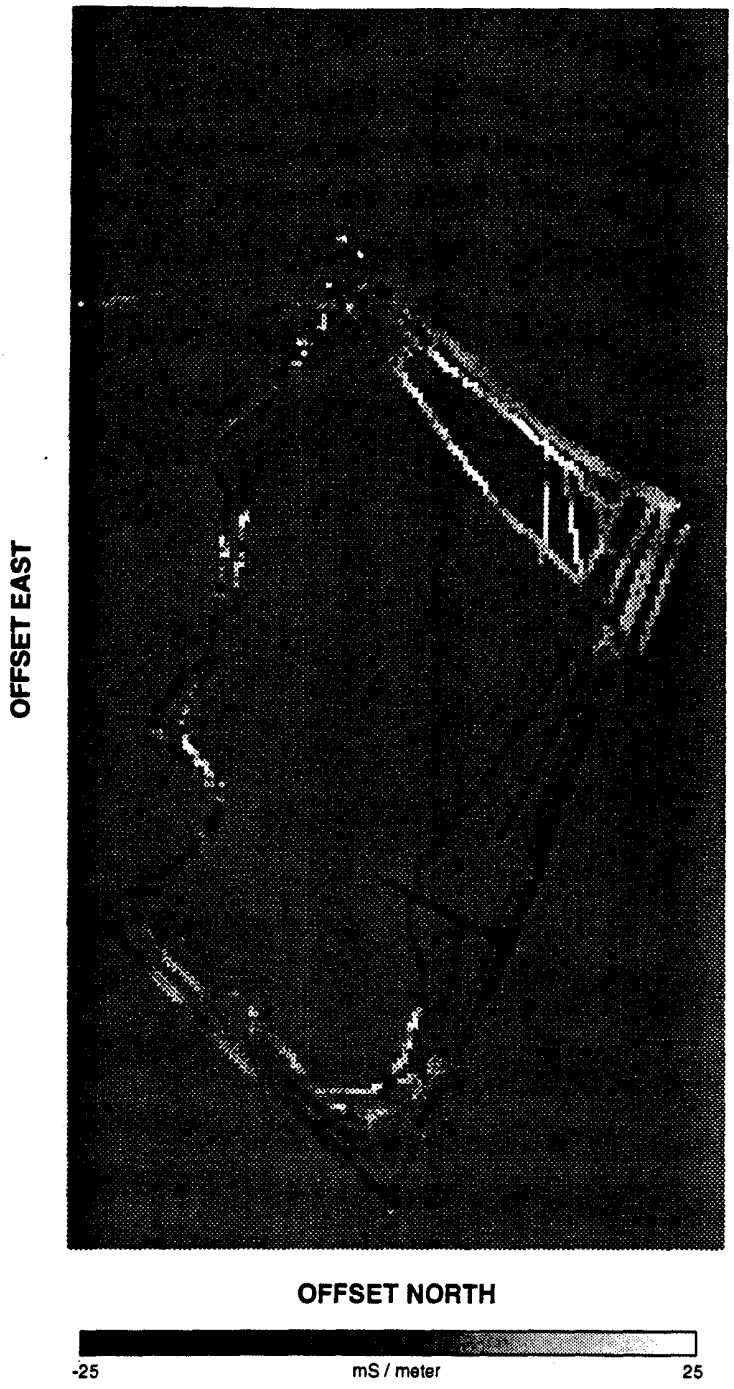


Figure 8. Site 2; 5x5 Grid, Phase (B) - 25 25

GEO-CENTERS, INC.

03820 P2 rev 9-15-95

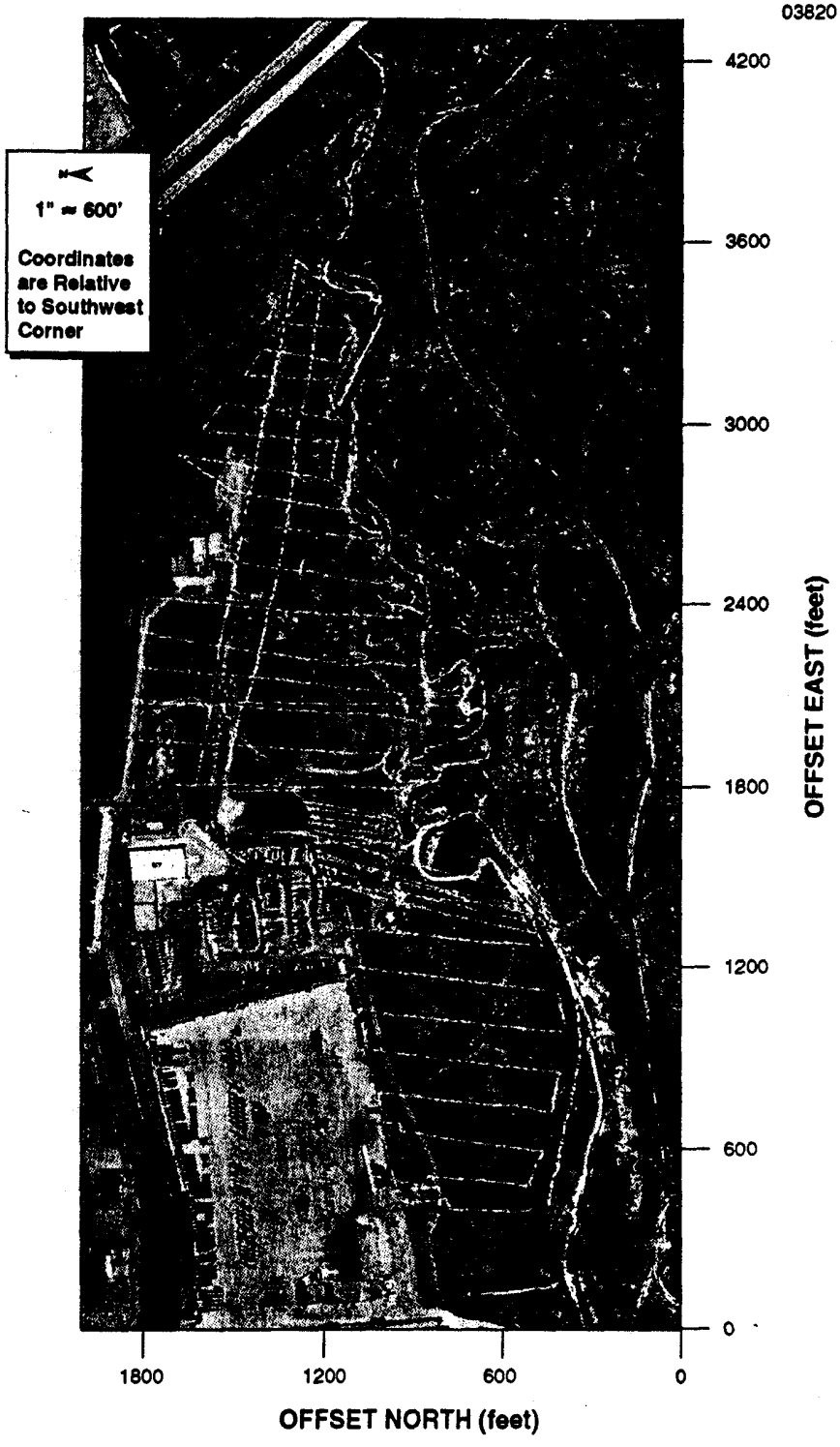


Figure 9. Landfill Site 5

GEO-CENTERS, INC.

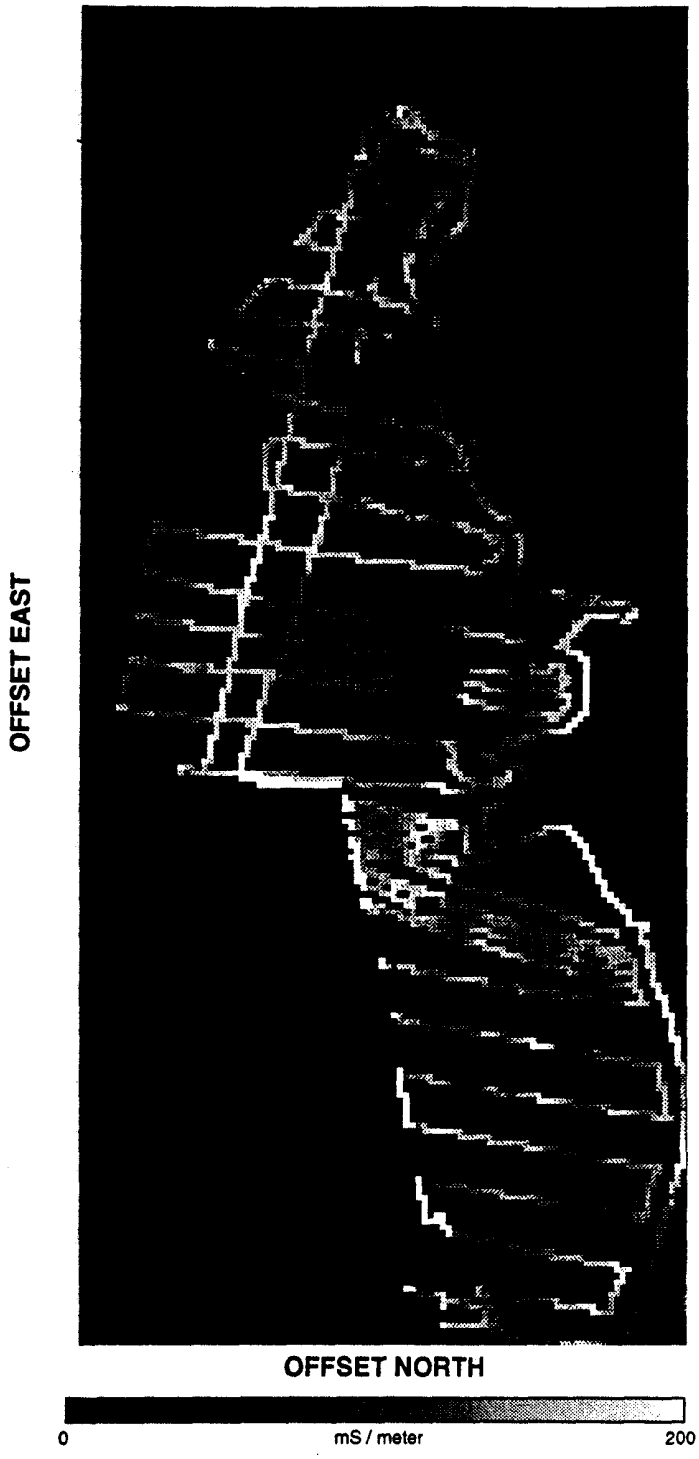


Figure 10. Site 5; 5x5 Grid, Quadrature (A) 0 - 200

GEO-CENTERS, INC.

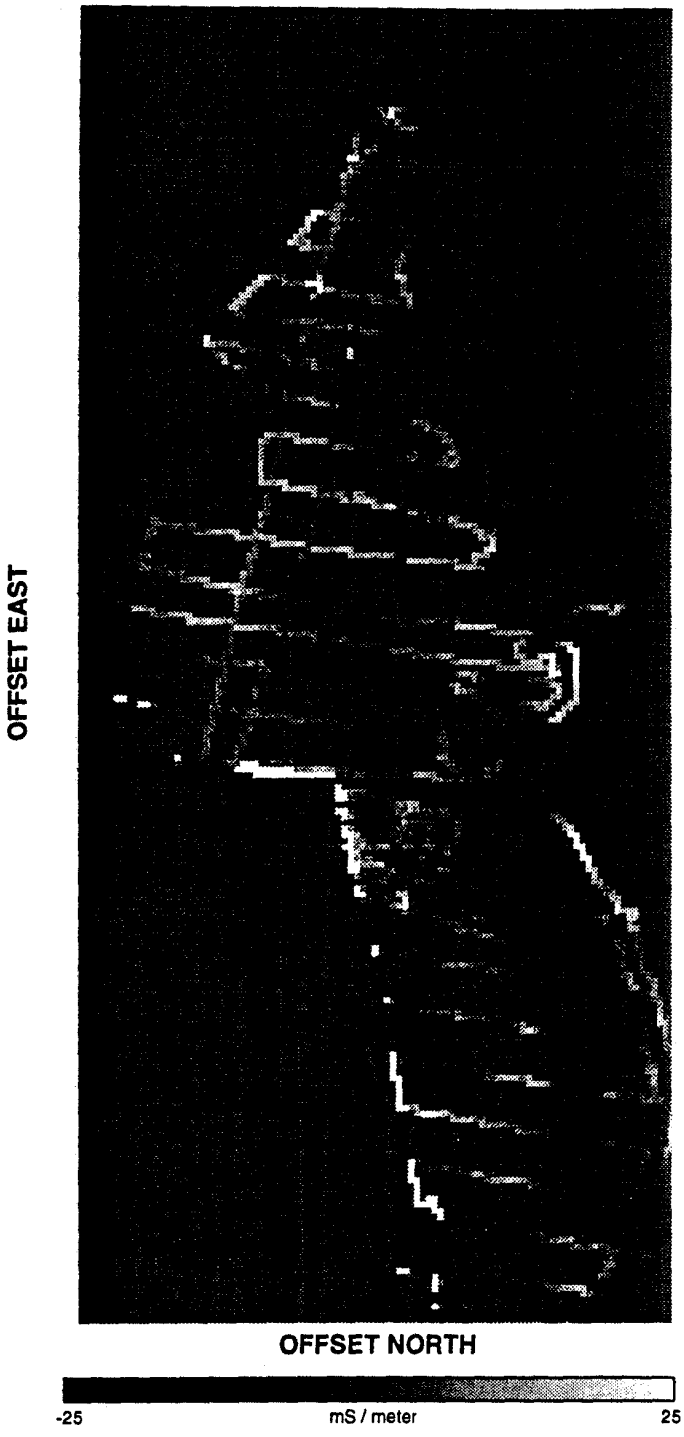


Figure 11. Site 5; 5x5 Grid, Phase (B) -25 25

GEO-CENTERS, INC.

Figure 12

GEO-CENTERS, INC.

APPENDIX A

GEO-CENTERS, INC.

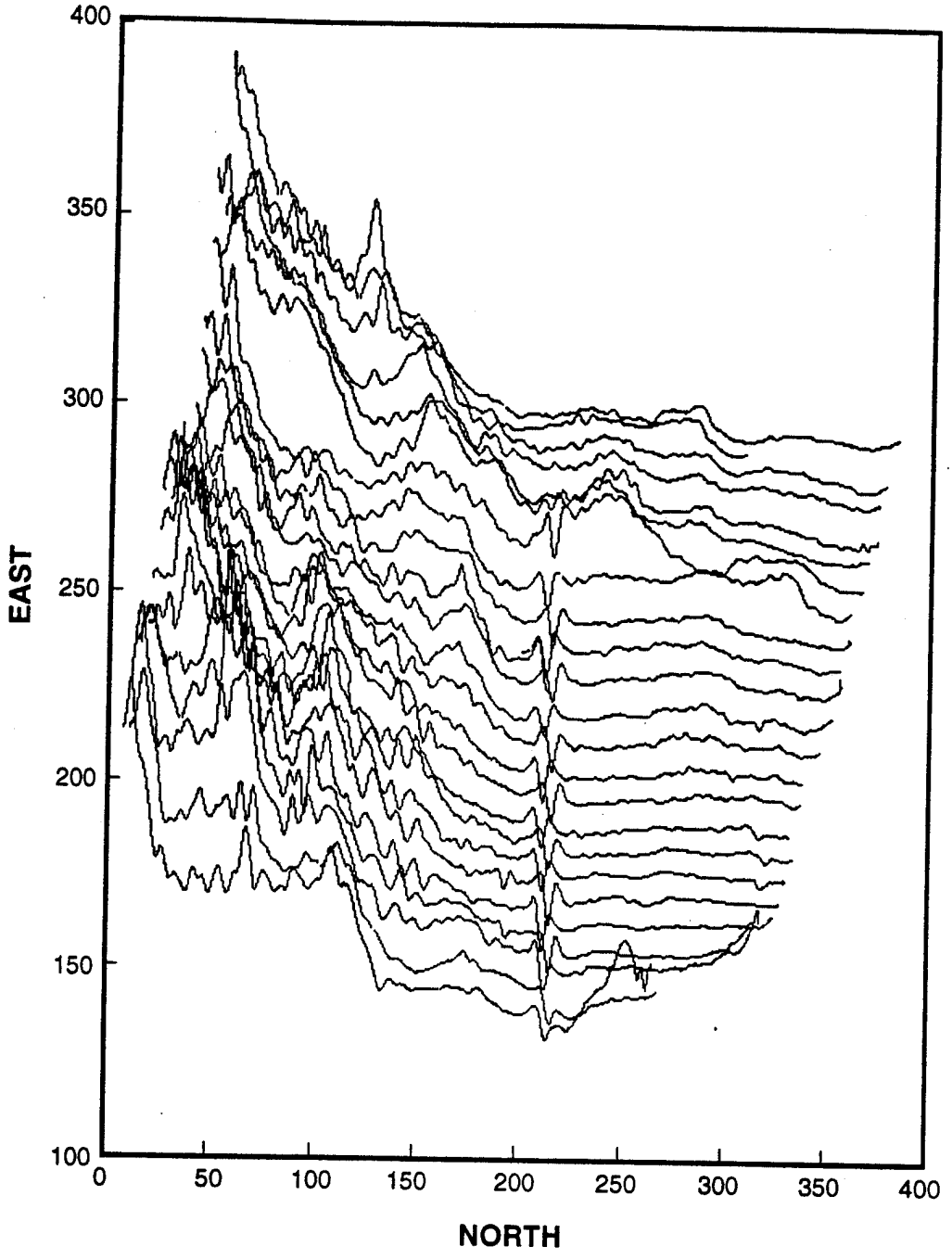


Figure A1. **Site 6; Profiles, Quadrature (A). Graphical representation of relative amplitudes of quadrature data acquired over Site 6.**

GEO-CENTERS, INC.

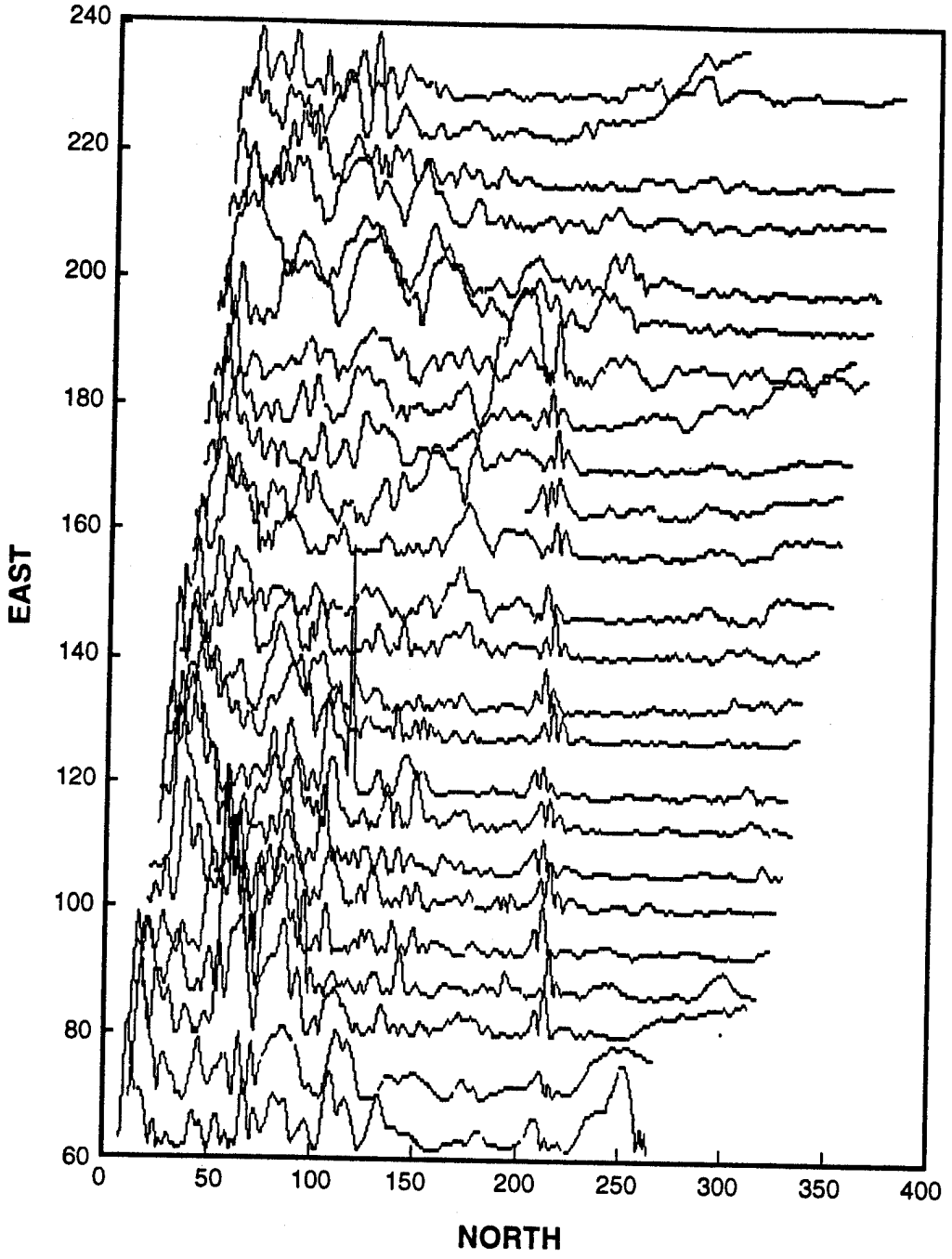


Figure A2. **Site 6; Profiles, Detrended Quadrature (A). Graphical representation of relative amplitudes of quadrature data over Site 6 (with trends removed).**

GEO-CENTERS, INC.

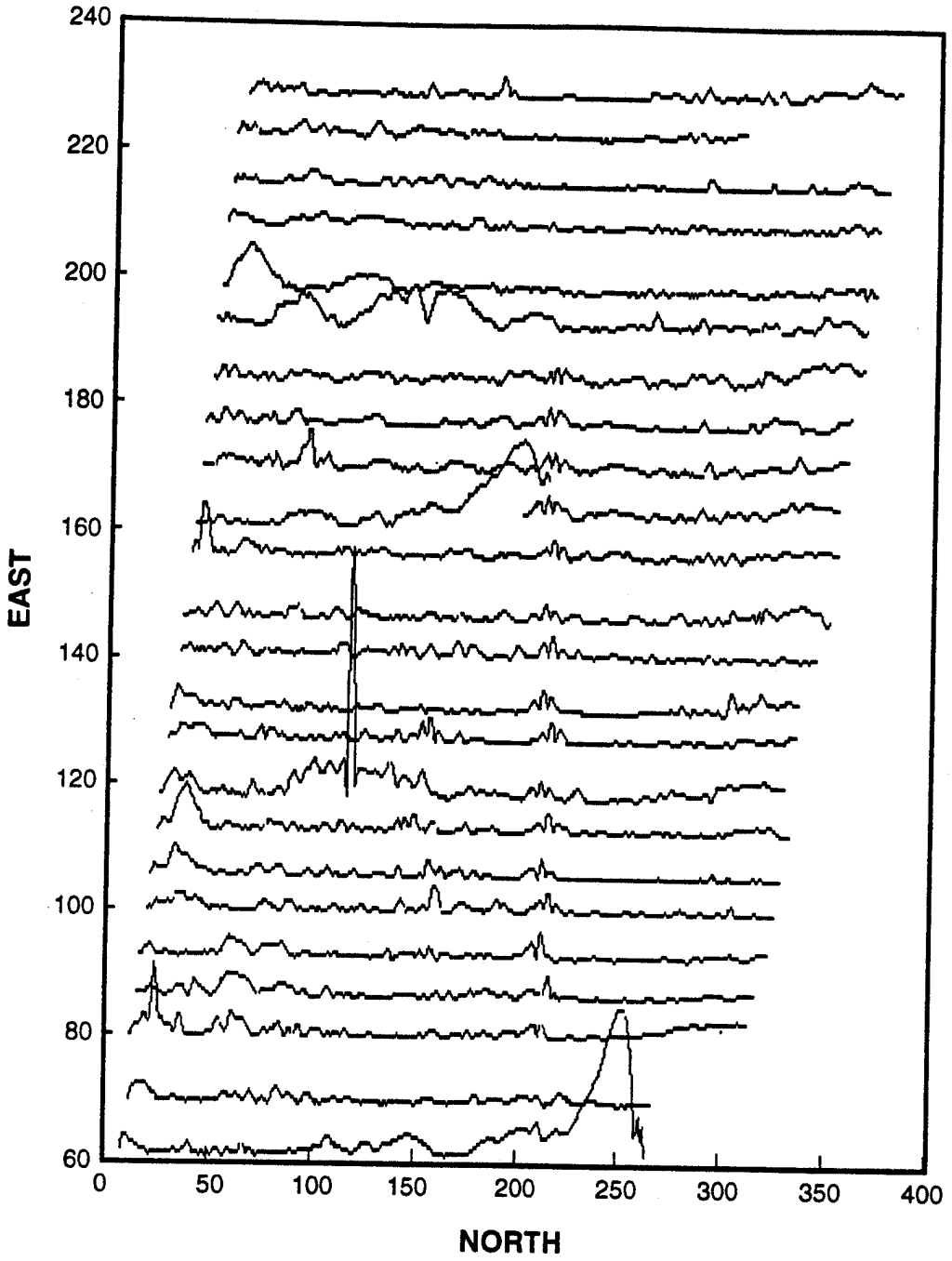


Figure A3. **Site 6; Profiles, Detrended Phase (B). Graphical representation of relative amplitudes of in-phase data over Site 6 (with trends removed).**

GEO-CENTERS, INC.

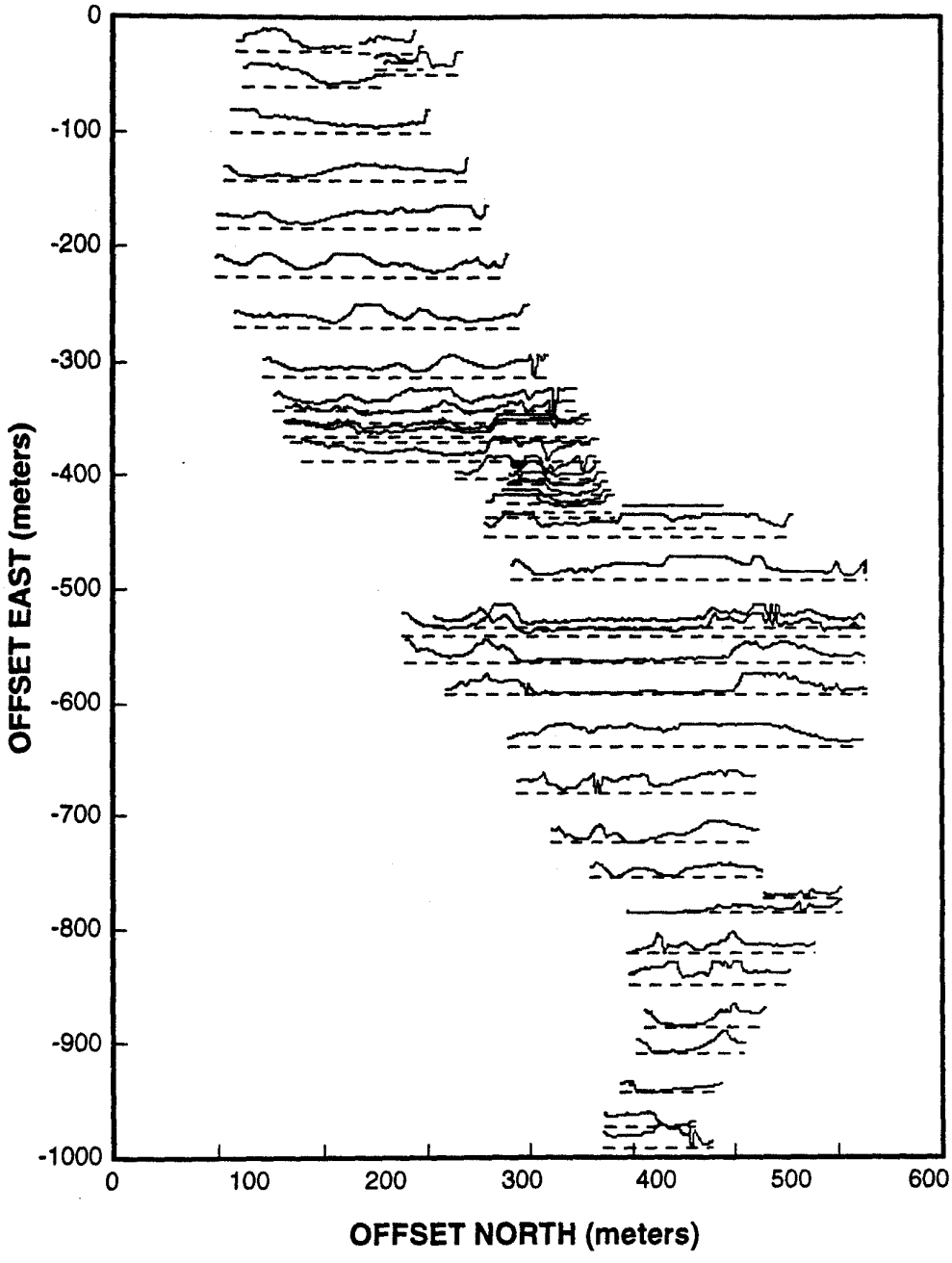


Figure A4. **Site 5; Quadrature (A), Scaler = 8, Offset = -50, Clip = 20. Graphical representation of relative amplitudes of quadrature data over Site 5.**

GEO-CENTERS, INC.

03846 P7 rev 10-26-95

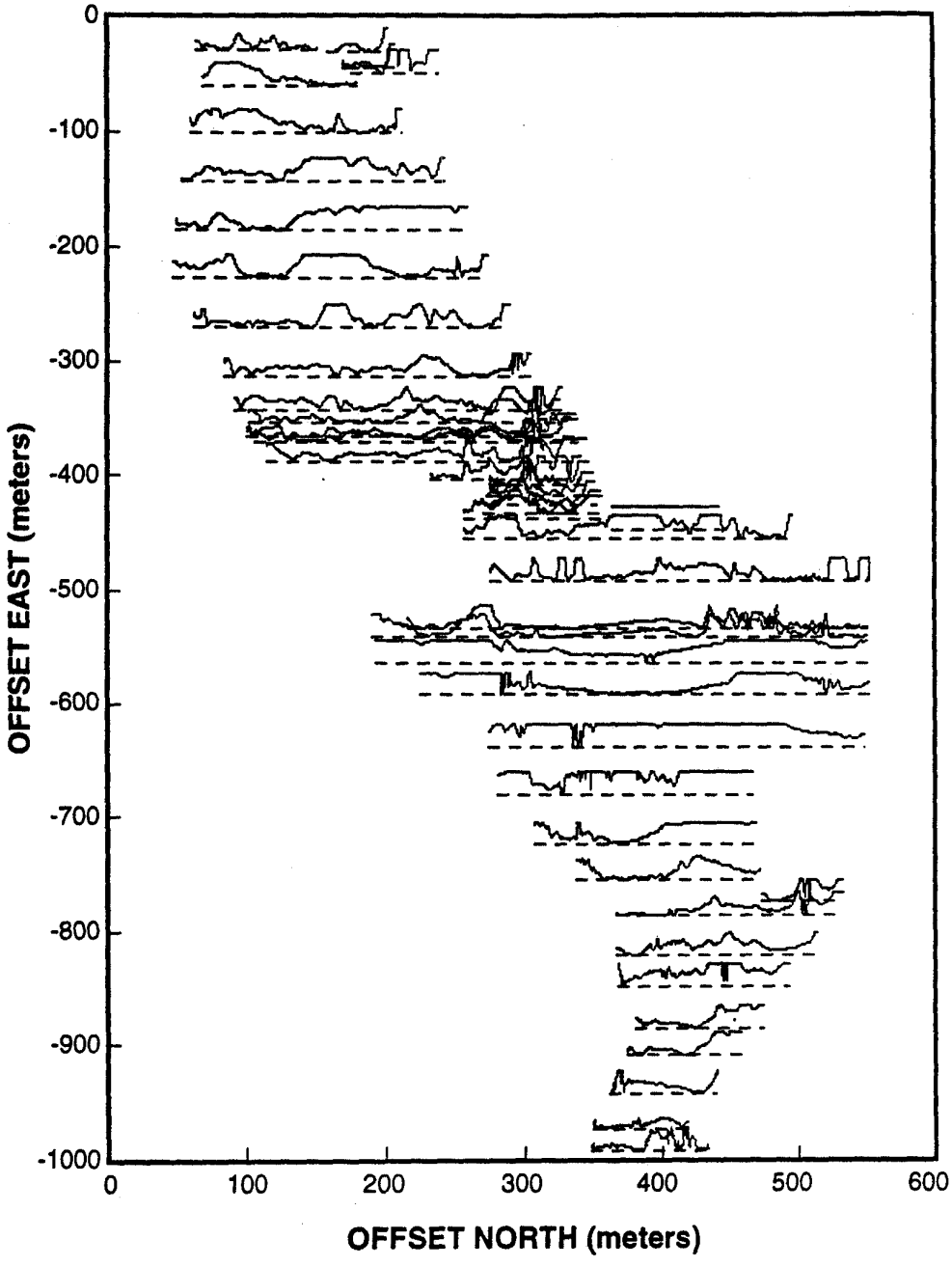


Figure A5. **Site 5; Phase (B), Clipping Set at 20. Graphical representation of relative amplitudes of in-phase data over Site 5.**

GEO-CENTERS, INC.

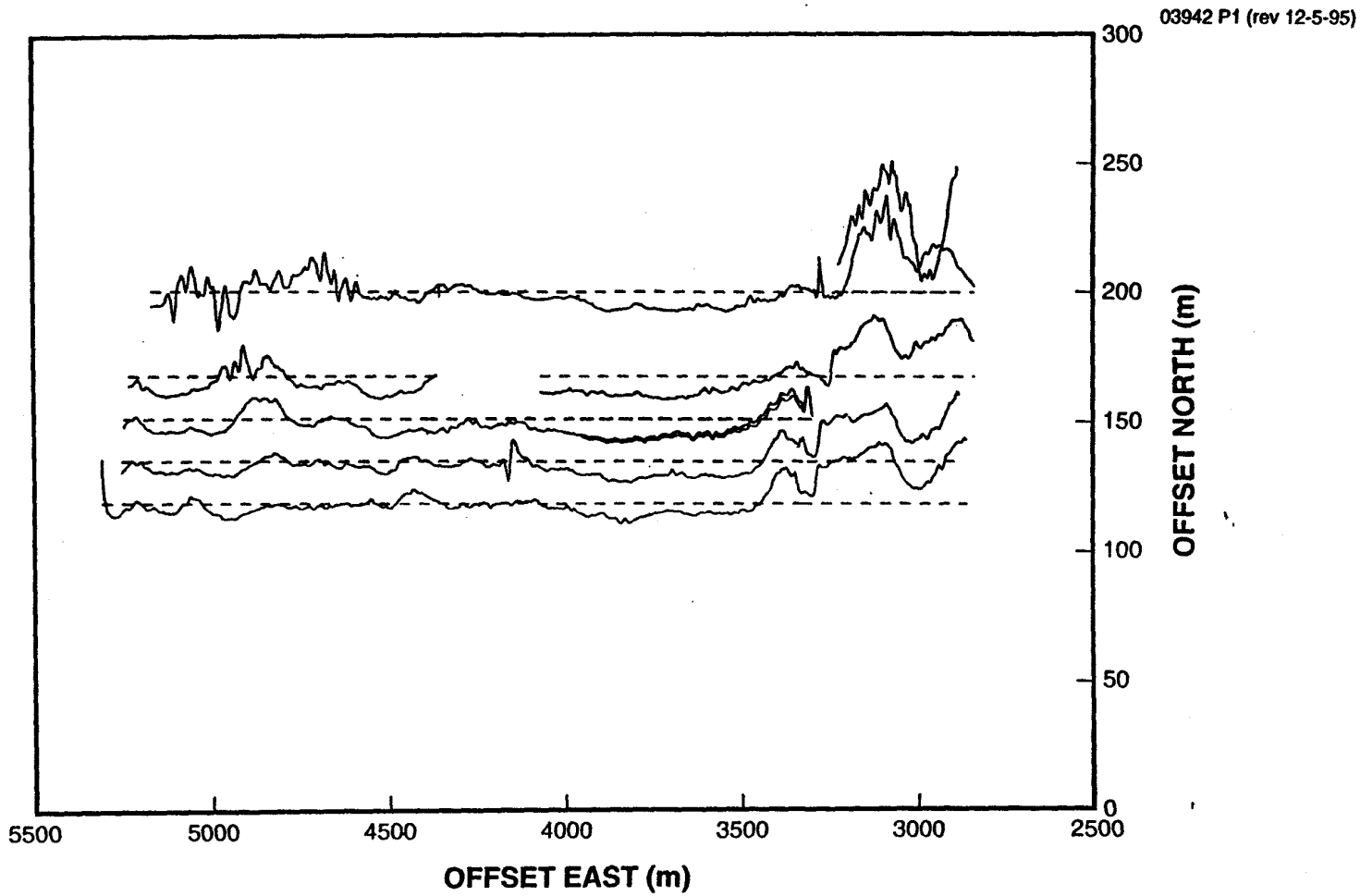


Figure A6. Site 2; Quadrature (A), Offset = -30. Graphical representation of relative amplitude of quadrature data over Site 2.

GEO-CENTERS, INC.

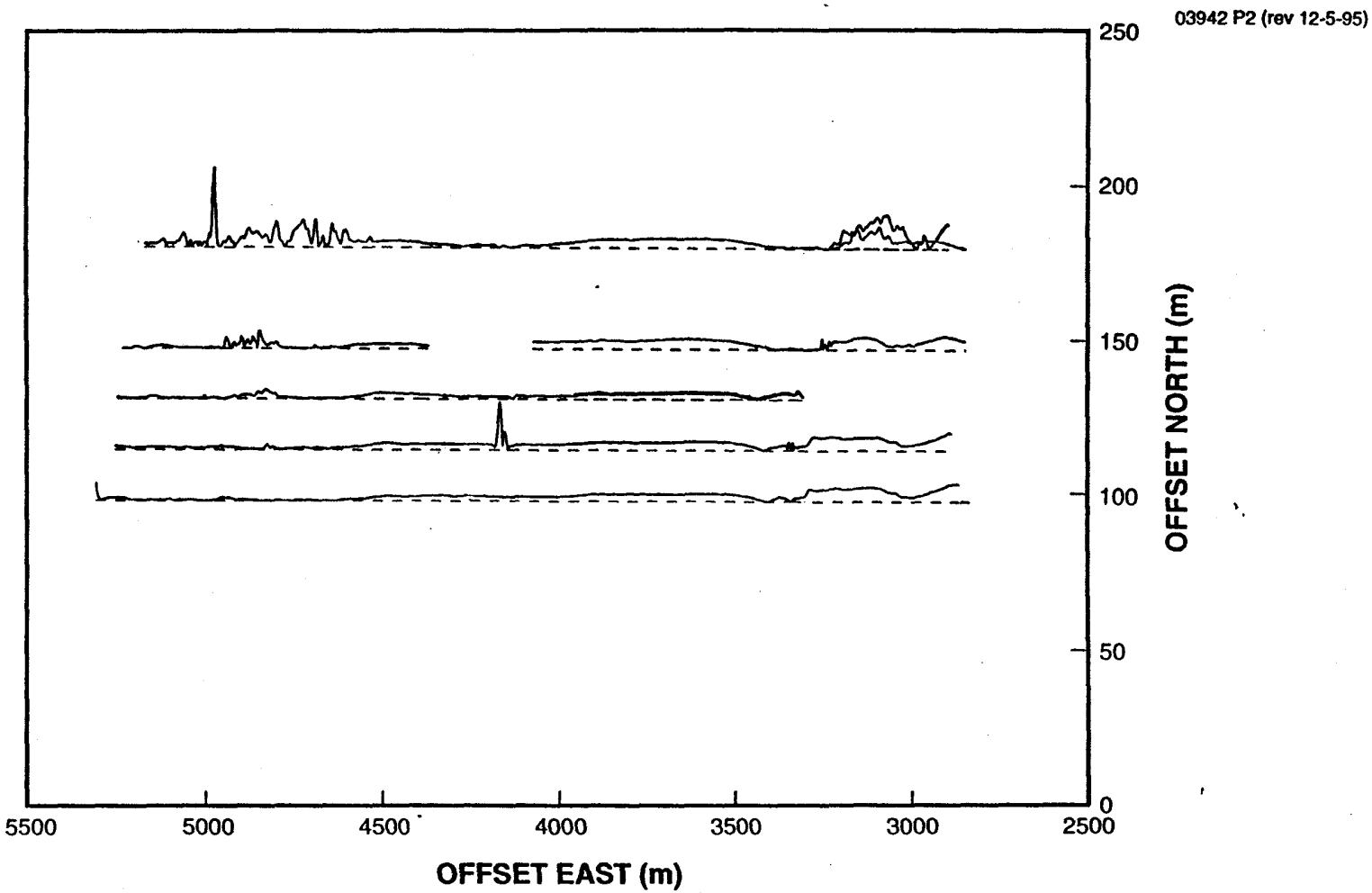


Figure A7. Site 2; In Phase (B). Graphical representation of relative amplitude of in phase data over Site 2.

GEO-CENTERS, INC.

APPENDIX B
SOIL BORING LOGS

- Geotechnical Soil Borings
(SB1-1 through SB-14)

- Cap Verification Test Borings
(CVT-1 through CVT-29)

Geotechnical Soil Borings
(SB-1 through SB-14)

HTW DRILLING LOG

HOLE NO.	SB-1
1. COMPANY NAME	RUST Environment & Infrastructure
2. DRILLING SUBCONTRACTOR	Site Services
SHEET 1	OF 1 SHEETS
3. PROJECT	Fort Carson Landfills
4. LOCATION	Fort Carson, Colorado
5. NAME OF DRILLER	Brian Dechante
6. MANUFACTURERS DESIGNATION OF DRILL	CME-75
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3.25" ID x 6" OD Hollow Stem Augers; 1 3/8" ID x 24" Split Spoon; 3" x 30" Shelby Tubes
8. HOLE LOCATION	Landfill #2
9. SURFACE ELEVATION	5901.5
10. DATE STARTED	6/19/95
11. DATE COMPLETED	6/19/95 By Grouting
12. OVERBURDEN THICKNESS	4.4 ft. to Landfill
15. DEPTH GROUNDWATER ENCOUNTERED	Not Encountered
13. DEPTH DRILLED INTO ROCK	Not Encountered
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	None
14. TOTAL DEPTH OF HOLE	8.0 ft.
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	None

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
See log	1 Spoon	3 Shelbys	0

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OIL & GREASE	SVOC	PCB	21. TOTAL CORE REC.
None						%

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHERS (SPECIFY)	23. SIGNATURE OF INSPECTOR
Grouted to surface				Rick Heidrick

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
0–1.4	CL	LEAN CLAY WITH SAND - Stiff, very dark grayish brown, moist, mostly clay, medium plasticity, little fine-grained sand, few angular clasts of shale randomly oriented (¼"). - FILL -		SB1-0 Shelby Tube		Time = 1155 P.P.= 1.5 tsf Recovery = 1.7'/2.0'
1.4–3.4	CH	FAT CLAY - Firm, yellowish brown, moist, mostly clay, trace sand and claystone fragments, piece of bark at 2.0'. - FILL -	0 ppm (after extrusion)	SB1-2 Shelby Tube		P.P.= 0.75 tsf Recovery = 1.8'/2.0'
3.4–5.4	CH	FAT CLAY - Stiff, yellowish brown, few decomposed leaves and organics, paper and black material in fat clay matrix, equal parts.	0 ppm (after extrusion)	SB1-4 Shelby Tube		Extremely bad odor 4' - 8'. Recovery = 2.0'/2.0'
5.4–8.0	CH	Paper, decomposed organics. - LANDFILL - Black material, paper and organics.	6 ppm (in field)	SB1-6 Split Spoon	3 23 6 5	Recovery = 0.5'/2.0'
8.0		Terminated boring at 8.0 feet. P.P.= Pocket Penetrometer				Time = 1228

MRF Form PDA-FTCb

PROJECT: 89868.200
Fort Carson Landfills

HOLE NO.: SB-1

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

HTW DRILLING LOG

HOLE NO.	SB-2
1. COMPANY NAME	RUST Environment & Infrastructure
2. DRILLING SUBCONTRACTOR	Site Services
SHEET 1	OF 1 SHEETS
3. PROJECT	Fort Carson Landfills
4. LOCATION	Fort Carson, Colorado
5. NAME OF DRILLER	Brian Dechante
6. MANUFACTURERS DESIGNATION OF DRILL	CME-75
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3.25" ID x 6" OD Hollow Stem Augers; 1 3/8" ID x 24" Split Spoon; 3" x 30" Shelby Tubes
8. HOLE LOCATION	Landfill #2
9. SURFACE ELEVATION	5877.6
10. DATE STARTED	6/19/95
11. DATE COMPLETED	6/19/95 By Grouting
12. OVERBURDEN THICKNESS	2 ft. to Shale
15. DEPTH GROUNDWATER ENCOUNTERED	Not Encountered
13. DEPTH DRILLED INTO ROCK	6.0 ft.
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	None
14. TOTAL DEPTH OF HOLE	8.0 ft.
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	None
18. GEOTECHNICAL SAMPLES	See log
DISTURBED	2 Spoons
UNDISTURBED	2 Shelbys
19. TOTAL NUMBER OF CORE BOXES	0

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OIL & GREASE	SVOC	PCB	21. TOTAL CORE REC.
None						%

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHERS (SPECIFY)	23. SIGNATURE OF INSPECTOR
Grouted to surface				Rick Heidrick

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
0–2	CL	LEAN CLAY WITH SAND - very stiff, dark brown, moist, mostly clay, medium plasticity, little fine-grained sand, mottled reddish brown, appears disturbed. - FILL - Becomes hard.		SB2-0 Shelby Tube		Time = 0921 P.P.= 3.75 tsf Recovery = 2.0'/2.0'
2–4	CL	LEAN CLAY WITH SAND - Hard, dark, grayish brown, moist, mostly clay, medium plasticity, little sand in thinly laminated beds, near horizontal, sand beds iron stained, smooth surfaces on clay bedding planes.		SB2-2 Shelby Tube		P.P.> 5 tsf Recovery = 1.8'/2.0'
4–6		- PIERRE SHALE -	0 ppm (in field)	SB2-4 Split Spoon	7 13 21 35	P.P.> 5 tsf Recovery = 2.0'/2.0'
6–8		Transparent prismatic crystals ~0.1" in yellowish clay matrix.	0 ppm (in field)	SB2-6 Split Spoon	8 15 19 28	P.P.> 5 tsf Recovery = 1.9'/2.0'
8		Terminated boring at 8.0 feet P.P.= Pocket Penetrometer				Time = 0959

MRF Form PDA-FTCb

PROJECT: 89868.200
Fort Carson Landfills

HOLE NO.: SB-2

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

HTW DRILLING LOG

HOLE NO.	SB-3
1. COMPANY NAME	RUST Environment & Infrastructure
2. DRILLING SUBCONTRACTOR	Site Services
SHEET	1 OF 1 SHEETS
3. PROJECT	Fort Carson Landfills
4. LOCATION	Fort Carson, Colorado
5. NAME OF DRILLER	Brian Dechante
6. MANUFACTURERS DESIGNATION OF DRILL	CME-75
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3.25" ID x 6" OD Hollow Stem Augers; 1 3/8" ID x 24" Split Spoon; 3" x 30" Shelby Tubes
8. HOLE LOCATION	Landfill #2
9. SURFACE ELEVATION	5872.5
10. DATE STARTED	6/19/95
11. DATE COMPLETED	6/19/95 By Grouting
12. OVERBURDEN THICKNESS	2 ft. to Shale
15. DEPTH GROUNDWATER ENCOUNTERED	Not Encountered
13. DEPTH DRILLED INTO ROCK	6.0 ft.
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	None
14. TOTAL DEPTH OF HOLE	8.0 ft.
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	None

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
See log	2 Spoons	2 Shelbys	0

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OIL & GREASE	SVOC	PCB	21. TOTAL CORE REC.
None						%

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHERS (SPECIFY)	23. SIGNATURE OF INSPECTOR
Grouted to surface				Rick Heidrick

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
0–2	CL	LEAN CLAY WITH SAND - Very stiff, very dark grayish brown, damp to moist, mostly clay, medium plasticity, little sand, mottled light gray, appears disturbed. - FILL -		SB3-0 Shelby Tube		Time = 1017 P.P.= 2.25 tsf Recovery = 1.8'/2.0'
2–4	CL	LEAN CLAY WITH SAND - Hard, brown, damp, mostly clay, medium plasticity, little sand, thinly laminated bedding planes in clay, near horizontal, few sandy beds.		SB3-2 Shelby Tube		P.P.> 5 tsf Recovery = 2.0'/2.0'
4–5		Sand bed ion stained. - PIERRE SHALE -	0 ppm (in field)	SB3-4 Split Spoon	8 9 15 22	P.P.> 5 tsf Recovery = 1.9'/2.0'
5–8			0 ppm (in field)	SB3-6 Split Spoon	7 11 20 29	P.P.> 5 tsf Recovery = 1.7'/2.0'
8–12		Terminated boring at 8.0 feet. P.P.= Pocket Penetrometer				Time = 1046

MRF Form PDA-FTCb

PROJECT: 89868.200
Fort Carson Landfills

HOLE NO.: SB-3

The stratification lines represent the approximate boundary between soil types and the transition may be gradual

HTW DRILLING LOG

HOLE NO.	SB-4
SHEET	1 OF 2 SHEETS
1. COMPANY NAME	RUST Environment & Infrastructure
2. DRILLING SUBCONTRACTOR	Site Services
3. PROJECT	Fort Carson Landfills
4. LOCATION	Fort Carson, Colorado
5. NAME OF DRILLER	Brian Dechante
6. MANUFACTURERS DESIGNATION OF DRILL	CME-75
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3.25" ID x 6" OD Hollow Stem Augers; 1 3/8" ID x 24" Split Spoon; 3" x 30" Shelby Tubes
8. HOLE LOCATION	Landfill #2
9. SURFACE ELEVATION	5867.5
10. DATE STARTED	6/15/95
11. DATE COMPLETED	6/15/95 By Grouting
12. OVERBURDEN THICKNESS	10 ft. to Shale
15. DEPTH GROUNDWATER ENCOUNTERED	Not Encountered
13. DEPTH DRILLED INTO ROCK	7.0 ft.
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	None
14. TOTAL DEPTH OF HOLE	17.0 ft.
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	None
18. GEOTECHNICAL SAMPLES	See log
DISTURBED	2 Spoons
UNDISTURBED	3 Shelbys
19. TOTAL NUMBER OF CORE BOXES	0
20. SAMPLES FOR CHEMICAL ANALYSIS	None
VOC	
METALS	
OIL & GREASE	
SVOC	
PCB	
21. TOTAL CORE REC.	%
22. DISPOSITION OF HOLE	Grouted to surface
BACKFILLED	
MONITORING WELL	
OTHERS (SPECIFY)	
23. SIGNATURE OF INSPECTOR	Rick Heidrick

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
0–2	CL	SANDY LEAN CLAY WITH GRAVEL - Very stiff, dark brown, moist, mostly clay, medium plasticity, little sand, little gravel to ½", subangular, randomly oriented, appears tight. - COLLUVIUM -		SB4-0 Shelby Tube		Time = 1215 Recovery = 1.9'/2.0'
2–4	CL	SANDY LEAN CLAY - Hard, dark yellowish brown, damp to dry, mostly clay, medium plasticity, some fine sand, appears tight/competent, few white nodules <0.1" (no reaction to HCL). - COLLUVIUM -	0 ppm (after extrusion)	SB4-2 Shelby Tube		Recovery = 1.8'/2.0'
4–6				SB4-4 Shelby Tube		Recovery = 2.0'/2.0'
6–10			0 ppm (in field)	Augered; No Sampled		
10–12	CL	SANDY CLAY - Hard, brown, dry, mostly clay, medium plasticity, some sand. - PIERRE SHALE -		SB4-10 Split Spoon	6 10 13 19	Time = 1248 Recovery = 1.8'/2.0'

MRF Form PDA-FTCb

PROJECT: 89868.200 Fort Carson Landfills

HOLE NO.: SB-4

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

HTW DRILLING LOG

HOLE NO. SB-4

1. COMPANY NAME: RUST Environment & Infrastructure

2. INSPECTOR: Rick Heidrick

SHEET 2 OF 2 SHEETS

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
12–15	CL	Rock-like qualities: Very soft, plastic, severely weathered, closely fractured (0.1' - 0.5'),v ery thinly bedded (0.5" - 1"), near horisontal bedding, iron stained, trace white micro-crystalline coatings (no reaction to HCL), appears tight, competent. - PIERRE SHALE - Becomes soft, weak, moderately weathered.		Augered; No Samples		
15–17			0 ppm (in field)	SB4-15 Split Spoon	11 20 32 37	Recovery = 2.0'/2.0'
17		Terminated boring at 17.0 feet.				Time = 1310

MRF Form PDA-FTCb

PROJECT: 89868.200
Fort Carson Landfills

HOLE NO.: SB-4

The stratification lines represent the approximate boundaries

HTW DRILLING LOG

HOLE NO.	SB-5
1. COMPANY NAME	RUST Environment & Infrastructure
2. DRILLING SUBCONTRACTOR	Site Services
SHEET 1 OF 1 SHEETS	
3. PROJECT	Fort Carson Landfills
4. LOCATION	Fort Carson, Colorado
5. NAME OF DRILLER	Brian Dechante
6. MANUFACTURERS DESIGNATION OF DRILL	CME-75
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3.25" ID x 6" OD Hollow Stem Augers; 1 3/8" ID x 24" Split Spoon; 3" x 30" Shelby Tubes
8. HOLE LOCATION	Landfill #2
9. SURFACE ELEVATION	5887.6
10. DATE STARTED	6/15/95
11. DATE COMPLETED	6/15/95 By Grouting
12. OVERBURDEN THICKNESS	7 ft. of Fill
15. DEPTH GROUNDWATER ENCOUNTERED	Not Encountered
13. DEPTH DRILLED INTO ROCK	Not Encountered
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	None
14. TOTAL DEPTH OF HOLE	11.0 ft.
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	None
18. GEOTECHNICAL SAMPLES	See log
DISTURBED	3 Spoons
UNDISTURBED	3 Shelbys
19. TOTAL NUMBER OF CORE BOXES	0
20. SAMPLES FOR CHEMICAL ANALYSIS	None
VOC / METALS / OIL & GREASE / SVOC / PCB	
21. TOTAL CORE REC.	%
22. DISPOSITION OF HOLE	Grouted to surface
BACKFILLED / MONITORING WELL / OTHERS (SPECIFY)	
23. SIGNATURE OF INSPECTOR	Rick Heidrick

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
0–3	SM	SILTY SAND WITH GRAVEL - Appears dense, brown, moist, mostly medium sand, little silt, little gravel to 3/4", subangular. - FILL -		SB5-0 Shelby Tube		Recovery = 1.4'/2.0'; End of tube collapsed.
3–4	CL	SANDY LEAN CLAY - Hard, dark gray, damp, mostly clay, medium plasticity, some sand, clasts of shale randomly oriented, disturbed. - FILL -		SB5-2 Shelby Tube		Recovery = 2.0'/2.0'; P.P.= 4 tsf
4–5				SB5-4 Shelby Tube		End of tube collapsed. Recovery = 1.0'/1.0'; Refusal at 5.0'
5–7	SP/SM	POORLY GRADED SAND WITH SILT AND GRAVEL - Medium dense, light gray, dry, mostly medium sand, few silt, some gravel, angular and randomly oriented. - FILL -		SB5-5 Split Spoon	10, 14, 12, 11	Recovery = 2.0'/2.0'
7–8	CL	SANDY CLAY - Stiff, dark brown, damp, mostly clay, medium plasticity, some sand, mostly coarse-grained, subrounded and randomly oriented in clay matrix. - COLLUVIUM -	0 ppm (in field)	SB5-7 Split Spoon	4, 6, 5, 9	Recovery = 1.5'/2.0'
9–11			0 ppm (in field)	SB5-9 Split Spoon	5, 7, 8, 9	Recovery = 1.0'/2.0'
11		Terminated boring at 11.0 feet.				Time = 1519

MRF Form PDA-FTCb

PROJECT: 89868.200
Fort Carson Landfills

HOLE NO.: SB-5

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

HTW DRILLING LOG

HOLE NO.	SB-6
1. COMPANY NAME	RUST Environment & Infrastructure
2. DRILLING SUBCONTRACTOR	Site Services
SHEET 1 OF 1 SHEETS	
3. PROJECT	Fort Carson Landfills
4. LOCATION	Fort Carson, Colorado
5. NAME OF DRILLER	Brian Dechante
6. MANUFACTURERS DESIGNATION OF DRILL	CME-75
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3.25" ID x 6" OD Hollow Stem Augers; 1 3/8" ID x 24" Split Spoon; 3" x 30" Shelby Tubes
8. HOLE LOCATION	Landfill #2
9. SURFACE ELEVATION	5871.9
10. DATE STARTED	6/16/95
11. DATE COMPLETED	6/16/95 By Grouting
12. OVERBURDEN THICKNESS	6 ft. of Fill
15. DEPTH GROUNDWATER ENCOUNTERED	Not Encountered
13. DEPTH DRILLED INTO ROCK	Not Encountered
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	None
14. TOTAL DEPTH OF HOLE	10.0 ft.
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	None
18. GEOTECHNICAL SAMPLES	See log
DISTURBED	3 Spoons
UNDISTURBED	3 Shelbys
19. TOTAL NUMBER OF CORE BOXES	0

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OIL & GREASE	SVOC	PCB	21. TOTAL CORE REC.
None						%

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHERS (SPECIFY)	23. SIGNATURE OF INSPECTOR
Grouted to surface				Rick Heidrick

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
0–6	CL	SANDY CLAY - Hard, brown, moist, mostly clay, medium plasticity, some sand, medium and coarse grained. - FILL -		SB6-0 Shelby Tube		Time = 0825 Recovery = 1.5'/2.0' P.P.= 4.25 tsf End of tube partially collapsed
			0 ppm (after extrusion)	SB6-2 Shelby Tube		Recovery = 1.3'/2.0' P.P.> 5 tsf End of tube partially collapsed
			0 ppm (after extrusion)	SB6-4 Shelby Tube		Recovery = 1.0'/2.0' P.P.> 5.tsf End of tube totally collapsed.
6–10	CL	SANDY CLAY - Firm, light gray, dry to moist, mostly clay, medium to low plasticity, some sand, plastic, paper and metal. - LANDFILL -	0 ppm (in field)	SB6-6 Split Spoon	4 3 3 4	Recovery = 0.2'/2.0'
			22 ppm (in field)	SB6-8 Split Spoon	2 7 14 4	Recovery = 0.2'/2.0'
10–12		Terminated boring at 10.0 feet P.P.= Pocket Penetrometer				Time = 0907

MRF Form PDA-FTCb

PROJECT: 89868.200 Fort Carson Landfills

HOLE NO.: SB-6

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

HTW DRILLING LOG

HOLE NO.	SB-7
1. COMPANY NAME	RUST Environment & Infrastructure
2. DRILLING SUBCONTRACTOR	Site Services
SHEET 1	OF 2 SHEETS
3. PROJECT	Fort Carson Landfills
4. LOCATION	Fort Carson, Colorado
5. NAME OF DRILLER	Brian Dechante
6. MANUFACTURERS DESIGNATION OF DRILL	CME-75
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3.25" ID x 6" OD Hollow Stem Augers; 1 3/8" ID x 24" Split Spoon; 3" x 30" Shelby Tubes
8. HOLE LOCATION	Landfill #2
9. SURFACE ELEVATION	5869.1
10. DATE STARTED	6/16/95
11. DATE COMPLETED	6/16/95 By Grouting
12. OVERBURDEN THICKNESS	15 ft. to Landfill
15. DEPTH GROUNDWATER ENCOUNTERED	Not Encountered
13. DEPTH DRILLED INTO ROCK	Not Encountered
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	None
14. TOTAL DEPTH OF HOLE	19.0 ft.
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	None

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
See log	4 Spoons	5 Shelbys	0

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OIL & GREASE	SVOC	PCB	21. TOTAL CORE REC.
None						%

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHERS (SPECIFY)	23. SIGNATURE OF INSPECTOR
Grouted to surface				Rick Heidrick

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
0–1	CL	LEAN CLAY WITH SAND - Very stiff, brown, moist, medium plasticity, mostly clay, little sand, few gravel. - FILL -		SB7-0 Shelby Tube		Time = 0930 Recovery = 1.5'/2.0' P.P.= 2.25 tsf
1–3	CH	FAT CLAY - Very stiff, yellowish brown, moist, mostly clay and silt, trace sand and claystone fragments. - FILL -	0 ppm (after extrusion)	SB7-2 Shelby Tube		Recovery = 1.9'/2.0' P.P.= 2.25 tsf
3–5		Few pieces of shale to ½", angular, randomly oriented in fill.		SB7-4 Shelby Tube		Recovery = 1.4'/2.0' P.P.= 2.25 tsf
5–7		As above, absence of shale fragments.		SB7-6 Shelby Tube		Recovery = 2.0'/2.0' P.P.= 2.75 tsf
7–9		Becomes hard, dark grayish brown.		SB7-8 Shelby Tube		Recovery = 1.5'/2.0' P.P.> 5 tsf End of tube partially collapsed.
9–11		Few clasts gravel to 1", angular, randomly oriented, becomes firm. - FILL -	0 ppm (in field)	SB7-10 Split Spoon	3 3 3 3	Recovery = 1.5'/2.0'

MRF Form PDA-FTCb

PROJECT: 89868.200
Fort Carson Landfills

HOLE NO.: SB-7

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

HTW DRILLING LOG

HOLE NO. SB-7

1. COMPANY NAME: RUST Environment & Infrastructure

2. INSPECTOR: Rick Heidrick

SHEET 2 OF 2 SHEETS

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
13	CH	FAT CLAY (cont.) - FILL - 1" piece of gravel at 13.0', iron stained sandstone, few pieces of angular shale to ½".		SB7-12 Split Spoon	5 9 9 8	Time = 1014 Recovery = 1.2'/2.0'
14				Augered; No Samples		
15	SM	SILTY SAND - Medium dense, black/brown, varies, damp, mostly sand, some silt, equal parts wood, paper, and plaster. - LANDFILL -	31 ppm (in field)	SB7-15 Split Spoon	2 4 6 6	Recovery = 1.0'/2.0'
17			24 ppm (in field)	SB7-17 Split Spoon	7 6 7 12	Recovery = 1.0'/2.0'
19		Terminated boring at 19.0 feet. P.P.= Pocket Penetrometer				Time = 1039

MRF Form PDA-FTCb

PROJECT: 89868.200 Fort Carson Landfills

HOLE NO.: SB-7

The stratification lines represent the approximate boundary between soil types and the transition may be gradual

HTW DRILLING LOG

HOLE NO.	SB-8
1. COMPANY NAME	RUST Environment & Infrastructure
2. DRILLING SUBCONTRACTOR	Site Services
SHEET 1	OF 1 SHEETS
3. PROJECT	Fort Carson Landfills
4. LOCATION	Fort Carson, Colorado
5. NAME OF DRILLER	Brian Dechante
6. MANUFACTURERS DESIGNATION OF DRILL	CME-75
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3.25" ID x 6" OD Hollow Stem Augers; 1 3/8" ID x 24" Split Spoon; 3" x 30" Shelby Tubes
8. HOLE LOCATION	Landfill #2
9. SURFACE ELEVATION	5859.0
10. DATE STARTED	6/15/95
11. DATE COMPLETED	6/15/95 By Grouting
12. OVERBURDEN THICKNESS	4 ft. to Landfill
15. DEPTH GROUNDWATER ENCOUNTERED	Not Encountered
13. DEPTH DRILLED INTO ROCK	Not Encountered
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	None
14. TOTAL DEPTH OF HOLE	6.0 ft.
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	None

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
See log	0	3 Shelbys	0

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OIL & GREASE	SVOC	PCB	21. TOTAL CORE REC.
None						%

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHERS (SPECIFY)	23. SIGNATURE OF INSPECTOR
Grouted to surface				Rick Heidrick

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
0–2	CL	SANDY CLAY - Very stiff, dark brown, moist, mostly clay, medium plasticity, little sand, few gravel to ½". - FILL -		SB8-0 Shelby Tube		Time = 1115 Recovery = 1.4'/2.0'
2–4	CH	FAT CLAY - Hard, light brown, moist, mostly clay and silt, medium plasticity, trace sand, claystone fragments, and roots. - FILL -	0 ppm (after extrusion)	SB8-2 Shelby Tube		Recovery = 1.5'/2.0'
4–6	CH	FAT CLAY - Wood, plastic, and roots in fat clay matrix, appears equal parts. - LANDFILL -		SB8-4 Shelby Tube		Recovery = 1.7'/2.0'
6		Terminated boring at 6.0 feet.				Time = 1137

MRF Form PDA-FTCb

PROJECT: 89868.200
Fort Carson Landfills

HOLE NO.: SB-8

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

HTW DRILLING LOG

HOLE NO.	SB-9
1. COMPANY NAME	RUST Environment & Infrastructure
2. DRILLING SUBCONTRACTOR	Site Services
SHEET 1 OF 1 SHEETS	
3. PROJECT	Fort Carson Landfills
4. LOCATION	Fort Carson, Colorado
5. NAME OF DRILLER	Brian Dechante
6. MANUFACTURERS DESIGNATION OF DRILL	CME-75
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3.25" ID x 6" OD Hollow Stem Augers; 1 3/8" ID x 24" Split Spoon; 3" x 30" Shelby Tubes
8. HOLE LOCATION	Landfill #2
9. SURFACE ELEVATION	5838.1
10. DATE STARTED	6/16/95
11. DATE COMPLETED	6/16/95 By Grouting
12. OVERBURDEN THICKNESS	4.5 ft. to Landfill
15. DEPTH GROUNDWATER ENCOUNTERED	Not Encountered
13. DEPTH DRILLED INTO ROCK	Not Encountered
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	None
14. TOTAL DEPTH OF HOLE	8.0 ft.
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	None
18. GEOTECHNICAL SAMPLES	See log
DISTURBED	1 Spoon
UNDISTURBED	3 Shelbys
19. TOTAL NUMBER OF CORE BOXES	0

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OIL & GREASE	SVOC	PCB	21. TOTAL CORE REC.
None						%

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHERS (SPECIFY)	23. SIGNATURE OF INSPECTOR
Grouted to surface				Rick Heidrick

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
0–4.5	SP/SM	POORLY GRADED SAND WITH SILT AND GRAVEL - Appears dense, yellowish brown, damp, mostly sand, little gravel, few silt. - FILL -		SB9-0 Shelby Tube		Recovery = 1.5'/2.0' End of tube dented.
4.5–6.5	CH	FAT CLAY - Very stiff, brown, moist, mostly clay and silt, medium plasticity, little fine sand, trace gravel. - FILL -	0 ppm (after extrusion)	SB9-2 Shelby Tube		Recovery = 2.0'/2.0' P.P.= 2.25 tsf End of tube dented.
6.5–8.0	CL	SANDY CLAY - Soft, black, moist, mostly sandy clay and debris (wood, plastic, glass, paper) 50/50, organic odor. - LANDFILL - Entirely wood.	0 ppm (after extrusion)	SB9-4 Shelby Tube		Recovery = 1.0'/2.0' P.P.= 2.0 tsf End of tube dented.
			2.1 ppm (in field)	SB9-6 Split Spoon	1 2 3 2	Recovery = 0.3'/2.0'
8		Terminated boring at 8.0 feet. P.P.= Pocket Penetrometer				

MRF Form PDA-FTCb

PROJECT: 89868.200 Fort Carson Landfills

HOLE NO.: SB-9

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

HTW DRILLING LOG

HOLE NO.	SB-10
1. COMPANY NAME	RUST Environment & Infrastructure
2. DRILLING SUBCONTRACTOR	Site Services
SHEET 1	OF 1 SHEETS
3. PROJECT	Fort Carson Landfills
4. LOCATION	Fort Carson, Colorado
5. NAME OF DRILLER	Brian Dechante
6. MANUFACTURERS DESIGNATION OF DRILL	CME-75
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3.25" ID x 6" OD Hollow Stem Augers; 1 3/8" ID x 24" Split Spoon; 3" x 30" Shelby Tubes
8. HOLE LOCATION	Landfill #2
9. SURFACE ELEVATION	5826.5
10. DATE STARTED	6/15/95
11. DATE COMPLETED	6/15/95 By Grouting
12. OVERBURDEN THICKNESS	6.5 ft. to Landfill
15. DEPTH GROUNDWATER ENCOUNTERED	Not Encountered
13. DEPTH DRILLED INTO ROCK	Not Encountered
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	None
14. TOTAL DEPTH OF HOLE	9.0 ft.
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	None

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
See log	2 Spoons	3 Shelbys	0

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OIL & GREASE	SVOC	PCB	21. TOTAL CORE REC.
None						%

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHERS (SPECIFY)	23. SIGNATURE OF INSPECTOR
Grouted to surface				Rick Heidrick

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
0–2	CH	FAT CLAY WITH SAND - Very stiff, dark yellowish brown, moist, mostly clay and silt, medium to high plasticity, little well-graded sand, trace claystone fragments to ½", subangular, randomly oriented, trace roots. - FILL -	0 ppm (after extrusion)	SB10-0 Shelby Tube		Time = 1115 Recovery = 1.0'/2.0'
2–5	CL	SANDY CLAY - Firm to stiff, brown, damp, mostly clay, medium plasticity, some fine sand, broken glass. - FILL -	2.1 ppm (in field)	SB10-2 Split Spoon	5 5 5 3	Recovery = 1.0'/2.0'
5–6	CH	FAT CLAY - Firm to stiff, brown, moist, high plasticity, few gravel to 1½". - FILL -	0 ppm (after extrusion)	SB10-4 Shelby Tube		Recovery = 1.8'/2.0' P.P.= 1.0 tsf
6–8	CL	LEAN CLAY - Soft, black, moist to wet, medium plasticity, equal parts rubber, paper, and wood, organic odor. - LANDFILL -	0 ppm (in field)	SB10-6 Shelby Tube		Recovery = 1.0'/2.0' P.P.= 0.25 tsf
8–9		Same as above.	68 ppm (in field)	SB10-8 Split Spoon	6 150/6"	Recovery = 0.2'/1.0' Rods bouncing as if on a tire.
9–12		Terminated boring at 9.0 feet. P.P.= Pocket Penetrometer				Time = 1145

MRF Form PDA-FTCb

PROJECT: 89868.200 Fort Carson Landfills

HOLE NO.: SB-10

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

HTW DRILLING LOG

HOLE NO.	SB-11
1. COMPANY NAME	RUST Environment & Infrastructure
2. DRILLING SUBCONTRACTOR	Site Services
SHEET 1	OF 2 SHEETS
3. PROJECT	Fort Carson Landfills
4. LOCATION	Fort Carson, Colorado
5. NAME OF DRILLER	Brian Dechante
6. MANUFACTURERS DESIGNATION OF DRILL	CME-75
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3.25" ID x 6" OD Hollow Stem Augers; 1 3/8" ID x 24" Split Spoon; 3" x 30" Shelby Tubes
8. HOLE LOCATION	Landfill #2
9. SURFACE ELEVATION	5826.4
10. DATE STARTED	6/15/95
11. DATE COMPLETED	6/15/95 By Grouting
12. OVERBURDEN THICKNESS	None
15. DEPTH GROUNDWATER ENCOUNTERED	Not Encountered
13. DEPTH DRILLED INTO ROCK	14.0 ft.
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	None
14. TOTAL DEPTH OF HOLE	14.0 ft.
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	None

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
See log	2 Spoons	3 Shelbys	0

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OIL & GREASE	SVOC	PCB	21. TOTAL CORE REC.
None						%

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHERS (SPECIFY)	23. SIGNATURE OF INSPECTOR
Grouted to surface				Rick Heidrick

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
0–1	CL	LEAN CLAY WITH SAND - Very stiff, dark grayish brown, damp, medium plasticity, little sand, faint bedding, laminated and near horizontal, bedding plans iron stained, vertically jointed, friable, crumbles to ~¼" pieces.		SB11-0 Shelby Tube		Time = 0940 Recovery = 2.0'/2.0'
1–3		- PIERRE SHALE - Rock qualities; very soft, extremely weathered, extremely weak, friable, near horizontal bedding, jointed near vertical, fractures appear tight and iron stained, smooth.	0 ppm (after extrusion)	SB11-2 Shelby Tube		Recovery = 2.0'/2.0'
3–5				SB11-4 Shelby Tube		Recovery = 1.9'/2.0'
5–10				Augered; No Samples		
10–12		Becomes moderately weathered, soft, bedding becomes very close (<0.2'), very narrow (<0.1"), infilled with white prismatic crystals (no reaction to HCL), possibly gypsum, occasional joints ~80°, less iron staining, appears tight.	0 ppm (in field)	SB11-10 Split Spoon	17 31 34 43	Recovery = 2.0'/2.0'

MRF Form PDA-FTCb

PROJECT: 89868.200
Fort Carson Landfills

HOLE NO.: SB-11

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.
atification lines represent the approximate boundary between soil types and the transition may be gradual

HTW DRILLING LOG

HOLE NO. SB-11

1. COMPANY NAME: RUST Environment & Infrastructure

2. INSPECTOR: Rick Heidrick

SHEET 2 OF 2 SHEETS

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
13	CL	- PIERRE SHALE - cont. Competent, lens of sandstone, tight.		SB11-12 Split Spoon	18 48 64 67	Recovery = 2.0'/2.0'
14		Terminated boring at 14.0 feet.				Time = 1038

MRF Form PDA-FTCb

PROJECT: 89868.200
Fort Carson Landfills

HOLE NO.: SB-11

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

HTW DRILLING LOG

HOLE NO.	SB-12
SHEET 1 OF 2 SHEETS	
1. COMPANY NAME	RUST Environment & Infrastructure
2. DRILLING SUBCONTRACTOR	Site Services
3. PROJECT	Fort Carson Landfills
4. LOCATION	Fort Carson, Colorado
5. NAME OF DRILLER	Brian Dechante
6. MANUFACTURERS DESIGNATION OF DRILL	CME-75
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3.25" ID x 6" OD Hollow Stem Augers; 1 3/8" ID x 24" Split Spoon; 3" x 30" Shelby Tubes
8. HOLE LOCATION	Landfill #2
9. SURFACE ELEVATION	5815.2
10. DATE STARTED	6/19/95
11. DATE COMPLETED	6/19/95 By Grouting
12. OVERBURDEN THICKNESS	8 ft. to Shale
15. DEPTH GROUNDWATER ENCOUNTERED	Not Encountered
13. DEPTH DRILLED INTO ROCK	6.0 ft.
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	None
14. TOTAL DEPTH OF HOLE	14.0 ft.
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	None
18. GEOTECHNICAL SAMPLES	See log
DISTURBED	1 Spoon
UNDISTURBED	4 Shelbys
19. TOTAL NUMBER OF CORE BOXES	0
20. SAMPLES FOR CHEMICAL ANALYSIS	None
VOC / METALS / OIL & GREASE / SVOC / PCB	
21. TOTAL CORE REC.	%
22. DISPOSITION OF HOLE	Grouted to surface
BACKFILLED / MONITORING WELL / OTHERS (SPECIFY)	
23. SIGNATURE OF INSPECTOR	Rick Heidrick

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
0–1	CL	LEAN CLAY WITH SAND - Soft to firm, dark grayish brown, moist, mostly clay, medium plasticity, little sand. - FILL -		SB12-0 Shelby Tube		Time = 1430 Recovery = 1.7'/2.0' P.P.= 0.5 tsf
1–2	CL	SANDY LEAN CLAY - Very stiff, dark grayish brown, moist, mostly clay, medium plasticity, some fine-grained sand. - ALLUVIUM -		SB12-2 Shelby Tube		Recovery = 2.0'/2.0' P.P.= 2.5 tsf
3–4		Becomes firm.				
4–5			0 ppm (after extrusion)	SB12-4 Shelby Tube		Recovery = 2.0'/2.0' P.P.= 0.75 tsf
5–6	CH	SANDY FAT CLAY - Firm to soft, yellowish brown, moist, mostly silty clay, some sand, trace gravel. - ALLUVIUM -				
6–8				Augered; No Samples		
8–10	CL	LEAN CLAY WITH SAND - Hard, dark grayish brown, damp, mostly clay, medium plasticity, little sand, very fine-grained, bedding near horizontal, iron stained. - PIERRE SHALE -				Slightly harder drilling from 8' to 10'.
10–11				SB12-10 Shelby Tube	17 31 34 43	Recovery = 2.0'/2.0' P.P.> 5 tsf
11–12						

MRF Form PDA-FTCb

PROJECT: 89868.200
Fort Carson Landfills

HOLE NO.: SB-12

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

HTW DRILLING LOG

HOLE NO. SB-12

1. COMPANY NAME: RUST Environment & Infrastructure

2. INSPECTOR: Rick Heidrick

SHEET 2 OF 2 SHEETS

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
13	CL	- PIERRE SHALE - cont. (as above)	0 ppm (in field)	SB12-12 Split Spoon	18 48 64 67	Recovery = 2.0'/2.0'
14		Terminated boring at 14.0 feet. P.P.= Pocket Penetrometer				Time = 1508

MRF Form PDA-FTCb

PROJECT: 89868.200
Fort Carson Landfills

HOLE NO.: SB-12

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.
ratification lines represent the approximate boundary between soil types and the transition may be gradual.

HTW DRILLING LOG

HOLE NO.	SB-13
1. COMPANY NAME	RUST Environment & Infrastructure
2. DRILLING SUBCONTRACTOR	Site Services
SHEET 1	OF 2 SHEETS
3. PROJECT	Fort Carson Landfills
4. LOCATION	Fort Carson, Colorado
5. NAME OF DRILLER	Brian Dechante
6. MANUFACTURERS DESIGNATION OF DRILL	CME-75
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3.25" ID x 6" OD Hollow Stem Augers; 1 3/8" ID x 24" Split Spoon; 3" x 30" Shelby Tubes
8. HOLE LOCATION	Landfill #2
9. SURFACE ELEVATION	5796.0
10. DATE STARTED	6/29/95
11. DATE COMPLETED	6/20/95 By Grouting
12. OVERBURDEN THICKNESS	17 ft. to Shale
15. DEPTH GROUNDWATER ENCOUNTERED	1.5 ft.
13. DEPTH DRILLED INTO ROCK	5.5 ft.
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	No water after completion of boring.
14. TOTAL DEPTH OF HOLE	22.5 ft.
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	Water measured 12.9' 6/20/95 at 0821

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
See log	3 Spoons	5 Shelbys	0

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OIL & GREASE	SVOC	PCB	21. TOTAL CORE REC.
None						%

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHERS (SPECIFY)	23. SIGNATURE OF INSPECTOR
Grouted to surface				Rick Heidrick

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
0–2	SP	POORLY GRADED SAND - Medium dense, brown, moist to wet, mostly sand, medium-grained, little fine- and coarse-grained, few gravel, subrounded to ½", increased fines with depth. - ALLUVIUM -		SB13-0 Shelby Tube		Time = 1251 Recovery = 2.0'/2.0' ▼ Water first encountered at 1.5'.
2–3	CH	FAT CLAY - Stiff, very dark, grayish brown, moist mostly clay, high plasticity, trace sand, one piece gravel at 2.7' (1½"), subangular quartzite, no apparent bedding. - ALLUVIUM -	0 ppm (in field)	SB13-2 Split Spoon		Recovery = 1.2'/2.0' P.P.= 2.75 tsf
4–5				SB13-4 Shelby Tube	4 10 4 7	Recovery = 2.0'/2.0' P.P.= 2.25 tsf
6–9				Augered; No Samples		
10–11		Becomes interbedded with SANDY LEAN CLAY.	0 ppm (in field)	SB13-10 Split Spoon	2 3 4 5	Recovery = 2.0'/2.0' P.P.= 1.75 tsf

MRF Form PDA-FTCb

PROJECT: 89868.200
Fort Carson Landfills

HOLE NO.: SB-13

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

HTW DRILLING LOG

HOLE NO. SB-13

1. COMPANY NAME: RUST Environment & Infrastructure

2. INSPECTOR: Rick Heidrick

SHEET 2 OF 2 SHEETS

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
13	CH	FAT CLAY (cont.; as above and slightly sandy) - ALLUVIUM -	0 ppm (after extrusion)	SB13-12 Shelby Tube		Recovery = 1.9'/2.0' P.P.= 1.75 tsf
14						Time = 1329
15			0 ppm (after extrusion)	SB13-14 Shelby Tube		Recovery = 1.6'/2.0' P.P.= 1.0 tsf
16						
17	CL	SANDY LEAN CLAY - Hard, dark grayish brown, damp, mostly clay, medium plasticity, some sand, fine-grained, laminated bedding near horizontal, coated with small (<0.1") white crystals, few iron stains on bedding surfaces.		Augered; No Samples		Harder drilling at 17' to 19'.
18						
19		- PIERRE SHALE -				
20				SB13-19 Shelby Tube		Recovery = 1.5'/1.5' P.P.> 5.tsf
21						Refusal at 20.5'.
22		Joints at 45 degrees	0 ppm (in field)	SB13-20.5 Split Spoon	12 26 26 35	Recovery = 2.0'/2.0' P.P.> 5 tsf
23		Terminated at 22.5 feet. P.P.= Pocket Penetrometer				Time = 1401
24						
25						
26						
27						
28						
29						
30						
31						
32						
33						

MRF Form PDA-FTCD

PROJECT: 89868.200
Fort Carson Landfills

HOLE NO.: SB-13

The stratification lines represent the approximate boundary between soil types and the transition may be gradual

HTW DRILLING LOG

HOLE NO.	SB-14
SHEET	1 OF 1 SHEETS
1. COMPANY NAME	RUST Environment & Infrastructure
2. DRILLING SUBCONTRACTOR	Site Services
3. PROJECT	Fort Carson Landfills
4. LOCATION	Fort Carson, Colorado
5. NAME OF DRILLER	Brian Dechante
6. MANUFACTURERS DESIGNATION OF DRILL	CME-75
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3.25" ID x 6" OD Hollow Stem Augers; 1 3/8" ID x 24" Split Spoon; 3" x 30" Shelby Tubes
8. HOLE LOCATION	Landfill #2
9. SURFACE ELEVATION	5846.5
10. DATE STARTED	6/19/95
11. DATE COMPLETED	6/19/95 By Grouting
12. OVERBURDEN THICKNESS	4 ft. to Shale
15. DEPTH GROUNDWATER ENCOUNTERED	Not Encountered
13. DEPTH DRILLED INTO ROCK	2.0 ft.
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	None
14. TOTAL DEPTH OF HOLE	6.0 ft.
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	None

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
See log	0	3 Shelbys	0

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OIL & GREASE	SVOC	PCB	21. TOTAL CORE REC.
None						%

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHERS (SPECIFY)	23. SIGNATURE OF INSPECTOR
Grouted to surface				Rick Heidrick

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
0–2	CL	LEAN CLAY WITH SAND - Very stiff, dark brown, moist, mostly clay, medium plasticity, little sand, fine-grained, few organics, trace gravel, angular, appears disturbed. - FILL -		SB14-0 Shelby Tube		Time = 1103 P.P.= 2.25 tsf Recovery = 2.0'/2.0'
2–4			0 ppm (after extrusion)	SB14-2 Shelby Tube		P.P.= 4.0 tsf Recovery = 2.0'/2.0'
4–6	CL	LEAN CLAY WITH SAND - Hard, dark brown, damp to moist, mostly clay, medium plasticity, little sand, thinly laminated bedding near horizontal, bedding planes smooth, occasional iron stained, trace of white crystals (<0.1"). - PIERRE SHALE -		SB14-4 Shelby Tube		P.P.> 5.tsf Recovery = 2.0'/2.0'
6–12		Terminated boring at 6.0 feet. P.P. = Pocket Penetrometer				Time = 1124

MRF Form PDA-FTCb

PROJECT: 89868.200 Fort Carson Landfills

HOLE NO.: SB-14

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

Cap Verification Test Borings
(CVT-1 through CVT-29)

HTW DRILLING LOG

HOLE NO.	CVT-1
1. COMPANY NAME	RUST Environment & Infrastructure
2. DRILLING SUBCONTRACTOR	Site Services
SHEET 1	OF 1 SHEETS
3. PROJECT	Fort Carson Landfills
4. LOCATION	Fort Carson, Colorado
5. NAME OF DRILLER	Lee Hackett
6. MANUFACTURERS DESIGNATION OF DRILL	CME-55
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3.25" ID x 6" OD Hollow Stem Augers; 1 3/8" ID x 24" Split Spoon; 3" x 30" Shelby Tubes
8. HOLE LOCATION	Landfill #2
9. SURFACE ELEVATION	5847.8
10. DATE STARTED	2/14/96
11. DATE COMPLETED	2/14/96
12. OVERBURDEN THICKNESS	5.5 ft. to Landfill
15. DEPTH GROUNDWATER ENCOUNTERED	Not Encountered
13. DEPTH DRILLED INTO ROCK	Not Encountered
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
14. TOTAL DEPTH OF HOLE	7.0 ft.
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
See Log	0 Spoons	3 Shelbys	0

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OIL & GREASE	SVOC	PCB	21. TOTAL CORE REC.
None						%

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHERS (SPECIFY)	23. SIGNATURE OF INSPECTOR
Grouted to Surface				Rick Heidrick

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
0–1	CH	LEAN CLAY WITH SAND - Hard, light olive brown, damp, mostly medium plasticity clay, little fine grained sand, some gravel, claystone fragments. - FILL -	0 ppm (in field)	CVT1-0 Shelby Tube		Time = 0950 Recovery = 2.0'/2.0' Pocket Penetrometer (PP) > 5 tsf
1–2	CH	LEAN CLAY - Hard, light olive brown, damp, some claystone fragments. - FILL -	0 ppm (in field)	CVT1-2 Shelby Tube		Recovery = 1.8'/2.0' PP > 5 tsf
2–3						
3–4						4.0'-4.5' Heavy rig chatter. Drill without sampling 4.0'-5.0'.
4–5						Recovery = 1.0'/2.0'
5–6		REFUSE - Mostly paper and plastic. - LANDFILL -	0 ppm (in field)	CVT1-5 Shelby Tube		
6–7		Terminated boring at 7.0 feet.				Time = 1015
7–12						

MRF Form PDA-FTCb

PROJECT: 55253.000 Fort Carson Landfills

HOLE NO.: CVT-1

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

HTW DRILLING LOG

HOLE NO.	CVT-2
SHEET 1 OF 1 SHEETS	
1. COMPANY NAME	RUST Environment & Infrastructure
2. DRILLING SUBCONTRACTOR	Site Services
3. PROJECT	Fort Carson Landfills
4. LOCATION	Fort Carson, Colorado
5. NAME OF DRILLER	Lee Hackett
6. MANUFACTURERS DESIGNATION OF DRILL	CME-55
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3.25" ID x 6" OD Hollow Stem Auger; 1 3/8" ID x 24" Split Spoon; 3" x 30" Shelby Tubes
8. HOLE LOCATION	Landfill #2
9. SURFACE ELEVATION	5876.3
10. DATE STARTED	2/12/96
11. DATE COMPLETED	2/12/96
12. OVERBURDEN THICKNESS	>9 ft.
15. DEPTH GROUNDWATER ENCOUNTERED	Not Encountered
13. DEPTH DRILLED INTO ROCK	Not Encountered
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
14. TOTAL DEPTH OF HOLE	9.0 ft.
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
See Log	1 Spoon	4 Shelbys	0

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OIL & GREASE	SVOC	PCB	21. TOTAL CORE REC.
None						%

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHERS (SPECIFY)	23. SIGNATURE OF INSPECTOR
Grouted to surface				Rick Heidrick

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
0–7	CH	FAT CLAY WITH SAND - Hard, brown, damp to moist, mostly clay, some fine grained sand, some claystone fragments. - FILL -	0 ppm (in field)	CVT2-0 Shelby Tube		Time = 1050 Recovery = 2.0'/2.0' Pocket Penetrometer (PP) > 5 tsf
			0 ppm (in field)	CVT2-2 Shelby Tube		Recovery = 2.0'/2.0' PP > 5 tsf
			0 ppm (in field)	CVT2-4 Shelby Tube		Recovery = 2.0'/2.0' PP > 5 tsf
		Becomes very stiff, dry to damp.	0 ppm (in field)	CVT2-6 Split Spoon	12 13	Recovery = 0.6'/1.0'
7–9	CL	LEAN CLAY - Hard, brown, moist, some claystone fragments. - FILL -	0 ppm (in field)	CVT2-7 Shelby Tube		Recovery = 2.0'/2.0' PP > 5 tsf
9–12		Terminated boring at 9.0 feet.				Time = 1150

MRF Form PDA-FTCb

PROJECT: 55253.000 Fort Carson Landfills

HOLE NO.: CVT-2

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

HTW DRILLING LOG

HOLE NO.	CVT-3
SHEET	1 OF 1 SHEETS
1. COMPANY NAME	RUST Environment & Infrastructure
2. DRILLING SUBCONTRACTOR	Site Services
3. PROJECT	Fort Carson Landfills
4. LOCATION	Fort Carson, Colorado
5. NAME OF DRILLER	Lee Hackett
6. MANUFACTURERS DESIGNATION OF DRILL	CME-55
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3.25" ID x 6" OD Hollow Stem Augers; 2" ID x 24" Split Spoon; 3" x 30" Shelby Tube
8. HOLE LOCATION	Landfill #2
9. SURFACE ELEVATION	5,887.5
10. DATE STARTED	2/7/96
11. DATE COMPLETED	2/7/96
12. OVERBURDEN THICKNESS	>9.5 ft.
15. DEPTH GROUNDWATER ENCOUNTERED	Not Encountered
13. DEPTH DRILLED INTO ROCK	Not Encountered
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
14. TOTAL DEPTH OF HOLE	9.5 ft.
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
See Log	3 Spoons	3 Shelbys	0

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OIL & GREASE	SVOC	PCB	21. TOTAL CORE REC.
None						%

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHERS (SPECIFY)	23. SIGNATURE OF INSPECTOR
Grouted to surface				Rick Heidrick

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
0–2	SC	CLAYEY SAND WITH GRAVEL - Medium dense, brown, damp, mostly medium and fine sand, little clay, little gravel to 0.5". - FILL -	0 ppm (in field)	CVT3-0 Split Spoon	7 15	Recovery = 1.0'/1.0'
2–3	SM	SILTY SAND - Brown, damp, mostly medium to fine sand, little silt. - FILL -	0 ppm (in field)	CVT3-1 Shelby Tube		Recovery = 2.0'/2.0'
3–4	CH	FAT CLAY - Very stiff, brown, moist, mostly clay, trace medium to fine sand, trace wood fragments, angular pieces of PIERRE SHALE in clay matrix, some FE staining, trace caliche. - FILL -	0 ppm (in field)	CVT3-3 Shelby Tube		Recovery = 2.0'/2.0'
4–5			0 ppp (in field)	CVT3-5 Split Spoon	9 12	Recovery = 1.0'/1.0'
5–6			0 ppm (in field)	CVT3-6 Shelby Tube		Recovery = 2.0'/2.0'
6–9			0 ppm (in field)	CVT3-8 Split Spoon	8 12 13	Recovery = 1.5'/1.5'
9–12		Terminated boring at 9.5 feet.				

MRF Form PDA-FTCb

PROJECT: 55253.000
Fort Carson Landfills

HOLE NO.: CVT-3

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

HTW DRILLING LOG

HOLE NO.	CVT-4
1. COMPANY NAME	RUST Environment & Infrastructure
2. DRILLING SUBCONTRACTOR	Site Services
SHEET 1	OF 1 SHEETS
3. PROJECT	Fort Carson Landfill
4. LOCATION	Fort Carson, Colorado
5. NAME OF DRILLER	Lee Hackett
6. MANUFACTURERS DESIGNATION OF DRILL	CME-55
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3.25" ID x 24" OD Hollow Stem Auger 2" ID x 24" Split Spoon 3" x 30" Shelby Tubes
8. HOLE LOCATION	Landfill #2
9. SURFACE ELEVATION	5884.9
10. DATE STARTED	2/7/96
11. DATE COMPLETED	2/7/96
12. OVERBURDEN THICKNESS	5.5 ft. to Landfill
15. DEPTH GROUNDWATER ENCOUNTERED	Not Encountered
13. DEPTH DRILLED INTO ROCK	Not Encountered
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
14. TOTAL DEPTH OF HOLE	6.0 ft.
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
See Log	2 Spoons	2 Shelbys	0

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OIL & GREASE	SVOC	PCB	21. TOTAL CORE REC.
None						%

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHERS (SPECIFY)	23. SIGNATURE OF INSPECTOR
Grouted to surface				Rick Heidrick

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
0–1	SC	CLAYEY SAND - Medium dense, brown, moist, mostly fine and medium sand, some clay, minor fine gravel.	0 ppm (in field)	CVT4-0 Split Spoon	10 12	Time = 1350 Recovery = 1.0'/1.0'
1–3		Becomes yellowish brown, Fe stained. - FILL -	0 ppm (in field)	CVT4-1 Shelby Tube		Recovery = 1.8'/2.0' Heavy rig chatter, refusal at 2.8. Granitic rock fragments in cuttings. Move hole 6'east; refusal at same depth. Move hole 6' further east.
3–5	CL	SANDY LEAN CLAY - Hard, brown, damp, mostly low to medium plasticity clay, some fine sand. - FILL -	0 ppm (in field)	CVT4-3 Shelby Tube		Recovery = 1.5'/2.0'
5–6	CL	SANDY LEAN CLAY - Stiff, brown, moist, minor paper, plastic, and foam. - LANDFILL -	0 ppm (in field)	CVT4-5 Split Spoon	6 8	Recovery = 1.0'/1/0'
6		Terminated boring at 6.0 feet.				Time = 1500

MRF Form PDA-FTCb

PROJECT: 55253.000
Fort Carson Landfill

HOLE NO.: CVT-4

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

HTW DRILLING LOG

HOLE NO.	CVT-5
1. COMPANY NAME	RUST Environment & Infrastructure
2. DRILLING SUBCONTRACTOR	Site Services
SHEET	1 OF 1 SHEETS
3. PROJECT	Fort Carson Landfills
4. LOCATION	Fort Carson, Colorado
5. NAME OF DRILLER	Lee Hackett
6. MANUFACTURERS DESIGNATION OF DRILL	CME-55
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3.25" ID x 6" OD Hollow Stem Augers; 2" ID x 24" Split Spoon; 3" x 30" Shelby Tube
8. HOLE LOCATION	Landfill #2
9. SURFACE ELEVATION	5881.5
10. DATE STARTED	2/8/96
11. DATE COMPLETED	2/8/96
12. OVERBURDEN THICKNESS	3.5 ft. to Landfill
15. DEPTH GROUNDWATER ENCOUNTERED	Not Encountered
13. DEPTH DRILLED INTO ROCK	Not Encountered
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
14. TOTAL DEPTH OF HOLE	5.0 ft.
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
See Log	1 Spoon	2 Shelbys	0

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OIL & GREASE	SVOC	PCB	21. TOTAL CORE REC.
None						%

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHERS (SPECIFY)	23. SIGNATURE OF INSPECTOR
Grouted to surface				Rick Heidrick

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
0–1.5	SC	CLAYEY SAND WITH GRAVEL - Dense, yellowish brown, damp, mostly fine and medium sand, little clay, minor gravel to 0.5". - FILL -	0 ppm (in field)	CVT5-0 Split Spoon	30 30	Time = 0855 Recovery = 1.0'/1.0'
1.5–3.5	CL	LEAN CLAY WITH SAND - Very stiff, dark grayish brown, moist, mostly medium plasticity clay, little fine and medium sand. - FILL -	0 ppm (in field)	CVT5-1 Shelby Tube		Recovery = 2.0'/2.0'
3.5–5.0	CL	LEAN CLAY WITH SAND - Very stiff, dark grayish brown, moist, some paper, glass, wire. - LANDFILL -	0 ppm (in field)	CVT5-3 Shelby Tube		Recovery = 1.5'/2.0' Pocket Penetrometer (PP) = 2.75 tsf
5.0		Terminated boring at 5.0 feet.				Time = 0923

MRF Form PDA-FTCb

PROJECT: 55253.000 Fort Carson Landfills

HOLE NO.: CVT-5

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

HTW DRILLING LOG

HOLE NO.	CVT-6
SHEET 1 OF 1 SHEETS	

1. COMPANY NAME	RUST Environment & Infrastructure
2. DRILLING SUBCONTRACTOR	Site Services
3. PROJECT	Fort Carson Landfills
4. LOCATION	Fort Carson, Colorado
5. NAME OF DRILLER	Lee Hackett
6. MANUFACTURERS DESIGNATION OF DRILL	CME-55
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3.25" ID x 6" OD Hollow Stem Auger; 2" ID x 24" Split Spoon; 3" x 30" Shelby Tube
8. HOLE LOCATION	Landfill #2
9. SURFACE ELEVATION	5873.7
10. DATE STARTED	2/8/96
11. DATE COMPLETED	2/8/96
12. OVERBURDEN THICKNESS	5.0 ft. to Landfill
15. DEPTH GROUNDWATER ENCOUNTERED	Not Encountered
13. DEPTH DRILLED INTO ROCK	Not Encountered
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
14. TOTAL DEPTH OF HOLE	7.0 ft.
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
See Log	1 Spoon	3 Shelbys	0

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OIL & GREASE	SVOC	PCB	21. TOTAL CORE REC.
None						%

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHERS (SPECIFY)	23. SIGNATURE OF INSPECTOR
Grouted to surface				Rick Heidrick

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
0–2	CH	SANDY FAT CLAY - Hard, brown, damp, mostly clay, some medium and coarse sand. - FILL -	0 ppm (in field)	CVT6-0 Split Spoon	10 21	Time = 0950 Recovery = 1.0'/1.0' Pocket Penetrometer (PP)>5 tsf
2–3			0 ppm (in field)	CVT6-1 Shelby Tube		Recovery = 2.0'/2.0' PP>5 tsf
3–5	CH	FAT CLAY WITH SAND - Hard, brown, moist, mostly clay, little fine sand, angular pieces of claystone. - FILL -	0 ppm (in field)	CVT6-3 Shelby Tube		Recovery = 1.8'/2.0' PP>5 tsf
5–7		REFUSE - Paper, wood, plastic. - LANDFILL -	0 ppm (in field)	CVT6-5 Shelby Tube		Recovery = 0.5'/2.0'
7		Terminated boring at 7.0 feet.				Time = 1020

MRF Form PDA-FTCb

PROJECT: 55253.000 Fort Carson Landfills

HOLE NO.: CVT-6

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

HTW DRILLING LOG

HOLE NO.	CVT-7
1. COMPANY NAME	RUST Environment & Infrastructure
2. DRILLING SUBCONTRACTOR	Site Services
SHEET 1 OF 1 SHEETS	
3. PROJECT	Fort Carson Landfills
4. LOCATION	Fort Carson, Colorado
5. NAME OF DRILLER	Lee Hackett
6. MANUFACTURERS DESIGNATION OF DRILL	CME-55
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3.25" ID x 6" OD Hollow Stem Auger; 2" ID x 24" Split Spoon; 3" x 30" Shelby Tube
8. HOLE LOCATION	Landfill #2
9. SURFACE ELEVATION	5876.0
10. DATE STARTED	2/8/96
11. DATE COMPLETED	2/8/96
12. OVERBURDEN THICKNESS	>8 ft.
15. DEPTH GROUNDWATER ENCOUNTERED	Not Encountered
13. DEPTH DRILLED INTO ROCK	Not Encountered
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
14. TOTAL DEPTH OF HOLE	8.0 ft.
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
See Log	3 Spoons	3 Shelbys	0

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OIL & GREASE	SVOC	PCB	21. TOTAL CORE REC.
None						%

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHERS (SPECIFY)	23. SIGNATURE OF INSPECTOR
Grouted to surface				Rick Heidrick

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
0	CH	FAT CLAY - Hard, yellowish brown, damp, mostly clay, little fine sand.	0 ppm (in field)	CVT7-0 Split Spooon	11 14	Time = 1045 Recovery = 1.0'/1.0'
1–2		Becomes moist.	0 ppm (in field)	CVT7-1 Shelby Tube		Recovery = 2.0'/2.0' Pocket Penetrometer (PP)>5 tsf
2–4		Some hard pieces of shale.	0 ppm (in field)	CVT7-3 Shelby Tube		Recovery = 2.0'/2.0' PP>5 tsf
4–5		Becomes stiff.	0 ppm (in field)	CVT7-5 Split Spoon	4 14	Recovery = 1.0'/1.0'
5–6			0 ppm (in field)	CVT7-6 Shelby Tube		Recovery = 0.7'/1.0'; Shelby refusal at 7.0'
6–7		Becomes hard with minor gravel. - FILL -	0 ppm (in field)	CVT7-7 Split Spoon	10 27	
8		Terminated boring at 8.0 feet.				Time = 1145

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PROJECT: 55253.000 Fort Carson Landfills

HOLE NO.: CVT-7

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

HTW DRILLING LOG

HOLE NO.	CVT-8
1. COMPANY NAME	RUST Environment & Infrastructure
2. DRILLING SUBCONTRACTOR	Site Services
SHEET	1 OF 1 SHEETS
3. PROJECT	Fort Carson Landfills
4. LOCATION	Fort Carson, Colorado
5. NAME OF DRILLER	Lee Hackett
6. MANUFACTURERS DESIGNATION OF DRILL	CME-55
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3.25" ID x 6" OD Hollow Stem Auger; 2" ID x 24" Split Spoon; 3" x 30" Shelby Tube
8. HOLE LOCATION	Landfill #2
9. SURFACE ELEVATION	5871.3
10. DATE STARTED	2/8/96
11. DATE COMPLETED	2/8/96
12. OVERBURDEN THICKNESS	>8 ft.
15. DEPTH GROUNDWATER ENCOUNTERED	Not Encountered
13. DEPTH DRILLED INTO ROCK	Not Encountered
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
14. TOTAL DEPTH OF HOLE	8.0 ft.
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
See Log	2 Spoons	3 Shelbys	0

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OIL & GREASE	SVOC	PCB	21. TOTAL CORE REC.
None						%

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHERS (SPECIFY)	23. SIGNATURE OF INSPECTOR
Grouted to surface				Rick Heidrick

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
0	CH	SANDY FAT CLAY - Very stiff, yellowish brown, damp, mostly medium plasticity clay, some fine to medium sand. - FILL -	0 ppm (in field)	CVT8-0 Split Spoon	11 14	Time = 1230 Recovery = 1.0'/1.0'
1	CH	FAT CLAY - Hard, very dark grayish brown, damp to moist, mostly clay, little fine sand, includes angular pieces of PIERRE SHALE. Becomes olive brown, moist.	0 ppm (in field)	CVT8-1 Shelby Tube		Recovery = 2.0'/2.0' Pocket Penetrometer (PP)=4.25 tsf
3		Cobbles from 4.0'-5.0'.	0 ppm (in field)	CVT8-3 Shelby Tube		Recovery = 1.5'/2.0'; hard push, rock fragment in tube bottom.
5		Broken cobble from 5.6'-5.9'. - FILL -	0 ppm (in field)	CVT8-5 Split Spoon	4 20	Recovery = 1.0'/1.0'
7			0 ppm (in field)	CVT8-6 Shelby Tube		Recovery = 2.0'/2.0' PP>5 tsf
8		Terminated boring at 8.0 feet.				Time = 1317
9						
10						
11						
12						

MRF Form PDA-FTCb

PROJECT: 55253.000 Fort Carson Landfills

HOLE NO.: CVT-8

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

HTW DRILLING LOG

HOLE NO.	CVT-9
SHEET	1 OF 1 SHEETS
1. COMPANY NAME	RUST Environment & Infrastructure
2. DRILLING SUBCONTRACTOR	Site Services
3. PROJECT	Fort Carson Landfills
4. LOCATION	Fort Carson, Colorado
5. NAME OF DRILLER	Lee Hackett
6. MANUFACTURERS DESIGNATION OF DRILL	CME-55
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3.25" ID x 6" OD Hollow Stem Auger; 1 3/8" x 24" Split Spoon; 3" x 30" Shelby Tubes
8. HOLE LOCATION	Landfill #2
9. SURFACE ELEVATION	5865.2
10. DATE STARTED	2/12/96
11. DATE COMPLETED	2/12/96
12. OVERBURDEN THICKNESS	>9.0 ft.
13. DEPTH DRILLED INTO ROCK	Not Encountered
14. TOTAL DEPTH OF HOLE	9.0 ft.
15. DEPTH GROUNDWATER ENCOUNTERED	Not Encountered
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	
18. GEOTECHNICAL SAMPLES	See Log
DISTURBED	2 Spoons
UNDISTURBED	4 Shelbys
19. TOTAL NUMBER OF CORE BOXES	0
20. SAMPLES FOR CHEMICAL ANALYSIS	None
VOC	
METALS	
OIL & GREASE	
SVOC	
PCB	
21. TOTAL CORE REC.	%
22. DISPOSITION OF HOLE	Grouted to surface
BACKFILLED	
MONITORING WELL	
OTHERS (SPECIFY)	
23. SIGNATURE OF INSPECTOR	Rick Heidrick

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
0–1	CH	FAT CLAY WITH SAND - Hard, brown, damp, mostly clay, some fine and medium sand, minor gravel to 0.5".	0 ppm (in field)	CVT9-0 Shelby Tube		Time = 0945 Recovery = 1.0'/1.0'; crushed tube
1–2			0 ppm (in field)	CVT9-1 Split Spoon	17 20	Recovery = 1.0'/1.0'
2–3		Becomes moist	0 ppm (in field)	CVT9-2 Shelby Tube		Recovery = 2.0'/2.0' Pocket Penetrometer (PP)>5 tsf
3–4		Contains angular pieces of PIERRE SHALE, no gravel. - FILL -	0 ppm (in field)	CVT9-4 Shelby Tube		Recovery = 2.0'/2.0' PP>5 tsf
4–5			0 ppm (in field)	CVT9-6 Shelby Tube		Recovery = 2.0'/2.0' PP>5 tsf
5–6			0 ppm (in field)	CVT9-8 Split Spoon	14 30	Recovery = 1.0'/1.0'
6–9		Terminated boring at 9.0 feet.				Time = 1035

MRF Form PDA-FTCb

PROJECT: 55253.000 Fort Carson Landfills

HOLE NO.: CVT-9

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

HTW DRILLING LOG

HOLE NO.	CVT-10
SHEET 1 OF 1 SHEETS	
1. COMPANY NAME	RUST Environment & Infrastructure
2. DRILLING SUBCONTRACTOR	Site Services
3. PROJECT	Fort Carson Landfills
4. LOCATION	Fort Carson, Colorado
5. NAME OF DRILLER	Lee Hackett
6. MANUFACTURERS DESIGNATION OF DRILL	CME-55
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3.25" ID x 6" OD Hollow Stem Auger; 1 3/8" ID x 24" Split Spoon; 3" x 30" Shelby Tubes
8. HOLE LOCATION	Landfill #2
9. SURFACE ELEVATION	5867.3
10. DATE STARTED	2/9/96
11. DATE COMPLETED	2/9/96
12. OVERBURDEN THICKNESS	9 ft. to Landfill
13. DEPTH DRILLED INTO ROCK	Not Encountered
14. TOTAL DEPTH OF HOLE	10.0 ft.
15. DEPTH GROUNDWATER ENCOUNTERED	Not Encountered
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	
18. GEOTECHNICAL SAMPLES	See Log
DISTURBED	1 Spoon
UNDISTURBED	5 Shelbys
19. TOTAL NUMBER OF CORE BOXES	0
20. SAMPLES FOR CHEMICAL ANALYSIS	None
VOC	
METALS	
OIL & GREASE	
SVOC	
PCB	
21. TOTAL CORE REC.	%
22. DISPOSITION OF HOLE	Grouted to surface
BACKFILLED	
MONITORING WELL	
OTHERS (SPECIFY)	
23. SIGNATURE OF INSPECTOR	Rick Heidrick

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
0–4	SC	CLAYEY SAND WITH GRAVEL - Brown, damp, mostly fine and medium sand, little clay, minor gravel to 0.5". - FILL -	0 ppm (in field)	CVT10-0 Shelby Tube		Time = 1315 Recovery = 2.0'/2.0'
			0 ppm (in field)	CVT10-2 Shelby Tube		Recovery = 1.5'/1.5' Refusal at 3.5 ft.
			0 ppm (in field)	CVT10-3.5 Split Spoon	13 13	Recovery = 1.0'/1.0'
4–9	CH	FAT CLAY - Hard, brown, damp to moist, mostly medium plasticity clay, minor medium and fine sand. Becomes moist. - FILL-	0 ppm (in field)	CVT10-4.5 Shelby Tube		Recovery = 2.0'/2.0' Pocket Penetrometer (PP)>5 tsf
			0 ppm (in field)	CVT10-6.5 Shelby Tube		Recovery = 2.0'/2.0' PP=4 tsf
9–10	CH	FAT CLAY - Hard, brown, damp to moist, wood and paper. - LANDFILL -	0 ppm (in field)	CTV10-8.5 Shelby Tube		Recovery = 1.5'/1.5' PP>5 tsf
10–12		Terminated boring at 10.0 feet.				Time = 1400

MRF Form PDA-FTCb

PROJECT: 55253.000 Fort Carson Landfills

HOLE NO.: CVT-10

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

HTW DRILLING LOG

HOLE NO.	CVT-11
SHEET 1 OF 1 SHEETS	

1. COMPANY NAME	RUST Environment & Infrastructure
2. DRILLING SUBCONTRACTOR	Site Services
3. PROJECT	Fort Carson Landfills
4. LOCATION	Fort Carson, Colorado
5. NAME OF DRILLER	Lee Hackett
6. MANUFACTURERS DESIGNATION OF DRILL	CME-55
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3.25" ID x 6" OD Hollow Stem Augers; 2" ID x 24" Split Spoon; 3" x 30" Shelby Tubes
8. HOLE LOCATION	Landfill #2
9. SURFACE ELEVATION	5865.1
10. DATE STARTED	2/9/96
11. DATE COMPLETED	2/9/96
12. OVERBURDEN THICKNESS	4.5 ft. to Landfill
15. DEPTH GROUNDWATER ENCOUNTERED	Not Encountered
13. DEPTH DRILLED INTO ROCK	Not Encountered
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
14. TOTAL DEPTH OF HOLE	5.5 ft.
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
See Log	1 Spoon	3 Shelbys	0

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OIL & GREASE	SVOC	PCB	21. TOTAL CORE REC.
None						%

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHERS (SPECIFY)	23. SIGNATURE OF INSPECTOR
Grouted to surface				Rick Heidrick

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
0–4.5	SC	CLAYEY SAND - Medium dense, brown, dry, mostly fine and medium sand, some clay. Becomes gravelly from 1.3'-1.5'. - FILL -	0 ppm (in field)	CVT11-0 Split Spoon	7 10	Time = 1230 Recovery = 1.0'/1.0'
				CVT11-1		Recovery = 0.3'/0.3' Shelby refusal. Drill out to 1.5'; heavy rig chatter.
			0 ppm (in field)	CVT11-1.5 Shelby Tube		Recovery = 2.0'/2.0'
			0 ppm (in field)	CVT11-3.5 Shelby Tube		Recovery = 1.2'/2.0' Pocket Penetrometer (PP)>5 tsf
4.5–5.5	CL	LEAN CLAY WITH SAND - Hard, brown, damp, medium plasticity, some wood and paper. - LANDFILL -				
5.5		Terminated boring at 5.5 feet.				Time = 1300

MRF Form PDA-FTCb

PROJECT: 55253.000 Fort Carson Landfills

HOLE NO.: CVT-11

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

HTW DRILLING LOG

HOLE NO.	CVT-12
SHEET	1 OF 1 SHEETS
1. COMPANY NAME	RUST Environment & Infrastructure
2. DRILLING SUBCONTRACTOR	Site Services
3. PROJECT	Fort Carson Landfills
4. LOCATION	Fort Carson, Colorado
5. NAME OF DRILLER	Lee Hackett
6. MANUFACTURERS DESIGNATION OF DRILL	CME-55
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3.25" ID x 6" OD Hollow Stem Auger; 1 3/8" ID x 24" Split Spoon; 3" x 30" Shelby Tubes
8. HOLE LOCATION	Landfill #2
9. SURFACE ELEVATION	5861.0
10. DATE STARTED	2/9/96
11. DATE COMPLETED	2/9/96
12. OVERBURDEN THICKNESS	6.0 to Landfill
15. DEPTH GROUNDWATER ENCOUNTERED	Not Encountered
13. DEPTH DRILLED INTO ROCK	Not Encountered
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
14. TOTAL DEPTH OF HOLE	7.0 ft.
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	
18. GEOTECHNICAL SAMPLES	See Log; DISTURBED: 1 Spoon; UNDISTURBED: 3 Shelbys
19. TOTAL NUMBER OF CORE BOXES	0
20. SAMPLES FOR CHEMICAL ANALYSIS	None; VOC: ; METALS: ; OIL & GREASE: ; SVOC: ; PCB:
21. TOTAL CORE REC.	%
22. DISPOSITION OF HOLE	Grouted to surface; BACKFILLED: ; MONITORING WELL: ; OTHERS (SPECIFY):
23. SIGNATURE OF INSPECTOR	Rick Heidrick

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
0–2	CH	SANDY FAT CLAY - Firm, olive brown, dry, mostly clay, some fine and medium sand. - FILL -	0 ppm (in field)	CVT12-0 Split Spoon	2 5	Time = 0920 Recovery = 0.5'/1.0'
2–3	CH	FAT CLAY - Hard, brown, moist, mostly clay, little fine sand, minor gravel to 0.25".	0 ppm (in field)	CVT12-1 Shelby Tube		Recovery = 2.0'/2.0' Pocket Penetrometer (PP)>5 tsf
3–5		With angular pieces of PIERRE SHALE. - FILL -	0 ppm (in field)	CVT12-3 Shelby Tube		Recovery = 2.0'/2.0' PP=4.25 tsf
5–6			0 ppm (in field)	CVT12-5 Shelby Tube		Recovery = 1.5'/2.0'
6–7		REFUSE - Mostly paper and plastic. - LANDFILL -				
7		Terminated boring at 7.0 feet.				Time = 0945

MRF Form PDA-FTCb

PROJECT: 55253.000 Fort Carson Landfills

HOLE NO.: CVT-12

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

HTW DRILLING LOG

HOLE NO.	CVT-13
1. COMPANY NAME	RUST Environment & Infrastructure
2. DRILLING SUBCONTRACTOR	Site Services
SHEET 1 OF 1 SHEETS	
3. PROJECT	Fort Carson Landfills
4. LOCATION	Fort Carson, Colorado
5. NAME OF DRILLER	Lee Hackett
6. MANUFACTURERS DESIGNATION OF DRILL	CME-55
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3.25" ID x 6" OD Hollow Stem Auger; 1 3/8" ID x 24" Split Spoon; 3" x 30" Shelby Tubes
8. HOLE LOCATION	Landfill #2
9. SURFACE ELEVATION	5860.1
10. DATE STARTED	2/9/96
11. DATE COMPLETED	2/9/96
12. OVERBURDEN THICKNESS	5.0 ft. to Landfill
15. DEPTH GROUNDWATER ENCOUNTERED	Not Encountered
13. DEPTH DRILLED INTO ROCK	Not Encountered
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
14. TOTAL DEPTH OF HOLE	6.0 ft.
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
See Log	2 Spoons	3 Shelbys	0

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OIL & GREASE	SVOC	PCB	21. TOTAL CORE REC.
None						%

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHERS (SPECIFY)	23. SIGNATURE OF INSPECTOR
Grouted to surface				Rick Heidrick

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
0–1	CH	SANDY FAT CLAY - Hard, brown, dry, some fine to coarse sand.	0 ppm (in field)	CVT13-0 Split Spoon	9 18	Time = 1015 Recovery = 1.0'/1.0'
1–2		Increased coarse sand and gravel. - FILL -		CVT13-1		Recovery = 0.3'/0.3'; Shelby refusal at 1.3'.
			0 ppm (in field)	CVT13-1.3 Split Spoon	24 23	Recovery = 0.2'/0.7'; Heavy rig chatter to 2'.
2–3	CH	FAT CLAY WITH SAND - Very stiff, dark yellowish brown, moist, some fine and medium sand, angular pieces of PIERRE SHALE. - FILL -	0 ppm (in field)	CVT13-2 Shelby Tube		Recovery = 2.0'/2.0' Pocket Penetrometer (PP)=3.0 tsf
4–5			0 ppm (in field)	CVT13-4 Shelby Tube		Recovery = 2.0'/2.0'
5–6		REFUSE - mostly paper and other trash. - LANDFILL -				
6–12		Terminated boring at 6.0 feet.				Time = 1050

MRF Form PDA-FTCb

PROJECT: 55253.000
Fort Carson Landfills

HOLE NO.: CVT-13

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

HTW DRILLING LOG

HOLE NO.	CVT-14
SHEET 1	OF 1 SHEETS
1. COMPANY NAME	RUST Environment & Infrastructure
2. DRILLING SUBCONTRACTOR	Site Services
3. PROJECT	Fort Carson Landfills
4. LOCATION	Fort Carson, Colorado
5. NAME OF DRILLER	Lee Hackett
6. MANUFACTURERS DESIGNATION OF DRILL	CME-55
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3.25" ID x 6" OD Hollow Stem Auger; 1 3/8" ID x 24" Split Spoon; 3" x 30" Shelby Tubes
8. HOLE LOCATION	Landfill #2
9. SURFACE ELEVATION	5855.1
10. DATE STARTED	2/9/96
11. DATE COMPLETED	2/9/96
12. OVERBURDEN THICKNESS	5.4 ft. to Landfill
15. DEPTH GROUNDWATER ENCOUNTERED	Not Encountered
13. DEPTH DRILLED INTO ROCK	Not Encountered
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
14. TOTAL DEPTH OF HOLE	8.0 ft.
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	
18. GEOTECHNICAL SAMPLES	See Log
DISTURBED	2 Spoons
UNDISTURBED	3 Shelbys
19. TOTAL NUMBER OF CORE BOXES	0
20. SAMPLES FOR CHEMICAL ANALYSIS	None
VOC	
METALS	
OIL & GREASE	
SVOC	
PCB	
21. TOTAL CORE REC.	%
22. DISPOSITION OF HOLE	Grouted to surface
BACKFILLED	
MONITORING WELL	
OTHERS (SPECIFY)	
23. SIGNATURE OF INSPECTOR	Rick Heidrick

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
0–1	CH	SANDY FAT CLAY - Very stiff, olive brown, damp, mostly clay, some fine and medium sand. - FILL -	0 ppm (in field)	CVT14-0 Split Spoon	7 10	Recovery = 0.3'/1.0'
1–2			0 ppm (in field)	CVT14-1 Shelby Tube		Recovery = 2.0'/2.0' Pocket Penetrometer (PP)>5 tsf
2–5	CH	FAT CLAY WITH SAND - Hard, olive brown, damp to moist, mostly clay, little fine sand, some angular pieces of PIERRE SHALE. - FILL -	0 ppm (in field)	CVT14-3 Shelby Tube		Recovery = 2.0'/2.0' PP>5 tsf
5–6	CH	FAT CLAY WITH SAND - Stiff, olive brown, moist. Layer of asphalt from 5.4'-5.5'. Wood and other refuse from 6.0'-8.0'. - LANDFILL -	185 ppm (in field)	CVT14-5 Split Spoon	5 8	Recovery = 0.6'/1.0'
6–8				CVT14-6 Shelby Tube		Recovery = 1.5'/2.0'
8		Terminated boring at 8.0 feet.				Time = 0850

MRF Form PDA-FTCb

PROJECT: 55253.000
Fort Carson Landfills

HOLE NO.: CVT-14

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

HTW DRILLING LOG

HOLE NO.	CVT-15
1. COMPANY NAME	RUST Environment & Infrastructure
2. DRILLING SUBCONTRACTOR	Site Services
SHEET 1	OF 1 SHEETS
3. PROJECT	Fort Carson Landfills
4. LOCATION	Fort Carson, Colorado
5. NAME OF DRILLER	Lee Hackett
6. MANUFACTURERS DESIGNATION OF DRILL	CME-55
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3.25" ID x 6" OD Hollow Stem Auger; 2" ID x 24" Split Spoon; 3" x 30" Shelby Tubes
8. HOLE LOCATION	Landfill #2
9. SURFACE ELEVATION	5851.7
10. DATE STARTED	2/8/96
11. DATE COMPLETED	2/8/96
12. OVERBURDEN THICKNESS	>10 ft.
15. DEPTH GROUNDWATER ENCOUNTERED	Not Encountered
13. DEPTH DRILLED INTO ROCK	Not Encountered
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
14. TOTAL DEPTH OF HOLE	10.0 ft.
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
See Log	2 Spoons	4 Shelbys	0

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OIL & GREASE	SVOC	PCB	21. TOTAL CORE REC.
None						%

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHERS (SPECIFY)	23. SIGNATURE OF INSPECTOR
Grouted to surface				Rick Heidrick

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
0–2	CH	SANDY FAT CLAY- Very stiff, very dark grayish brown, damp, mostly clay, some fine and medium sand. - FILL -	0 ppm (in field)	CVT15-0 Split Spoon	9 15	Time =1340 Recovery = 1.0'/1.0'
2–4	CH	FAT CLAY WITH SAND - Very stiff, olive brown, damp to moist, mostly clay, little fine sand. - FILL - Becomes moist.	0 ppm (in field)	CVT15-1 Shelby Tube		Recovery = 2.0'/2.0' Pocket Penetrometer (PP)=3.0 tsf
4–5			0 ppm (in field)	CVT15-3 Shelby Tube		Recovery = 1.5'/2.0' PP=3.25 tsf
5–6			0 ppm (in field)	CVT15-5 Shelby Tube		Recovery = 1.0'/2.0'
6–7	SW-SC	WELL GRADED SAND - CLAYEY SAND WITH GRAVEL - Brown, moist, mostly fine to coarse sand, some clay, gravel to 0.5". - FILL -				Hard drilling 6.0'-7.0'.
7–8	CL	LEAN CLAY WITH SAND - Very stiff, dark grayish brown, moist, mostly clay, little fine sand. - FILL -	0 ppm (in field)	CVT15-7 Split Spoon	4 10	Recovery = 1.0'/1.0' PP=3.0 tsf
8–10	CH	FAT CLAY - Very stiff, dark grayish brown, moist, mostly clay, minor fine grained sand. - FILL -		CVT15-8 Shelby Tube		Recovery = 2.0'/2.0' PP=3.25 tsf
10		Terminated boring at 10.0 feet.				Time = 1440

MRF Form PDA-FTCb

PROJECT: 55253.000
Fort Carson Landfills

HOLE NO.: CVT-15

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

HTW DRILLING LOG

HOLE NO.	CVT-16
SHEET 1 OF 1 SHEETS	
1. COMPANY NAME	RUST Environment & Infrastructure
2. DRILLING SUBCONTRACTOR	Site Services
3. PROJECT	Fort Carson Landfill
4. LOCATION	Fort Carson, Colorado
5. NAME OF DRILLER	Lee Hackett
6. MANUFACTURERS DESIGNATION OF DRILL	CME-55
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3.25" ID x 6" OD Hollow Stem Auger; 2" ID x 24" Split Spoon; 3" x 30" Shelby Tubes
8. HOLE LOCATION	Landfill #2
9. SURFACE ELEVATION	5839.6
10. DATE STARTED	2/8/96
11. DATE COMPLETED	2/8/96
12. OVERBURDEN THICKNESS	5.5 ft. to Landfill
15. DEPTH GROUNDWATER ENCOUNTERED	Not Encountered
13. DEPTH DRILLED INTO ROCK	Not Encountered
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
14. TOTAL DEPTH OF HOLE	6.0 ft.
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	
18. GEOTECHNICAL SAMPLES	See Log; DISTURBED: 2 Spoons; UNDISTURBED: 2 Shelbys
19. TOTAL NUMBER OF CORE BOXES	0
20. SAMPLES FOR CHEMICAL ANALYSIS	None; VOC: ; METALS: ; OIL & GREASE: ; SVOC: ; PCB:
21. TOTAL CORE REC.	%
22. DISPOSITION OF HOLE	Grouted to surface; BACKFILLED: ; MONITORING WELL: ; OTHERS (SPECIFY):
23. SIGNATURE OF INSPECTOR	Rick Heidrick

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
0–1.5	CL	LEAN CLAY WITH SAND - Very stiff, brown, damp, mostly medium plasticity clay, little fine sand.	0 ppm (in field)	CVT16-0 Split Spoon	8 20	Time = 1450 Recovery = 1.0'/1.0'
1.5–2.5	CH	FAT CLAY WITH SAND - Hard, brown, moist, mostly clay, little fine sand. - FILL -	0 ppm (in field)	CVT16-1 Shelby Tube		Recovery = 2.0'/2.0' Pocket Penetrometer (PP)>5.0 tsf
2.5–4.5	CH	- FILL -	0 ppm (in field)	CVT16-3 Shelby Tube		Recovery = 1.5'/2.0' PP>5.0 tsf
4.5–6.0	CH	FAT CLAY WITH SAND - Very stiff, brown, moist, mostly clay, little fine sand, minor refuse - paper, wood, asphalt. - LANDFILL -	3 ppm (in field)	CVT16-5 Split Spoon	5 11	Recovery = 1.0'/1.0' PP=2.25 tsf
		Terminated boring at 6.0 feet.				Time = 1520

MRF Form PDA-FTCb

PROJECT: 55253.000 Fort Carson Landfill

HOLE NO.: CVT-16

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

HTW DRILLING LOG

HOLE NO.	CVT-17
SHEET 1 OF 1 SHEETS	
1. COMPANY NAME	RUST Environment & Infrastructure
2. DRILLING SUBCONTRACTOR	Site Services
3. PROJECT	Fort Carson Landfills
4. LOCATION	Fort Carson, Colorado
5. NAME OF DRILLER	Lee Hackett
6. MANUFACTURERS DESIGNATION OF DRILL	CME-55
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3.25" ID x 6" OD Hollow Stem Auger; 1 3/8" ID x 24" Split Spoon; 3" x 30" Shelby Tubes
8. HOLE LOCATION	Landfill #2
9. SURFACE ELEVATION	5841.9
10. DATE STARTED	2/12/96
11. DATE COMPLETED	2/12/96
12. OVERBURDEN THICKNESS	3.0 ft. to Landfill
15. DEPTH GROUNDWATER ENCOUNTERED	Not Encountered
13. DEPTH DRILLED INTO ROCK	Not Encountered
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
14. TOTAL DEPTH OF HOLE	3.5 ft.
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
See Log	2 Spoons	2 Shelbys	0

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OIL & GREASE	SVOC	PCB	21. TOTAL CORE REC.
None						%

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHERS (SPECIFY)	23. SIGNATURE OF INSPECTOR
Grouted to surface				Rick Heidrick

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
	SC	CLAYEY SAND WITH GRAVEL - Medium dense, dark brown, dry, mostly fine to coarse sand, little clay, minor gravel to 0.5". - FILL -	0 ppm (in field)	CVT17-0 Shelby Tube		Recovery = 0.5'/0.5' Refusal at 0.5'
1			0 ppm (in field)	CVT17-0.5 Split Spoon	19 10	Recovery = 1.0'/1.0'
2			0 ppm (in field)	CVT17-1.5 Shelby Tube		No Recovery Refusal at 2.5' Heavy rig chatter.
3	CH	FAT CLAY WITH SAND - Very stiff, brown, moist, mostly clay, little fine sand, some refuse - paper, plastic, glass. - LANDFILL -		CVT17-2.5 Split Spoon	9 7	Recovery = 0.5'/1.0'
4		Terminated boring at 3.5 feet.				Time = 1245
5						
6						
7						
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12						

MRF Form PDA-FTCb

PROJECT: 55253.000
Fort Carson Landfills

HOLE NO.: CVT-17

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

HTW DRILLING LOG

HOLE NO.	CVT-18
SHEET 1 OF 1 SHEETS	
1. COMPANY NAME	RUST Environment & Infrastructure
2. DRILLING SUBCONTRACTOR	Site Services
3. PROJECT	Fort Carson Landfills
4. LOCATION	Fort Carson, Colorado
5. NAME OF DRILLER	Lee Hackett
6. MANUFACTURERS DESIGNATION OF DRILL	CME-55
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3.25" ID x 6" OD Hollow Stem Auger; 1 3/8" ID x 24" Split Spoon; 3" x 30" Shelby Tubes
8. HOLE LOCATION	Landfill #2
9. SURFACE ELEVATION	5844.4
10. DATE STARTED	2/12/96
11. DATE COMPLETED	2/12/96
12. OVERBURDEN THICKNESS	>10 ft.
15. DEPTH GROUNDWATER ENCOUNTERED	Not Encountered
13. DEPTH DRILLED INTO ROCK	Not Encountered
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
14. TOTAL DEPTH OF HOLE	10.0 ft.
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	
18. GEOTECHNICAL SAMPLES	See Log
DISTURBED	1 Spoon
UNDISTURBED	5 Shelbys
19. TOTAL NUMBER OF CORE BOXES	0
20. SAMPLES FOR CHEMICAL ANALYSIS	None
VOC / METALS / OIL & GREASE / SVOC / PCB	
21. TOTAL CORE REC.	%
22. DISPOSITION OF HOLE	Grouted to surface
BACKFILLED / MONITORING WELL / OTHERS (SPECIFY)	
23. SIGNATURE OF INSPECTOR	Rick Heidrick

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
0–4	CH	FAT CLAY WITH SAND - Hard, brown, damp, mostly clay, some fine sand. - FILL - Piece of wood.	0 ppm (in field)	CVT18-0 Shelby Tube		Time = 1300; Recovery = 1.5'/2.0'; Pocket Penetrometer (PP)>5 tsf
			0 ppm (in field)	CVT18-2 Shelby Tube		Recovery = 2.0'/2.0'
4–7	SC	CLAYEY SAND WITH GRAVEL - Brown, damp to moist, mostly fine to coarse sand, little clay, minor gravel to 0.5". - FILL -	0 ppm (in field)	CVT18-4 Shelby Tube		Recovery = 0.5'/2.0'
			0 ppm (in field)	CVT18-6 Split Spoon	12 21	Recovery = 0.8'/1.0'
7–10	CH	FAT CLAY - Hard, brown, damp, mostly clay, little fine sand, 50% angular pieces of PIERRE SHALE. - FILL -	0 ppm (in field)	CVT18-7 Shelby Tube		Recovery = 2.0'/2.0' PP>5 tsf
				CVT18-9 Shelby Tube		Recovery = 1.0'/1.0' PP>5 tsf
10–12		Terminated boring at 10.0 feet.				Time = 1345

MRF Form PDA-FTCb

PROJECT: 55253.000 Fort Carson Landfills

HOLE NO.: CVT-18

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

HTW DRILLING LOG

HOLE NO.	CVT-19
1. COMPANY NAME	RUST Environment & Infrastructure
2. DRILLING SUBCONTRACTOR	Site Services
SHEET 1 OF 1 SHEETS	
3. PROJECT	Fort Carson Landfills
4. LOCATION	Fort Carson, Colorado
5. NAME OF DRILLER	Lee Hackett
6. MANUFACTURERS DESIGNATION OF DRILL	CME-55
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3.25" ID x 6" OD Hollow Stem Auger; 1 3/8" ID x 24" Split Spoon; 3" x 30" Shelby Tubes
8. HOLE LOCATION	Landfill #2
9. SURFACE ELEVATION	5843.1
10. DATE STARTED	2/12/96
11. DATE COMPLETED	2/12/96
12. OVERBURDEN THICKNESS	>9.0 ft. to Landfill
15. DEPTH GROUNDWATER ENCOUNTERED	Not Encountered
13. DEPTH DRILLED INTO ROCK	Not Encountered
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
14. TOTAL DEPTH OF HOLE	9.0 ft.
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
See Log	1 Spoon	4 Shelbys	0

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OIL & GREASE	SVOC	PCB	21. TOTAL CORE REC.
None						%

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHERS (SPECIFY)	23. SIGNATURE OF INSPECTOR
Grouted to surface				Rick Heidrick

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
0–2	CH	SANDY FAT CLAY - Hard, brown, dry, mostly clay, some fine sand. - FILL -	0 ppm (in field)	CVT19-0 Shelby Tube		Recovery = 2.0'/2.0'
2–4	CH	FAT CLAY - Hard, brown, damp to moist, mostly clay, little fine sand.	0 ppm (in field)	CVT19-2 Shelby Tube		Recovery = 2.0'/2.0' Pocket Penetrometer (PP)>5 tsf
4–6	CH	Becomes stiff, moist to wet - FILL -	0 ppm (in field)	CVT19-4 Shelby Tube		Recovery = 2.0'/2.0' PP=1.75 tsf
6–7	CH	SANDY FAT CLAY - Stiff, brown, moist, mostly clay, some fine to coarse sand. - FILL -	0 ppm (in field)	CVT19-6 Split Spoon	4 5	Recovery = 0.6'/1.0'
7–8	CH	FAT CLAY - Very stiff, dark gray, moist, mostly clay, minor fine sand. - FILL -	0 ppm (in field)	CVT19-7 Shelby Tube		Recovery = 2.0'/2.0' PP=3.75 tsf
8–9		Terminated boring at 9.0 feet.				Time = 1450

MRF Form PDA-FTCb

PROJECT: 55253.000
Fort Carson Landfills

HOLE NO.: CVT-19

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

HTW DRILLING LOG

HOLE NO.	CVT-20
1. COMPANY NAME	RUST Environment & Infrastructure
2. DRILLING SUBCONTRACTOR	Site Services
SHEET 1	OF 1 SHEETS
3. PROJECT	Fort Carson Landfills
4. LOCATION	Fort Carson, Colorado
5. NAME OF DRILLER	Lee Hackett
6. MANUFACTURERS DESIGNATION OF DRILL	CME-55
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3.25" ID x 6" OD Hollow Stem Augers; 1 3/8" ID x 24" Split Spoon; 3" x 30" Shelby Tubes
8. HOLE LOCATION	Landfill #2
9. SURFACE ELEVATION	5844.5
10. DATE STARTED	2/12/96
11. DATE COMPLETED	2/12/96
12. OVERBURDEN THICKNESS	4.5 ft. to Landfill
15. DEPTH GROUNDWATER ENCOUNTERED	Not Encountered
13. DEPTH DRILLED INTO ROCK	Not Encountered
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
14. TOTAL DEPTH OF HOLE	5.0 ft.
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
See Log	1 Spoon	3 Shelbys	0

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OIL & GREASE	SVOC	PCB	21. TOTAL CORE REC.
None						%

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHERS (SPECIFY)	23. SIGNATURE OF INSPECTOR
Grouted to surface				Rick Heidrick

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
0–1	SC	CLAYEY SAND - Very dense, brown, dry, mostly fine to coarse sand, little clay, minor gravel to 0.25". - FILL -	0 ppm (in field)	CVT20-0 Shelby Tube		Time = 1500 Recovery = 0.5'/0.5' Refusal at 0.5'
1–2			0 ppm (in field)	CVT20-0.5 Split Spoon	25 35	Recovery = 0.9'/1.0'
2–4	CH	FAT CLAY WITH SAND - Hard, dark brown, damp, mostly clay, little fine and medium sand, angular pieces of PIERRE SHALE, friable and crumbly. Brown, moist, minor gravel (sandstone) to 1.5".	0 ppm (in field)	CVT20-1.5 Shelby Tube		Recovery = 2.0'/2.0' Pocket Penetrometer (PP)>5 tsf
4–5			0 ppm (in field)	CVT20-3.5 Shelby Tube		Recovery = 1.0'/1.5'
5		REFUSE - Paper, plastic. - LANDFILL - Terminated boring at 5.0 feet.				Refusal at 5.0' Time = 1525

MRF Form PDA-FTCb

PROJECT: 55253.000 Fort Carson Landfills

HOLE NO.: CVT-20

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

HTW DRILLING LOG

HOLE NO.	CVT-21
1. COMPANY NAME	RUST Environment & Infrastructure
2. DRILLING SUBCONTRACTOR	Site Services
SHEET 1 OF 1 SHEETS	
3. PROJECT	Fort Carson Landfills
4. LOCATION	Fort Carson, Colorado
5. NAME OF DRILLER	Lee Hackett
6. MANUFACTURERS DESIGNATION OF DRILL	CME-55
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3.25" ID x 6" OD Hollow Stem Auger; 1 3/8" ID x 24" Split Spoon; 3" x 30" Shelby Tubes
8. HOLE LOCATION	Landfill #2
9. SURFACE ELEVATION	5842.3
10. DATE STARTED	2/13/96
11. DATE COMPLETED	2/13/96
12. OVERBURDEN THICKNESS	3.5 ft. to Landfill
15. DEPTH GROUNDWATER ENCOUNTERED	Not Encountered
13. DEPTH DRILLED INTO ROCK	Not Encountered
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
14. TOTAL DEPTH OF HOLE	5.0 ft.
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
See Log	1 Spoon	2 Shelbys	0

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OIL & GREASE	SVOC	PCB	21. TOTAL CORE REC.
None						%

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHERS (SPECIFY)	23. SIGNATURE OF INSPECTOR
Grouted to surface				Rick Heidrick

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
0–3	CH	FAT CLAY - Hard, brown, damp, mostly clay, minor fine and medium sand, few caliche nodules.	0 ppm (in field)	CVT21-0 Shelby Tube		Time = 0810 Recovery = 2.0'/2.0' Pocket Penetrometer (PP)>5 tsf
		Becomes moist - FILL -	0 ppm (in field)	CVT21-2 Shelby Tube		Recovery = 1.5'/1.5' PP=5.0 tsf Shelby refusal at 3.5'. Split Spoon refusal at 3.5'. Auger without sampling to 4'.
3–4		REFUSE - Wood, metal.				
4–5		- LANDFILL -	24 ppm (in field)	CVT21-4 Split Spoon	5 9	Recovery = 0.2'/1.0'
5–12		Terminate boring at 5.0 feet.				

MRF Form PDA-FTCb

PROJECT: 55253.000 Fort Carson Landfills

HOLE NO.: CVT-21

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

HTW DRILLING LOG

HOLE NO.	CVT-22
SHEET 1 OF 1 SHEETS	
1. COMPANY NAME	RUST Environment & Infrastructure
2. DRILLING SUBCONTRACTOR	Site Services
3. PROJECT	Fort Carson Landfills
4. LOCATION	Fort Carson, Colorado
5. NAME OF DRILLER	Lee Hackett
6. MANUFACTURERS DESIGNATION OF DRILL	CME-55
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3.25" ID x 6" OD Hollow Stem Auger; 1 3/8" ID x 24" Split Spoon; 3" x 30" Shelby Tubes
8. HOLE LOCATION	Landfill #2
9. SURFACE ELEVATION	5838.9
10. DATE STARTED	2/13/96
11. DATE COMPLETED	2/13/96
12. OVERBURDEN THICKNESS	9.5 ft. to Landfill
15. DEPTH GROUNDWATER ENCOUNTERED	Not Encountered
13. DEPTH DRILLED INTO ROCK	Not Encountered
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
14. TOTAL DEPTH OF HOLE	10.0 ft.
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	
18. GEOTECHNICAL SAMPLES	See Log
DISTURBED	1 Spoon
UNDISTURBED	5 Shelbys
19. TOTAL NUMBER OF CORE BOXES	0
20. SAMPLES FOR CHEMICAL ANALYSIS	None
VOC / METALS / OIL & GREASE / SVOC / PCB	
21. TOTAL CORE REC.	%
22. DISPOSITION OF HOLE	Grouted to surface
BACKFILLED / MONITORING WELL / OTHERS (SPECIFY)	
23. SIGNATURE OF INSPECTOR	Rick Heidrick

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
0–3	CH	FAT CLAY WITH SAND - Hard, brown, damp, mostly clay, some fine and medium sand, rare fine gravel, few caliche nodules. - FILL -	0 ppm (in field)	CVT22-0 Shelby Tube		Time = 0855 Recovery = 1.0'/2.0' Pocket Penetrometer (PP)>5 tsf
			0 ppm (in field)	CVT22-2 Shelby Tube		Recovery = 2.0'/2.0'
4–5	SC	CLAYEY SAND WITH GRAVEL - Brown, moist, mostly fine and medium sand, some clay, little gravel to 0.5".	0 ppm (in field)	CVT22-4 Shelby Tube		Recovery = 1.0'/1.0'
5–6	SM	Gravel becomes coarser, to 1.25". SILTY SAND WITH GRAVEL - Dense, light brown, dry, mostly fine and medium sand, some silt, little gravel to 1.25".	0 ppm (in field)	CVT22-5 Split Spoon	21 13	Shelby refusal at 5.0'
6–7	CH	FAT CLAY WITH SAND - Hard, dark grayish brown, moist, mostly clay, little fine sand. - FILL -	0 ppm (in field)	CVT22-6 Shelby Tube		Recovery = 1.5'/2.0' PP>5 tsf
8–9				CVT22-8 Shelby Tube		Recovery = 1.5'/2.0' PP>5 tsf
9–10	CH	FAT CLAY - Hard, dark gray, moist, mostly clay, minor fine sand, some refuse - decomposed wood. - LANDFILL -				
10–12		Terminated boring at 10 feet.				Time = 0945

MRF Form PDA-FTCb

PROJECT: 55253.000 Fort Carson Landfills

HOLE NO.: CVT-22

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

HTW DRILLING LOG

HOLE NO.	CVT-23
1. COMPANY NAME	RUST Environment & Infrastructure
2. DRILLING SUBCONTRACTOR	Site Services
SHEET	1 OF 1 SHEETS
3. PROJECT	Fort Carson Landfills
4. LOCATION	Fort Carson, Colorado
5. NAME OF DRILLER	Lee Hackett
6. MANUFACTURERS DESIGNATION OF DRILL	CME-55
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3.25" ID x 6" OD Hollow Stem Auger; 1 3/8" ID x 24" Split Spoon; 3" x 30" Shelby Tubes
8. HOLE LOCATION	Landfill #2
9. SURFACE ELEVATION	5833.0
10. DATE STARTED	2/13/96
11. DATE COMPLETED	2/13/96
12. OVERBURDEN THICKNESS	8.7 ft. to Landfill
15. DEPTH GROUNDWATER ENCOUNTERED	Not Encountered
13. DEPTH DRILLED INTO ROCK	Not Encountered
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
14. TOTAL DEPTH OF HOLE	9.0 ft.
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
See Log	1 Spoon	4 Shelbys	0

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OIL & GREASE	SVOC	PCB	21. TOTAL CORE REC.
None						%

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHERS (SPECIFY)	23. SIGNATURE OF INSPECTOR
Grouted to surface				Rick Heidrick

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
0–4	CH	FAT CLAY WITH GRAVEL - Hard, very dark grayish brown, damp, mostly clay, some fine sand and gravel, chunk of PIERRE SHALE at 3'.	0 ppm (in field)	CVT23-0 Shelby Tube		Time = 1005 Recovery = 2.0'/2.0' Pocket Penetrometer (PP)>5 tsf
		Becomes very stiff, moist. - FILL -	0 ppm (in field)	CVT23-2 Shelby Tube		Recovery = 2.0'/2.0' PP=3.25 tsf
4–7	SM	SILTY SAND WITH GRAVEL - Medium dense, dark yellowish brown, damp to moist, mostly fine to coarse sand, some silt, minor gravel to 0.5". - FILL -		CVT23-4 Split Spoon	13 13	Recovery = 1.0'/1.0'
				CVT23-5 Shelby Tube		Recovery = 0.5'/2.0' Rig chatter from 5.0'-6.0'.
7–9	CH	FAT CLAY WITH SAND - Hard, black, moist. - FILL -	0 ppm (in field)	CVT23-7 Shelby Tube		Recovery = 1.3'/2.0' PP>5 tsf
9		REFUSE - Glass, paper. - LANDFILL -				Time = 1040
		Terminated boring at 9.0 feet.				

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PROJECT: 55253.000 Fort Carson Landfills

HOLE NO.: CVT-23

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

HTW DRILLING LOG

HOLE NO.	CVT-24
1. COMPANY NAME	RUST Environment & Infrastructure
2. DRILLING SUBCONTRACTOR	Site Services
SHEET 1 OF 1 SHEETS	
3. PROJECT	Fort Carson Landfills
4. LOCATION	Fort Carson, Colorado
5. NAME OF DRILLER	Lee Hackett
6. MANUFACTURERS DESIGNATION OF DRILL	CME-55
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3.25" ID x 6" OD Hollow Stem Auger; 2" ID x 24" Split Spoon; 3" x 30" Shelby Tubes
8. HOLE LOCATION	Landfill #2
9. SURFACE ELEVATION	5823.7
10. DATE STARTED	2/13/96
11. DATE COMPLETED	2/13/96
12. OVERBURDEN THICKNESS	3.5 ft. to Landfill
15. DEPTH GROUNDWATER ENCOUNTERED	Not Encountered
13. DEPTH DRILLED INTO ROCK	Not Encountered
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
14. TOTAL DEPTH OF HOLE	5.0 ft.
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
See Log	1 Spoon	2 Shelbys	0

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OIL & GREASE	SVOC	PCB	21. TOTAL CORE REC.
None						%

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHERS (SPECIFY)	23. SIGNATURE OF INSPECTOR
Grouted to surface				Rick Heidrick

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
0–1	CH	FAT CLAY WITH SAND - Hard, brown, dry to damp, mostly clay, little fine and medium sand.		CVT24-0 Split Spoon	31 30	Time = 1115 Recovery = 1.0'/1.0'
1–2	SC	CLAYEY SAND - Brown, dry, mostly fine and medium sand.				Recovery = 2.0'/2.0' Pocket Penetrometer (PP)=3.5 tsf
2–3	CH	FAT CLAY - Very stiff, brown, moist, mostly clay, minor fine and medium sand. - FILL -		CVT24-1 Shelby Tube		
3–4		REFUSE - Decomposed organics. - LANDFILL -		CVT24-1 Shelby Tube		Recovery = 1.0'/2.0'
5		Terminated boring at 5.0 feet.				Time = 1145

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PROJECT: 55253.000 Fort Carson Landfills

HOLE NO.: CVT-24

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

HTW DRILLING LOG

HOLE NO.	CVT-25
1. COMPANY NAME	RUST Environment & Infrastructure
2. DRILLING SUBCONTRACTOR	Site Services
SHEET 1	OF 1 SHEETS
3. PROJECT	Fort Carson Landfills
4. LOCATION	Fort Carson, Colorado
5. NAME OF DRILLER	Lee Hackett
6. MANUFACTURERS DESIGNATION OF DRILL	CME-55
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3.25" ID x 6" OD Hollow Stem Auger; 1 3/8" ID x 24" Split Spoon; 3" x 30" Shelby Tubes
8. HOLE LOCATION	Landfill #2
9. SURFACE ELEVATION	5829.9
10. DATE STARTED	2/13/96
11. DATE COMPLETED	2/13/96
12. OVERBURDEN THICKNESS	>9.5 ft.
15. DEPTH GROUNDWATER ENCOUNTERED	Not Encountered
13. DEPTH DRILLED INTO ROCK	Not Encountered
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
14. TOTAL DEPTH OF HOLE	9.5 ft.
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
See Log	3 Spoons	4 Shelbys	0

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OIL & GREASE	SVOC	PCB	21. TOTAL CORE REC.
None						%

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHERS (SPECIFY)	23. SIGNATURE OF INSPECTOR
Grouted to surface				Rick Heidrick

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
	CH	FAT CLAY - Hard, olive brown, dry, mostly clay, minor fine sand.	0 ppm (in field)	CVT25-0		Time = 1430 Recovery = 0.5'/0.5' Shelby refusal at 0.5'
1			0 ppm (in field)	CVT25-0.5 Split Spoon	10 17	Recovery = 0.8'/1.0'
2				CVT25-1.5 Shelby Tube		Recovery = 2.0'/2.0' Pocket Penetrometer (PP)>5 tsf
3						
4		Becomes damp to moist.		CVT25-3.5 Shelby Tube		Recovery = 1.8'/2.0' PP=5 tsf
5						
6				CVT25-5.5 Split Spoon	11 14	
7		Contains angular pieces of PIERRE SHALE to 1.5".	0 ppm (in field)	CVT25-6.5 Shelby Tube		Recovery = 1.7'/2.0'
8						
9		2" piece of gravel (sandstone) at 9.5'.		CVT25-8.5 Split Spoon	16 25	Recovery = 1.0'/1.0'
10		Terminated boring at 9.5 feet.				Time = 1520
11						
12						

MRF Form PDA-FTCb

PROJECT: 55253.000 Fort Carson Landfills

HOLE NO.: CVT-25

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

HTW DRILLING LOG

HOLE NO.	CVT-26
1. COMPANY NAME	RUST Environment & Infrastructure
2. DRILLING SUBCONTRACTOR	Site Services
SHEET 1	OF 1 SHEETS
3. PROJECT	Fort Carson Landfills
4. LOCATION	Fort Carson, Colorado
5. NAME OF DRILLER	Lee Hackett
6. MANUFACTURERS DESIGNATION OF DRILL	CME-55
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3.25" ID x 6" OD Hollow Stem Auger; 1 3/8" ID x 24" Split Spoon; 3" x 30" Shelby Tubes
8. HOLE LOCATION	Landfill #2
9. SURFACE ELEVATION	5828.9
10. DATE STARTED	2/13/96
11. DATE COMPLETED	2/13/96
12. OVERBURDEN THICKNESS	3.9 ft. to Landfill
15. DEPTH GROUNDWATER ENCOUNTERED	Not Encountered
13. DEPTH DRILLED INTO ROCK	Not Encountered
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
14. TOTAL DEPTH OF HOLE	4.0 ft.
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
See Log	0 Spoons	2 Shelbys	0

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OIL & GREASE	SVOC	PCB	21. TOTAL CORE REC.
None						%

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHERS (SPECIFY)	23. SIGNATURE OF INSPECTOR
Grouted to surface				Rick Heidrick

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
0–4	CH	FAT CLAY - Hard, dark grayish brown, damp, mostly clay, little fine sand. - FILL -	0 ppm (in field)	CVT26-0 Shelby Tube		Time = 1345 Recovery = 1.5'/2.0' Pocket Penetrometer (PP)>5 tsf
				CVT26-2 Shelby Tube		Recovery = 2.0'/2.0'
4–4.0	CH	FAT CLAY - Moist, dark gray to black, mostly clay, some refuse - paper, metal, decomposed organics. - LANDFILL -				Time = 1405

Terminated boring at 4.0 feet.

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PROJECT: 55253.000 Fort Carson Landfills

HOLE NO.: CVT-26

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

HTW DRILLING LOG

HOLE NO.	CVT-27
1. COMPANY NAME	RUST Environment & Infrastructure
2. DRILLING SUBCONTRACTOR	Site Services
SHEET 1 OF 1 SHEETS	
3. PROJECT	Fort Carson Landfills
4. LOCATION	Fort Carson, Colorado
5. NAME OF DRILLER	Lee Hackett
6. MANUFACTURERS DESIGNATION OF DRILL	CME-55
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3.25" ID x 6" OD Hollow Stem Auger; 1 3/8" ID x 24" Split Spoon; 3" x 30" Shelby Tubes
8. HOLE LOCATION	Landfill #2
9. SURFACE ELEVATION	5825.1
10. DATE STARTED	2/13/96
11. DATE COMPLETED	2/13/96
12. OVERBURDEN THICKNESS	4.8 ft. to Landfill
15. DEPTH GROUNDWATER ENCOUNTERED	Not Encountered
13. DEPTH DRILLED INTO ROCK	Not Encountered
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
14. TOTAL DEPTH OF HOLE	5.0 ft.
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
See Log	2 Spoons	3 Shelbys	0

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OIL & GREASE	SVOC	PCB	21. TOTAL CORE REC.
None						%

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHERS (SPECIFY)	23. SIGNATURE OF INSPECTOR
Grouted to surface				Rick Heidrick

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
0–1	SC	CLAYEY SAND - Dense, brown, damp, mostly fine to coarse sand, some clay, minor gravel to 0.5".	0 ppm (in field)	CVT27-0 Shelby Tube		Time = 1300 Recovery = 0.7'/0.8' Shelby refusal at 0.8'
1–2			0 ppm (in field)	CVT27-0.8 Split Spoon	33 40	Recovery = 0.8'/1.0'
2–3		Medium dense. - FILL -		CVT27-1.8 CVT27-2 Split Spoon	9 11	Recovery = 0.2'/0.2' Shelby refusal at 2.0' Recovery = 0.1'/1.0'
3–5	CH	FAT CLAY - Grayish brown, damp, mostly clay, little sand. -FILL	109 ppm (in field)	CVT27-3 Shelby Tube		Recovery = 2.0'/2.0'
5		REFUSE - Paper, glass. - LANDFILL - Terminated boring at 5.0 feet.				Time = 1330

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PROJECT: 55253.000
Fort Carson Landfills

HOLE NO.: CVT-27

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

HTW DRILLING LOG

HOLE NO.	CVT-28
1. COMPANY NAME	RUST Environment & Infrastructure
2. DRILLING SUBCONTRACTOR	Site Services
SHEET 1 OF 1 SHEETS	
3. PROJECT	Fort Carson Landfills
4. LOCATION	Fort Carson, Colorado
5. NAME OF DRILLER	Lee Hackett
6. MANUFACTURERS DESIGNATION OF DRILL	CME-55
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3.25" ID x 6" OD Hollow Stem Auger; 1 3/8" ID x 24" Split Spoon; 3" x 30" Shelby Tubes
8. HOLE LOCATION	Landfill #2
9. SURFACE ELEVATION	5820.7
10. DATE STARTED	2/13/96
11. DATE COMPLETED	2/13/96
12. OVERBURDEN THICKNESS	3.5 ft. to Landfill
15. DEPTH GROUNDWATER ENCOUNTERED	Not Encountered
13. DEPTH DRILLED INTO ROCK	Not Encountered
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
14. TOTAL DEPTH OF HOLE	6.0 ft.
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
See Log	0 Spoons	3 Shelbys	0

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OIL & GREASE	SVOC	PCB	21. TOTAL CORE REC.
None						%

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHERS (SPECIFY)	23. SIGNATURE OF INSPECTOR
Grouted to surface				Rick Heidrick

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
0–3	CH	SANDY FAT CLAY - Hard, brown, damp, mostly clay, some fine sand. - FILL - Very stiff, dark grayish brown, moist.	0 ppm (in field)	CVT28-0 Shelby Tube		Time = 1215 Recovery = 2.0'/2.0' Pocket Penetrometer (PP)>5 tsf
3–4.5	CH	FAT CLAY - Black, moist, some paper, plastic, strong organic odor, increasing refuse content with depth. - LANDFILL -	0 ppm (in field)	CVT28-2 Shelby Tube		Recovery = 2.0'/2.0' PP=3.5 tsf
4.5–6				CVT28-4 Shelby Tube		Recovery = 2.0'/2.0'
6		Terminated boring at 6.0 feet.				Time = 1235

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PROJECT: 55253.000 Fort Carson Landfills

HOLE NO.: CVT-28

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

HTW DRILLING LOG

HOLE NO.	CVT-29
1. COMPANY NAME	RUST Environment & Infrastructure
2. DRILLING SUBCONTRACTOR	Site Services
SHEET 1 OF 1 SHEETS	
3. PROJECT	Fort Carson Landfill
4. LOCATION	Fort Carson, Colorado
5. NAME OF DRILLER	Lee Hackett
6. MANUFACTURERS DESIGNATION OF DRILL	CME-55
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3.25" ID x 6" OD Hollow Stem Auger; 1 3/8" ID x 24" Split Spoon; 3" x 30" Shelby Tubes
8. HOLE LOCATION	Landfill #2
9. SURFACE ELEVATION	5809.1
10. DATE STARTED	2/14/96
11. DATE COMPLETED	2/14/96
12. OVERBURDEN THICKNESS	6.0 ft. to PIERRE SHALE
15. DEPTH GROUNDWATER ENCOUNTERED	Not Encountered
13. DEPTH DRILLED INTO ROCK	1.0 ft.
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
14. TOTAL DEPTH OF HOLE	7.0 ft.
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
See Log	3 Spoons	2 Shelbys	0

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OIL & GREASE	SVOC	PCB	21. TOTAL CORE REC.
None						%

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHERS (SPECIFY)	23. SIGNATURE OF INSPECTOR
Grouted to surface				Rick Heidrick

DEPTH (feet)	USCS	DESCRIPTION OF MATERIALS	OVM SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX NO.	BLOW COUNTS	TIME/REMARKS
0–1	CH	FAT CLAY WITH SAND - Stiff, dark grayish brown, dry, mostly clay, little fine and medium sand.	0 ppm (in field)	CVT29-0 Split Spoon	5 6	Time = 0835 Recovery = 1.0'/1.0'
1–2			0 ppm (in field)	CVT29-1 Split Spoon	9 11	Heavy rig chatter. Recovery = 0.8'/1.0'
2–3		Becomes damp - FILL -		CVT29-2 Shelby Tube		Recovery = 1.8'/2.0' Pocket Penetrometer (PP)=5 tsf
4–5		Stiff to very stiff, brown, moist, angular pieces of PIERRE SHALE to 0.25".		CVT29-4 Shelby Tube		Recovery = 1.0'/2.0' PP=2.0 tsf
6–7	CH	FAT CLAY - Hard, dark grayish brown, damp, mostly clay, medium to high plasticity, minor fine sand. Weathered bedrock - very soft, friable, near horizontal bedding. - PIERRE SHALE -		CVT29-6 Split Spoon	13 31	Recovery = 1.0'/1.0'
7–12		Terminated boring at 7.0 feet.				Time = 0920

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PROJECT: 55253.000 Fort Carson Landfill

HOLE NO.: CVT-29

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

APPENDIX C
GEOTECHNICAL LABORATORY TESTING RESULTS

APPENDIX C
GEOTECHNICAL LABORATORY TESTING

C-1.0 INTRODUCTION

This appendix includes a discussion of test procedures and results of the laboratory investigation performed by Rust E&I for the Fort Carson Landfill Project. The investigation program was carried out employing currently accepted test procedures of the American Society of Testing and Materials (ASTM).

Undisturbed thin-wall tube samples and bag samples used in the laboratory investigation were obtained during the course of the field investigation as described in Section 3.4 of this report. Identification of each sample is by landfill number, boring/sample number, and depth.

C-2.0 INDEX PROPERTIES TESTING

In the field of soil mechanics and geotechnical design, it is advantageous to have a standard method of identifying soils and classifying them into categories or groups that have similar or distinct engineering properties. The most commonly used method of identifying and classifying soils according to their engineering properties is the Unified Soil Classification System (USCS), as described by ASTM D2487-93. The USCS is based on a recognition of the various types and significant distribution of soil characteristics, and plasticity of materials.

The index properties tests discussed in this report include the determination of natural water content and in-place dry density, grain-size distribution and Atterberg limits.

C-2.4 Compaction Characteristics

Moisture content versus dry density relationship, per ASTM standard procedure D698, is presented in Figure C-16 for potential borrow soils.

C-3.0 ENGINEERING PROPERTIES TESTING

The engineering properties testing consisted of triaxial shear and permeability testing.

C-3.1 Static Triaxial Shear Testing

Selected samples were tested for triaxial shear strength in accordance with ASTM D4767-88 "isotropically-consolidated-undrained" (I.C.U.) or D2850-87 "unconsolidated-undrained" (U.U.).

a. **Sample Preparation** - Samples selected for testing were extruded from the tubes using a hydraulically operated ram capable of exerting the minimum force necessary to free the sample from the tube. The samples were then trimmed to an approximate 2:1 height to diameter ratio. With the aid of a special trimming device which completely supported the sample, the possibility of sample disturbance due to handling was significantly reduced.

After the initial weight and volume measurements were determined, each specimen was placed in a triaxial cell, encased in a latex membrane and sealed to the bottom pedestal and top cap with rubber "O" rings. After securing the triaxial chamber, the cell was filled with water and fitted with a 1-inch-diameter stainless steel piston for load application and transported to the saturation bay.

b. **Sample Saturation and Consolidation** - The laboratory is equipped with a panel of nine bays, with individual pressure control to each bay, such that nine triaxial samples can be simultaneously saturated and/or consolidated at different individual pressures. Bleeding air

c. **Sample Failure** - The triaxial specimens were failed by compression loading at a constant rate of strain while maintaining a constant minor principal stress. The rate of strain selected for sample failure was dependent upon the materials' consolidation characteristics. Load readings were recorded during the tests at specified axial deformations using a BLH (0-2,000 lb) load cell. Pore pressure measurements were obtained by a Stathom pore pressure transducer (0-200 psi). The adopted failure criterion used for the presentation of the Mohr circle of stress for the ICU, triaxial tests was the point of maximum principal effective stress ratio, and for the UU tests, 15 percent strain. Results of the ICU and UU triaxial compression tests are presented on Figures C-11 and C-12, respectively.

C-3.2 Permeability Tests

Permeability coefficients were determined on selected undisturbed samples in accordance with ASTM D5084-90. The samples were tested in a triaxial cells after back pressure saturation and consolidation to 4 psi. The permeability was determined by applying a constant head hydraulic gradient and monitoring the flow of water from bottom to top of the sample through calibrated constant diameter sight tubes as a function of time. The permeability test of the samples tested, are presented in Table C-3 for existing cover and fill soils, and in Table C-5 for potential borrow soils. Permeability results for samples obtained for cap permeability testing from Borings CVT-1 through CVT-29 are provided in Attachment 1 of this appendix.

TABLES

TABLE C-1
NATURAL WATER CONTENT & DRY DENSITY DATA

Landfill No.	Boring No./ Sample No.	Depth ft	Water Content, %	Dry Density, pcf
LF-2	SB1-2	2.0-3.8	27.5	92.8
LF-2	SB1-2	2.0-3.8	26.8	95.9
LF-2	SB1-4	4.0-6.0	24.8	97.1
LF-2	SB4-2	2.0-3.8	20.8	103.5
LF-2	SB7-2	2.0-3.9	23.5	100.5
LF-2	SB7-2	2.0-3.9	22.6	102.4
LF-2	SB8-2	2.0-3.5	25.0	95.1
LF-2	SB9-2	2.0-4.0	22.7	99.0
LF-2	SB10-0	0.0-1.0	19.6	97.8
LF-2	SB11-2	2.0-4.0	19.3	100.9
LF-2	SB12-4	4.0-6.0	24.0	92.4
LF-2	SB13-12	12.0-13.9	26.4	98.9
LF-2	SB13-14	14.0-15.6	26.7	98.1
LF-2	SB13-14	14.0-15.6	26.9	97.4

TABLE C-2
PERCENT PASSING THE NO. 200 SIEVE

Landfill No.	Boring No./ Sample No.	Depth, Ft	Percent Passing #200 Sieve
LF-2	SB1-2	2.0-3.8	94.1
LF-2	SB1-4	4.0-6.0	90.1
LF-2	SB4-2	2.0-3.8	68.0*
LF-2	SB7-2	2.0-3.9	90.7*
LF-2	SB8-2	2.0-3.5	91.7*
LF-2	SB9-2	2.0-4.0	87.4*
LF-2	SB10-0	0.0-1.0	82.2*
LF-2	SB11-2	2.0-4.0	81.9*
LF-2	SB12-4	4.0-6.0	65.6*
LF-2	SB13-12	12.0-13.9	85.4
LF-2	SB13-14	14.0-15.6	86.5

*Particle distribution test performed. See data sheets.

TABLE C-3
PERMEABILITY TEST DATA

Landfill No.	Boring No./ Sample No.	Depth, Ft.	Natural		As Tested		Consol. Pressure psi	Head, psi	Cofficient of Permeability cm/sec
			Water Content, %	Dry Density, pcf	Water Content %	Dry Density, pcf			
LF-2	SB7-2	2.0-3.9	23.5	100.5	25.9	101.8	4.0	4.0	1.9×10^{-7}
LF-2	SB8-2	2.0-3.9	25.0	95.1	28.1	95.9	4.0	2.0	3.0×10^{-7}
LF-2	SB9-2	2.0-4.0	22.7	99.0	26.4	100.3	4.0	4.0	1.0×10^{-7}
LF-2	SB10-0	0.0-1.0	19.6	97.8	26.5	99.5	4.0	1.0	4.5×10^{-5}

TABLE C-4

SUMMARY OF INDEX PROPERTIES OF POTENTIAL BORROW SOILS

PROJECT : FORT CARSON

PROJECT NO. : 89868.200

Sample No.	Depth (ft)	USCS	Dry Density (pcf)	Moisture Content (%)	Percent Passing No. 4 Sieve	Percent Passing No. 200 Sieve	Specific Gravity	Organic Content (%)
TS1A	0-5.5	CL	-----	11.0	98.2	83.6	-----	-----
TS2A	0-2	CL	-----	10.2	99.0	91.8	-----	-----
TS2B	3-5.5	CL	-----	10.5	100.0	94.5	-----	-----
TS3A	0-6	CL	-----	15.1	100.0	98.3	-----	-----
TS4A	5	CL	-----	14.4	98.5	87.3	-----	-----
TS5A	5	CL	-----	11.0	99.7	94.3	-----	-----
TS6A	5	CL	-----	12.0	99.5	87.9	-----	-----

TABLE C-5

PERMEABILITY TEST RESULTS OF POTENTIAL BORROW SOILS

PROJECT : FORT CARSON
PROJECT NO. : 89868.200

Sample	Initial		As Tested		Consolidation Pressure (psi)	Head (psi)	Coefficient of Permeability (cm/sec)
	Dry Density (pcf)	Water Content (%)	Dry Density (pcf)	Water Content (%)			
TS-3A 0'-6' 95% @ opt. +3% w/c	103.6	21.1	104.5	22.6	5.0	5.0	1.0×10^{-7}
TS-3A 0'-6' 95% @ opt. w/c	102.9	19.0	101.0*	25.2	5.0	1.0	3.0×10^{-5}
TS-3A 0'-6' 90% @ opt. +3% w/c	98.1	21.2	99.5	26.0	5.0	1.0	1.9×10^{-5}
TS-3A 0'-6' 90% @ opt. w/c	98.0	18.4	99.2	26.9	5.0	1.0	2.4×10^{-4}
TS-3A 0'-6' 98% @ 20% w/c	107.3	19.8	107.3	21.8	5.0	5.0	2.4×10^{-8}
TS-3A 0'-6' 98% @ opt. w/c	107.1	17.9	106.0*	22.6	5.0	5.0	3.6×10^{-7}
-----	-----	-----	-----	-----	-----	-----	-----
-----	-----	-----	-----	-----	-----	-----	-----

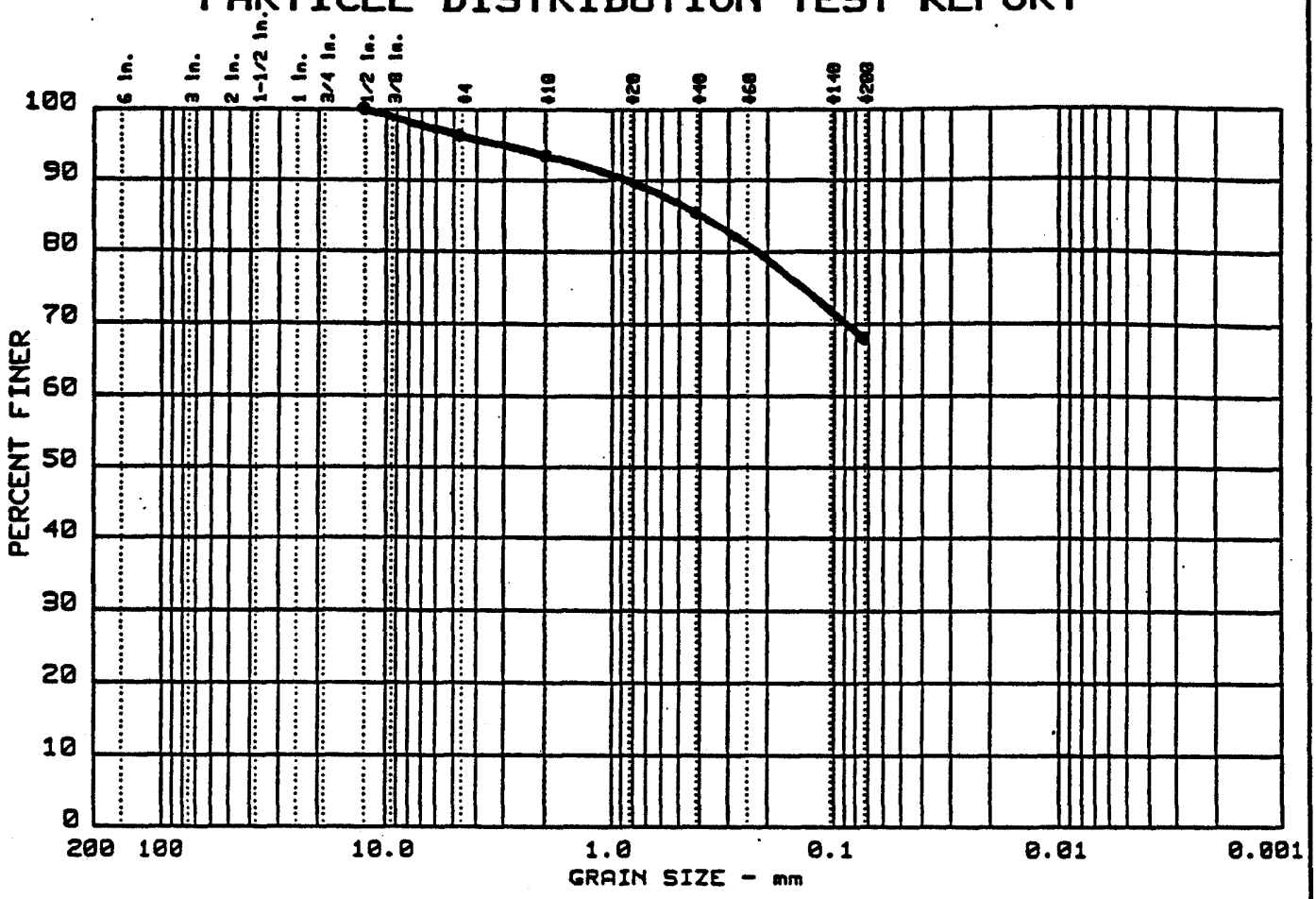
* samples swelled slightly

c:\tang\lab\labform1.xls

Checked By : D.Tang

FIGURES

PARTICLE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	3.7	28.4	67.9		CH	53.7	31.2

SIEVE inches size	PERCENT FINER ●		
0.5	100.0		
	GRAIN SIZE		
D_{60}			
D_{30}			
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ●		
4	96.3		
10	93.4		
40	85.4		
200	68.0		

Sample information:
● SB4-2 @ 2-3.8'
BROWN SANDY FAT CLAY

Remarks:
LF-2

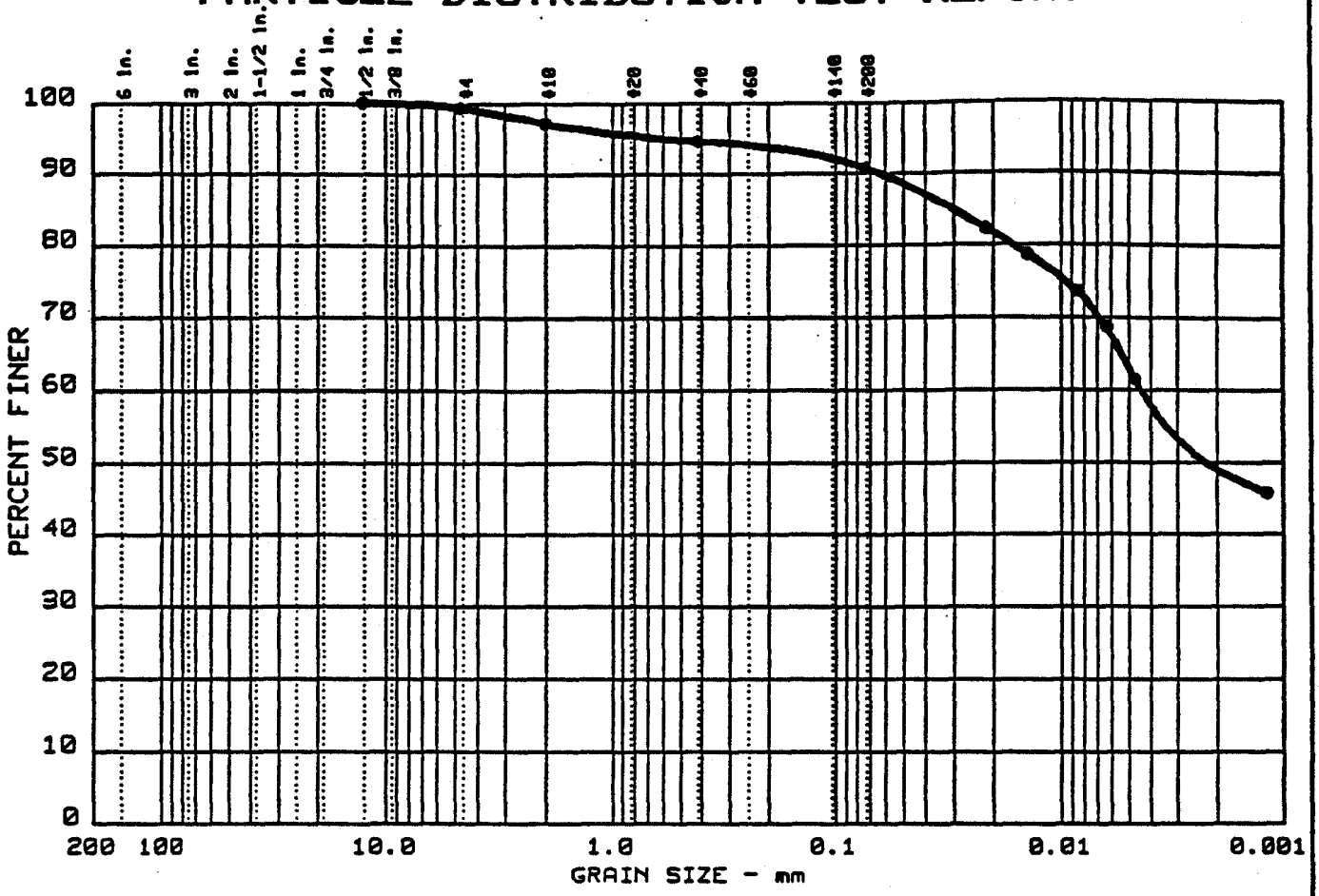
RAN BY: KLR
OTHERS-GR11

RUST
ENVIRONMENT &
INFRASTRUCTURE

Project No.: 89868.300
Project: FORT CARSON

Date: 07.28.95 Lab. No.428

PARTICLE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	0.7	8.7	41.7	48.9	CH	55.1	28.3

SIEVE inches size	PERCENT FINER ●		
0.5	100.0		
	GRAIN SIZE		
D_{60}			
D_{30}			
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ●		
4	99.3		
10	97.2		
40	94.6		
200	90.7		

Sample information:
● SB7-2 @ 2-3.9'
BROWN FAT CLAY

Remarks:
LF-2

RAN BY: KLR
OTHERS-GR13

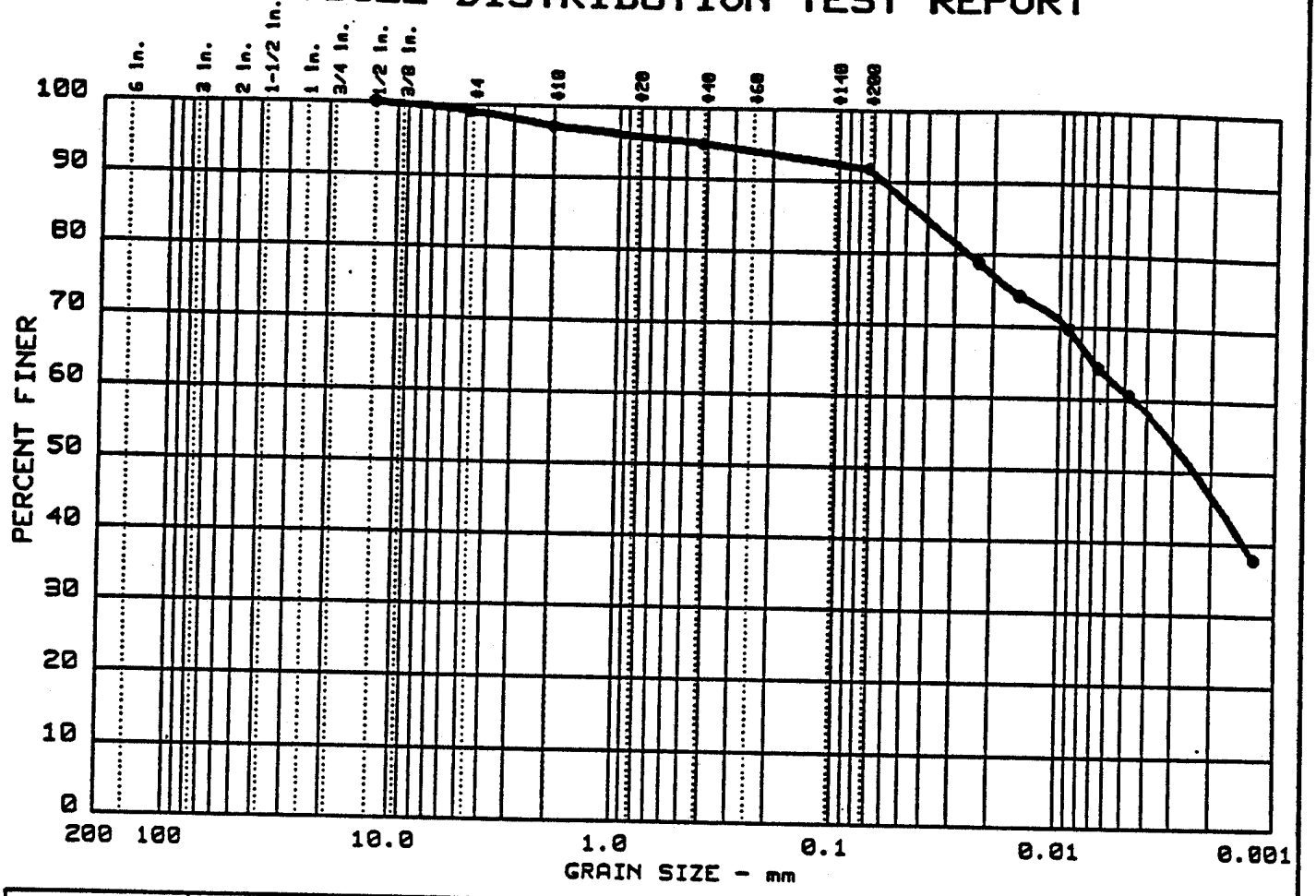
RUST
ENVIRONMENT &
INFRASTRUCTURE

Project No.: 89868.300
Project: FORT CARSON

Date: 07.28.95 Lab. No.430

Fig. C-2

PARTICLE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	1.0	7.3	44.7	47.0	CH	54.7	31.6

SIEVE inches size	PERCENT FINER ●		
0.5	100.0		
GRAIN SIZE			
D_{60}			
D_{30}			
D_{10}			
COEFFICIENTS			
C_c			
C_u			

SIEVE number size	PERCENT FINER ●		
4	99.0		
10	97.1		
40	95.0		
200	91.7		

Sample Information:
● SB8-2 @ 2-3.5'
BROWN FAT CLAY

Remarks:
LF-2

RAN BY: KLR
OTHERS-GR14

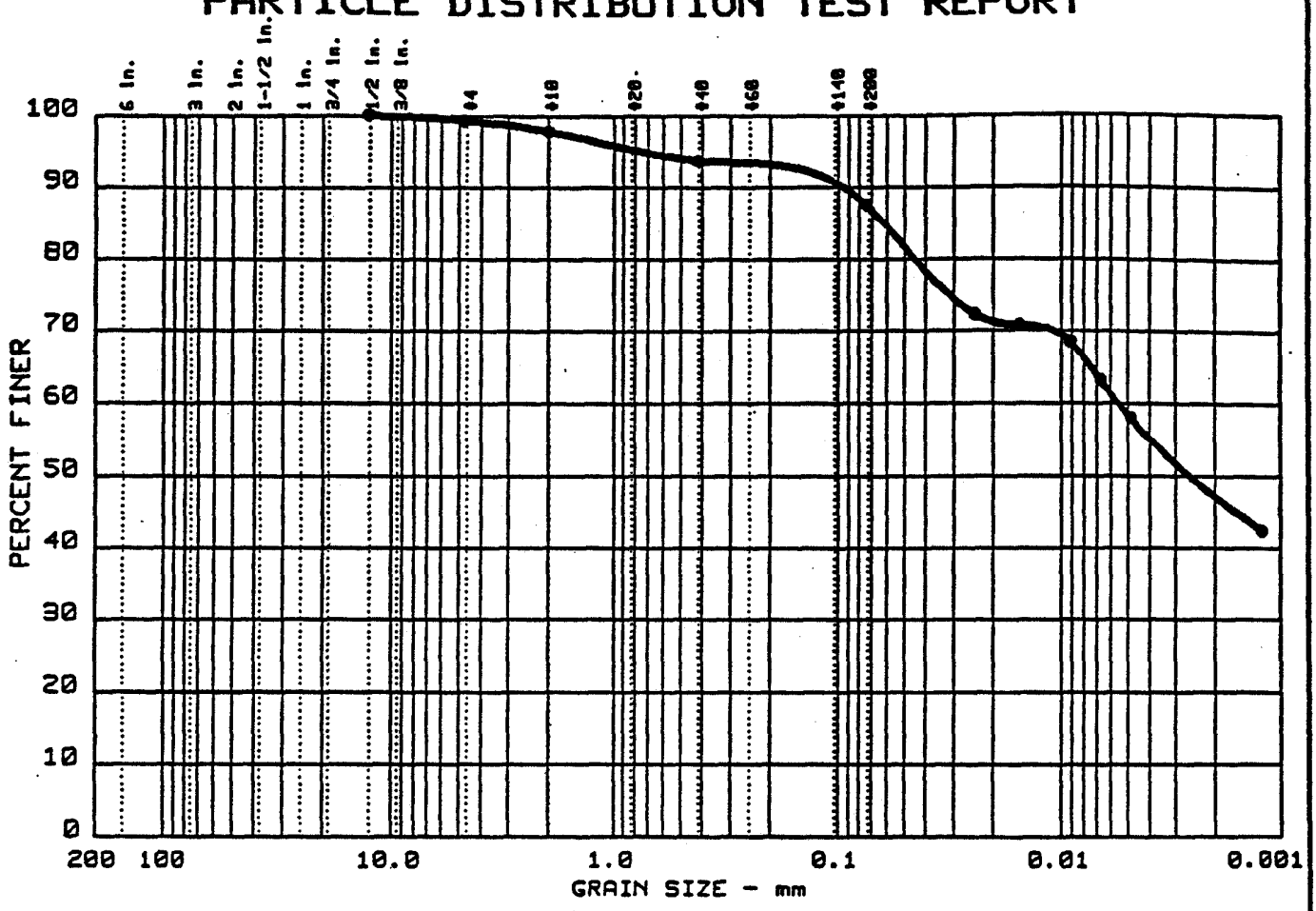
RUST
ENVIRONMENT &
INFRASTRUCTURE

Project No.: 89868.300
Project: FORT CARSON

Date: 07.28.95

Lab. No.430

PARTICLE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	0.7	11.9	40.2	47.2	CH	50.4	27.3

SIEVE inches size	PERCENT FINER ●		
0.5	100.0		
	GRAIN SIZE		
D_{60}			
D_{30}			
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ●		
4	99.3		
10	97.8		
40	93.7		
200	87.4		

Sample information:
● SB9-2 @ 2-4'
BROWN FAT CLAY

Remarks:
LF-2

RAN BY: KLR
OTHERS-GR15

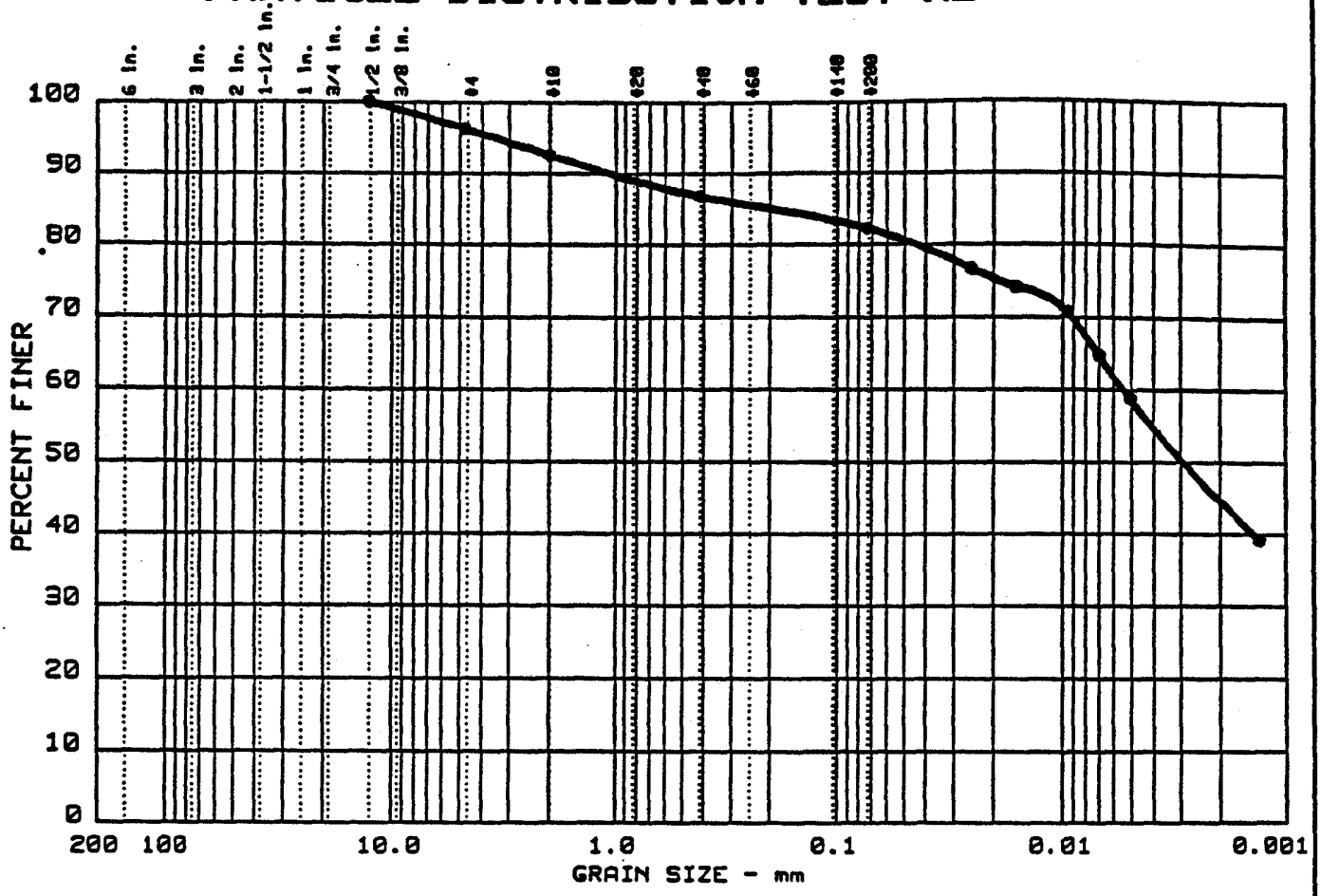
RUST ENVIRONMENT & INFRASTRUCTURE

Project No.: 89868.300
Project: FORT CARSON

Date: 07.28.95 Lab. No.430

Fig. C-4

PARTICLE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	3.8	14.0	37.5	44.7	CH	57.8	34.5

SIEVE inches size	PERCENT FINER ●		
0.5	100.0		
	GRAIN SIZE		
D_{60}			
D_{30}			
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ●		
4	96.2		
10	92.5		
40	86.7		
200	82.2		

Sample Information:
● SB10-0 @ 0-1'
BROWN FAT CLAY WITH SAND

Remarks:
LF-2

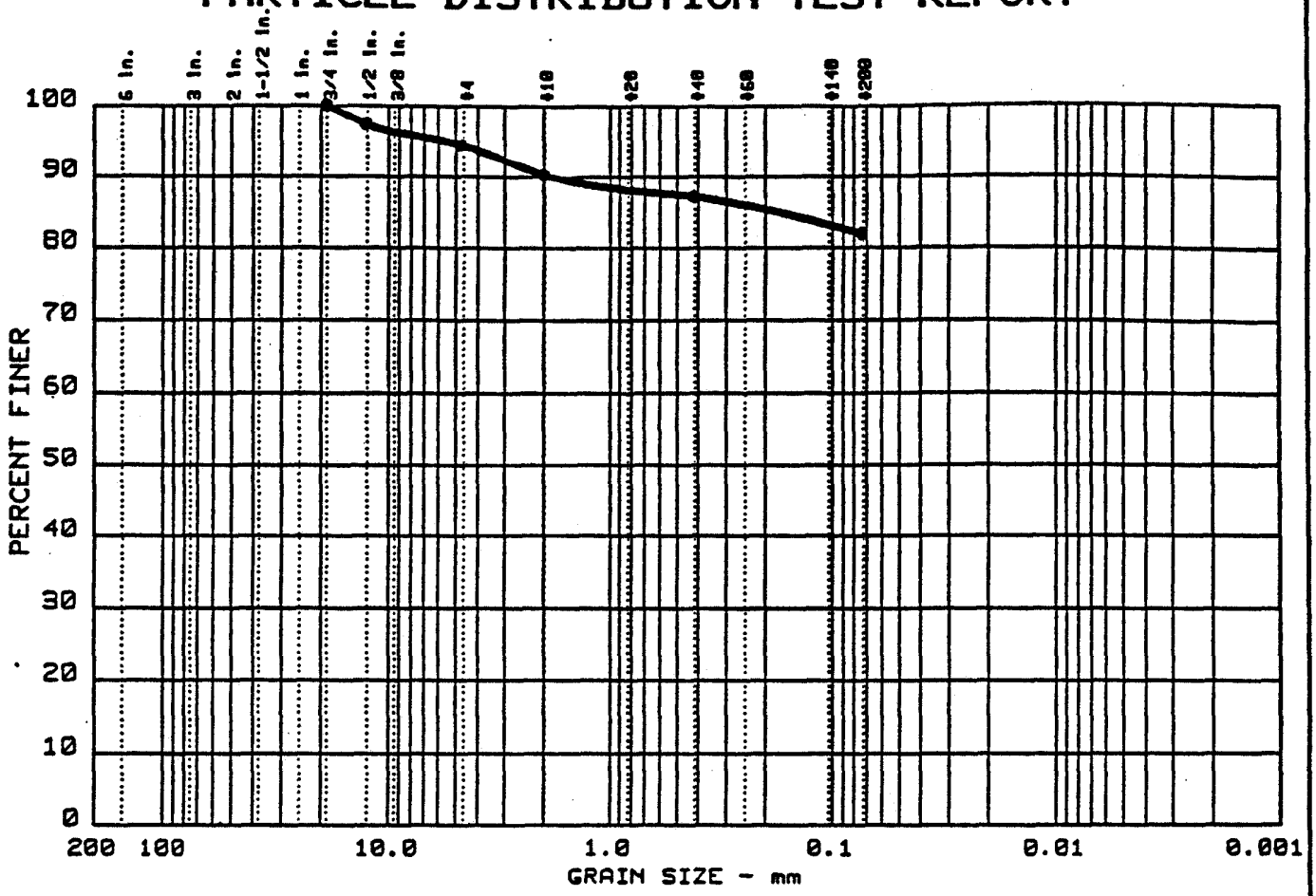
RAN BY: KLR
OTHERS-GR01

RUST ENVIRONMENT & INFRASTRUCTURE

Project No.: 89868.300
Project: FORT CARSON

Date: 07.28.95 Lab. No.430

PARTICLE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	5.6	12.5	81.9		CL	46.4	20.8

SIEVE inches size	PERCENT FINER ●		
0.75	100.0		
0.5	97.4		
	GRAIN SIZE		
D_{60}			
D_{30}			
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ●		
4	94.4		
10	90.3		
40	87.1		
200	81.9		

Sample Information:
● SB11-2 @ 2-4'
BROWN LEAN CLAY WITH SAND

Remarks:
LF-2

RAN BY: KLR
OTHERS-GR16

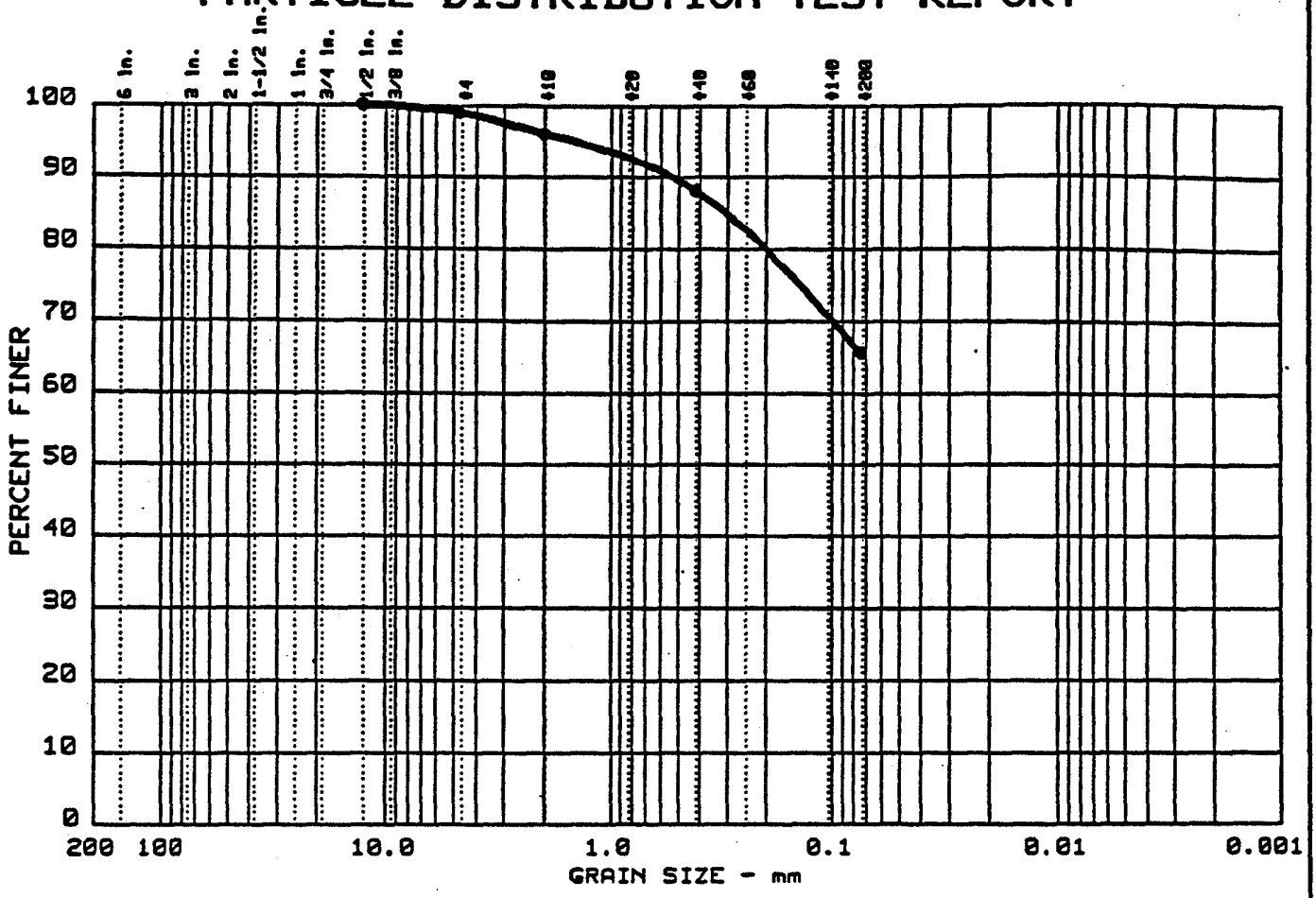
RUST ENVIRONMENT & INFRASTRUCTURE

Project No.: 89868.300
Project: FORT CARSON

Date: 07.28.95 Lab. No.428

Fig. C-6

PARTICLE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	1.0	33.3	65.7		CH	54.5	31.7

SIEVE inches size	PERCENT FINER ●		
0.5	100.0		
GRAIN SIZE			
D_{60}			
D_{30}			
D_{10}			
COEFFICIENTS			
C_c			
C_u			

SIEVE number size	PERCENT FINER ●		
4	99.0		
10	96.0		
40	88.1		
200	65.6		

Sample information:
● SB12-4 @ 4-6'
BROWN SANDY FAT CLAY

Remarks:
LF-2

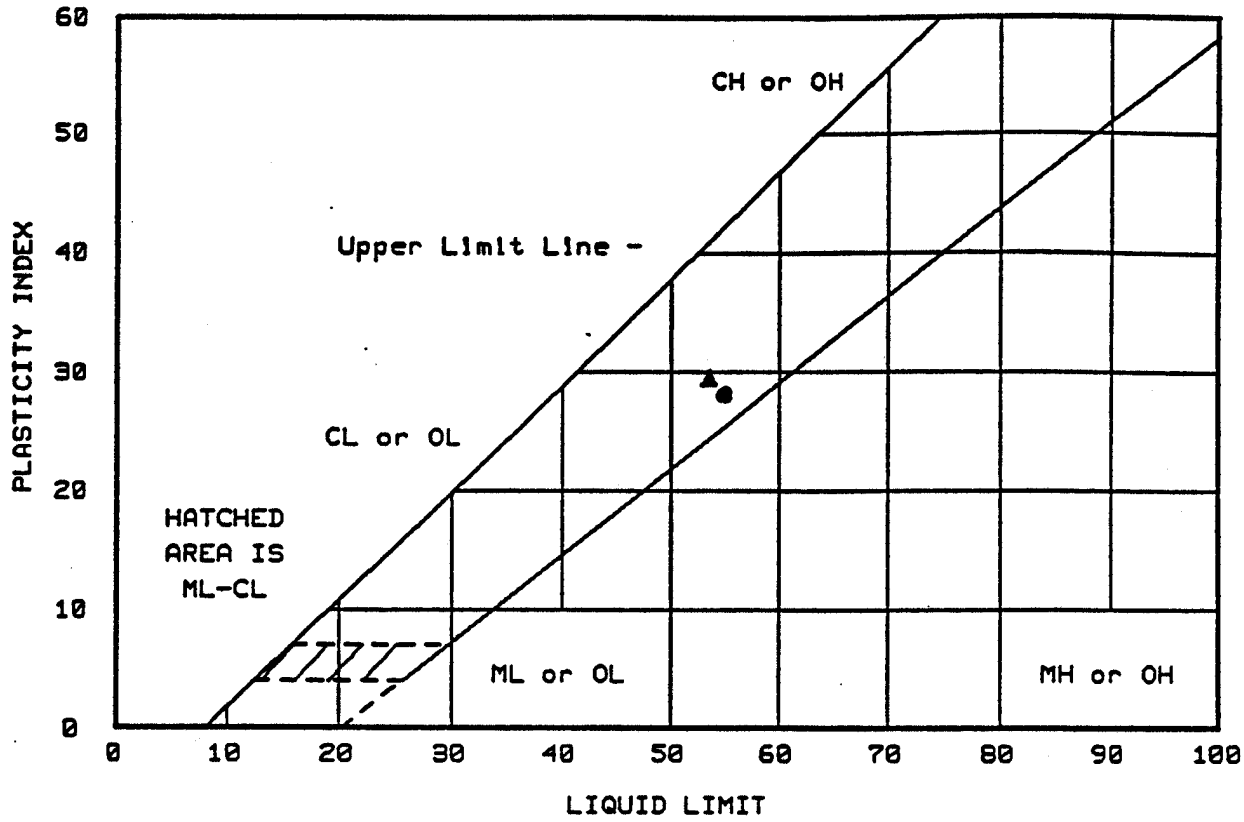
RAN BY: KLR
OTHERS-GR17

RUST ENVIRONMENT & INFRASTRUCTURE

Project No.: 89868.300
Project: FORT CARSON

Date: 07.28.95 Lab. No.428

LIQUID AND PLASTIC LIMITS TEST REPORT



	Location + Description	LL	PL	PI	-200	ASTM D 2487-90
●	SB1-4 @ 4-6' BROWN FAT CLAY	54.9	26.8	28.1	90.1	CH, Fat clay
▲	SB1-2 @ 2-3.8' BROWN FAT CLAY	53.5	24.0	29.5	94.1	CH, Fat clay

Project No.: 89868.300
Project: FORT CARSON

Client: CORPS OF ENGINEERS
Location: LF-2

Date: 08.01.95

LIQUID AND PLASTIC LIMITS TEST REPORT

RUST ENVIRONMENT & INFRASTRUCTURE

Remarks:

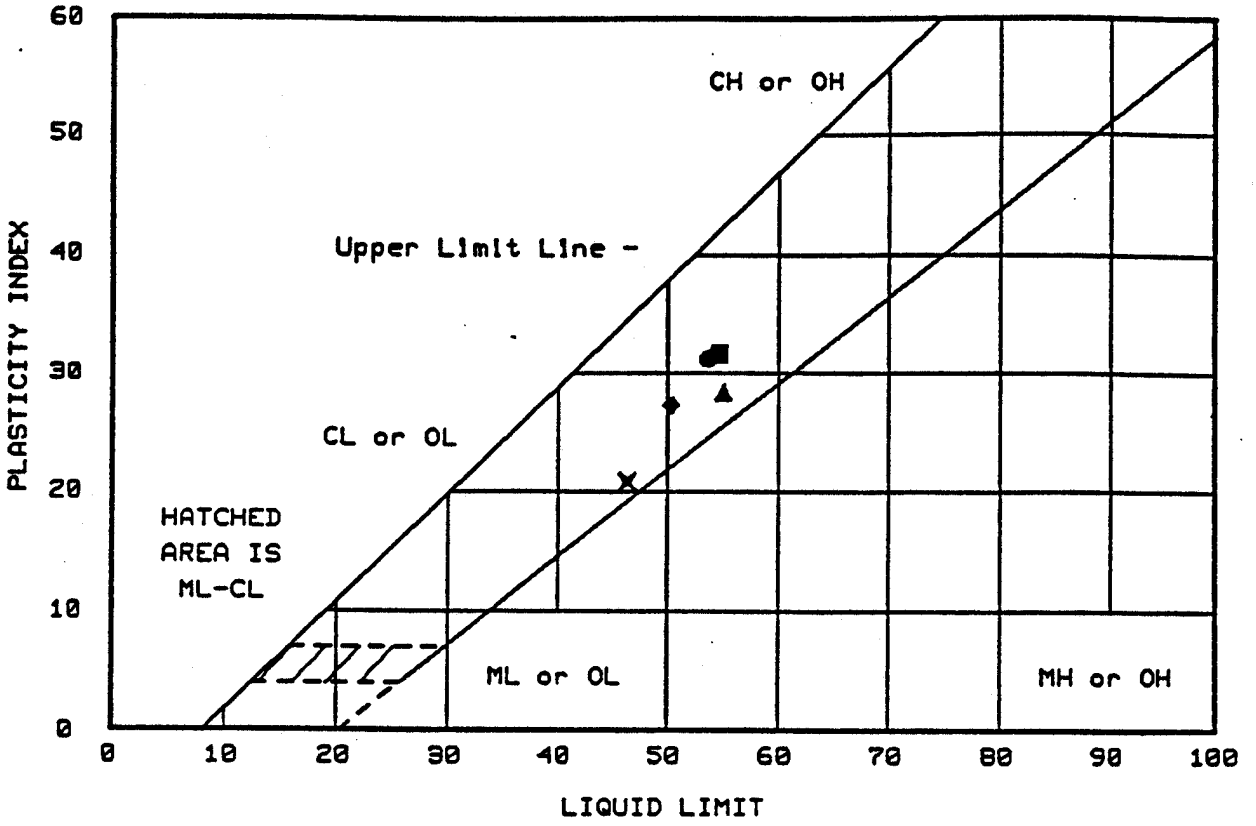
SB1-4 @ 4-6'

SB1-2 @ 2-3.8'

Lab. No.152

Fig. C-8

LIQUID AND PLASTIC LIMITS TEST REPORT



	Location + Description	LL	PL	PI	-200	ASTM D 2487-90
●	SB4-2 @ 2-3.8' BROWN SANDY FAT CLAY	53.7	22.5	31.2	68.0	CH, Sandy fat clay
▲	SB7-2 @ 2-3.9' BROWN FAT CLAY	55.1	26.8	28.3	90.7	CH, Fat clay
■	SB8-2 @ 2-3.5' BROWN FAT CLAY	54.7	23.1	31.6	91.7	CH, Fat clay
◆	SB9-2 @ 2-4' BROWN FAT CLAY	50.4	23.1	27.3	87.4	CH, Fat clay
X	SB11-2 @ 2-4' BROWN LEAN CLAY WITH SAND	46.4	25.6	20.8	81.9	CL, Lean clay with sand

Project No.: 89868.300
Project: FORT CARSON

Client: CORPS OF ENGINEERS
Location: LF-2

Date: 07.28.95

LIQUID AND PLASTIC LIMITS TEST REPORT

RUST ENVIRONMENT & INFRASTRUCTURE

Remarks:

SB4-2 @ 2-3.8'

SB7-2 @ 2-3.9'

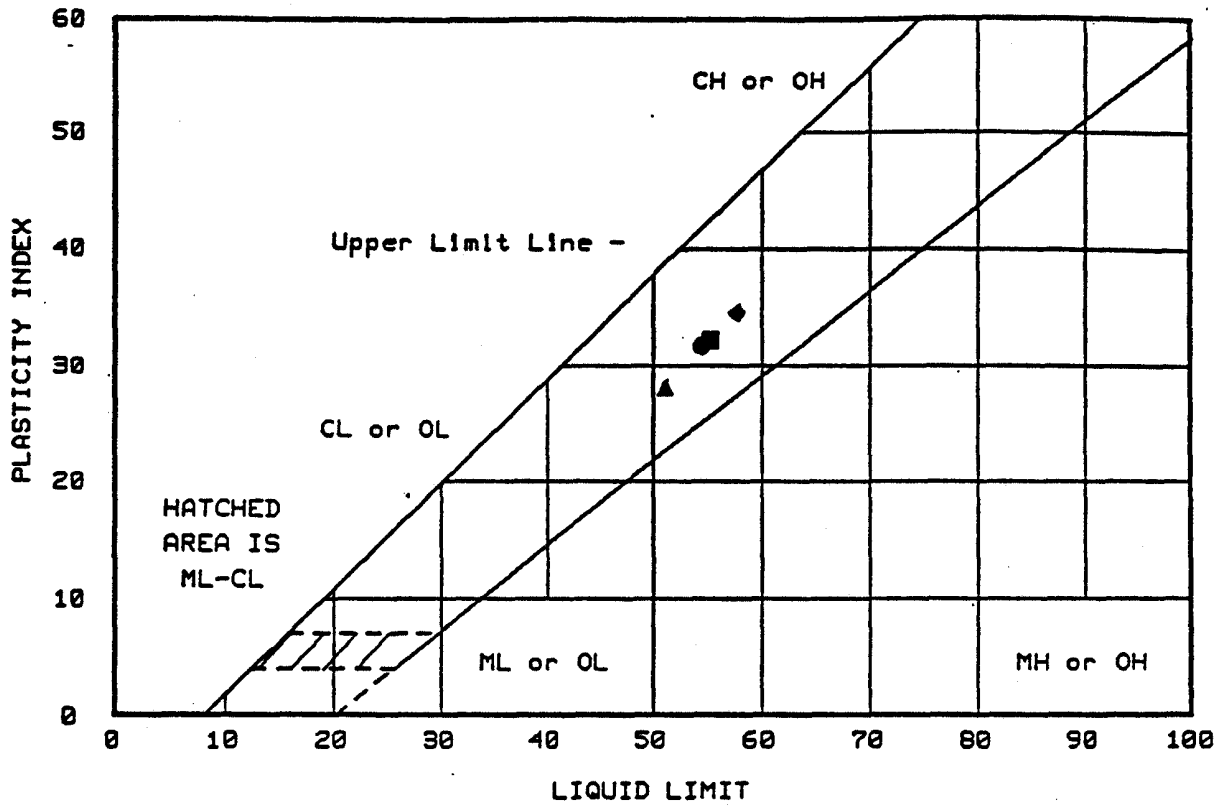
SB8-2 @ 2-3.5'

SB9-2 @ 2-4'

SB11-2 @ 2-4'

Lab. No.141

LIQUID AND PLASTIC LIMITS TEST REPORT



	Location + Description	LL	PL	PI	-200	ASTM D 2487-90
●	SB12-4 @ 4-6' BROWN SANDY FAT CLAY	54.5	22.8	31.7	65.6	CH, Sandy fat clay
▲	SB13-12 @ 12-13.9' BROWN FAT CLAY	51.2	23.1	28.1	85.4	CH, Fat clay
■	SB13-14 @ 14-15.6' BROWN FAT CLAY	55.3	23.1	32.2	86.5	CH, Fat clay
◆	SB10-0 @ 0-1' BROWN FAT CLAY WITH SAND	57.8	23.3	34.5	82.2	CH, Fat clay with sand

Project No.: 89868.300
Project: FORT CARSON

Client: CORPS OF ENGINEERS
Location: LF-2

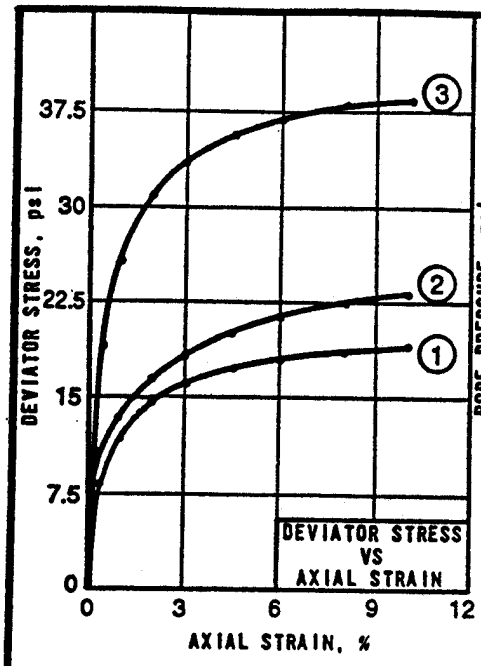
Date: 07.28.95

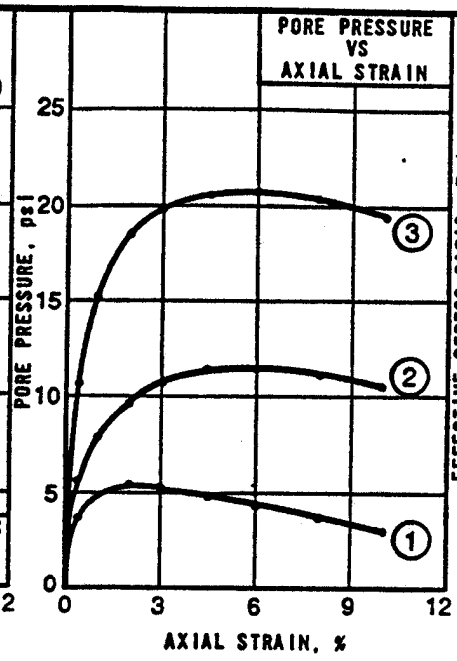
Remarks:
SB12-2 @ 4-6'
SB13-12 @ 12-13.9'
SB13-14'@ 14-15.6'
SB10-0 @ 0-1'

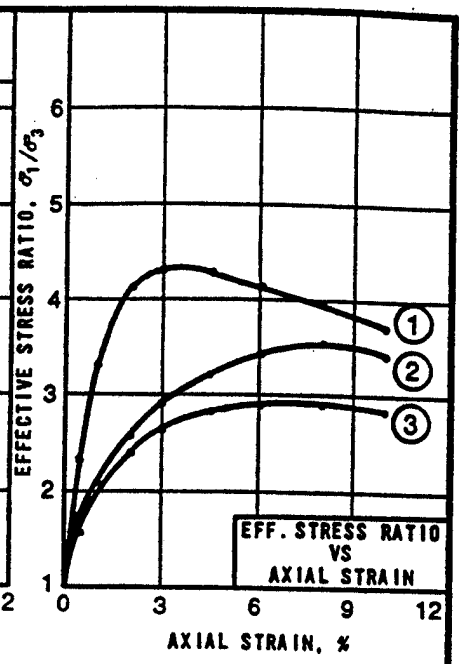
LIQUID AND PLASTIC LIMITS TEST REPORT

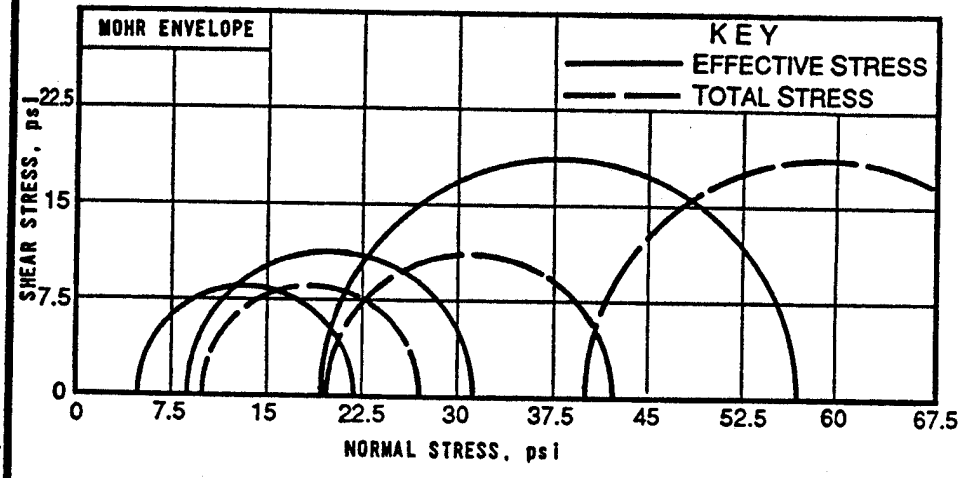
RUST ENVIRONMENT & INFRASTRUCTURE

Lab. No.142



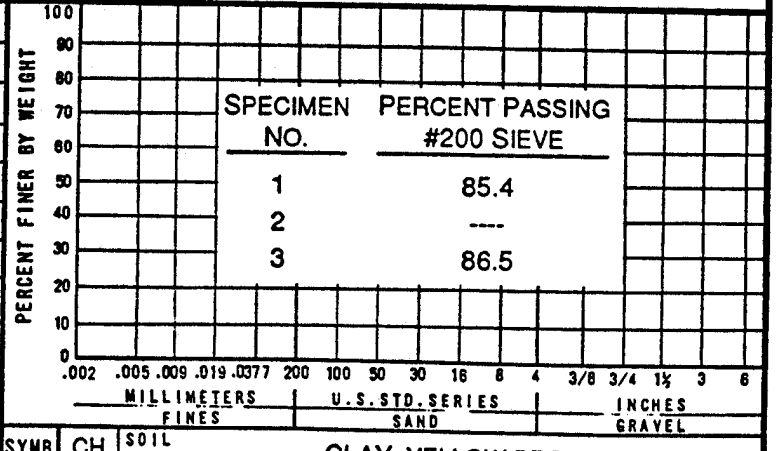






SPECIMEN NO.	VOLUME CHANGE DURING CONSOL., %
1	2.37
2	4.59
3	6.94

	SPECIMEN NO.	1	2	3
INITIAL CONDITION	Water Content,%	26.4	26.7	26.9
	Opt.Water Content,%	----	----	----
	Dry Density,pcf	98.9	98.1	97.4
	Max.Dry Density,pcf	----	----	----
	Void Ratio	0.767	0.781	0.793
	Saturation,%	96	96	95
FINAL CONDITION	Consol.Pressure,psi	10.0	20.0	40.0
	Water Content,%	25.9	25.0	23.9
	Dry Density, pcf	101.3	102.8	104.7
	Void Ratio	0.725	0.699	0.669
	Saturation,%	100	100	100
GENERAL	Specimen Diameter,in	2.88	2.88	2.88
	Back Pressure,psi	70.0	70.0	60.0
	Test Time,hr	2.05	1.97	1.97
	Rate of Strain,%/hr	4.87	5.07	5.07



SPECIMEN NO.	PERCENT PASSING #200 SIEVE
1	85.4
2	----
3	86.5

SYMB	CH	SOIL CLASSIFICATION	CLAY, YELLOW BROWN
LL	see limits data		
PL		SAMPLE LOCATION	SPECIMEN #1: SB13-12, 12-13.9'
PI			SPECIMEN #2 & 3: SB13-14, 14-15.6'
SG	2.8 (est.)	NOTE:	UNDISTURBED TUBE SPECIMENS

RUST

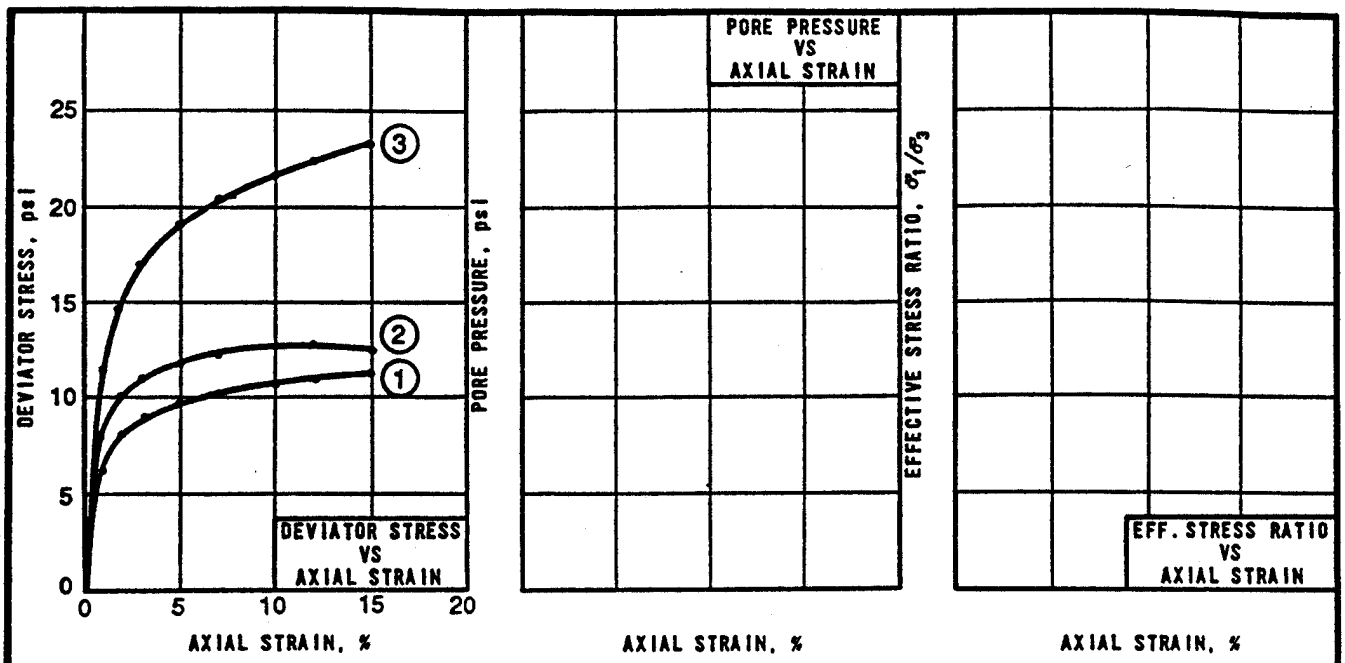
SAN JOSE • CALIFORNIA

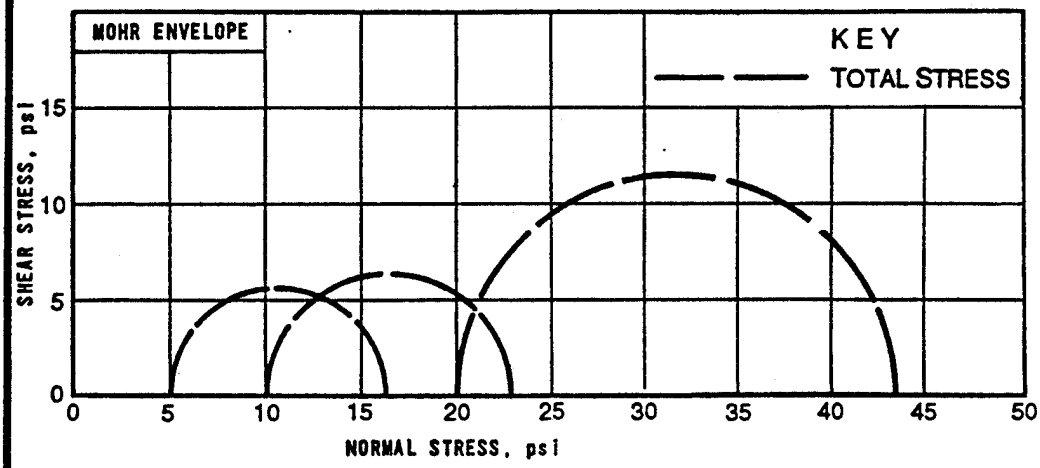
FT. CARSON LANDFILLS

TRIAXIAL TEST RESULTS
CONSOLIDATED UNDRAINED

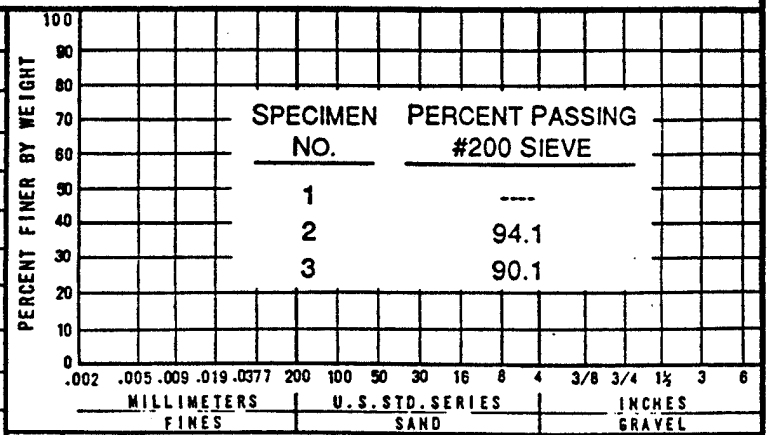
PROJECT NO.	DATE	FIGURE NO.
89868	AUGUST 1995	

LANDFILL NO. LF-2





	SPECIMEN NO.	1	2	3
INITIAL CONDITION	Water Content,%	27.5	26.8	24.8
	Opt.Water Content,%	----	----	----
	Dry Density,pcf	92.8	95.9	97.1
	Max.Dry Density,pcf	----	----	----
	Void Ratio	0.883	0.822	0.799
	Saturation,%	87	91	87
FINAL CONDITION	Confin. Pressure, psi	5.0	10.0	20.0
	Water Content,%	----	----	----
	Dry Density, pcf	----	----	----
	Void Ratio	----	----	----
	Saturation,%	----	----	----
GENERAL	Specimen Diameter,in	2.90	2.90	2.88
	Back Pressure,psi	0	0	0
	Test Time, min.	15	15	15
	Rate of Strain, %/min	1.0	1.0	1.0



SPECIMEN NO.	PERCENT PASSING #200 SIEVE
1	----
2	94.1
3	90.1

SYMB	CH	SOIL CLASSIFICATION	CLAY, YELLOW BROWN
LL	see limits data		
PL		SAMPLE LOCATION	SPECIMEN #1&2: SB1-2, 2-3.8'
PI			SPECIMEN #3: SB1-4, 4-6'
SG	2.8 (est.)	NOTE:	UNDISTURBED TUBE SPECIMENS

RUST

FT. CARSON LANDFILLS

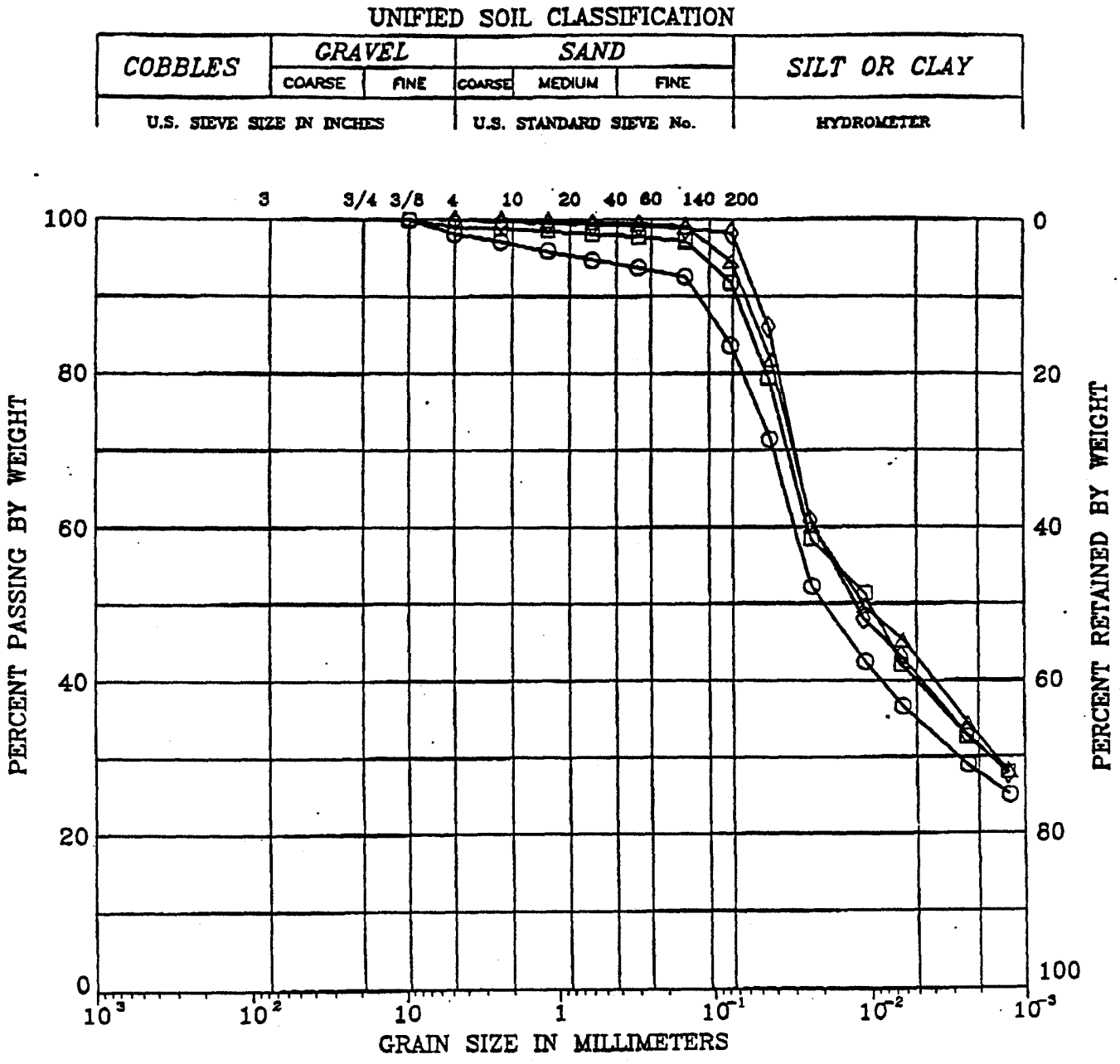
SAN JOSE • CALIFORNIA

TRIAXIAL TEST RESULTS
UNCONSOLIDATED UNDRAINED

PROJECT NO.	DATE	FIGURE NO.
89868	AUGUST 1995	

LANDFILL NO. LF-2

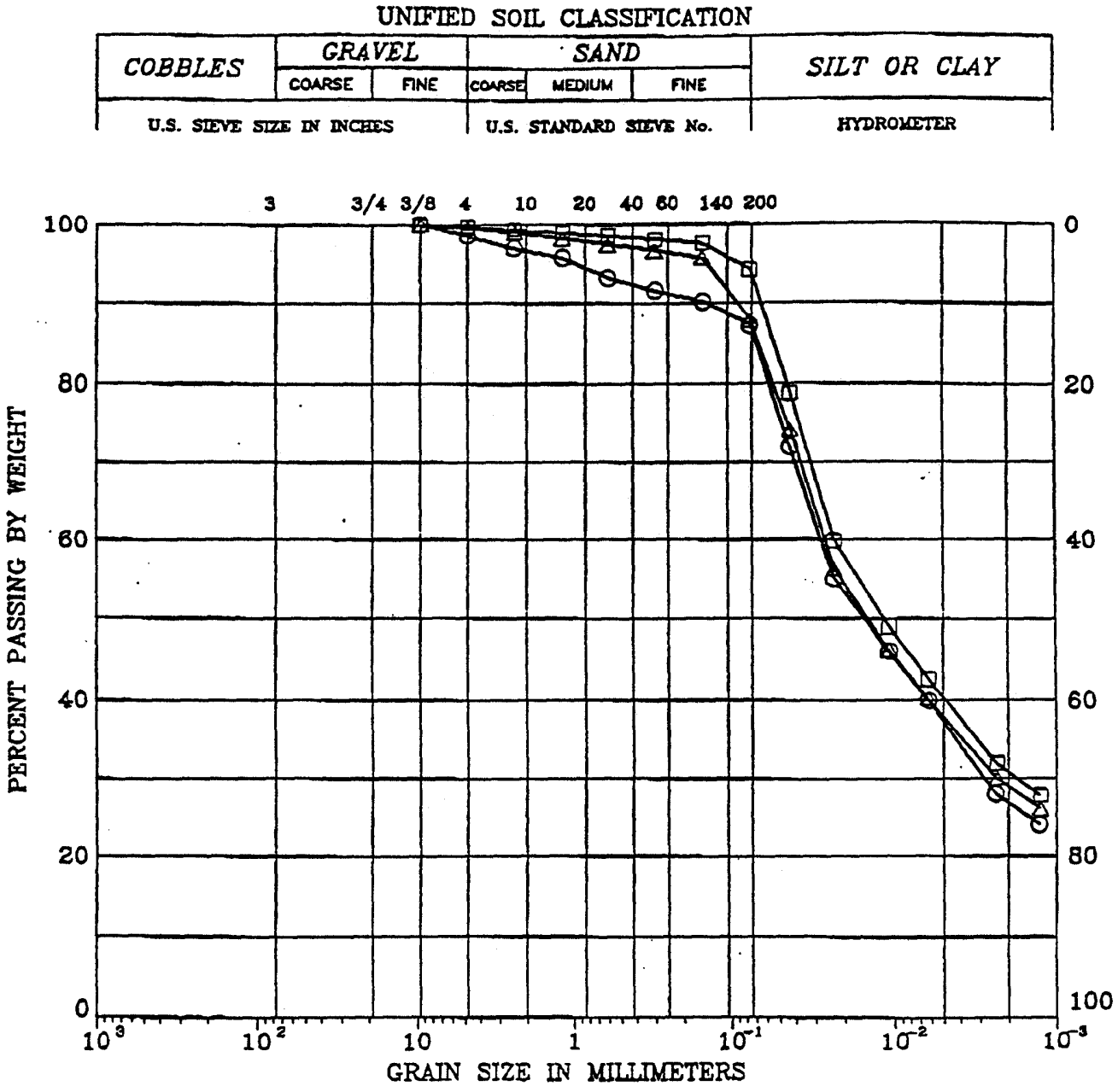
Fig. C-12



SYMBOL	BORING	DEPTH (ft)	LL (%)	PI (%)	DESCRIPTION
○	TS-1A	0-5.5	40	23	lean CLAY w/sand, yellow brown (CL)
□	TS-2A	0-2	43	24	lean CLAY, yellow brown (CL)
△	TS-2B	3-5.5	43	26	lean CLAY, yellow brown (CL)
◇	TS-3A	0-6	43	25	lean CLAY, yellow brown (CL)

Remark : December 1995

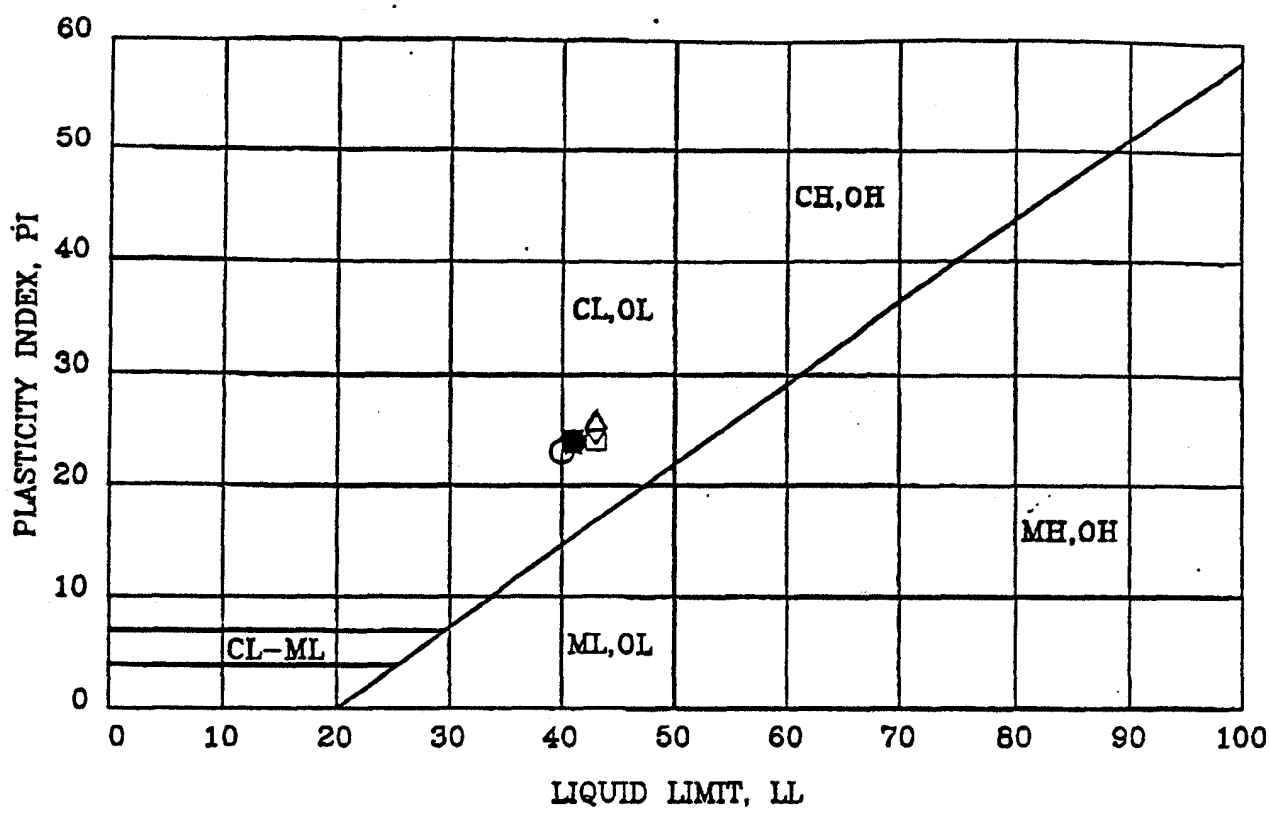
Project No. 89868	Fort Carson
RUST ENVIRONMENT & INFRASTRUCTURE	GRAIN SIZE DISTRIBUTION OF POTENTIAL BORROW SOILS Figure No. C-13



SYMBOL	BORING	DEPTH (ft)	LL (%)	PI (%)	DESCRIPTION
○	TS-4A	5	41	24	lean CLAY, yellow brown (CL)
□	TS-5A	5	41	24	lean CLAY, yellow brown (CL)
△	TS-6A	5	41	24	lean CLAY, yellow brown (CL)

Remark : December 1995

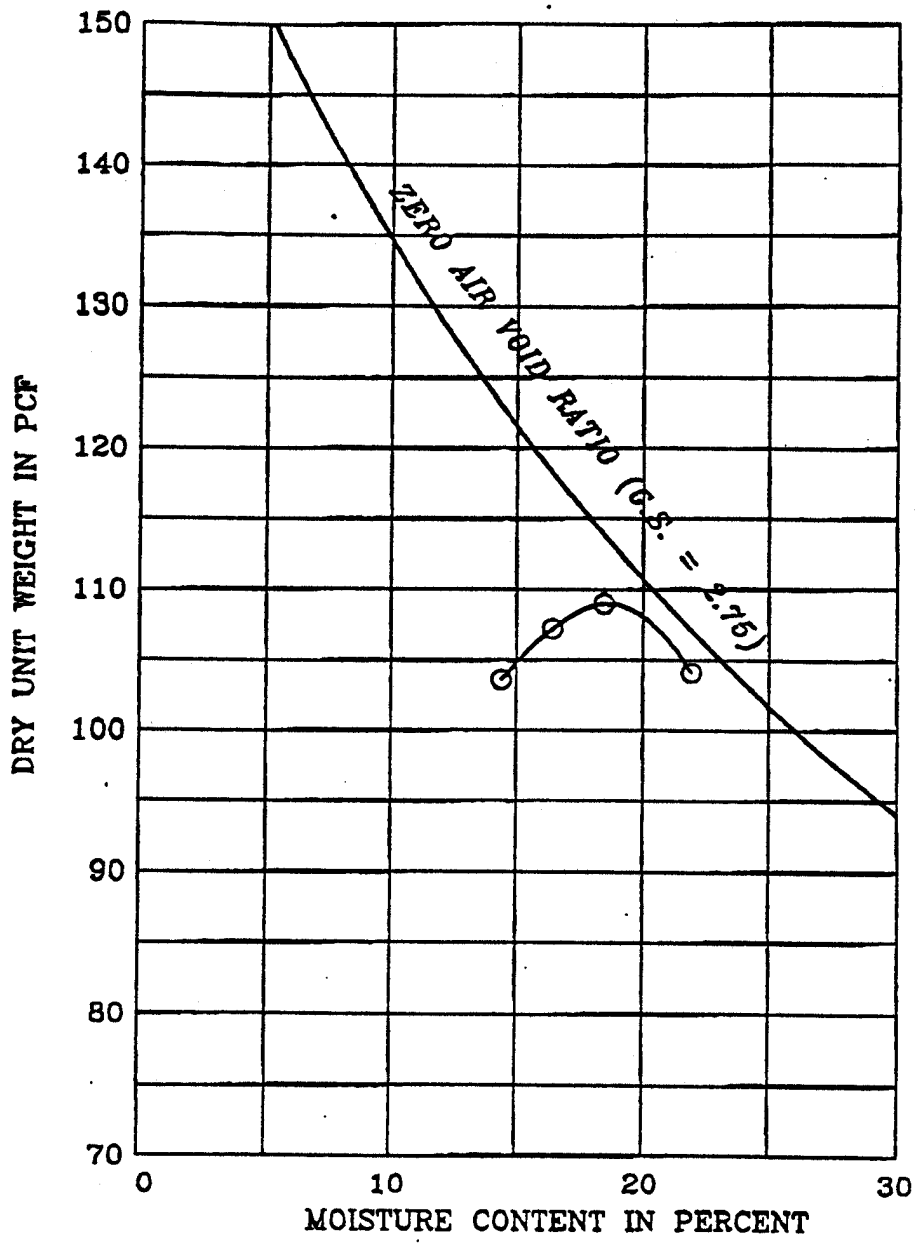
Project No. 89868	Fort Carson
RUST ENVIRONMENT & INFRASTRUCTURE	GRAIN SIZE DISTRIBUTION OF POTENTIAL BORROW SOILS — Figure No. C-14



SYMBOL	BORING	DEPTH (ft)	MC (%)	LL (%)	PL (%)	PI (%)	LI (-)	DESCRIPTION
○	TS-1A	0-5.5	11.0	40	17	23	-.26	lean CLAY w/sand, yel brn (CL)
□	TS-2A	0-2	10.2	43	19	24	-.36	lean CLAY, yellow brown (CL)
△	TS-2B	3-5.5	10.5	43	17	26	-.25	lean CLAY, yellow brown (CL)
◇	TS-3A	0-6	15.1	43	18	25	-.11	lean CLAY, yellow brown (CL)
☆	TS-4A	5	14.4	41	17	24	-.10	lean CLAY, yellow brown (CL)
●	TS-5A	5	11.0	41	17	24	-.25	lean CLAY, yellow brown (CL)
■	TS-6A	5	12.0	41	17	24	-.20	lean CLAY, yellow brown (CL)

Remark : December 1995

Project No. 89868	Fort Carson
RUST ENVIRONMENT & INFRASTRUCTURE	PLASTICITY CHART OF POTENTIAL BORROW SOILS — Figure No. C-15



SYMBOL	SAMPLE LOCATION	DEPTH (ft)	DESCRIPTION	TEST METHOD	OPTIMUM MOISTURE (%)	MAXIMUM DRY DENSITY (pcf)
O	TS-3A	0-6	lean CLAY, yel brown (CL)	D698-91B	18.4	109.0

Remark : December 1995

Project No. 89868	Fort Carson
RUST ENVIRONMENT & INFRASTRUCTURE	COMPACTION TEST OF POTENTIAL BORROW SOILS — Figure No. C-16

ATTACHMENT 1

Lab Results for Cap Verification Test (CVT) Borings

PERMEABILITY TEST RESULTS

PROJECT : FORT CARSON - LANDFILL 2
PROJECT NO. : 55253.000

Sample	Initial		As Tested		Consolidation Pressure (psi)	Coefficient of Permeability (cm/sec)
	Dry Density (pcf)	Water Content (%)	Dry Density (pcf)	Water Content (%)		
CVT 1-0 0'-2'	110.7	12.9	110.4	21.6	4.0	3.0×10^{-6}
CVT 1-2 2'-4'	93.4	15.7	94.1	24.5	4.0	2.8×10^{-5}
CVT 2-0 0'-2'	108.8	17.0	107.5	23.1	4.0	1.1×10^{-7}
CVT 2-7 7'-9'	99.3	17.7	98.9	27.4	4.0	1.1×10^{-6}
CVT 3-3 3'-5'	87.0	15.7	87.8	26.2	4.0	5.3×10^{-7}
CVT 4-3 3'-5'	113.4	11.5	113.8	17.2	4.0	4.0×10^{-7}
CVT 6-3 3'-5'	97.8	19.9	98.0	28.1	4.0	1.4×10^{-4}
CVT 7-3 3'-5'	88.4	19.3	88.8	28.2	4.0	1.0×10^{-4}

PERMEABILITY TEST RESULTS

PROJECT : FORT CARSON - LANDFILL 2
PROJECT NO. : 55253.000

Sample	Initial		As Tested		Consolidation Pressure (psi)	Coefficient of Permeability (cm/sec)
	Dry Density (pcf)	Water Content (%)	Dry Density (pcf)	Water Content (%)		
CVT 8-6 6'-8'	97.3	24.7	97.3	26.5	4.0	4.0×10^{-7}
CVT 9-4 4'-6'	101.7	15.2	102.2	24.0	4.0	4.6×10^{-6}
CVT 10-4.5 4.5'-6.5'	101.5	16.6	102.0	25.9	4.0	1.7×10^{-6}
CVT 11-3.5 3.5'-5.5'	92.1	25.1	91.8	35.0	4.0	3.7×10^{-8}
CVT 12-3 3'-5'	84.8	28.3	86.5	35.3	4.0	7.6×10^{-6}
CVT 13-2 2'-4'	93.6	22.7	94.1	29.8	4.0	2.4×10^{-4}
CVT 14-3 3'-5'	95.4	28.3	95.4	31.6	4.0	6.0×10^{-8}
CVT 15-3 3'-5'	100.9	24.4	101.4	25.8	4.0	6.1×10^{-8}

PERMEABILITY TEST RESULTS

PROJECT : FORT CARSON - LANDFILL 2
PROJECT NO. : 55253.000

Sample	Initial		As Tested		Consolidation Pressure (psi)	Coefficient of Permeability (cm/sec)
	Dry Density (pcf)	Water Content (%)	Dry Density (pcf)	Water Content (%)		
CVT 16-3 3'-5'	106.2	21.5	106.0	23.8	4.0	1.5×10^{-8}
CVT 18-2 2'-4'	93.7	15.0	94.3	30.1	4.0	4.5×10^{-5}
CVT 18-7 7'-9'	95.4	25.1	95.4	30.7	4.0	1.8×10^{-7}
CVT 19-4 4'-6'	88.63	29.58	88.63	----	4.0	3.9x10-5
CVT 20-1.5 1.5'-3.5'	104.4	18.0	104.4	27.4	4.0	3.0×10^{-8}
CVT 21-2 2'-3.5'	92.1	17.5	92.7	31.4	4.0	9.2×10^{-5}
CVT 22-2 2'-4'	108.0	17.8	108.0	19.9	4.0	2.8×10^{-8}
CVT 22-6 6'-8' Not Testable	----	----	----	----	----	----

PERMEABILITY TEST RESULTS

PROJECT : FORT CARSON - LANDFILL 2
PROJECT NO. : 55253.000

Sample	Initial		As Tested		Consolidation Pressure (psi)	Coefficient of Permeability (cm/sec)
	Dry Density (pcf)	Water Content (%)	Dry Density (pcf)	Water Content (%)		
CVT 23-2 2'-4'	94.6	21.4	95.3	27.6	4.0	$1.2x10^{-4}$
CVT 23-7 7'-9'	103.1	18.4	103.1	21.9	4.0	$5.8x10^{-8}$
CVT 24-1 1'-3'	88.0	21.2	88.7	32.0	4.0	$1.2x10^{-3}$
CVT 25-3.5 3.5'-5.5'	98.1	18.8	98.6	26.7	4.0	$4.2x10^{-6}$
CVT 25-6.5 6.5'-8.5' **Not Testable**	----	----	----	----	----	----
CVT 26-2 2'-4'	89.9	17.7	90.7	32.7	4.0	$8.5x10^{-5}$
CVT 27-3 3'-5'	88.5	24.5	88.5	32.0	4.0	$1.7x10^{-7}$
CVT 28-4 4'-6'	109.5	11.7	109.5	18.5	4.0	$1.2x10^{-8}$

PERMEABILITY TEST RESULTS

PROJECT : FORT CARSON - LANDFILL 2
PROJECT NO. : 55253.000

Sample	Initial		As Tested		Consolidation Pressure (psi)	Coefficient of Permeability (cm/sec)
	Dry Density (pcf)	Water Content (%)	Dry Density (pcf)	Water Content (%)		
CVT 29-2 2'-4'	116.4	12.4	116.4	16.4	4.0	3.8×10^{-8}
----	----	----	----	----	----	----
----	----	----	----	----	----	----
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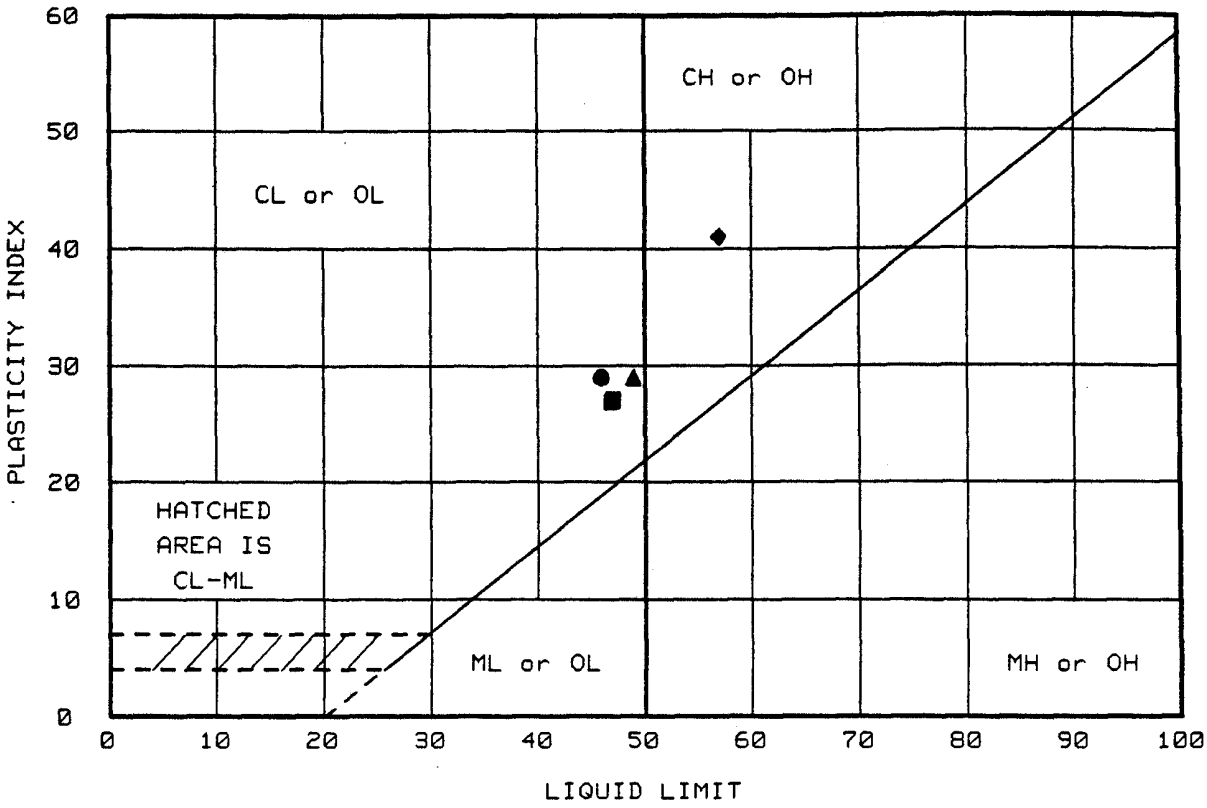
LIQUID AND PLASTIC LIMITS TEST REPORT



	Location + Description	LL	PL	PI	-200	ASTM D 2487-90
●	CVT1-0 @ 0'-1' BROWN LEAN CLAY WITH SAND	46	17	29	83.6	CL, Lean clay with sand
▲	CVT1-2 @ 2'-4' BROWN LEAN CLAY	49	20	29	90.3	CL, Lean clay
■	CVT2-7 @ 7'-9' BROWN LEAN CLAY	47	20	27	89.8	CL, Lean clay
◆	CVT28-4 @ 4'-6' BROWN FAT CLAY	57	16	41	91.7	CH, Fat clay

Project No.: 55253
Project: FORT CARSON

Client: USACE
Location: FORT CARSON, COLORADO

Date: 4.3.96

LIQUID AND PLASTIC LIMITS TEST REPORT

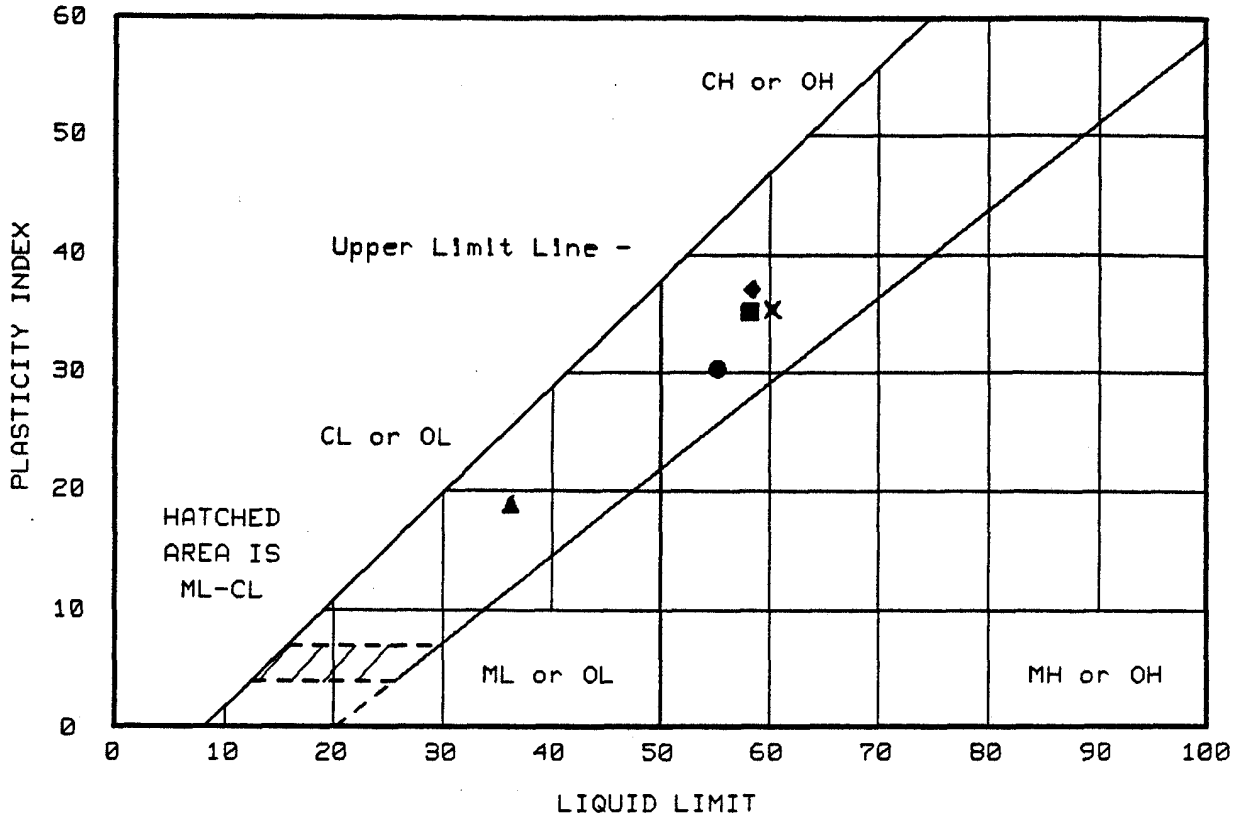
RUST ENVIRONMENT & INFRASTRUCTURE

Remarks:

TESTED BY MCM

Fig. No. _____

LIQUID AND PLASTIC LIMITS TEST REPORT



	Location + Description	LL	PL	PI	-200	USCS	AASHTO
●	2-0 @ 0'- 2' BROWN AND GRAY FAT CLAY WITH SAND	55.3	25.0	30.3	82.7	CH	A-7-6(27)
▲	4-3 @ 3'- 5' BROWN AND GRAY SANDY LEAN CLAY	36.3	17.5	18.8	63.4	CL	A-6(9)
■	6-3 @ 3'- 5' BROWN AND GRAY FAT CLAY WITH SAND	58.3	23.1	35.2	74.0	CH	A-7-6(26)
◆	9-4 @ 4'- 6' BROWN AND GRAY FAT CLAY WITH SAND	58.5	21.4	37.1	78.6	CH	A-7-6(30)
X	10-4.5 @ 4.5'- 6.5' BROWN AND GRAY FAT CLAY	60.3	24.9	35.4	92.8	CH	A-7-6(37)

Project No.: 55253.000
Project: FORT CARSON

Client: CORPS OF ENGINEERS
Location:

Date: 03.15.96

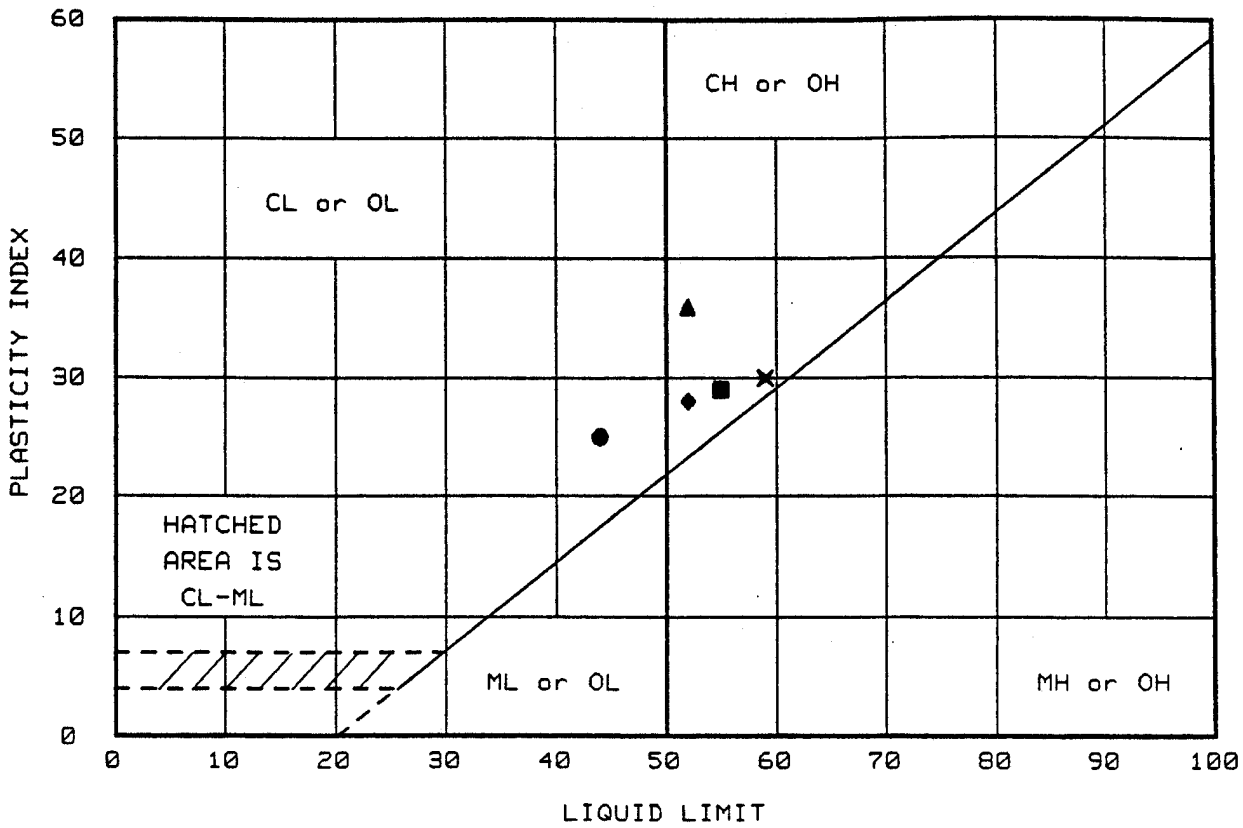
LIQUID AND PLASTIC LIMITS TEST REPORT

RUST ENVIRONMENT & INFRASTRUCTURE

Remarks:
2-0 @ 0'- 2'
4-3 @ 3'- 5'
6-3 @ 3'- 5'
9-4 @ 4'- 6'
10-4.5 @ 4.5'- 6.5'

Lab. No.182

LIQUID AND PLASTIC LIMITS TEST REPORT



	Location + Description	LL	PL	PI	-200	ASTM D 2487-90
●	CVT11-3.5 @ 3.5'-5.5' BROWN LEAN CLAY W/SAND	44	19	25	83.5	CL, Lean clay with sand
▲	CVT3-3 @ 3'-5' BROWN FAT CLAY	52	16	36	88.5	CH, Fat clay
■	CVT8-6 @ 6'-8' BROWN FAT CLAY	55	26	29	93.7	CH, Fat clay
◆	CVT12-3 @ 3'-5' BROWN FAT CLAY	52	24	28	90.5	CH, Fat clay
×	CVT7-3 @ 3'-5' BROWN FAT CLAY	59	29	30	90.9	CH, Fat clay

Project No.: 55253
Project: FORT CARSON

Client: USACE
Location: FORT CARSON, COLORADO

Date: 4.3.96

Remarks:

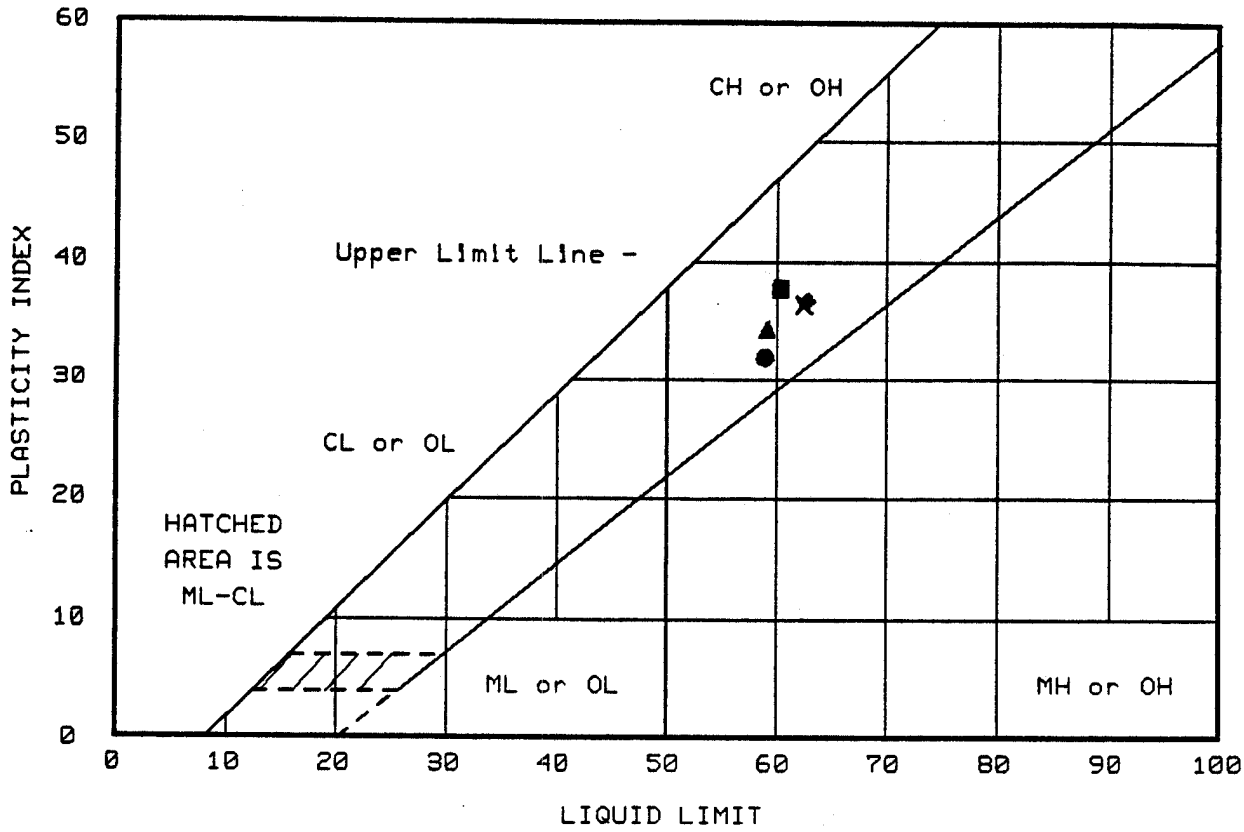
TESTED BY MCM

LIQUID AND PLASTIC LIMITS TEST REPORT

RUST ENVIRONMENT & INFRASTRUCTURE

Fig. No. _____

LIQUID AND PLASTIC LIMITS TEST REPORT



	Location + Description	LL	PL	PI	-200	USCS	AASHTO
●	13-2 @ 2'- 4' BROWN AND GRAY FAT CLAY WITH SAND	59.0	27.1	31.9	75.4	CH	A-7-6(25)
▲	15-3 @ 3'- 5' BROWN AND GRAY FAT CLAY WITH SAND	59.2	24.9	34.3	77.5	CH	A-7-6(28)
■	16-3 @ 3'- 5' BROWN AND GRAY FAT CLAY	60.4	22.7	37.7	85.2	CH	A-7-6(35)
◆	18-2 @ 2'- 4' BROWN AND GRAY FAT CLAY WITH SAND	62.8	26.1	36.7	82.0	CH	A-7-6(33)
X	21-2 @ 2'- 3.5' BROWN AND GRAY FAT CLAY	62.5	26.1	36.4	90.0	CH	A-7-6(37)

Project No.: 55253.000
Project: FORT CARSON

Client: CORPS OF ENGINEERS
Location:

Date: 03.15.96

LIQUID AND PLASTIC LIMITS TEST REPORT

RUST ENVIRONMENT & INFRASTRUCTURE

Remarks:

13-2 @ 2'- 4'

15-3 @ 3'- 5'

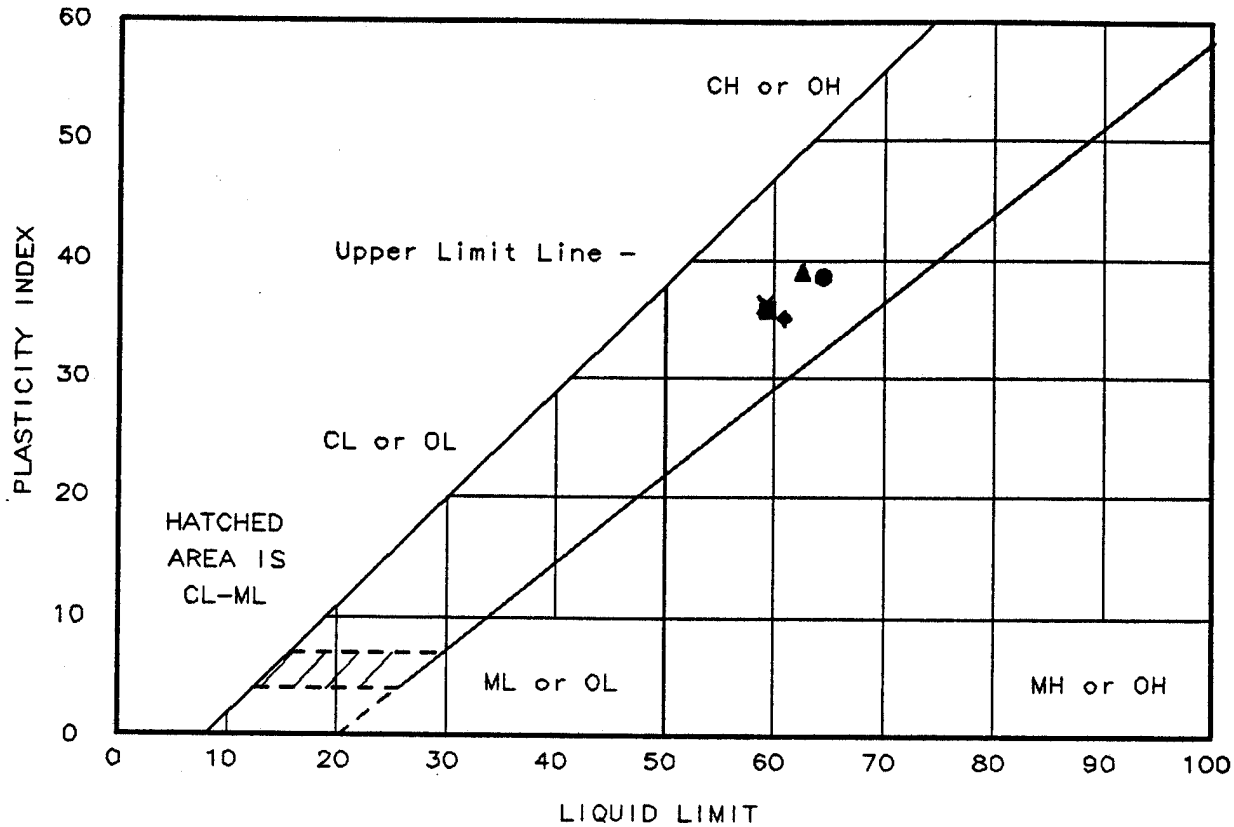
16-3 @ 3'- 5'

18-2 @ 2'- 4'

21-2 @ 2'- 3.5'

Lab. No.183

LIQUID AND PLASTIC LIMITS TEST REPORT



	Location + Description	LL	PL	PI	-200	USCS	AASHTO
●	CVT 14.3 FAT CLAY WITH SAND	64.5	25.9	38.6	81.7	CH	A-7-6(35)
▲	CVT 18.7 @ 7'- 9' FAT CLAY	62.6	23.6	39	95.6	CH	A-7-6(43)
■	CVT 19.4 FAT CLAY	59.4	23.6	35.8	89.9	CH	A-7-6(36)
◆	CVT 20-1.5 FAT CLAY WITH SAND	60.9	25.8	35.1	81.5	CH	A-7-6(31)
X	CVT 22-2 @ 2'- 4' FAT CLAY WITH SAND	59.2	22.9	36.3	85.0	CH	A-7-6(33)

Project No.: 55253.000
Project: FORT CARSON

Client: SAN JOSE
Location:

Date: 04.05.96

LIQUID AND PLASTIC LIMITS TEST REPORT

RUST ENVIRONMENT & INFRASTRUCTURE

Remarks:

CVT 14.3

CVT 18.7 @ 7'- 9'

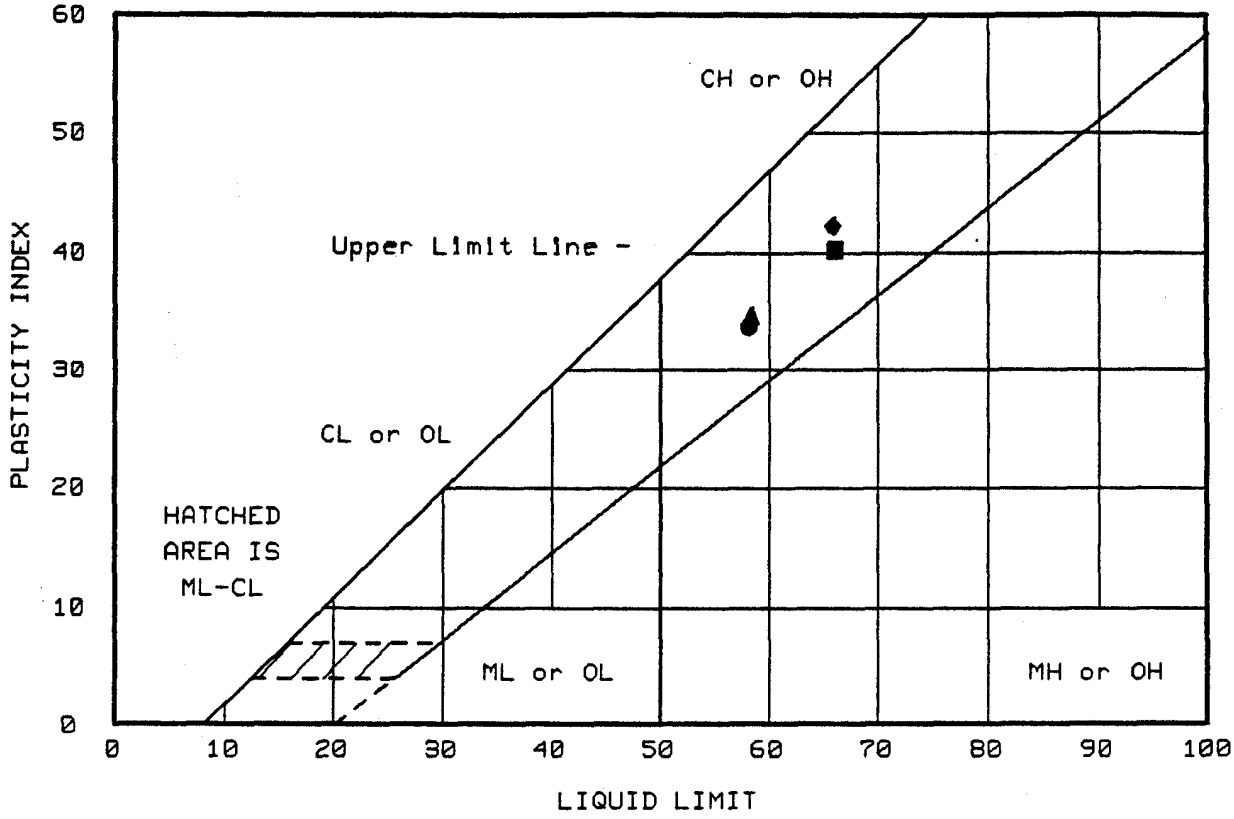
CVT 19.4

CVT 20-1.5

CVT 22-2 @ 2'- 4'

Lab. No.9

LIQUID AND PLASTIC LIMITS TEST REPORT



	Location + Description	LL	PL	PI	-200	USCS	AASHTO
●	23-2 @ 2'- 4' BROWN AND GRAY FAT CLAY WITH GRAVEL	58.2	24.5	33.7	71.5	CH	A-7-6(24)
▲	24-1 @ 1'- 3' GRAY FAT CLAY	58.4	23.7	34.7	94.2	CH	A-7-6(37)
■	25-3.5 @ 3.5'- 5.5' GRAY FAT CLAY	66.1	25.9	40.2	91.2	CH	A-7-6(41)
◆	26-2 @ 2'- 4' GRAY FAT CLAY	65.9	23.7	42.2	89.8	CH	A-7-6(42)

Project No.: 55253.000
Project: FORT CARSON

Client: CORPS OF ENGINEERS
Location:

Date: 03.15.96

LIQUID AND PLASTIC LIMITS TEST REPORT

RUST ENVIRONMENT & INFRASTRUCTURE

Remarks:

23-2 @ 2'- 4'

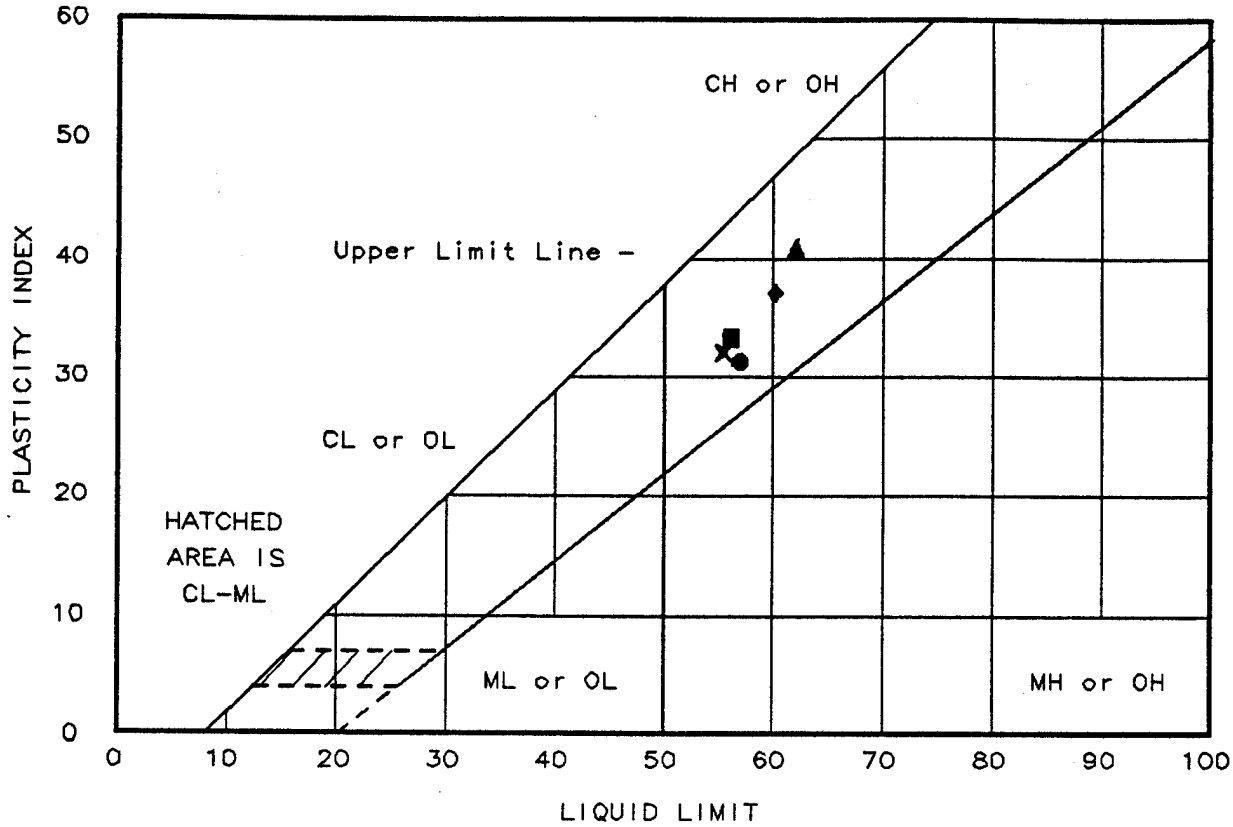
24-1 @ 1'- 3'

25-3.5 @ 3.5'- 5.5'

26-2 @ 2'- 4'

Lab. No.184

LIQUID AND PLASTIC LIMITS TEST REPORT



	Location + Description	LL	PL	PI	-200	USCS	AASHTO
●	CVT 22-6 @ 6'- 8' FAT CLAY WITH SAND	57.0	25.7	31.3	71.7	CH	A-7-6(23)
▲	CVT 23.7 @ 7'- 9' FAT CLAY WITH SAND	62.1	21.2	40.9	81.3	CH	A-7-6(35)
■	CVT 25-6.5 @ 6.5'- 8.5' SANDY FAT CLAY	56.2	22.9	33.3	69.6	CH	A-7-6(22)
◆	CVT 27.3 @ 3'- 5' FAT CLAY	60.2	23.1	37.1	96.8	CH	A-7-6(41)
X	CVT 29-2 @ 2'- 4' FAT CLAY WITH SAND	55.5	23.4	32.1	81.2	CH	A-7-6(27)

Project No.: 55253.000
Project: FORT CARSON

Client: SAN JOSE
Location:

Date: 04.05.96

LIQUID AND PLASTIC LIMITS TEST REPORT

RUST ENVIRONMENT & INFRASTRUCTURE

Remarks:

CVT 22-6 @ 6'- 8'

CVT 23.7 @ 7'- 9'

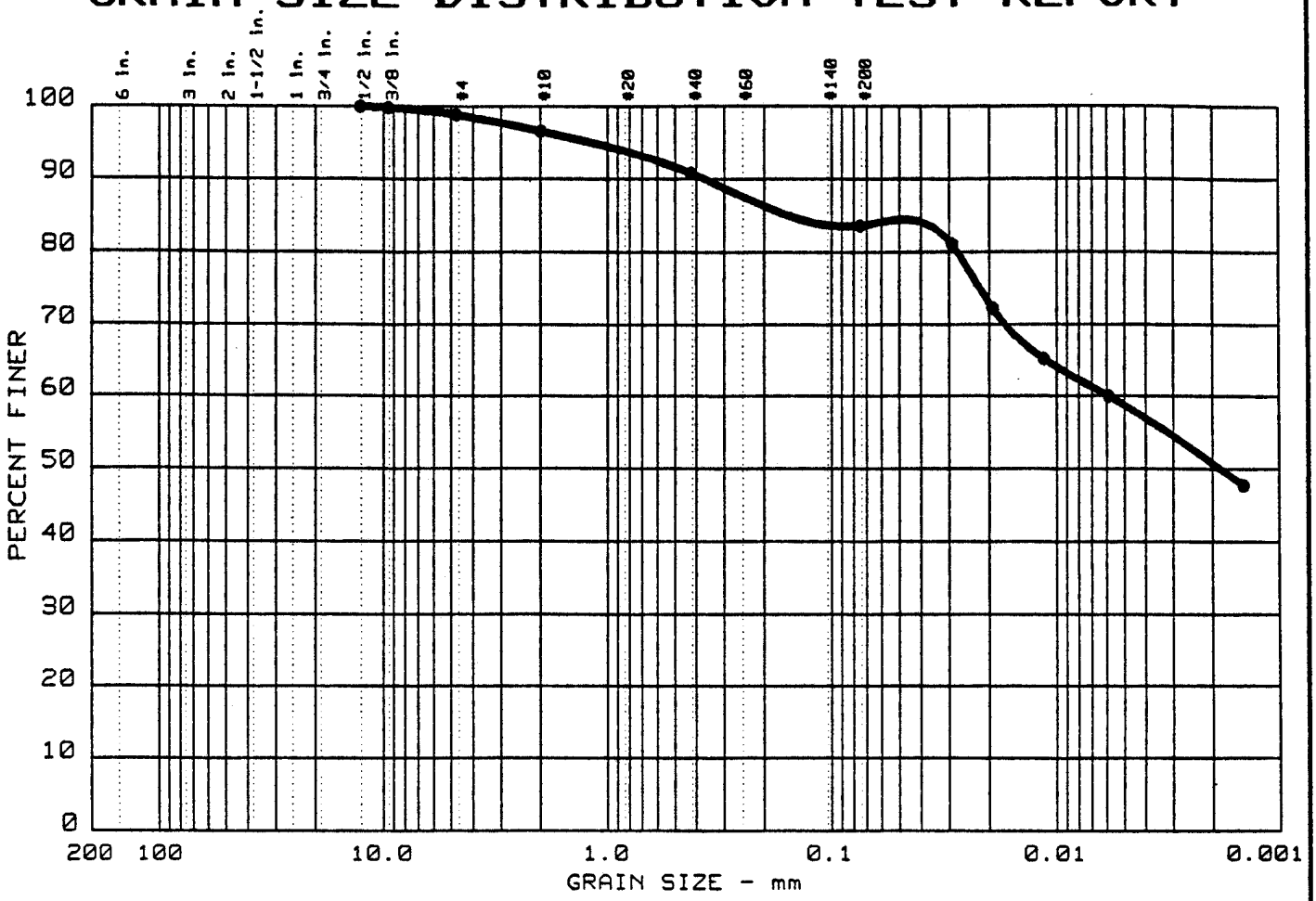
CVT 25-6.5 @ 6.5'- 8.5'

CVT 27.3 @ 3'- 5'

CVT 29-2 @ 2'- 4'

Lab. No.10

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	6	0.0	1.1	15.3	24.8	58.8

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	46	29	0.150		0.0018					

MATERIAL DESCRIPTION	USCS	AASHTO
● BROWN LEAN CLAY W/ SAND	CL	

Project No.: 55253
Project: FORT CARSON
● Location: CVT1-0 @ 0'-2'

Date: 4.3.96

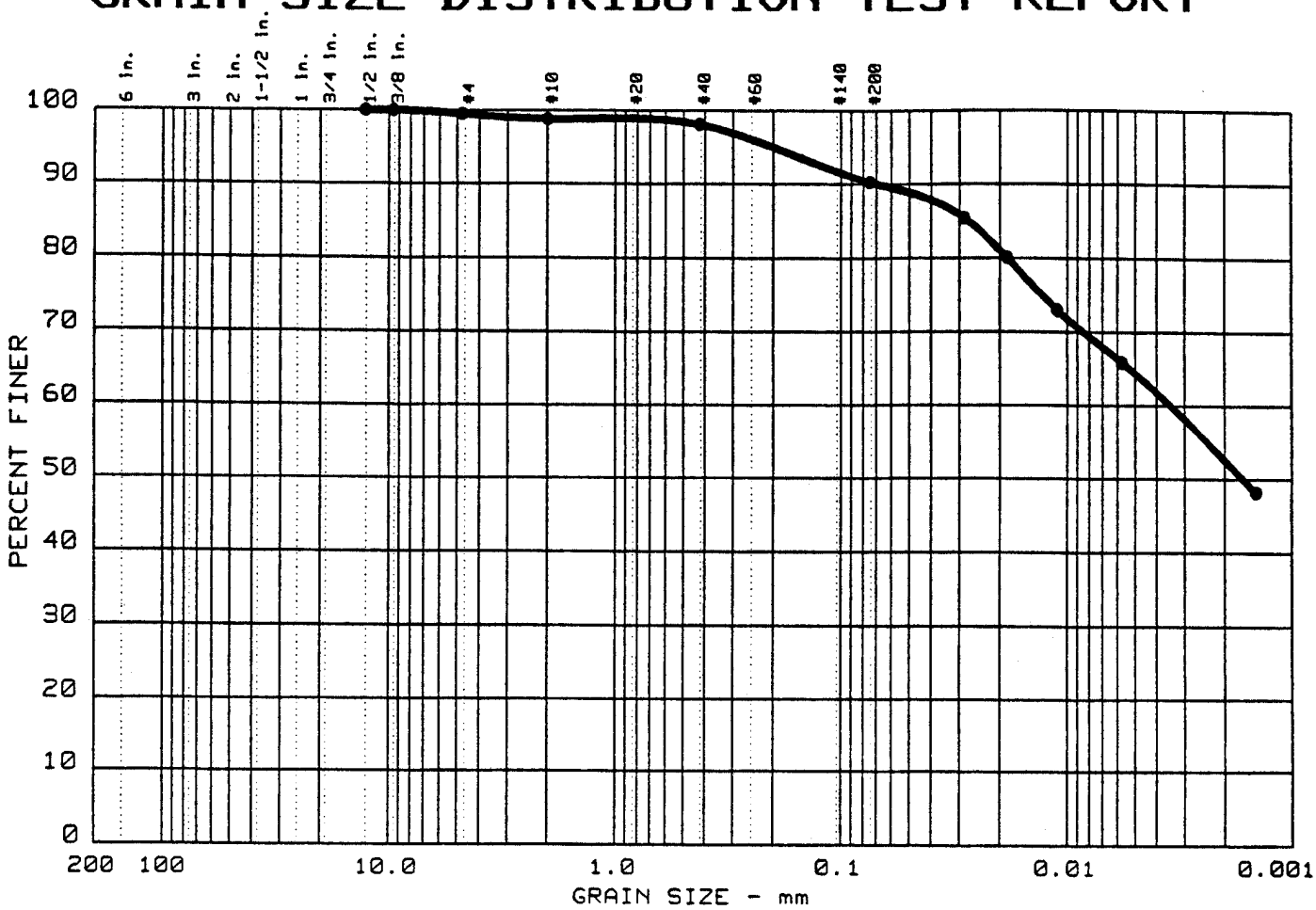
Remarks:
TESTED BY MCM

GRAIN SIZE DISTRIBUTION TEST REPORT

RUST ENVIRONMENT & INFRASTRUCTURE

Fig. No.: _____

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	7	0.0	0.5	9.2	25.9	64.4

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	49	29			0.0016					

MATERIAL DESCRIPTION	USCS	AASHTO
● BROWN LEAN CLAY	CL	

Project No.: 55253
Project: FORT CARSON
● Location: CVT1-2 @ 2'-4'

Date: 4.3.96

Remarks:

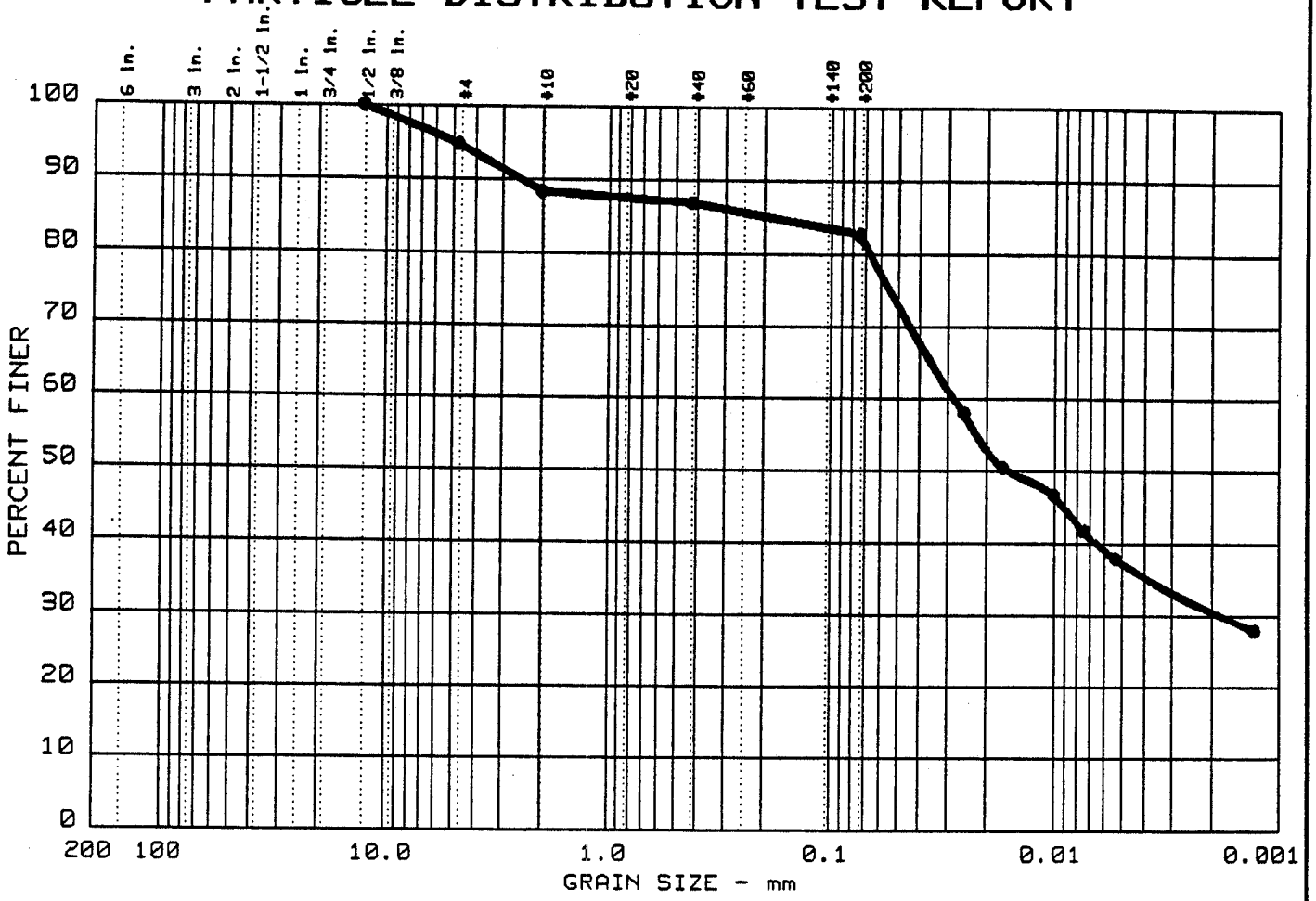
TESTED BY MCM

GRAIN SIZE DISTRIBUTION TEST REPORT

RUST ENVIRONMENT & INFRASTRUCTURE

Fig. No.: _____

PARTICLE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	5.3	12.0	52.2	30.5	CH	55.3	30.3

SIEVE inches size	PERCENT FINER ●		
0.5	100.0		
GRAIN SIZE			
D_{60} D_{30} D_{10}	0.002		
COEFFICIENTS			
C_c C_u			

SIEVE number size	PERCENT FINER ●		
4	94.7		
10	88.3		
40	86.9		
200	82.7		

Sample information:

● 2-0 @ 0'- 2'
BROWN AND GRAY
FAT CLAY WITH SAND

Remarks:

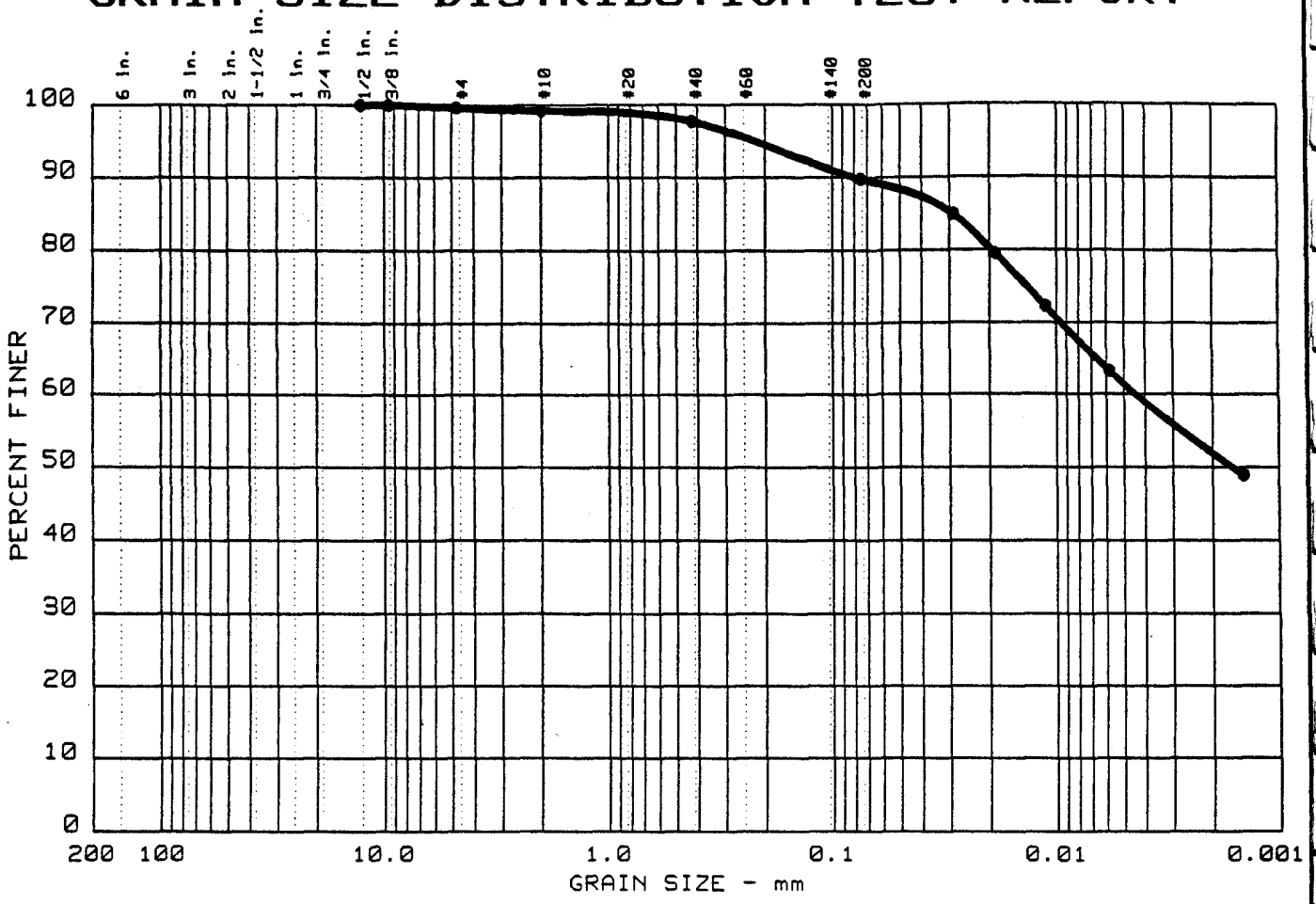
RAN BY: KLR
SANJOSE GR01

RUST ENVIRONMENT & INFRASTRUCTURE

Project No.: 55253.000
Project: CORPS OF ENGINEERS

Date: 03.13.96 Lab. No. ____

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	8	0.0	0.4	9.8	28.4	61.4

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	47	27			0.0016					

MATERIAL DESCRIPTION	USCS	AASHTO
● BROWN LEAN CLAY	CL	

Project No.: 55253
Project: FORT CARSON
● Location: CVT2-7 @ 7'-9'

Date: 4.3.96

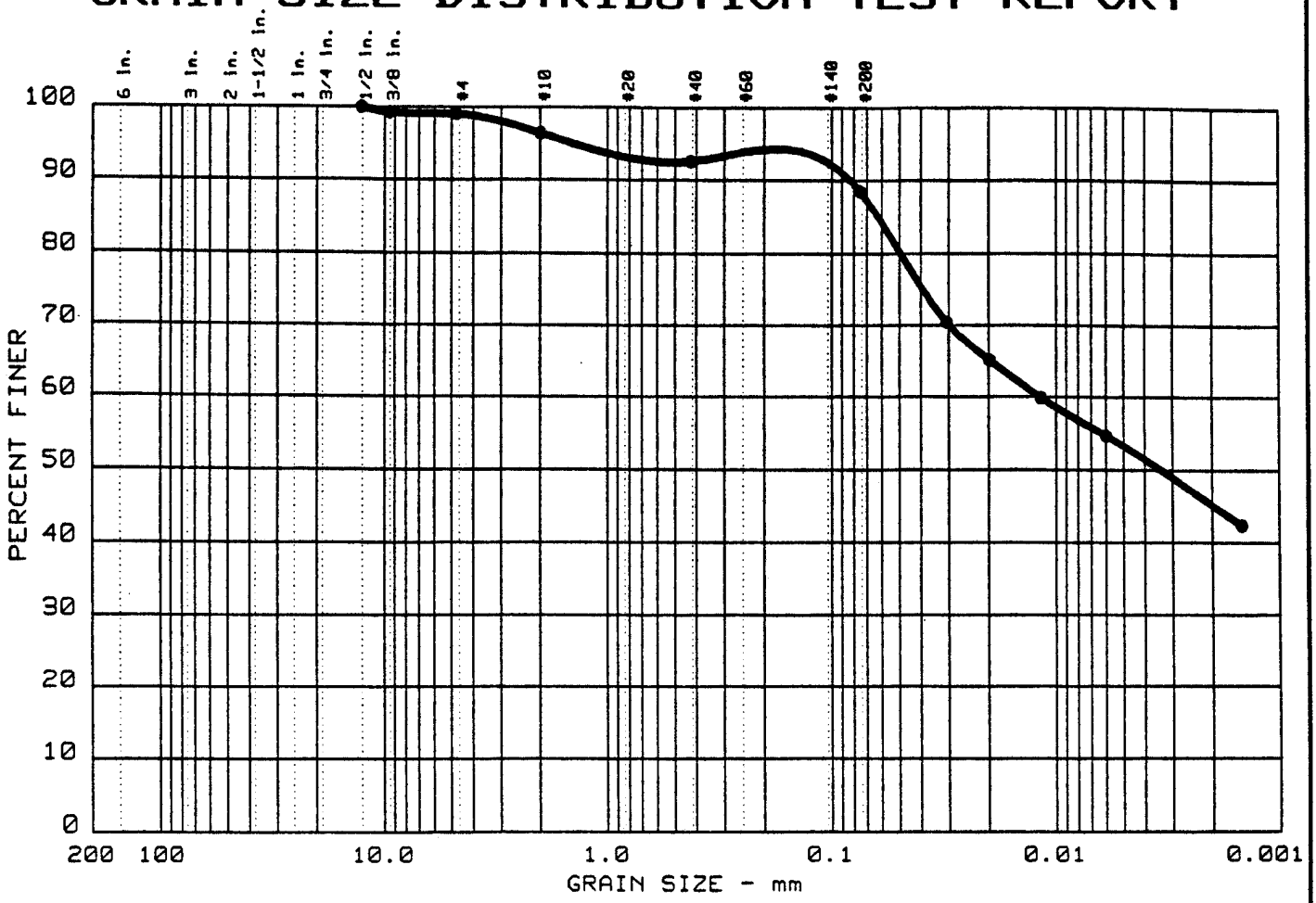
Remarks:
TESTED BY MCM

GRAIN SIZE DISTRIBUTION TEST REPORT

RUST ENVIRONMENT & INFRASTRUCTURE

Fig. No.: _____

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	2	0.0	0.9	10.5	35.3	53.3

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	52	36			0.0033					

MATERIAL DESCRIPTION	USCS	AASHTO
● BROWN FAT CLAY	CH	

Project No.: 55253
Project: FORT CARSON
● Location: CVT3-3 @ 3'-5'

Date: 4.3.96

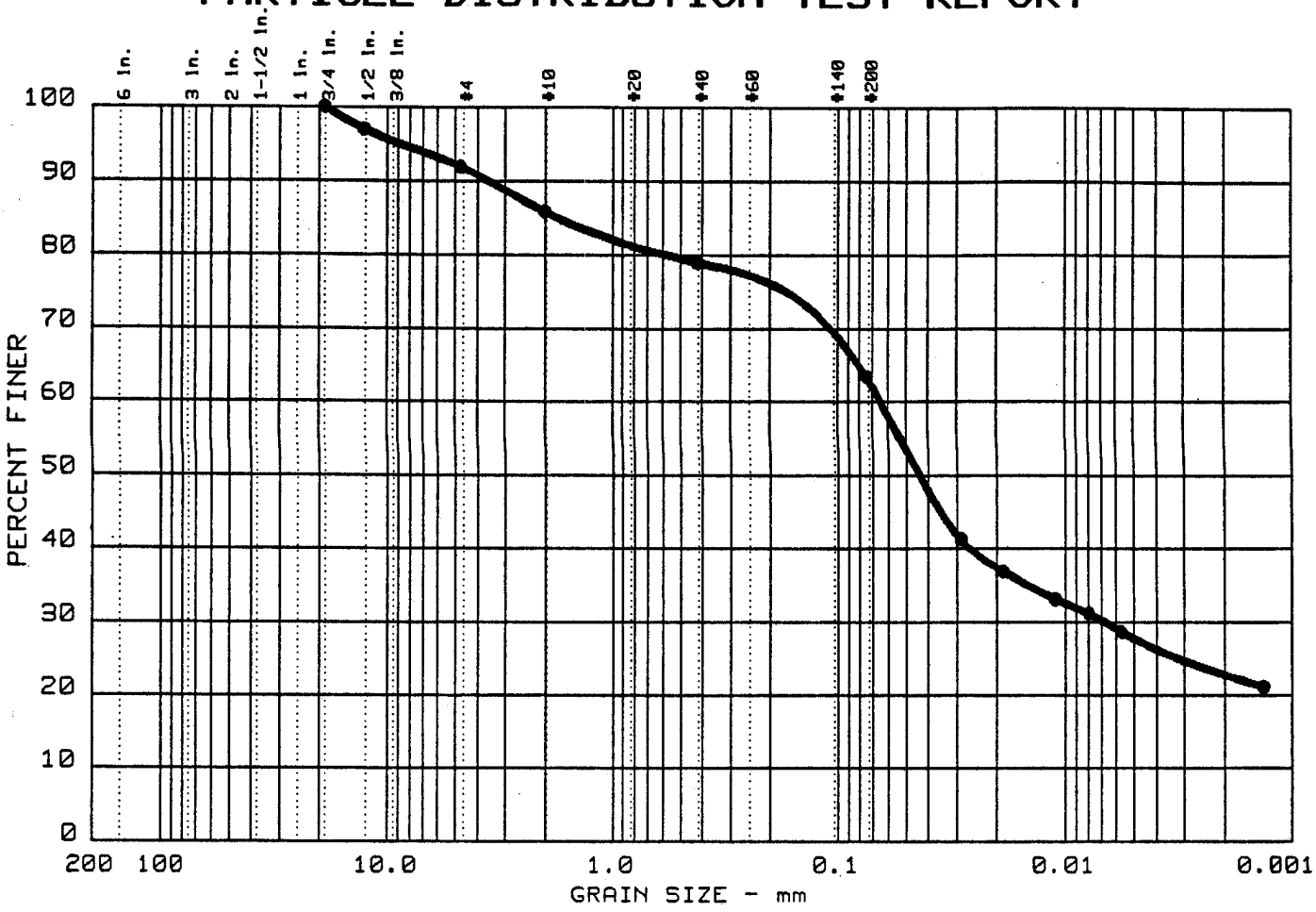
Remarks:

GRAIN SIZE DISTRIBUTION TEST REPORT

RUST ENVIRONMENT & INFRASTRUCTURE

Fig. No.: _____

PARTICLE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	8.1	28.5	40.6	22.8	CL	36.3	18.8

SIEVE inches size	PERCENT FINER ●		
0.75	100.0		
0.5	97.0		
	GRAIN SIZE		
D_{60} D_{30} D_{10}	0.01		
	COEFFICIENTS		
C_c C_u			

SIEVE number size	PERCENT FINER ●		
4	91.9		
10	85.8		
40	79.0		
200	63.4		

Sample information:

● 4-3 @ 3'- 5'
BROWN AND GRAY
SANDY LEAN CLAY

Remarks:

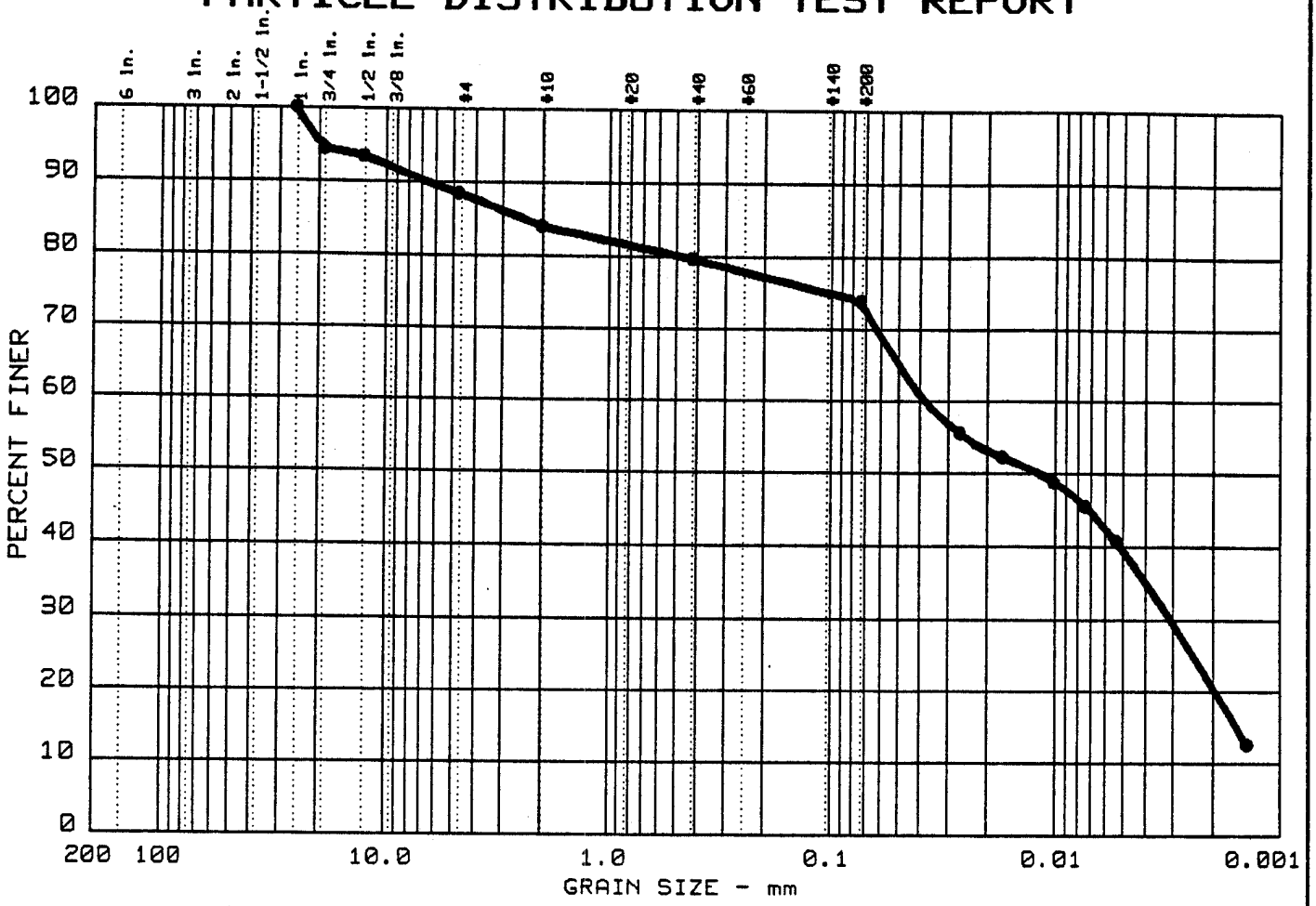
RAN BY: KLR
SANJOSE GR02

RUST ENVIRONMENT & INFRASTRUCTURE

Project No.: 55253.000
Project: CORPS OF ENGINEERS

Date: 03.13.96 Lab. No. ——

PARTICLE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	11.6	14.4	53.2	20.8	CH	58.3	35.2

SIEVE inches size	PERCENT FINER ●		
1	100.0		
0.75	94.4		
0.5	93.4		
	GRAIN SIZE		
D_{60} D_{30} D_{10}	0.003		
	COEFFICIENTS		
C_c C_u			

SIEVE number size	PERCENT FINER ●		
4	88.4		
10	84.0		
40	79.7		
200	74.0		

Sample information:
● 6-3 @ 3'- 5'
BROWN AND GRAY
FAT CLAY WITH SAND

Remarks:

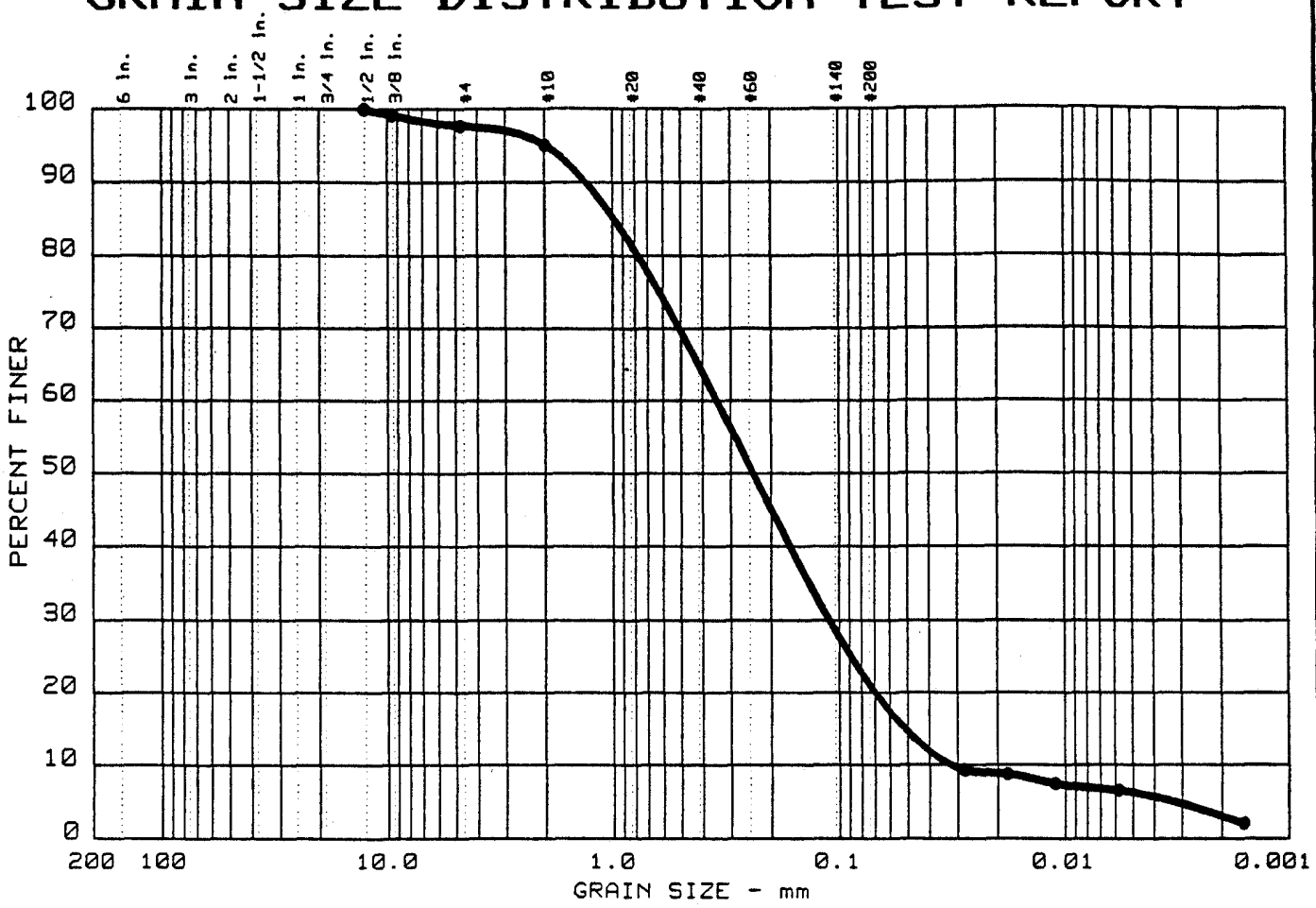
RAN BY: KLR
SANJOSE GR03

RUST ENVIRONMENT & INFRASTRUCTURE

Project No.: 55253.000
Project: CORPS OF ENGINEERS

Date: 03.13.96 Lab. No. ____

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	5	0.0	2.3	76.1	15.3	6.3

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	59	30	0.977	0.343	0.237	0.110	0.0513	0.0320	1.10	10.7

MATERIAL DESCRIPTION	USCS	AASHTO
● BROWN FAT CLAY	CH	

Project No.: 55253
Project: FORT CARSON
● Location: CVT7-3 @ 3'-5'

Date: 4.3.96

Remarks:

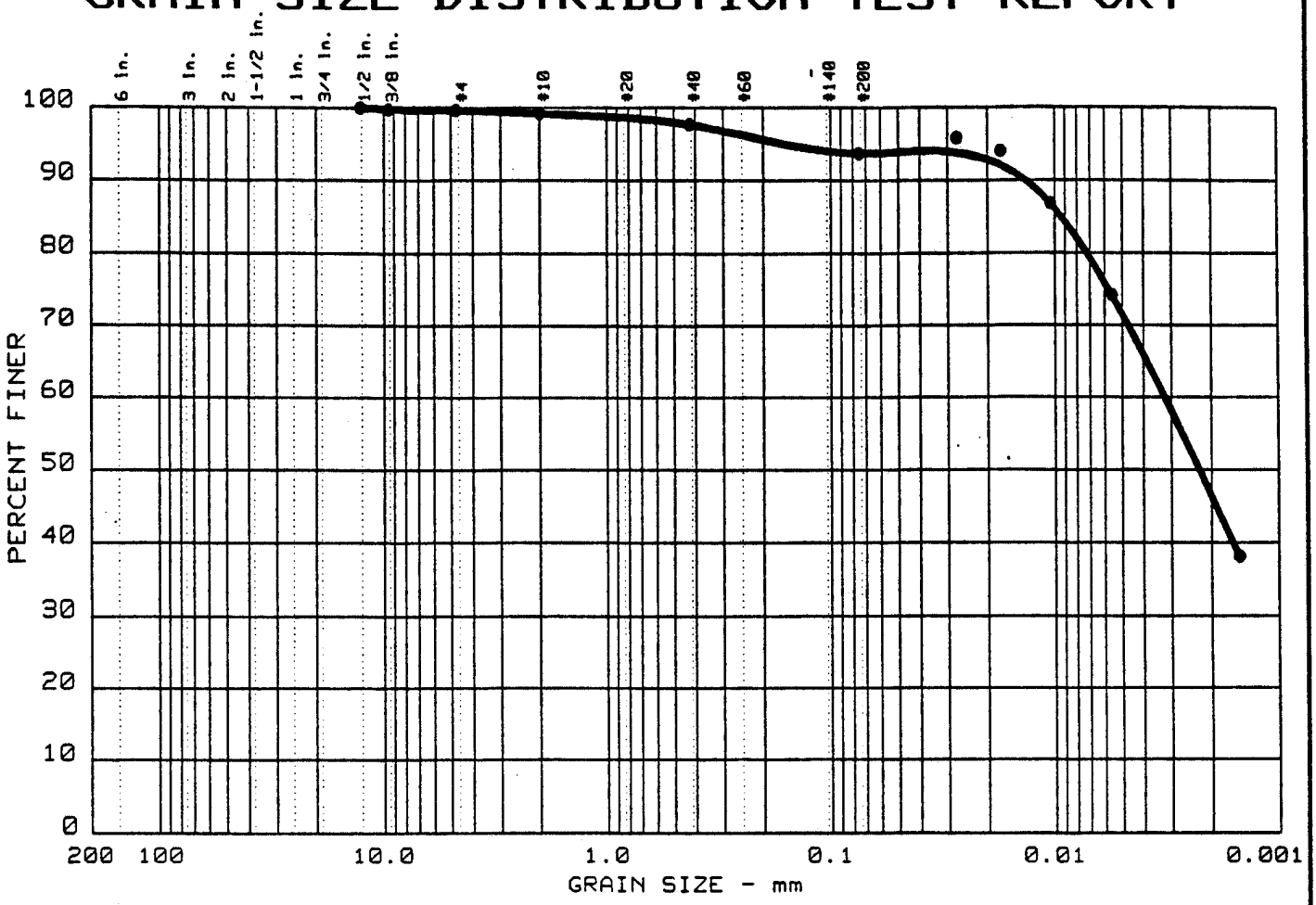
TESTED BY MCM

GRAIN SIZE DISTRIBUTION TEST REPORT

RUST ENVIRONMENT & INFRASTRUCTURE

Fig. No.: _____

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	3	0.0	0.4	5.9	22.1	71.6

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	55	29			0.0023					

MATERIAL DESCRIPTION	USCS	AASHTO
● BROWN FAT CLAY	CH	

Project No.: 55253
Project: FORT CARSON
● Location: CVT8-6 @ 6'-8'

Date: 4.3.96

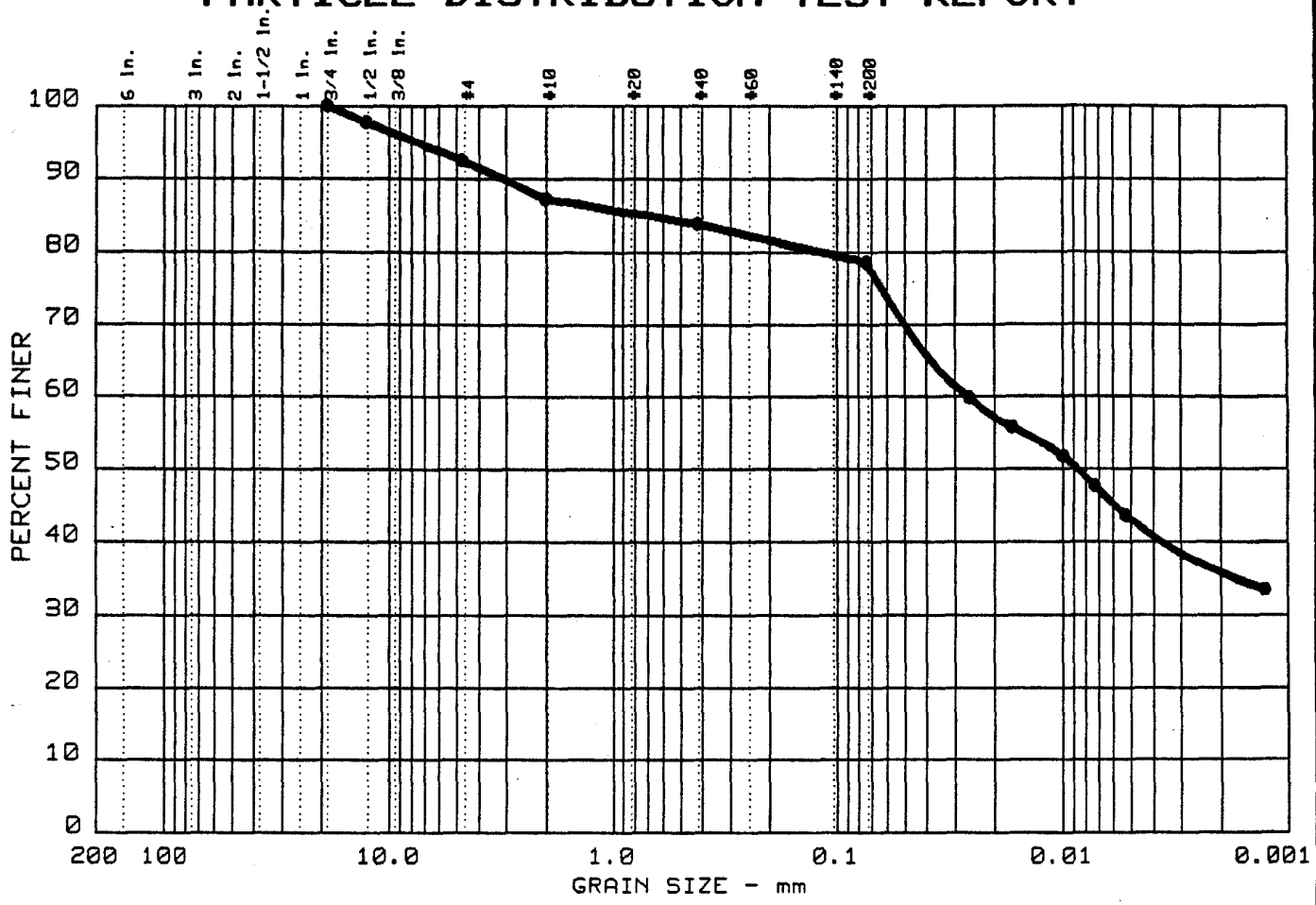
Remarks:
TESTED BY MCM

GRAIN SIZE DISTRIBUTION TEST REPORT

RUST ENVIRONMENT & INFRASTRUCTURE

Fig. No.: _____

PARTICLE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	7.5	13.9	42.7	35.9	CH	58.5	37.1

SIEVE inches size	PERCENT FINER ●		
0.75	100.0		
0.5	97.7		
GRAIN SIZE			
D_{60}			
D_{30}			
D_{10}			
COEFFICIENTS			
C_c			
C_u			

SIEVE number size	PERCENT FINER ●		
4	92.5		
10	87.2		
40	83.8		
200	78.6		

Sample information:
● 9-4 @ 4'- 6'
BROWN AND GRAY
FAT CLAY WITH SAND

Remarks:

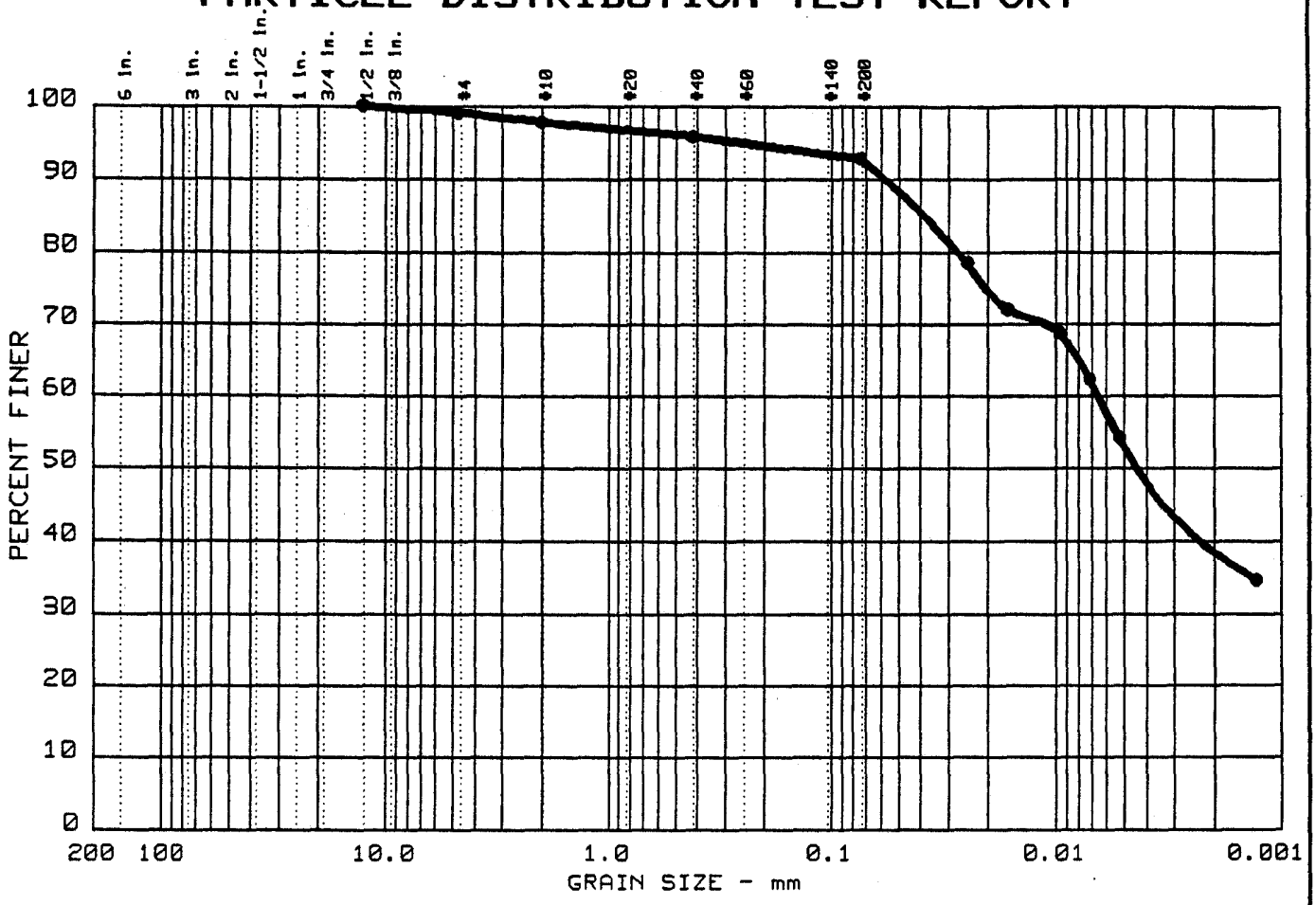
RAN BY: KLR
SANJOSE GR04

RUST ENVIRONMENT & INFRASTRUCTURE

Project No.: 55253.000
Project: CORPS OF ENGINEERS

Date: 03.13.96 Lab. No. ——

PARTICLE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	1.0	6.3	54.3	38.4	CH	60.3	35.4

SIEVE inches size	PERCENT FINER ●		
0.5	100.0		
GRAIN SIZE			
D_{60}			
D_{30}			
D_{10}			
COEFFICIENTS			
C_c			
C_u			

SIEVE number size	PERCENT FINER ●		
4	99.0		
10	97.8		
40	95.8		
200	92.8		

Sample information:
● 10-4.5 @ 4.5'- 6.5'
BROWN AND GRAY
FAT CLAY

Remarks:

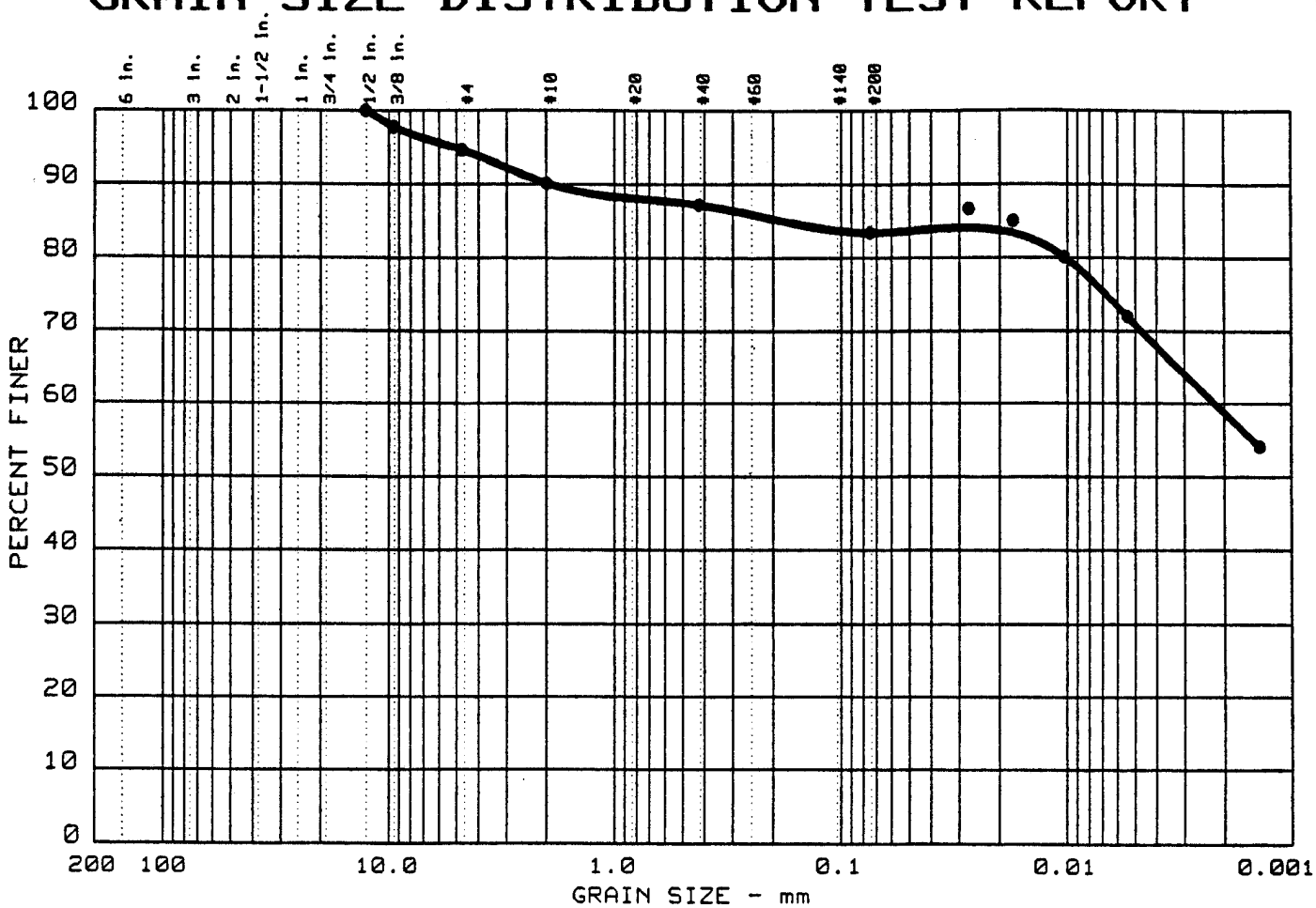
RAN BY: KLR
SANJOSE GR05

RUST ENVIRONMENT & INFRASTRUCTURE

Project No.: 55253.000
Project: CORPS OF ENGINEERS

Date: 03.13.96 Lab. No. ——

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	1	0.0	5.3	11.2	12.6	70.9

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	44	25	0.168							

MATERIAL DESCRIPTION	USCS	AASHTO
● BROWN LEAN CLAY W/SAND	CL	

Project No.: 55253
Project: FORT CARSON
● Location: CVT11-3.5 @ 3.5'-5.5'

Date: 4.3.96

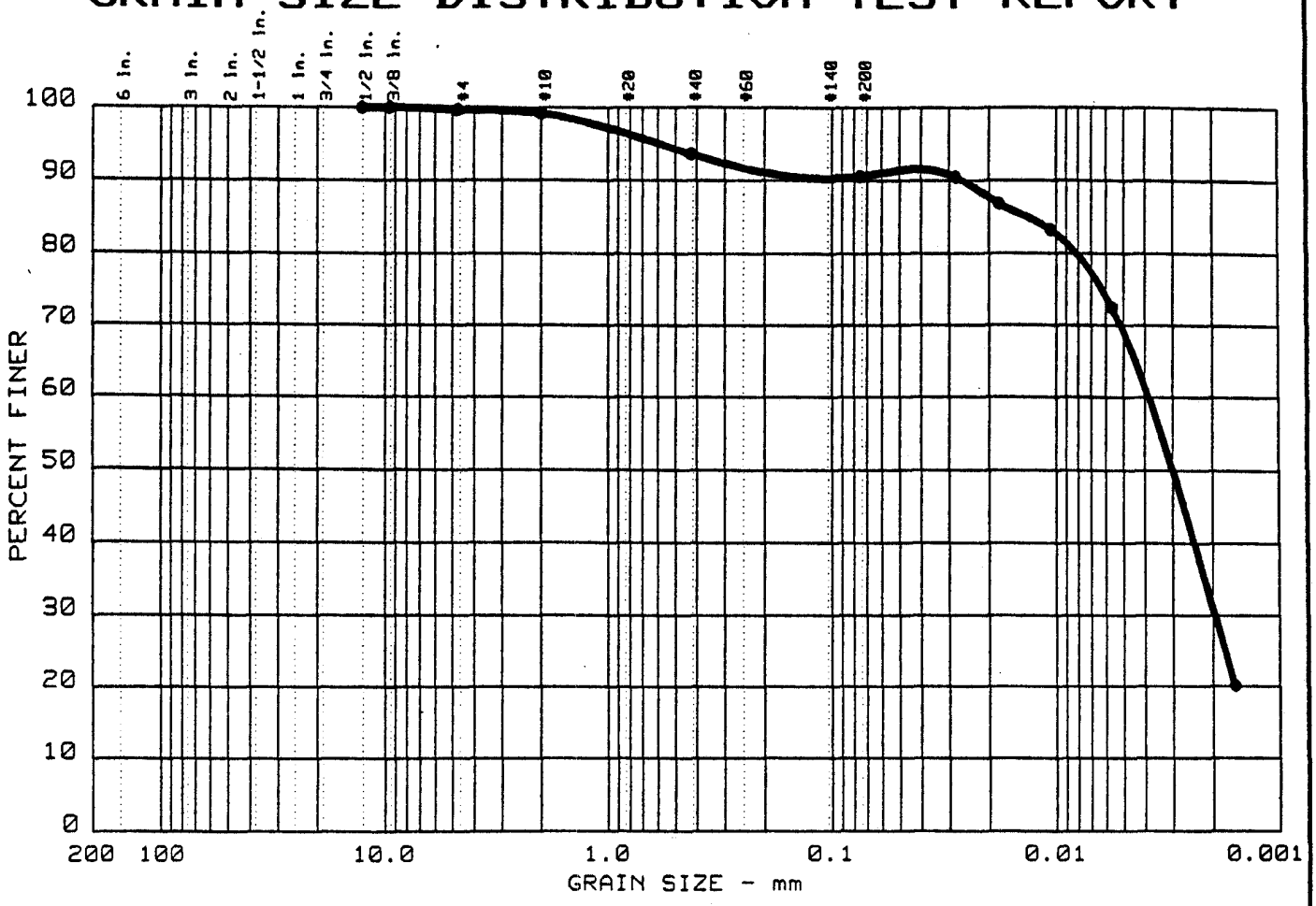
Remarks:
CVT11-3.5

GRAIN SIZE DISTRIBUTION TEST REPORT

RUST ENVIRONMENT & INFRASTRUCTURE

Fig. No.: _____

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	4	0.0	0.3	9.2	21.4	69.1

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	52	28			0.0030	0.0019				

MATERIAL DESCRIPTION	USCS	AASHTO
● BROWN FAT CLAY	CH	

Project No.: 55253
Project: FORT CARSON
● Location: CVT12-3 @ 3'-5'

Date: 4.3.96

Remarks:

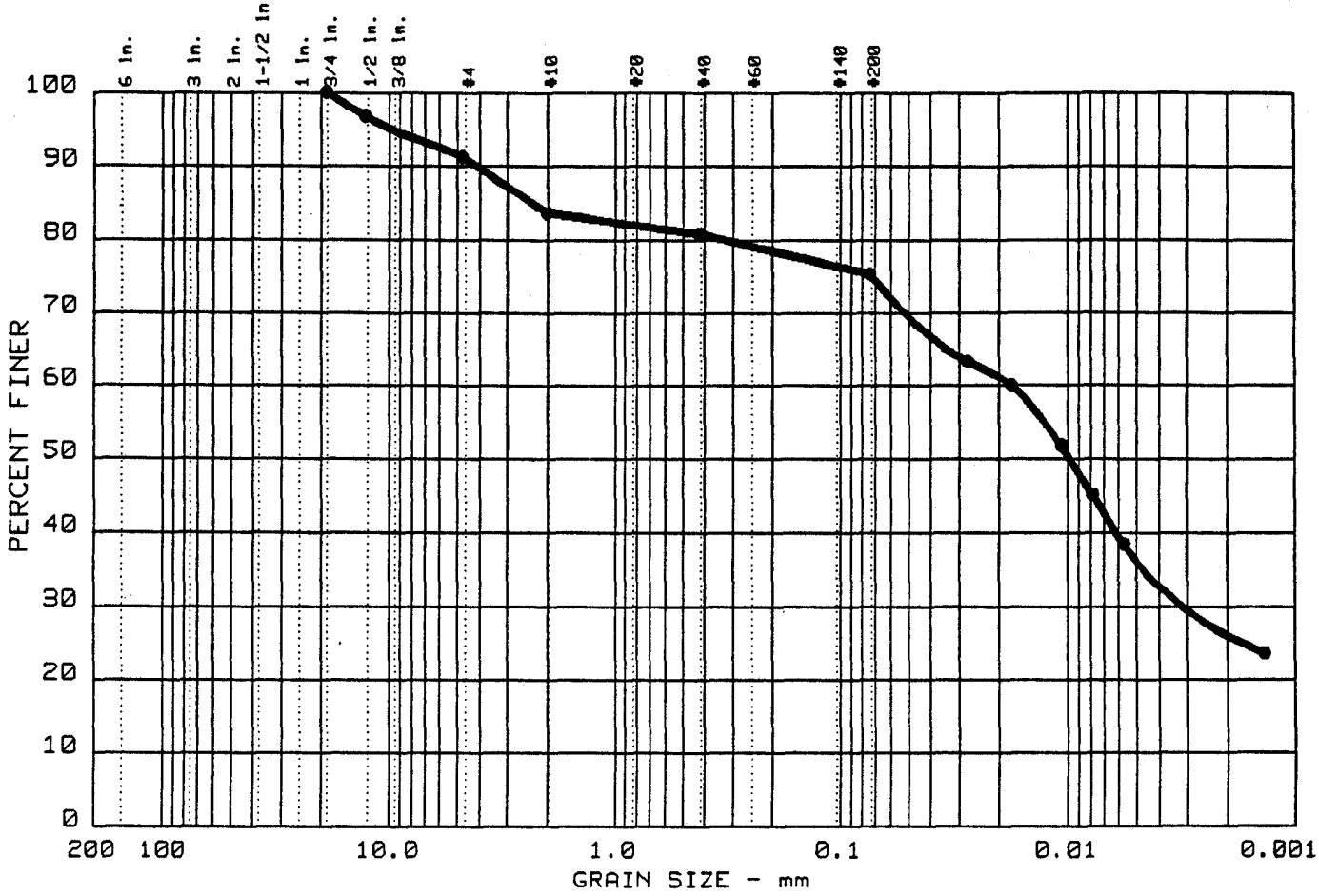
TESTED BY MCM

GRAIN SIZE DISTRIBUTION TEST REPORT

RUST ENVIRONMENT & INFRASTRUCTURE

Fig. No.: _____

PARTICLE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	8.8	15.9	49.2	26.1	CH	59.0	31.9

SIEVE inches size	PERCENT FINER ●		
0.75	100.0		
0.5	96.8		
	GRAIN SIZE		
D_{60} D_{30} D_{10}	0.003		
	COEFFICIENTS		
C_c C_u			

SIEVE number size	PERCENT FINER ●		
4	91.2		
10	83.6		
40	80.8		
200	75.4		

Sample information:

● 13-2 @ 2'- 4'
BROWN AND GRAY
FAT CLAY WITH SAND

Remarks:

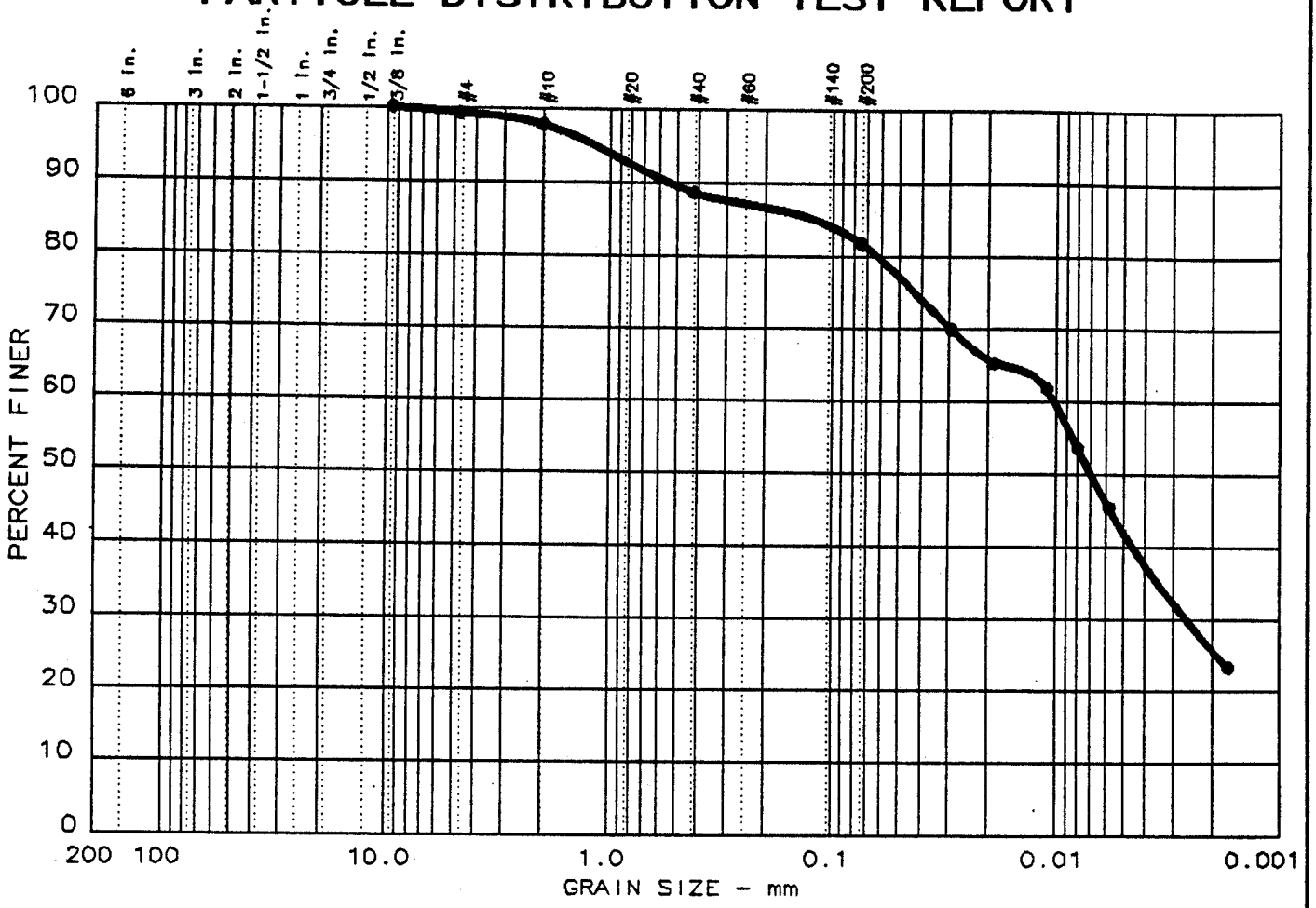
RAN BY: KLR
SANJOSE GR06

RUST ENVIRONMENT & INFRASTRUCTURE

Project No.: 55253.000
Project: CORPS OF ENGINEERS

Date: 03.13.96 Lab. No. ——

PARTICLE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	0.7	17.5	55.8	26.0	CH	64.5	38.6

SIEVE Inches size	PERCENT FINER ●		
0.375	100.0		
	GRAIN SIZE		
D_{60} D_{30} D_{10}	0.003		
	COEFFICIENTS		
C_c C_u			

SIEVE number size	PERCENT FINER ●		
4	99.3		
10	97.8		
40	88.6		
200	81.7		

Sample information:
● CVT 14.3
FAT CLAY WITH SAND

Remarks:
NMC 22.4%

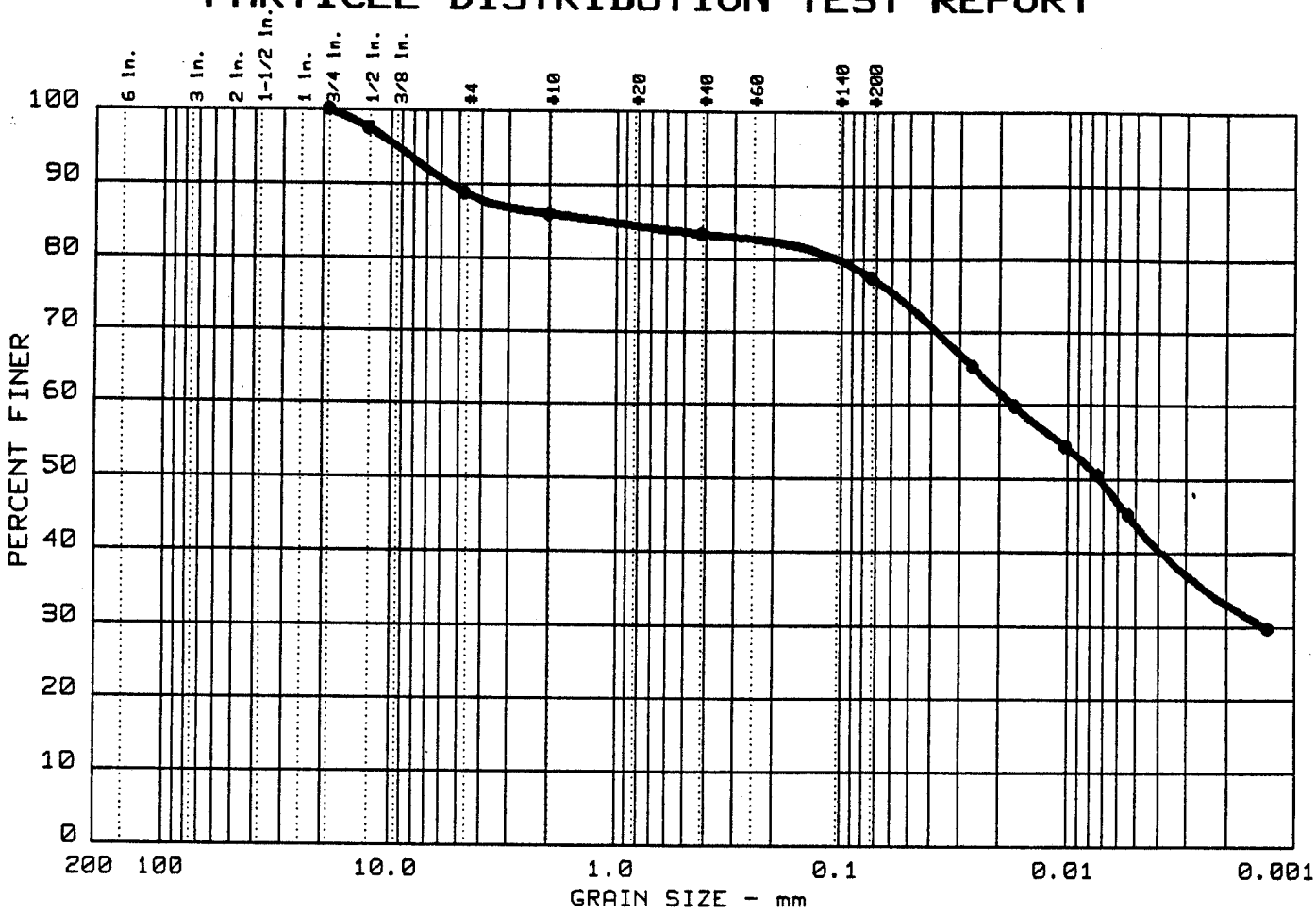
RAN BY: KLR
SANJOSE GR15

RUST ENVIRONMENT & INFRASTRUCTURE

Project No.: 55253.000
Project: FORT CARSON

Date: 04.05.96 Lab. No. ——

PARTICLE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	11.2	11.3	44.3	33.2	CH	59.2	34.3

SIEVE inches size	PERCENT FINER ●		
0.75	100.0		
0.5	97.5		
	GRAIN SIZE		
D_{60}	0.001		
D_{30}			
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ●		
4	88.8		
10	86.0		
40	83.4		
200	77.5		

Sample information:

● 15-3 @ 3'- 5'
BROWN AND GRAY
FAT CLAY WITH SAND

Remarks:

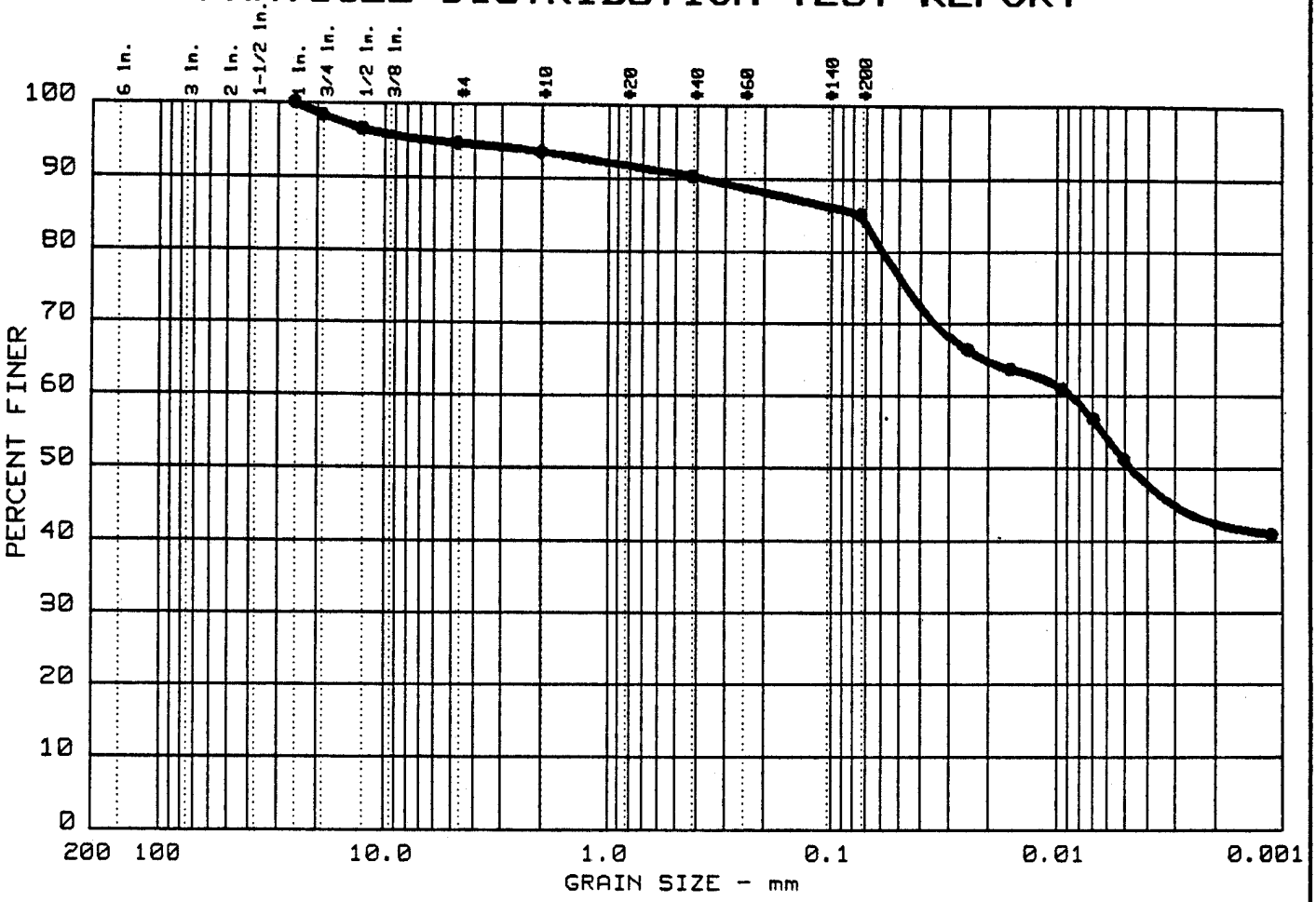
RAN BY: KLR
SANJOSE GR07

RUST ENVIRONMENT & INFRASTRUCTURE

Project No.: 55253.000
Project: CORPS OF ENGINEERS

Date: 03.13.96 Lab. No. ____

PARTICLE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	5.3	9.5	42.7	42.5	CH	60.4	37.7

SIEVE inches size	PERCENT FINER ●		
1	100.0		
0.75	98.3		
0.5	96.5		
GRAIN SIZE			
D_{60}			
D_{30}			
D_{10}			
COEFFICIENTS			
C_c			
C_u			

SIEVE number size	PERCENT FINER ●		
4	94.7		
10	93.5		
40	90.3		
200	85.2		

Sample information:

● 16-3 @ 3'- 5'
BROWN AND GRAY
FAT CLAY

Remarks:

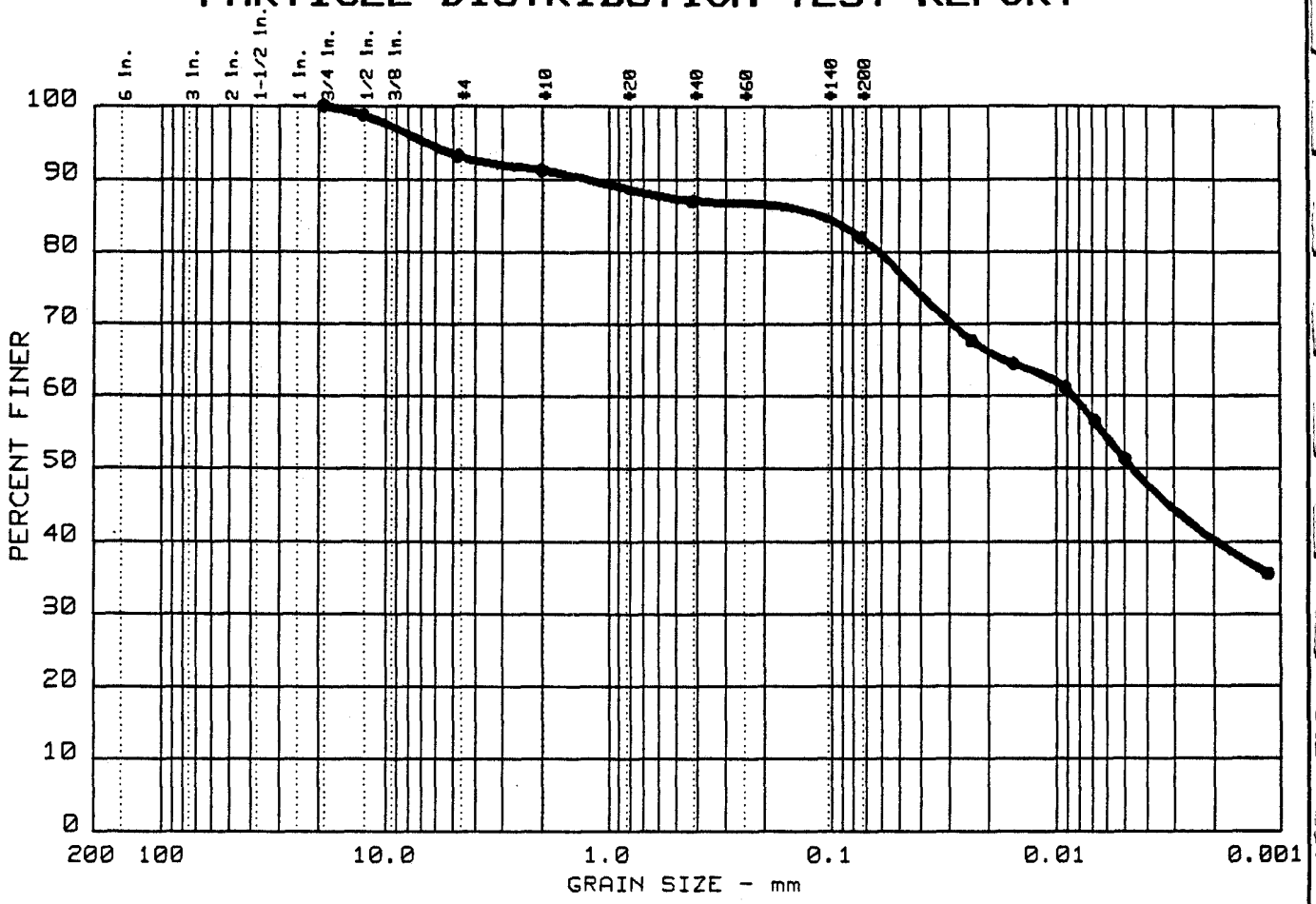
RAN BY: KLR
SANJOSE GR08

RUST ENVIRONMENT & INFRASTRUCTURE

Project No.: 55253.000
Project: CORPS OF ENGINEERS

Date: 03.13.96 Lab. No. ——

PARTICLE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	6.8	11.2	41.7	40.3	CH	62.8	36.7

SIEVE inches size	PERCENT FINER ●		
0.75	100.0		
0.5	98.7		
GRAIN SIZE			
D_{60}			
D_{30}			
D_{10}			
COEFFICIENTS			
C_c			
C_u			

SIEVE number size	PERCENT FINER ●		
4	93.2		
10	91.2		
40	87.0		
200	82.0		

Sample information:

● 18-2 @ 2'- 4'
BROWN AND GRAY
FAT CLAY WITH SAND

Remarks:

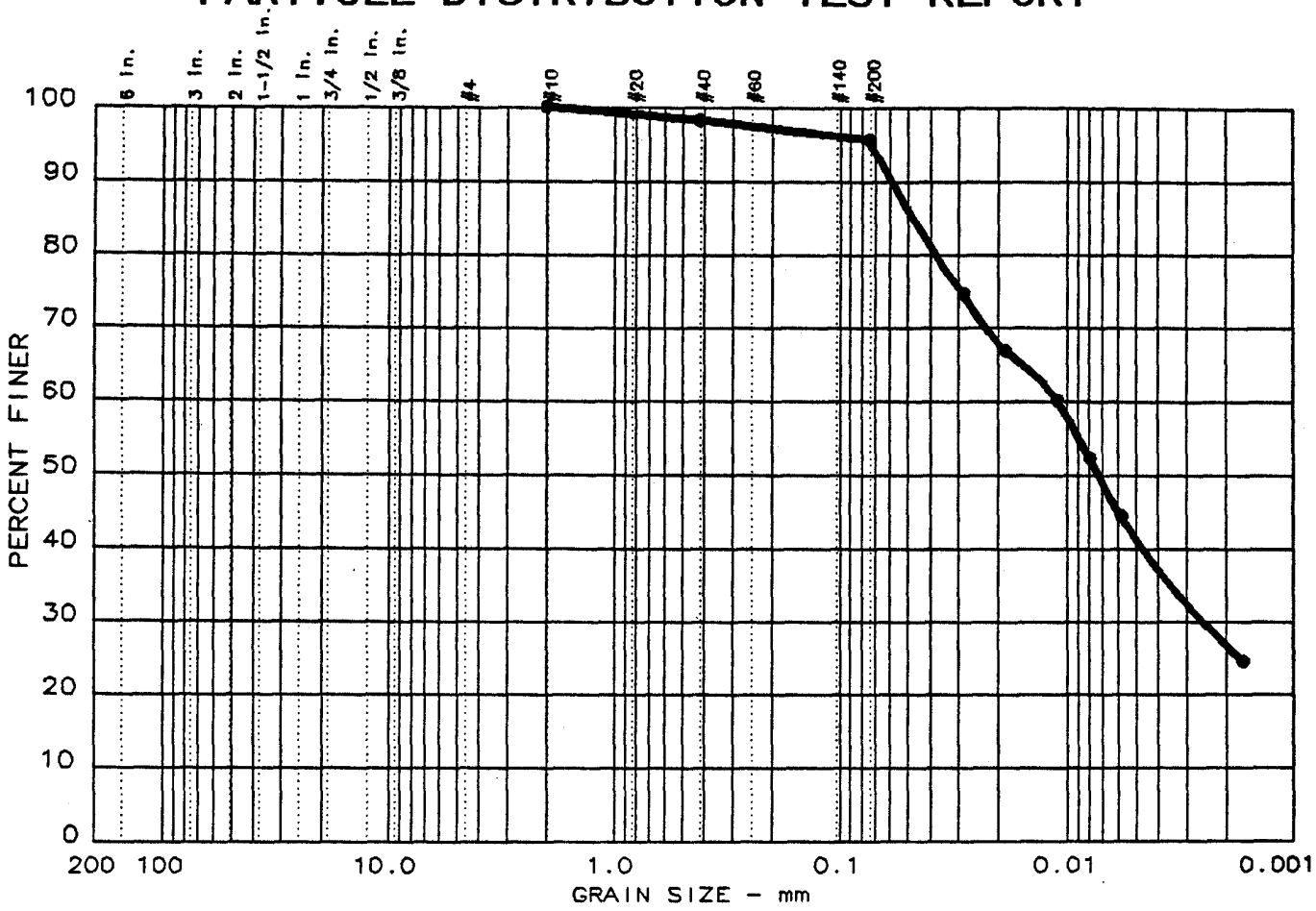
RAN BY: KLR
SANJOSE GR09

RUST ENVIRONMENT & INFRASTRUCTURE

Project No.: 55253.000
Project: CORPS OF ENGINEERS

Date: 03.13.96 Lab. No. ____

PARTICLE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	0.0	4.4	68.8	26.8	CH	62.6	39.0

SIEVE inches size	PERCENT FINER ●		
GRAIN SIZE			
D_{60} D_{30} D_{10}	0.003		
COEFFICIENTS			
C_c C_u			

SIEVE number size	PERCENT FINER ●		
10	100.0		
40	98.3		
200	95.6		

Sample information:
● CVT 18.7 @ 7'- 9'
FAT CLAY

Remarks:
NMC 17.0%

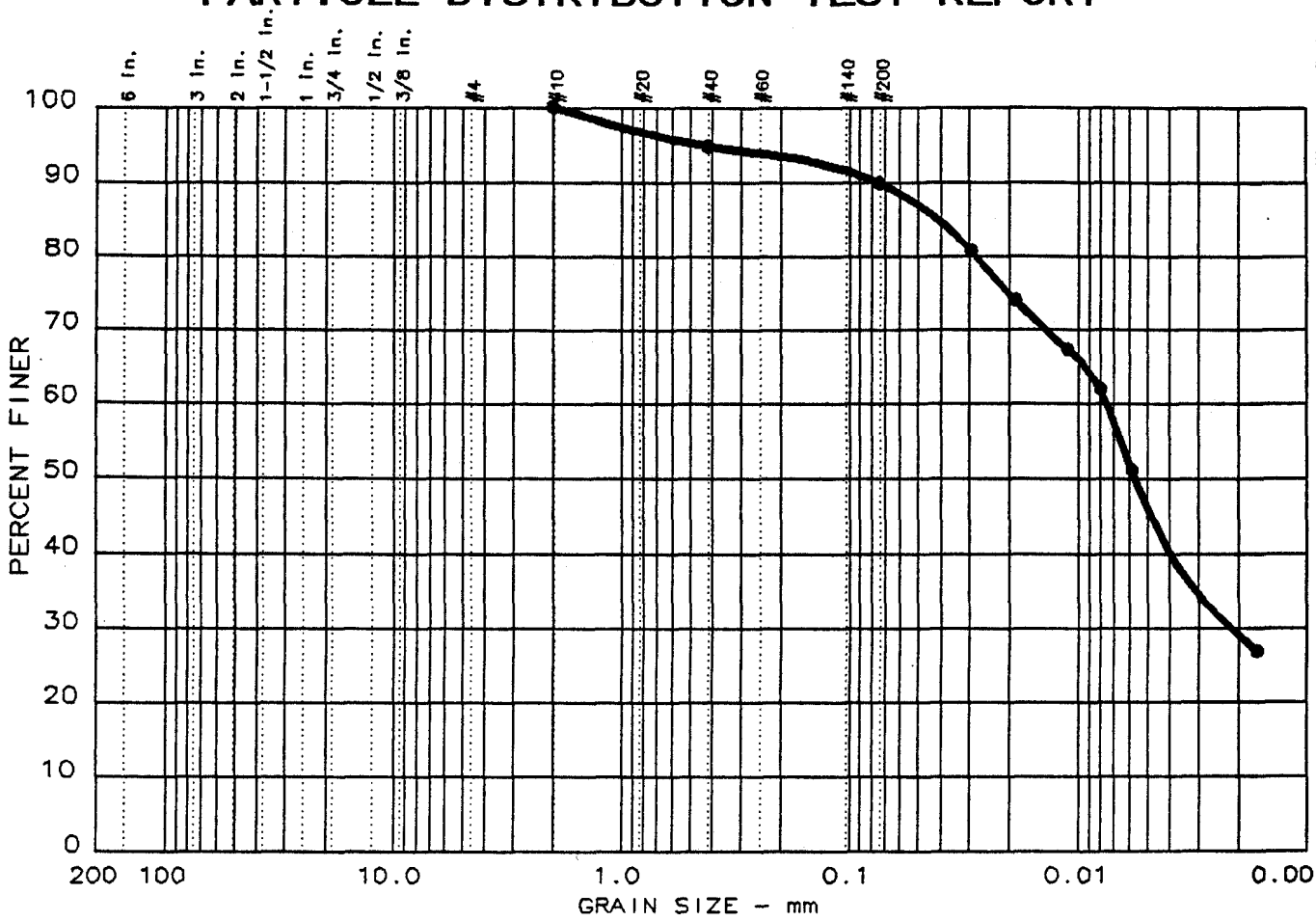
RAN BY: KLR
SANJOSE GR16

RUST ENVIRONMENT & INFRASTRUCTURE

Project No.: 55253.000
Project: FORT CARSON

Date: 04.05.96 Lab. No. ——

PARTICLE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	0.0	10.1	60.8	29.1	CH	59.4	35.8

SIEVE inches size	PERCENT FINER ●		
GRAIN SIZE			
D_{60} D_{30} D_{10}	0.002		
COEFFICIENTS			
C_c C_u			

SIEVE number size	PERCENT FINER ●		
10	100.0		
40	94.8		
200	89.9		

Sample information:

● CVT 19.4
FAT CLAY

Remarks:
NMC 22.1%

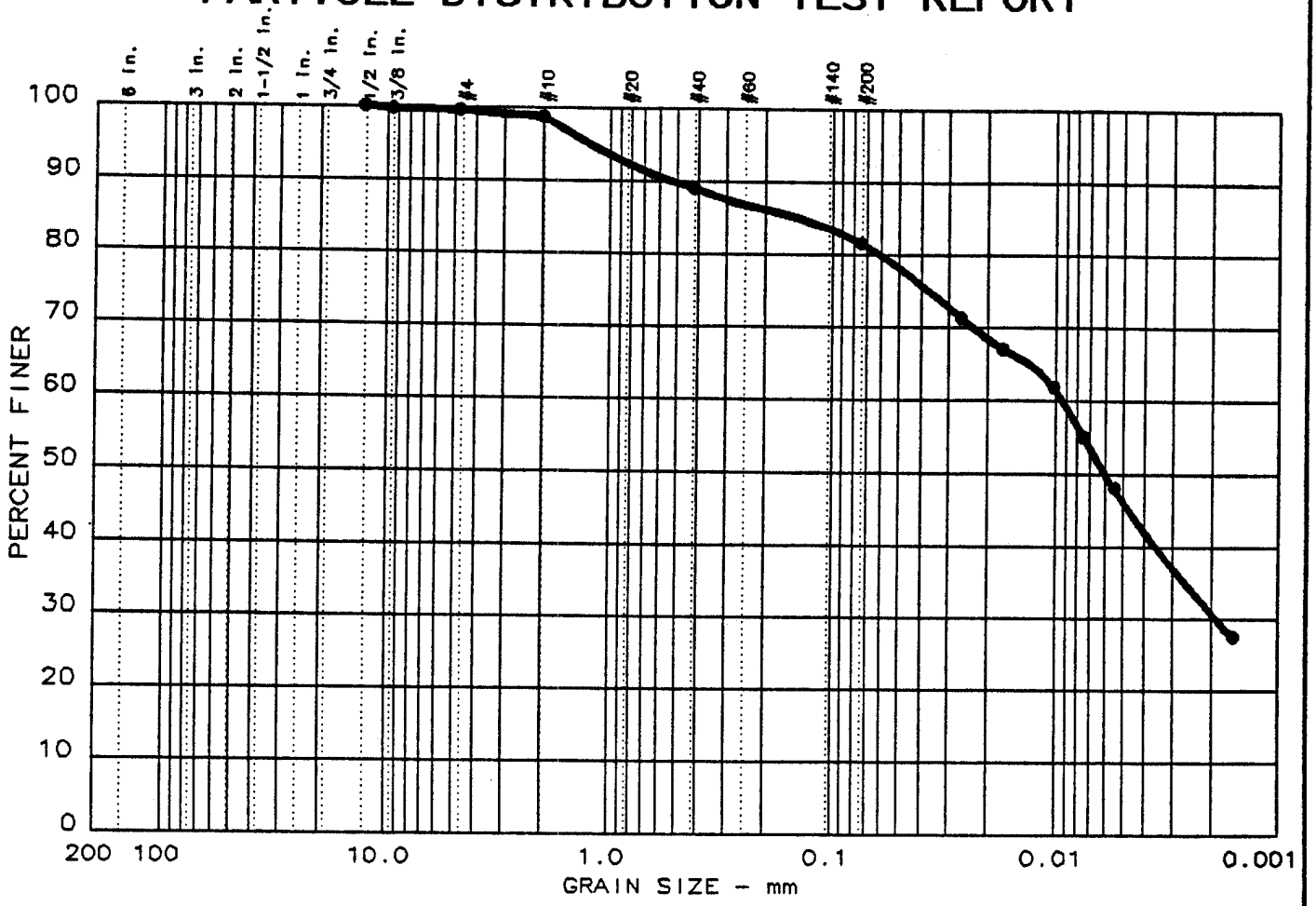
RAN BY: KLR
SANJOSE GR17

RUST ENVIRONMENT & INFRASTRUCTURE

Project No.: 55253.000
Project: FORT CARSON

Date: 04.05.96 Lab. No. ——

PARTICLE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	0.5	18.0	50.6	30.9	CH	60.9	35.1

SIEVE inches size	PERCENT FINER ●		
0.5	100.0		
0.375	99.7		
	GRAIN SIZE		
D_{60} D_{30} D_{10}	0.002		
	COEFFICIENTS		
C_c C_u			

SIEVE number size	PERCENT FINER ●		
4	99.5		
10	98.7		
40	89.1		
200	81.5		

Sample information:
● CVT 20-1.5
FAT CLAY WITH SAND

Remarks:
NMC 14.8%

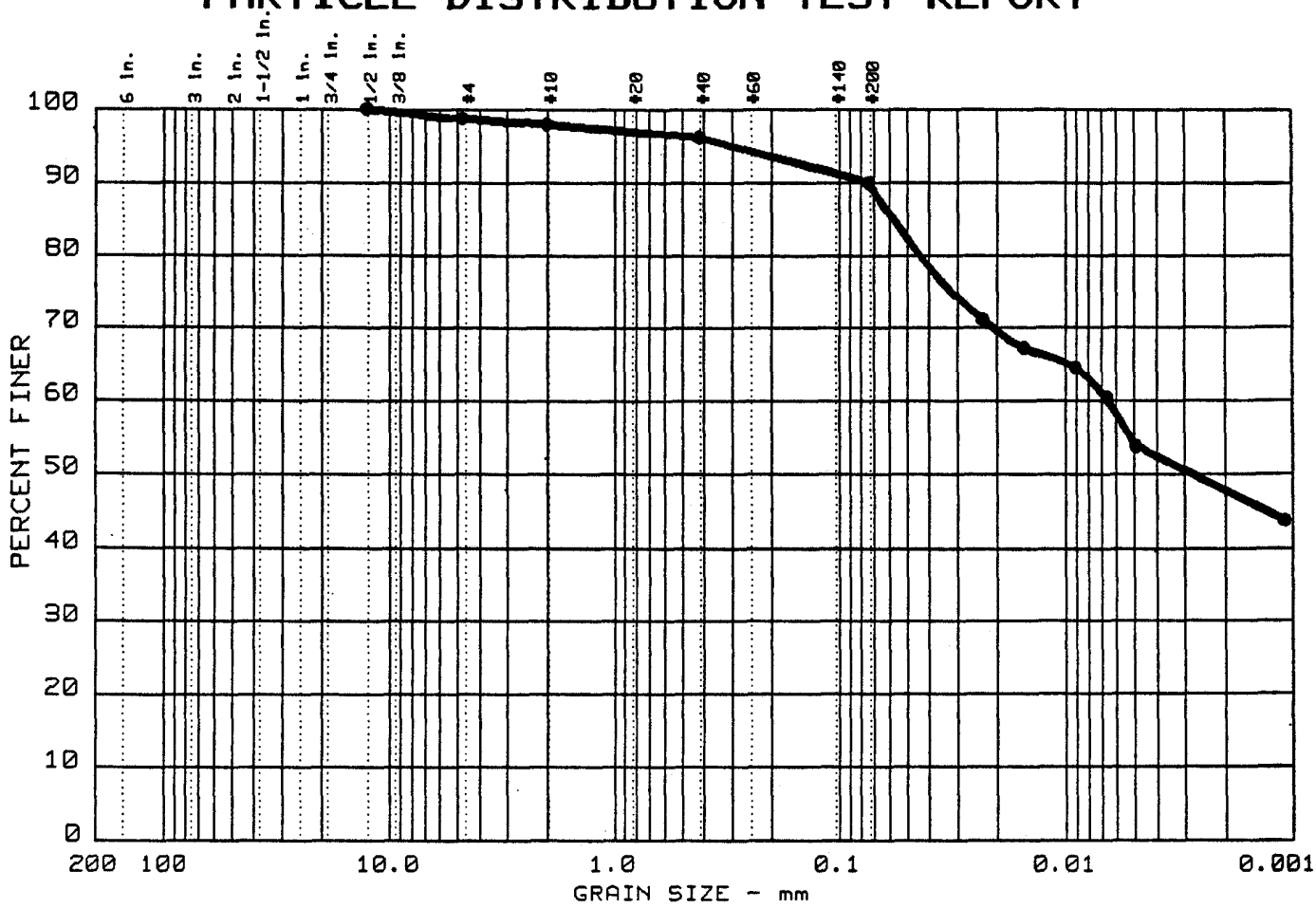
RAN BY: KLR
SANJOSE GR18

RUST ENVIRONMENT & INFRASTRUCTURE

Project No.: 55253.000
Project: FORT CARSON

Date: 04.05.96 Lab. No. ——

PARTICLE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	1.3	8.7	42.1	47.9	CH	62.5	36.4

SIEVE inches size	PERCENT FINER ●		
0.5	100.0		
	GRAIN SIZE		
D_{60}			
D_{30}			
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ●		
4	98.7		
10	98.0		
40	96.1		
200	90.0		

Sample information:
● 21-2 @ 2'- 3.5'
BROWN AND GRAY
FAT CLAY

Remarks:

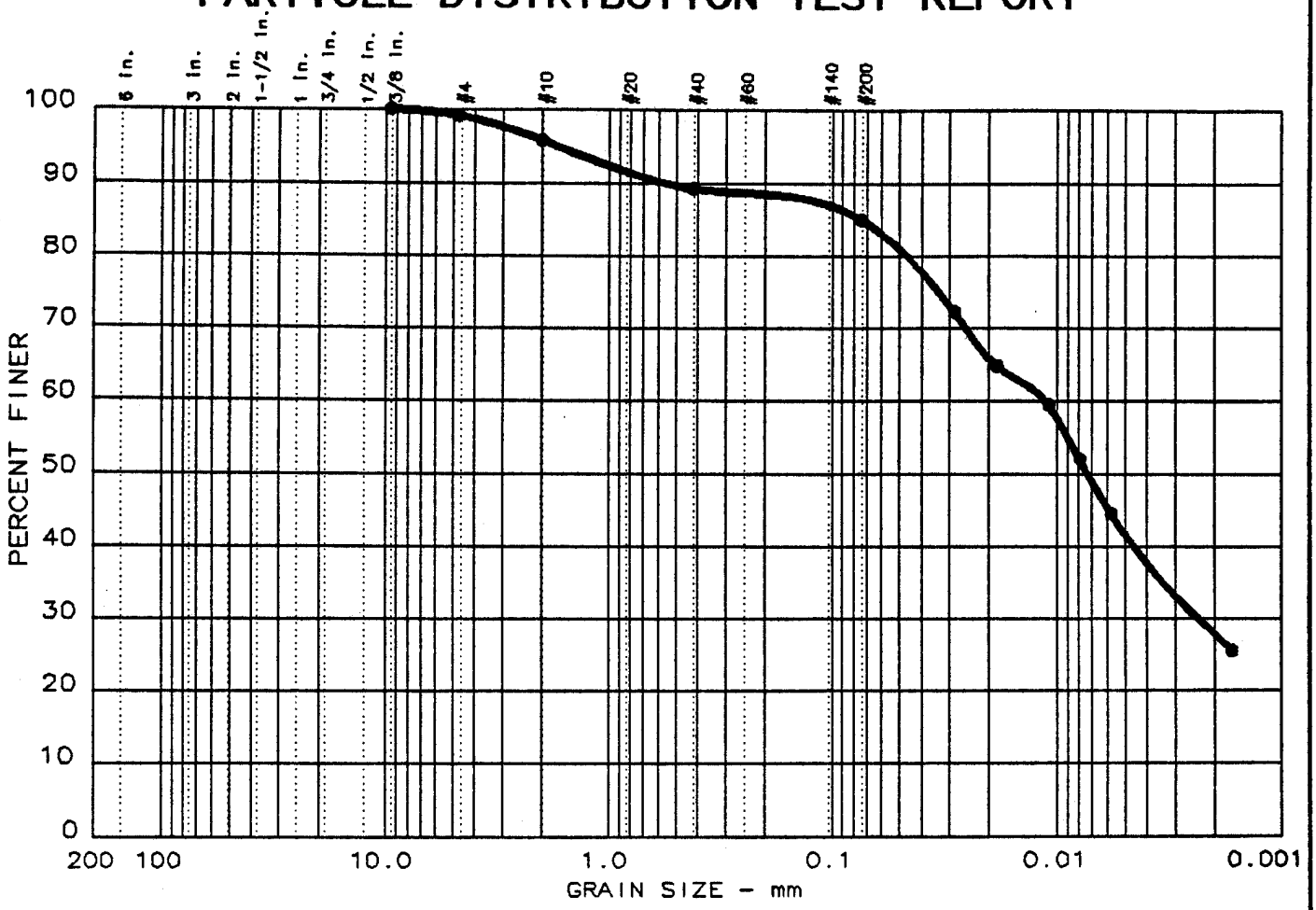
RAN BY: KLR
SANJOSE GR10

RUST ENVIRONMENT & INFRASTRUCTURE

Project No.: 55253.000
Project: CORPS OF ENGINEERS

Date: 03.13.96 Lab. No. ——

PARTICLE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	0.9	14.2	57.2	27.7	CH	59.2	36.3

SIEVE inches size	PERCENT FINER ●		
0.375	100.0		
GRAIN SIZE			
D_{60} D_{30} D_{10}	0.002		
COEFFICIENTS			
C_c C_u			

SIEVE number size	PERCENT FINER ●		
4	99.1		
10	95.8		
40	89.2		
200	85.0		

Sample information:

● CVT 22-2 @ 2'- 4'
FAT CLAY WITH SAND

Remarks:
NMC 17.7%

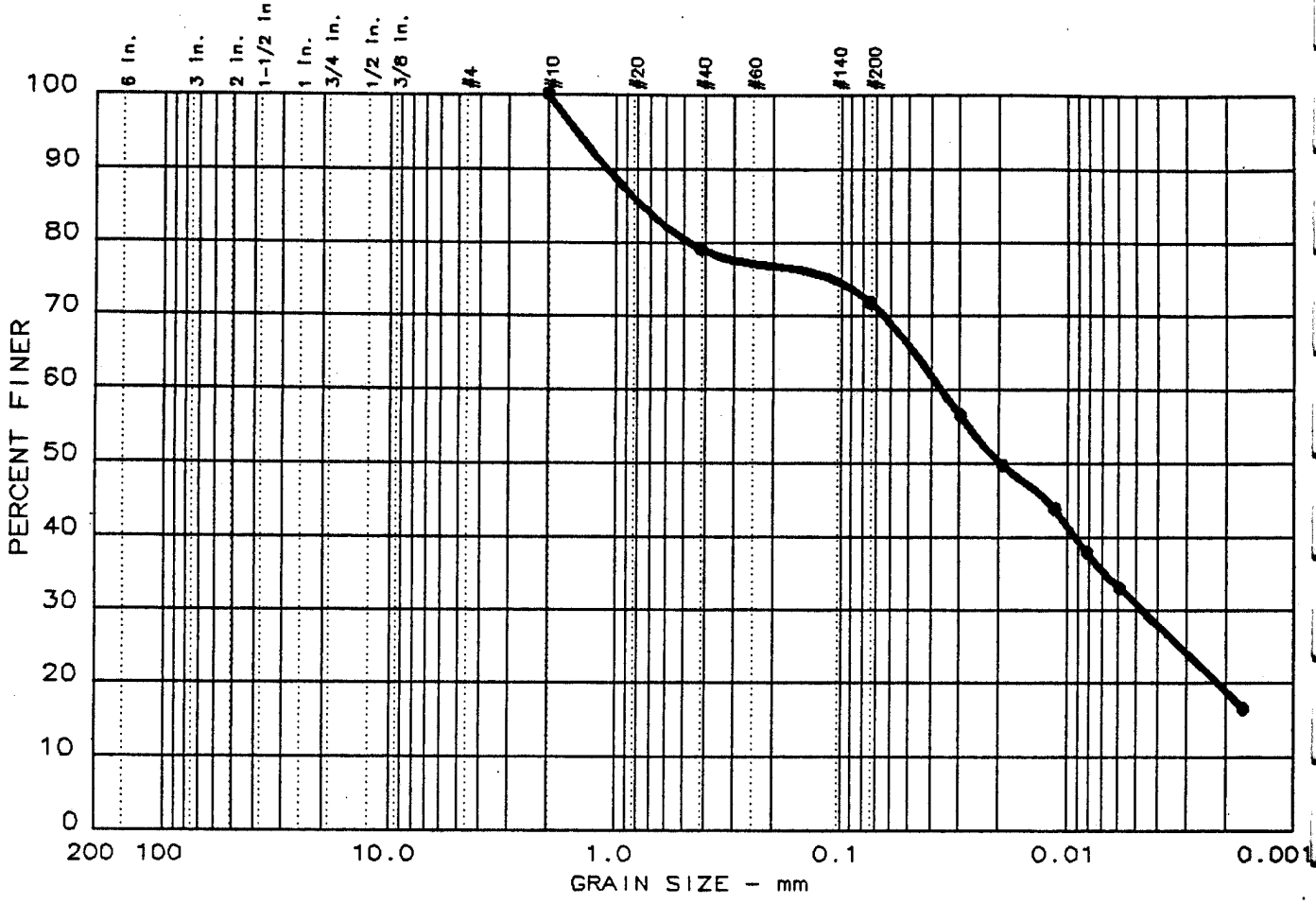
RAN BY: KLR
SANJOSE GR19

RUST ENVIRONMENT & INFRASTRUCTURE

Project No.: 55253.000
Project: FORT CARSON

Date: 04.05.96 Lab. No. ——

PARTICLE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	0.0	28.3	52.9	18.8	CH	57.0	31.3

SIEVE inches size	PERCENT FINER ●		
	GRAIN SIZE		
D_{60} D_{30} D_{10}	0.005		
	COEFFICIENTS		
C_c C_u			

SIEVE number size	PERCENT FINER ●		
10	100.0		
40	79.1		
200	71.7		

Sample information:

● CVT 22-6 @ 6'- 8'
FAT CLAY WITH SAND

Remarks:
NMC 19.4%

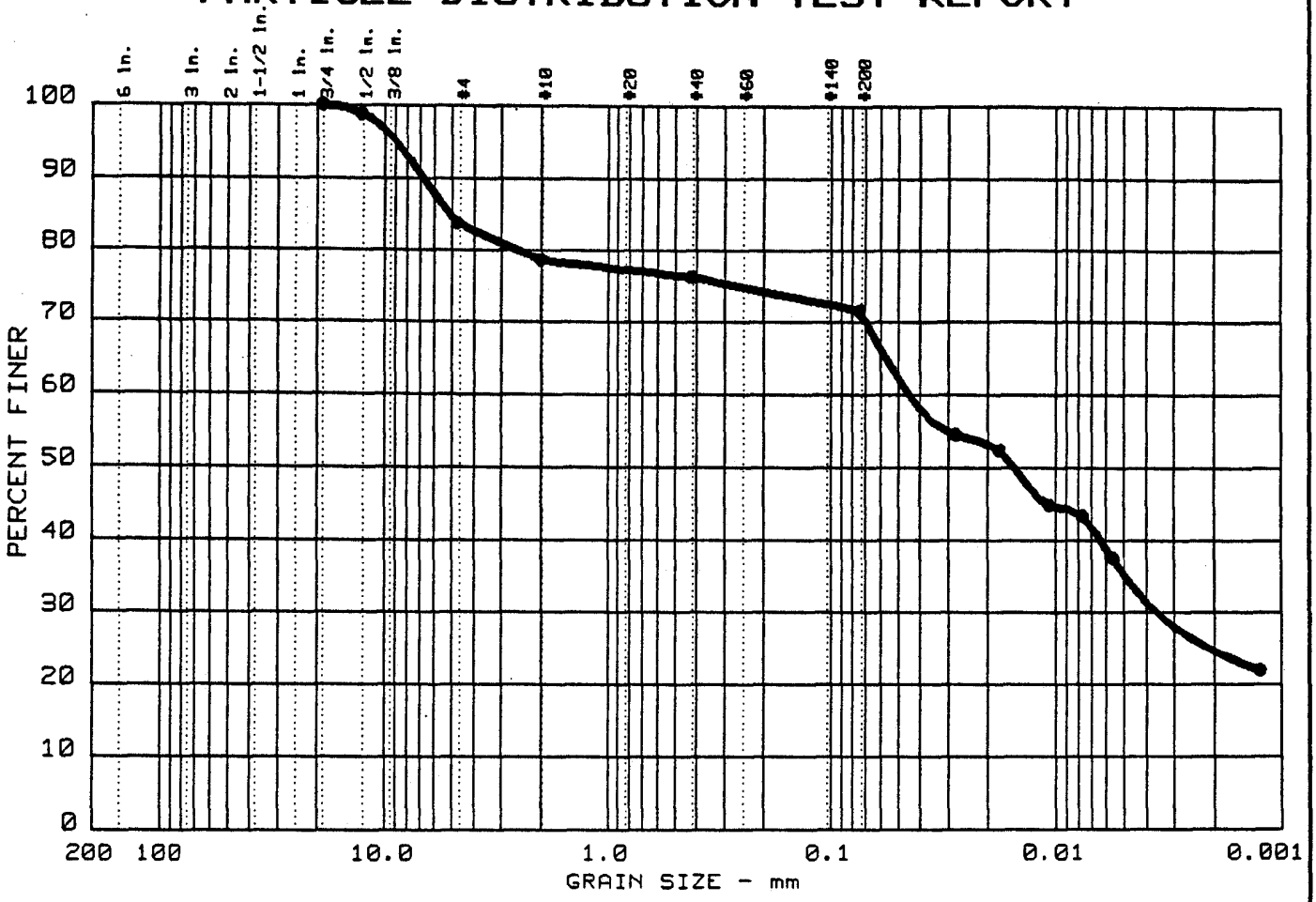
RAN BY: KLR
SANJOSE GR20

RUST ENVIRONMENT & INFRASTRUCTURE

Project No.: 55253.000
Project: FORT CARSON

Date: 04.05.96 Lab. No. ____

PARTICLE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	16.4	12.1	46.9	24.6	CH	58.2	33.7

SIEVE inches size	PERCENT FINER ●		
0.75	100.0		
0.5	98.7		
GRAIN SIZE			
D_{60} D_{30} D_{10}	0.004		
COEFFICIENTS			
C_c C_u			

SIEVE number size	PERCENT FINER ●		
4	83.6		
10	78.5		
40	76.2		
200	71.5		

Sample information:

● 23-2 @ 2'- 4'
BROWN AND GRAY
FAT CLAY WITH GRAVEL

Remarks:

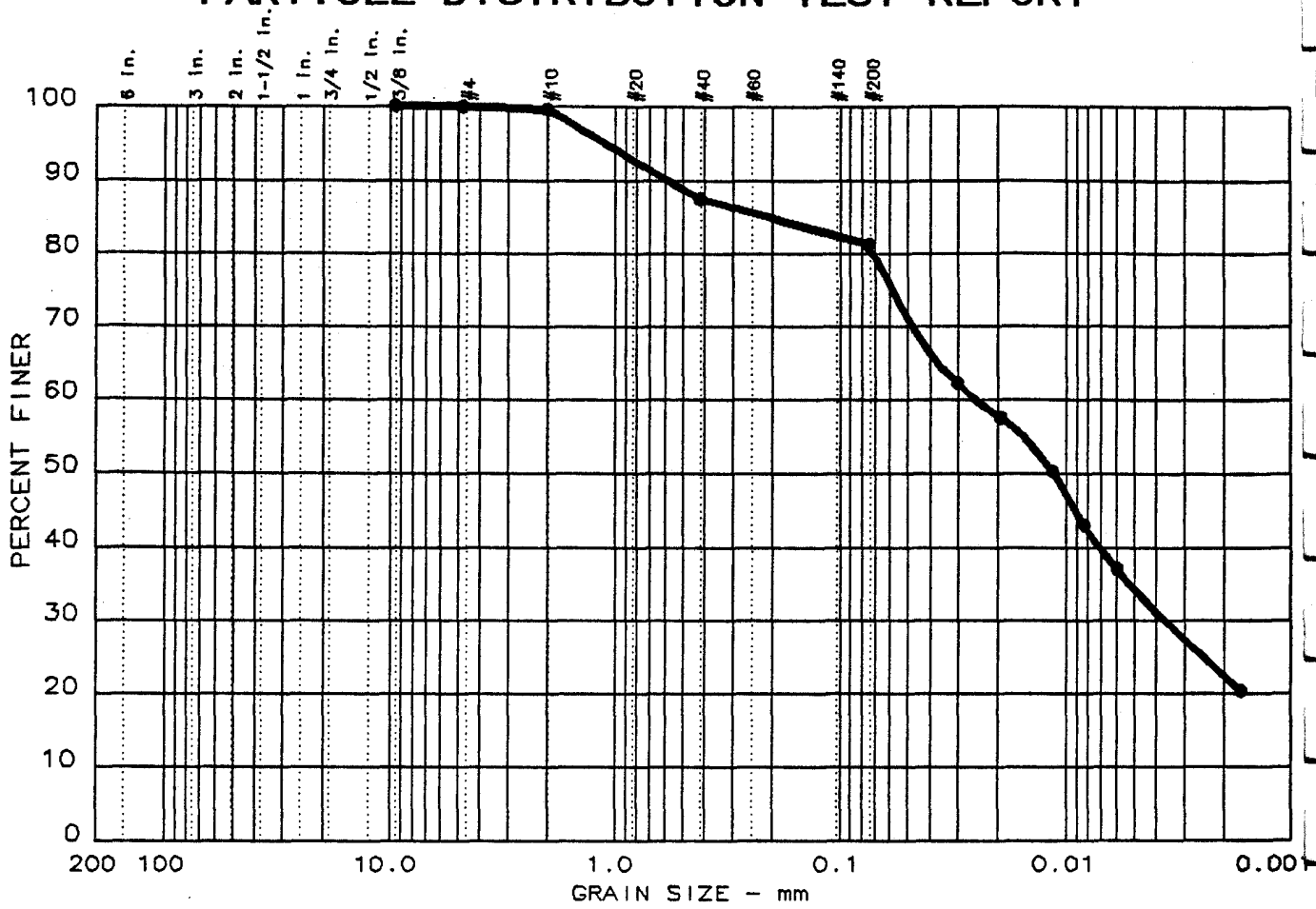
RAN BY: KLR
SANJOSE GR11

RUST ENVIRONMENT & INFRASTRUCTURE

Project No.: 55253.000
Project: CORPS OF ENGINEERS

Date: 03.13.96 Lab. No. ——

PARTICLE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	0.1	18.6	58.8	22.5	CH	62.1	40.9

SIEVE inches size	PERCENT FINER ●		
0.375	100.0		
	GRAIN SIZE		
D_{60} D_{30} D_{10}	0.004		
	COEFFICIENTS		
C_c C_u			

SIEVE number size	PERCENT FINER ●		
4	99.9		
10	99.5		
40	87.5		
200	81.3		

Sample information:
● CVT 23.7 @ 7'- 9'
FAT CLAY WITH SAND

Remarks:
NMC 21.9%

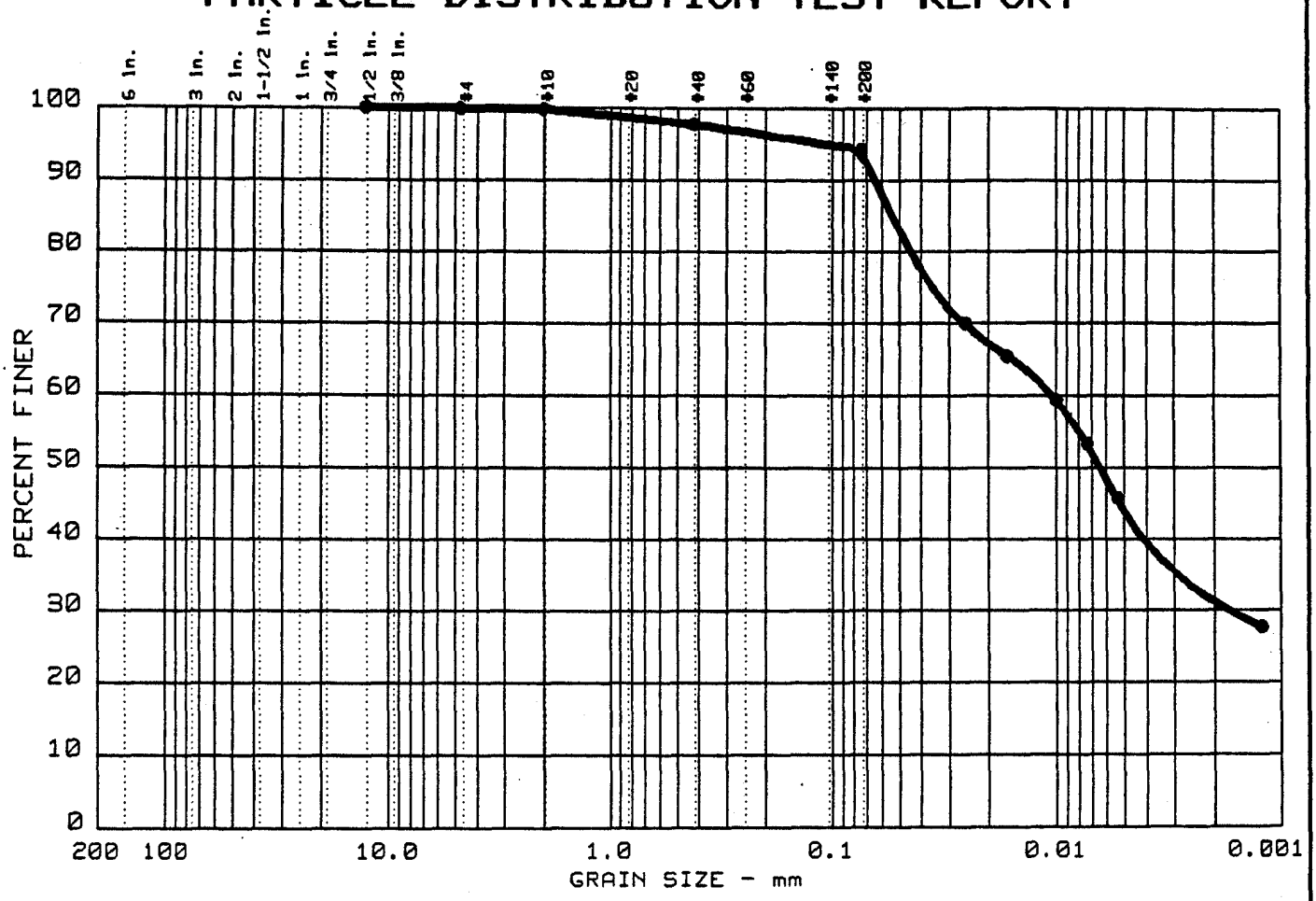
RAN BY: KLR
SANJOSE GR1-01

RUST ENVIRONMENT & INFRASTRUCTURE

Project No.: 55253.000
Project: FORT CARSON

Date: 04.05.96 Lab. No. ——

PARTICLE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	0.1	5.7	63.1	31.1	CH	58.4	34.7

SIEVE inches size	PERCENT FINER ●		
0.5	100.0		
	GRAIN SIZE		
D_{60} D_{30} D_{10}	0.002		
	COEFFICIENTS		
C_c C_u			

SIEVE number size	PERCENT FINER ●		
4	99.9		
10	99.7		
40	97.7		
200	94.2		

Sample information:
● 24-1 @ 1'- 3'
GRAY FAT CLAY

Remarks:

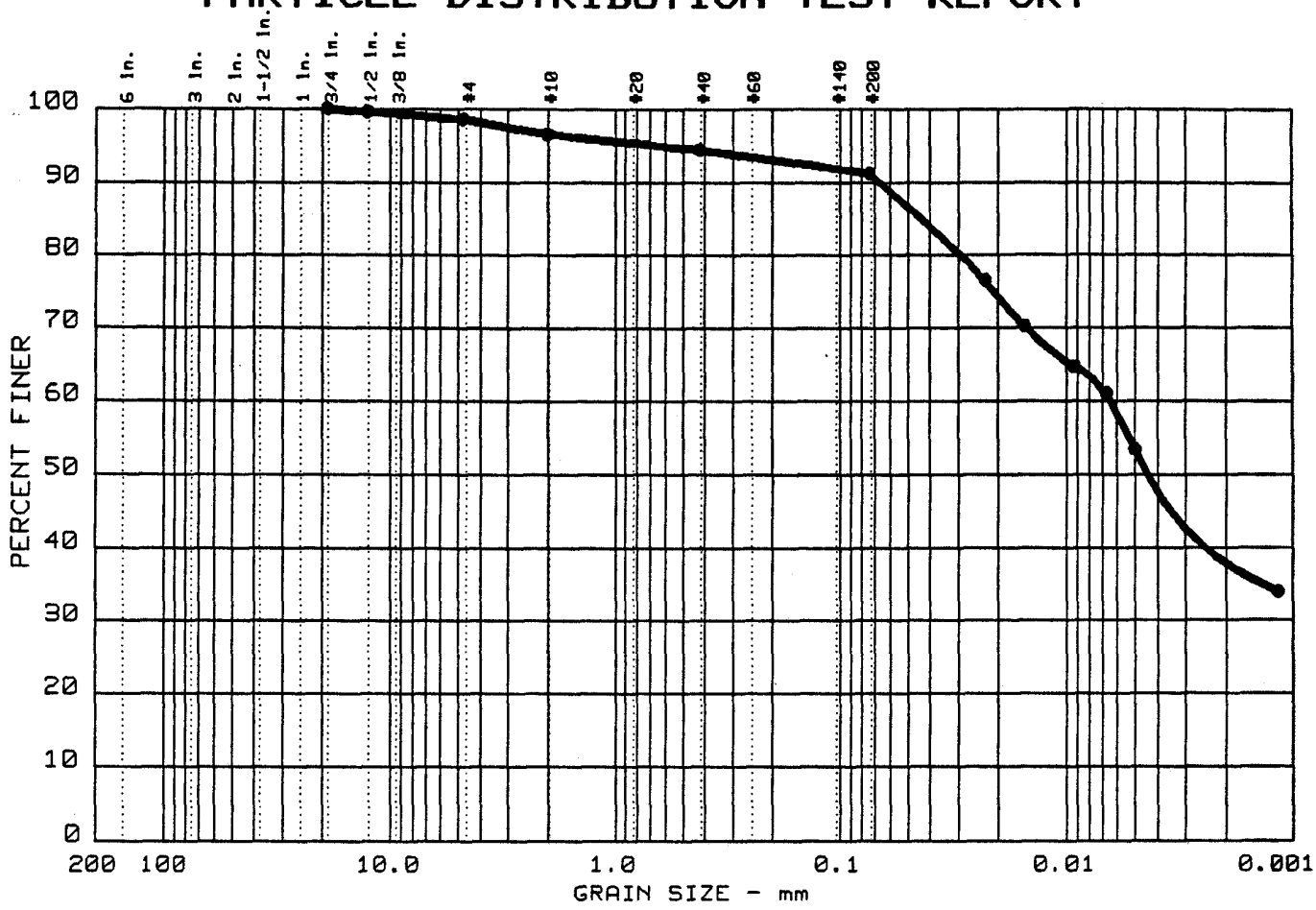
RAN BY: KLR
SANJOSE GR12

RUST ENVIRONMENT & INFRASTRUCTURE

Project No.: 55253.000
Project: CORPS OF ENGINEERS

Date: 03.13.96 Lab. No. ——

PARTICLE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	1.5	7.3	53.4	37.8	CH	66.1	40.2

SIEVE inches size	PERCENT FINER ●		
0.75	100.0		
0.5	99.5		
GRAIN SIZE			
D_{60}			
D_{30}			
D_{10}			
COEFFICIENTS			
C_c			
C_u			

SIEVE number size	PERCENT FINER ●		
4	98.5		
10	96.5		
40	94.4		
200	91.2		

Sample information:
● 25-3.5 @ 3.5'- 5.5'
GRAY FAT CLAY

Remarks:

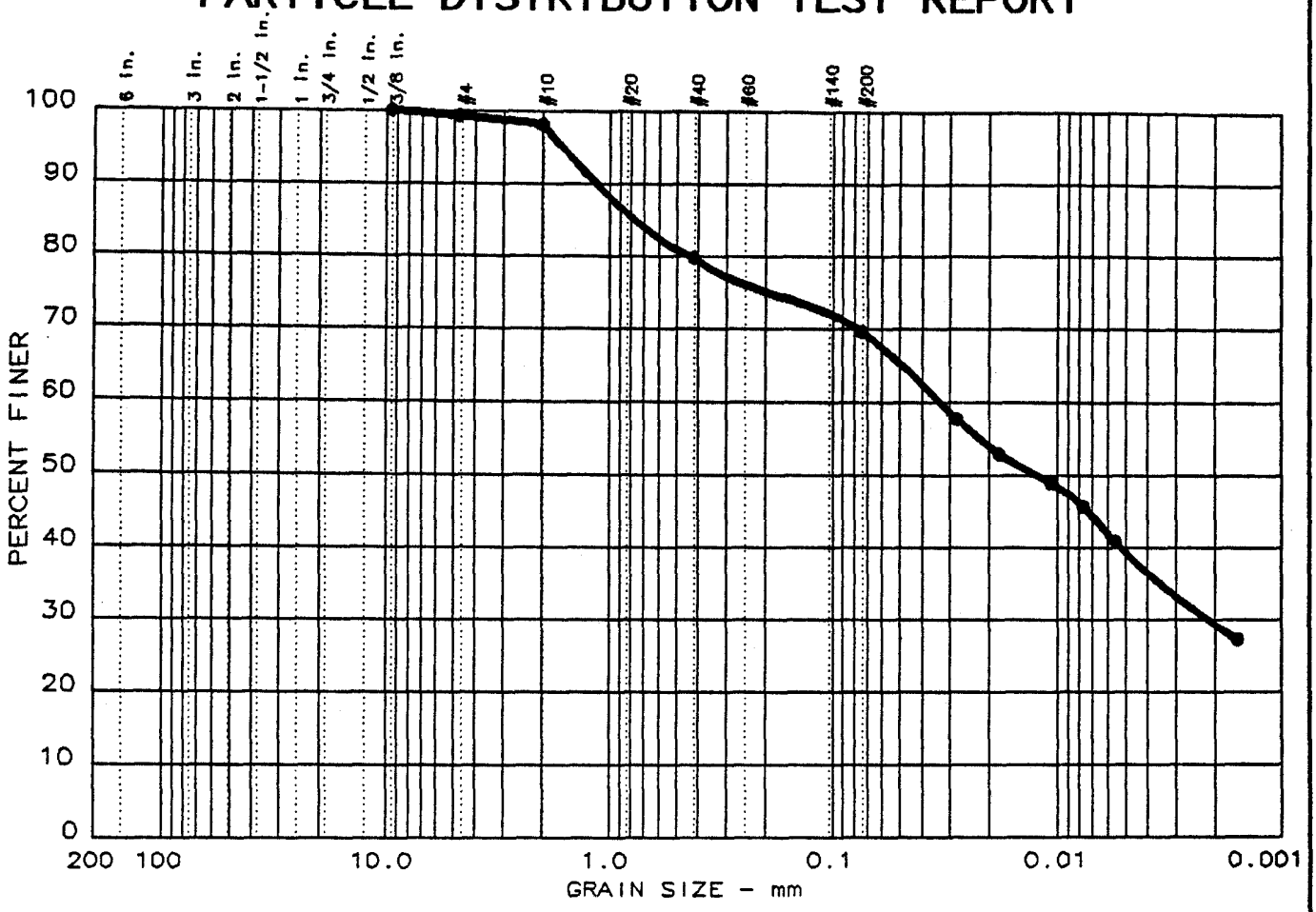
RAN BY: KLR
SANJOSE GR13

RUST ENVIRONMENT & INFRASTRUCTURE

Project No.: 55253.000
Project: CORPS OF ENGINEERS

Date: 03.13.96 Lab. No. ——

PARTICLE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	0.8	29.7	40.3	29.2	CH	56.2	33.3

SIEVE inches size	PERCENT FINER ●		
0.375	100.0		
GRAIN SIZE			
D_{60} D_{30} D_{10}	0.002		
COEFFICIENTS			
C_c C_u			

SIEVE number size	PERCENT FINER ●		
4	99.2		
10	98.1		
40	79.8		
200	69.6		

Sample information:

● CVT 25-6.5 @ 6.5'- 8.5'
SANDY FAT CLAY

Remarks:
NMC 12.1%

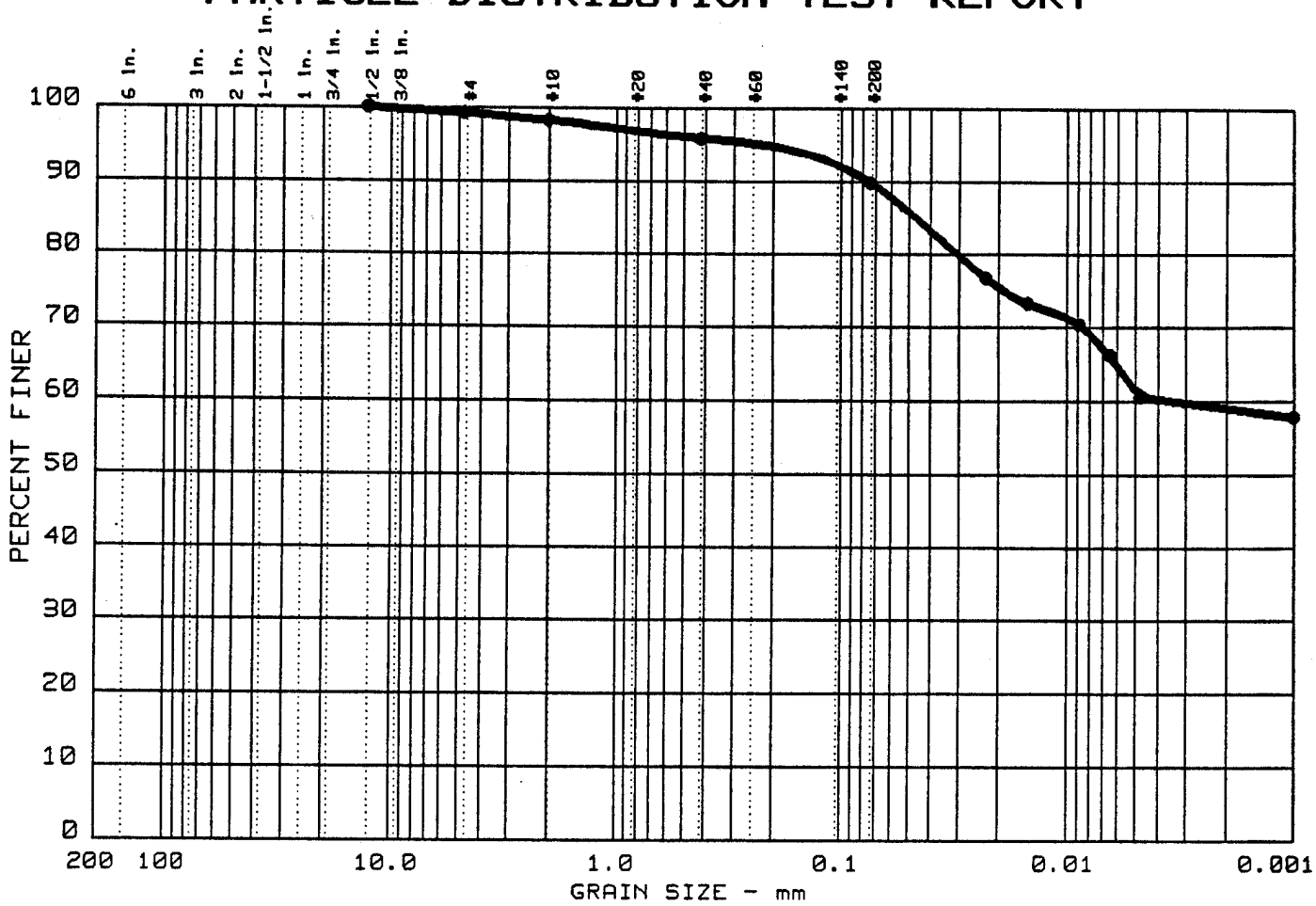
RAN BY: KLR
SANJOSE GR1-02

RUST ENVIRONMENT & INFRASTRUCTURE

Project No.: 55253.000
Project: FORT CARSON

Date: 04.05.96 Lab. No. ——

PARTICLE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	0.8	9.4	30.8	59.0	CH	65.9	42.2

SIEVE inches size	PERCENT FINER ●		
0.5	100.0		
	GRAIN SIZE		
D_{60}			
D_{30}			
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ●		
4	99.2		
10	98.3		
40	95.8		
200	89.8		

Sample information:
● 26-2 @ 2'- 4'
GRAY FAT CLAY

Remarks:

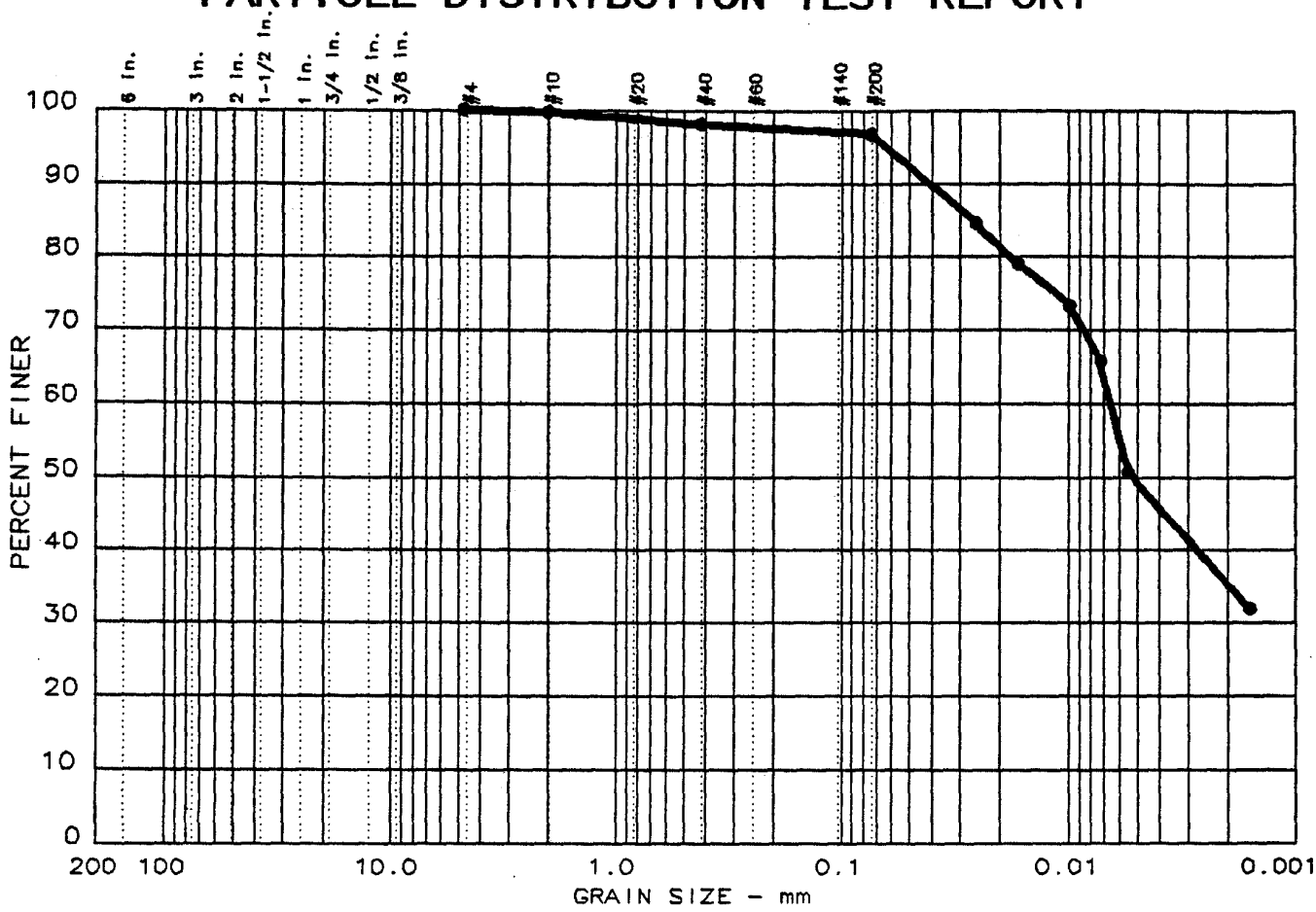
RAN BY: KLR
SANJOSE GR14

RUST ENVIRONMENT & INFRASTRUCTURE

Project No.: 55253.000
Project: CORPS OF ENGINEERS

Date: 03.13.96 Lab. No. ——

PARTICLE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	0.0	3.2	61.4	35.4	CH	60.2	37.1

SIEVE Inches size	PERCENT FINER ●		
	GRAIN SIZE		
D_{60} D_{30} D_{10}			
	COEFFICIENTS		
C_c C_u			

SIEVE number size	PERCENT FINER ●		
4	100.0		
10	99.7		
40	98.1		
200	96.8		

Sample information:
● CVT 27.3 @ 3'- 5'
FAT CLAY

Remarks:
NMC 22.5%

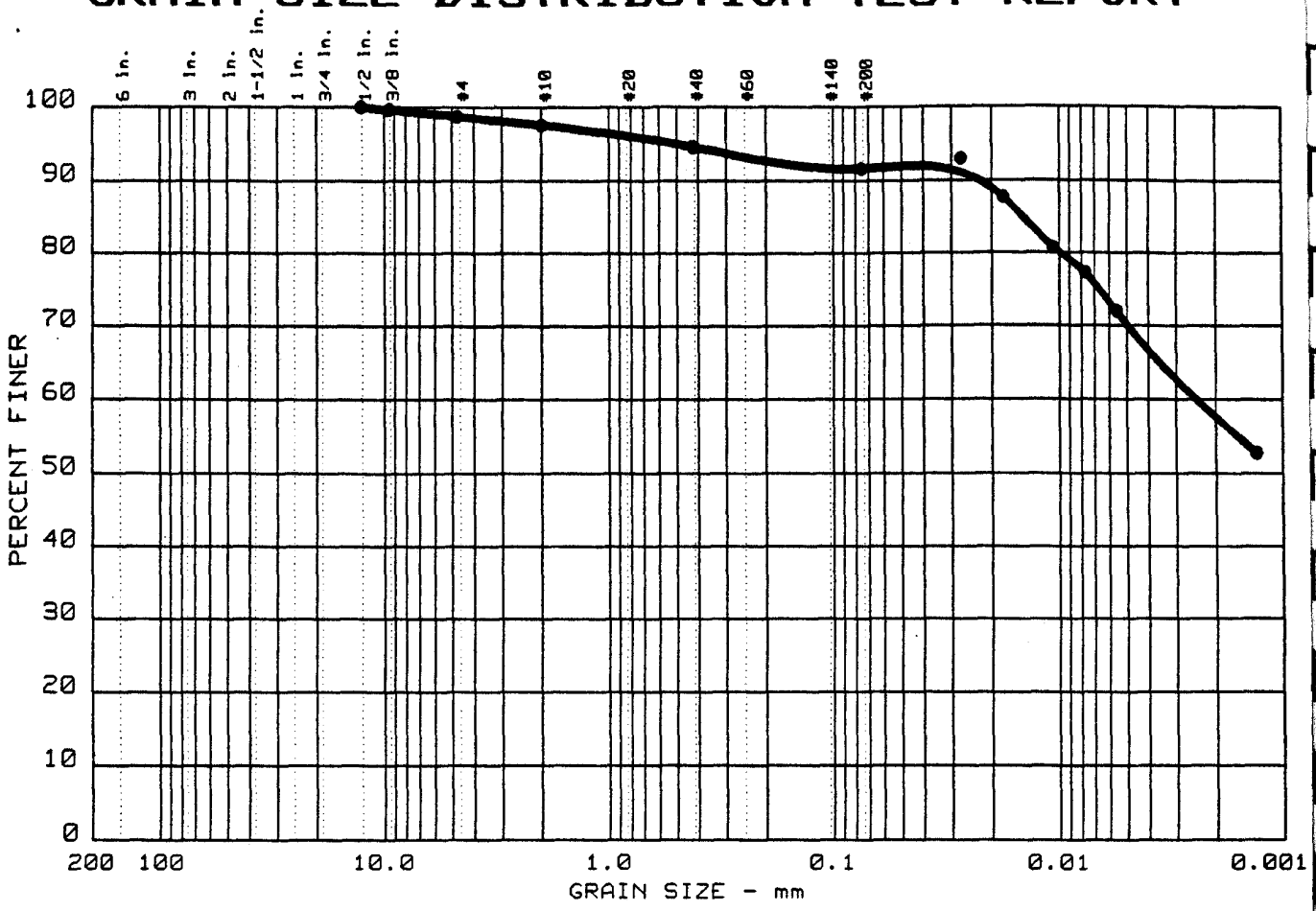
RAN BY: KLR
SANJOSE GR1-03

RUST ENVIRONMENT & INFRASTRUCTURE

Project No.: 55253.000
Project: FORT CARSON

Date: 04.05.96 Lab. No. ——

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	2	0.0	1.3	7.1	21.4	70.2

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	57	41								

MATERIAL DESCRIPTION	USCS	AASHTO
● BROWN FAT CLAY	CH	

Project No.: 55253
Project: FORT CARSON
● Location: CVT.28-4 @ 4'-6'

Date: 4.11.96

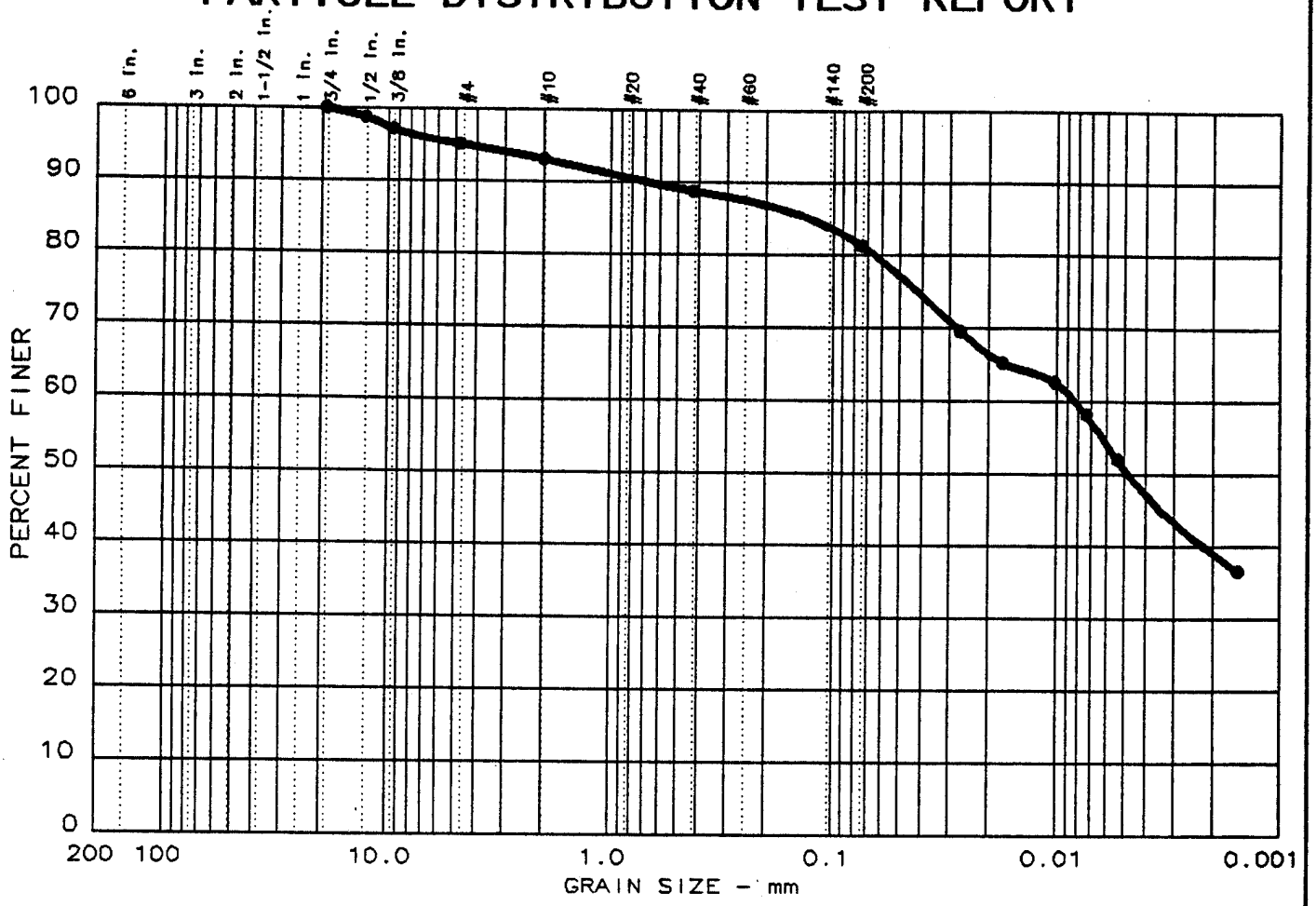
Remarks:
TESTED BY MCM

GRAIN SIZE DISTRIBUTION TEST REPORT

RUST ENVIRONMENT & INFRASTRUCTURE

Fig. No.: _____

PARTICLE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	4.9	13.9	42.2	39.0	CH	55.5	32.1

SIEVE Inches size	PERCENT FINER ●		
0.75	100.0		
0.5	98.7		
0.375	97.1		
	GRAIN SIZE		
D_{60}			
D_{30}			
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ●		
4	95.1		
10	93.0		
40	88.7		
200	81.2		

Sample information:
● CVT 29-2 @ 2'- 4'
FAT CLAY WITH SAND

Remarks:
NMC 19.5%

RAN BY: KLR
SANJOSE GR1-04

RUST ENVIRONMENT & INFRASTRUCTURE

Project No.: 55253.000
Project: FORT CARSON

Date: 04.05.96 Lab. No. ____

APPENDIX D
CONSTRUCTION COST ESTIMATE

TABLE D-1
Fort Carson Landfill No.2
Cap Construction Costs

	No Fee No Overhead Cost	With Fee With Overhead Cost
Cut/Fill =	$635,076	$848,683
Barrier Layer =	$622,028	$831,247
Reworked Soil for Barrier Layer =	$220,529	$294,704
Soil/Frost Protection Layer =	$769,854	$1,028,794
Reworked Soil for Frost Protection Layer =	$272,253	$363,825
Drill Seeding =	$72,000	$96,217
Silt Fencing =	$2,352	$3,143
Straw Bales =	$12,800	$17,105
Bedding Layer for Riprap Channels =	$17	$23
Geotextile Separator Layer for Riprap =	$16	$21
Riprap =	$195	$261
Permanent Erosion Mat =	$26,070	$34,839
Temporary Erosion Mat =	$8,219	$10,983
Diversion Berms=	$16,858	$22,528
Fencing=	$8,000	$10,691
CQA Costs =	$188,279	$251,606
Total Cost =	$2,854,546	$3,814,670

RUST **Rust Environment & Infrastructure**

CALCULATION SHEET

PROJECT NO. 89868

CLIENT USACE SUBJECT COST ESTIMATE Prepared By MWW Date 5/2/96

PROJECT FTC LF2 Reviewed By MKY Date 5/3/96

Approved By _____ Date _____

① CUT/FILL

A) PRECOMPACTION = (2,268,179 SF)($\frac{SY}{9SF}$)($0.11/SY) = $27,722 ✓

B) CUT & HAUL = (157,473 CY)($\frac{1}{2580\ CY/day}$)($7,508.64/day) = $458,298 ✓

C) COMPACTION CREW = (157,473 CY)($\frac{1}{2580\ CY/day}$)($1715.80/day) = $104,726 ✓

D) FINISH GRADE = (2,268,179 SF)($\frac{SY}{9SF}$)($\frac{1}{7100\ SY/day}$)($1,248.89/day) = $44,330 ✓

TOTAL = $635,076 ✓

② BARRIER LAYER

A) LOAD CREW = (116,387 CY)($\frac{1}{2580\ CY/day}$)($1,202.93/day) = $54,266 ✓

B) HAUL - 5 mi RT = (116,387 CY)($3.49/CY) = $406,191 ✓

C) COMPACTION CREW = (116,387 CY)($\frac{1}{2600\ CY/day}$)($2,923.37/day) = $130,862 ✓

D) FINISH GRADING = (1,571,219 SF)($\frac{SY}{9SF}$)($\frac{1}{7100\ SY/day}$)($1248.89/day) = $30,709 ✓

$622,028 ✓

RUST **Rust Environment & Infrastructure**

CALCULATION SHEET

PROJECT NO. 89868

CLIENT USACE SUBJECT COST ESTIMATE Prepared By MWW Date 5/2/96

PROJECT FTC LF2 Reviewed By MKJ Date 5/3/96

Approved By _____ Date _____

③ REWORKED SOIL FOR BARRIER LAYER

A) CUT & HAUL = (51,627 cy)(1/2580 cy/day)($7,439.07/day) = $148,859 ✓

B) CLAY COMPACT CREW = (51,627 cy)(1/2600 cy/day)($2,923.37/day) = $58,048 ✓

C) FINISH GRADING = (696,960 SF)(SY/9SF)(1/7100 SY/day)($1,248.89/day) = 13,622 ✓

$220,529 ✓

④ FROST PROTECTION LAYER

A) LOAD CREW = (145,483 cy)(1/2580 cy/day)($1,202.93/day) = $67,832 ✓

B) HAUL - 5 mi RT = (145,483 cy)($3.49/cy) = $507,736 ✓

C) COMPACTION CREW = (145,483 cy)(1/2600 cy/day)($2,923.37/day) = $163,577 ✓

D) FINISH GRADING = (1,571,219 SF)(SY/9SF)(1/7100 SY/day)($1248.89/day) = $30,709 ✓

$769,854 ✓

⑤ REWORKED SOIL FOR FROST PROTECTION LAYER

A) CUT & HAUL = (64,533 cy)(1/2580 cy/day)($7,439.07/day) = $186,072 ✓

B) COMPACTION CREW = (64,533 cy)(1/2600 cy/day)($2,923.37/day) = $72,559 ✓

C) FINISH GRADING = (696,960 SF)(SY/9SF)(1/7100 SY/day)($1,248.89/day) = 13,622 ✓

$272,253 ✓

RUST **Rust Environment & Infrastructure**

CALCULATION SHEET

PROJECT NO. 89868

CLIENT USACE SUBJECT COST ESTIMATE Prepared By MWW Date 5/2/96

PROJECT FTC LF2 Reviewed By MJY Date 5/3/96

Approved By _____ Date _____

(6) SEEDING, EROSION/DRAINAGE CONTROL

A) DRILL SEEDING = (3,484,800 SF)(AC / 43560 SF)($900/AC) = $72,000 ✓

B) SILT FENCING = (4,200 LF)($0.56/LF) = $2352 ✓

C) HAY BALES = (50 TONS)($256/TON) = $12,800 ✓

D) 4" BEDDING LAYER FOR RIPRAP

1) MAT'L AND HAUL = (1 CY)(27 CF/CY)(120 lb/CF)(TON/2000 lb)($8.77/TON) = $14

2) PLACEMENT = (1 CY / 783 CY/day)($1901.72/day) = $3

$17

E) GEOTEXTILE SEPARATOR FOR RIPRAP = (20 SY)(0.77/SY) = $16
(MAT'L & INSTALL)

F) RIPRAP

1) MAT'L & HAUL = (100 CF)(130 lb/CF)(TON/2000 lb)($24.00/TON) = 156

2) PLACEMENT = (0.25)($ 156) 39

ASSUME COST IS 25% OF MAT'L & HAUL COST $195

★G) PERMANENT EROSION MAT = (3476 SY)($7.50/SY) = $26,070 ✓
(MAT'L & INSTALLATION FOR ENKAMAT 7010)

★H) TEMPORARY EROSION MAT = (6575 SY)($1.25/SY) $8,219 ✓
(MAT'L & INSTALLATION FOR STANDARD EXCELSIOR MAT)

I) DIVERSION BERM/DOWNSLOPE CHANNEL SOILS (4480 LF)

A) LOAD CREW = (3318 CY)(1 / 2580 CY/day)($1,202.93/day) = $1,547 ✓

B) HAUL - 5 mi RT = (3318 CY)($3.49/CY) = $11,580 ✓

C) COMPACT = (3318 CY)(1 / 2600 CY/day)($2,923.37/day) = 3,731 ✓

$16,858 ✓

Rev. 11/94 ★ UNIT COSTS PROVIDED BY VANCE BROTHERS, AURORA, CO scale: 4 sq./inch F051/General

TOTAL = $138,527 ✓

RUST **Rust Environment & Infrastructure**

CALCULATION SHEET

PROJECT NO. 89868

CLIENT USACE SUBJECT COST ESTIMATE Prepared By MWW Date 5/2/96

PROJECT FTC LF2 Reviewed By MJ Date 5/3/96

Approved By _____ Date _____

(7) CQA COSTS

TOTAL YARDAGE VOLUME:

WASTE	BARRIER	FROST PROT.
157,473	168,014 cy	210,016

No. OF DAYS BASED ON PLACEMENT $= \left(\frac{157{,}473\ cy}{2580\ cy/day}\right) + \left(\frac{168{,}014\ cy}{2600\ cy/day}\right) + \left(\frac{210{,}016\ cy}{2600\ cy/day}\right) = 207$ days ✓

ADDITIONAL DAYS FOR SITE STARTUP AND SEEDING = 18 days

TOTAL DAYS = 225 DAYS ✓

A) LABOR COSTS/EXPENSES

		COST
CQA FIELD TECH =	225 DAYS × 8hr/day × $50/hr =	$90,000 ✓
CQA PM =	$\left[\left(\frac{225}{5}\right)1.5 + 7\ DAYS\right] \times 8hr/day \times \$70/hr =$	$41,720 ✓
CQA CE =	(225/14 DAY) × 8hr/day × $80/hr =	$10,286 ✓
WP/COORD =	5 DAYS × 8hr/day × $35/hr =	$1,400 ✓
CAD TECH =	5 DAYS × 8hr/day × $50/hr =	$2,000 ✓
CAD COMP =	5 DAYS × 8hr/day × $20/hr =	$800 ✓
EXPENSES =	=	$12,750
		$158,956 ✓

B)

SOIL TESTING	D422	D4318	D698	D698	D5084	D2216	D3017 D2922	D1556
BARRIER LAYER	56	56	56	56	34	112	560	12
FROST PROTECTION	21	21	21	21	13	—	—	—
	77	77	77	77	47	112	560	12
COST/TEST	$67	$41	$88	$20	$245	$5.70	—	—
COST	$5159	3157	6,776	1540	$11,515	639		

TOTAL SOIL TESTING COST = $28,786 ✓

RUST **Rust Environment & Infrastructure**

CALCULATION SHEET

PROJECT NO. 89868

CLIENT USACE

SUBJECT COST ESTIMATE

PROJECT FTC LF2

Prepared By MWW Date 5/2/96

Reviewed By MJV Date 5/3/96

Approved By _____ Date _____

(8) FENCING

ASSUME THAT 50% OF THE EXISTING PERIMETER FENCE WILL NEED TO BE REPLACED/REUSED.

8,350 LF ÷ 2 = 4175 → say 4000 LF x $2.00/LF = $8000 .k

RUST **Rust Environment & Infrastructure**

CALCULATION SHEET

PROJECT NO. 89868

CLIENT USACE

SUBJECT COST ESTIMATE

PROJECT FTC LF2

Prepared By MWW Date 5/2/94

Reviewed By MRJ Date 5/3/96

Approved By _____ Date _____

SUMMARY OF COSTS

	NO FEE, NO OVERHEAD	☆ WITH FEE WITH OVERHEAD
(1) CUT/FILL	$635,076	$848,683
(2) BARRIER LAYER	$622,028	$831,247
(3) REWORKED SOIL FOR BARRIER LAYER	$220,529	$294,704
(4) FROST PROTECTION LAYER	$769,854	$1,028,794
(5) REWORKED SOIL FOR FROST PROTECTION LAYER	$272,253	$363,825
(6) SEEDING, EROSION/DRAINAGE CONTROL	$138,527	$185,120
(7) CQA COSTS	$188,279	$251,606
(8) FENCING	$8000	$10,691
TOTAL =	$2,854,546	$3,814,670 ✓

☆ FEE/OVERHEAD COST FACTOR OBTAINED FROM OHM

APPENDIX E
HELP MODELING

FINAL COVER PERFORMANCE BY HELP ANALYSIS

Objective

Two final cover systems were evaluated using the USEPA's Hydrologic Evaluation of Landfill Performance (HELP) model. The cover systems evaluated were the following: existing cap system and a proposed clay cap system The performance of each cover were analyzed for the 100 year, 24 hr storm event. The purpose of the computer simulations were to determine the amount of leakage through the final cap over 30 years during post closure conditions.

Design Criteria, Assumptions, and Methodology

- The following are the final cover components:

Existing Cap: 36" existing soil cover/frost protection layer (k=5.0E-05 cm/sec)
29" existing barrier layer soil (k=5.0E-07 cm/sec)
Note: permeabilities used are from perm. tests done on site of existing soils.

Proposed Clay Cap: 30" soil cover/frost protection layer (k=5.0E-05 cm/sec)
upper 4" consist of a topsoil layer (k=5.2E-02 cm/sec)
24" barrier layer soil (k=5.0E-07 cm/sec)

The existing soil cover consisted of a silty sand with gravel (SM) and the existing barrier layer consisted of sandy lean clay (CL). Proposed soil layer parameters (porosity, field capacity, wilting point) were taken from HELP model default soils that were closest in permeability and soil type to the existing soils. The default soil textures chosen were #7 for the topsoil and soil cover/frost protection layer and #24 for the barrier layer.

- Colorado Springs, Colorado used as reference point for synthetic weather data (rainfall and temperature) input to aid in generation of climatological data for use with this model (see attachment 1).
- 100 year, 24 hour storm event of 4.2 inches used as input. Source: "City of Colorado Springs/El Paso County Drainage Criteria Manual", Revised 1991.
- SCS curve number for rainfall runoff assumed to be 79 (see attachment 2).
- One acre design area used for modeling purposes.
- The evapotranspiration depth used was 36 inches for the existing cap and 30 inches for the

proposed clay cap.

- The maximum leaf area index used was 2.0.

HELP Model Summary

Average Annual

Final Cap	Precip (in)	Runoff (in)	Evapotrans. (in)	Leakage (in)	Ave. Head (in)
Existing	16.25	0.14	16.08	0.00	0.00
2' Clay	16.25	0.15	16.08	0.00	0.00

Peak Daily

Final Cap	Precip (in)	Runoff (in)	Leakage (in)	Ave. Head (in)
Existing	4.20	2.36	0.00	0.00
2' Clay	4.20	2.38	0.00	0.00

CONCLUSION:

THE PROPOSED CAP IS THINNER THAN THE PARTICULAR EXISTING CAP PROFILE ANALYZED HEREIN. THEREFORE, THE PROPOSED CAP PROFILE SHOULD BE THE BASIS FOR COMPARISON FOR DETERMINING THE ADEQUACY OF EXISTING CAP SOILS. BOTH ANALYSES INDICATE ZERO LEAKAGE.

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.04    (10 APRIL 1995)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:     C:\HELP3\ftc\100YR.D4
TEMPERATURE DATA FILE:       C:\HELP3\ftc\DATA7.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\ftc\DATA13.D13
EVAPOTRANSPIRATION DATA:     C:\HELP3\ftc\DATA11.D11
SOIL AND DESIGN DATA FILE:   C:\HELP3\ftc\lf2\30%\INSITU.D10
OUTPUT DATA FILE:            C:\HELP3\ftc\lf2\90%\insitu.OUT


TIME:   9:40     DATE:   4/23/1996


******************************************************************************

     TITLE:  Fort Carson Landfill No.2:   In-situ soils

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   0
          THICKNESS                    =     36.00   INCHES
          POROSITY                     =      0.4730 VOL/VOL
          FIELD CAPACITY               =      0.2220 VOL/VOL
          WILTING POINT                =      0.1040 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.1341 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.499999987000E-04 CM/SEC


                                  LAYER  2
```

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	29.00	INCHES
POROSITY	=	0.3650	VOL/VOL
FIELD CAPACITY	=	0.3050	VOL/VOL
WILTING POINT	=	0.2020	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3650	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.499999999000E-06	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	79.00	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	30.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	3.493	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	14.190	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	3.120	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	15.414	INCHES
TOTAL INITIAL WATER	=	15.414	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
COLORADO SPRINGS COLORADO

STATION LATITUDE	=	38.49	DEGREES
MAXIMUM LEAF AREA INDEX	=	2.00	
START OF GROWING SEASON (JULIAN DATE)	=	126	
END OF GROWING SEASON (JULIAN DATE)	=	282	
EVAPORATIVE ZONE DEPTH	=	30.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	10.20	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	49.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	47.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	51.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	48.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR COLORADO SPRINGS COLORADO

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC

0.29	0.40	0.94	1.19	2.15	2.25
2.90	3.02	1.33	0.84	0.47	0.46

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR COLORADO SPRINGS COLORADO

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
28.80	32.00	37.30	46.40	55.40	65.00
70.80	68.00	60.40	49.90	37.80	29.80

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR COLORADO SPRINGS COLORADO
AND STATION LATITUDE = 38.49 DEGREES

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.26	0.45	0.89	1.12	2.28	2.28
	2.79	2.93	1.40	0.90	0.51	0.45
STD. DEVIATIONS	0.22	0.29	0.48	0.70	1.10	1.12
	0.93	1.42	0.80	0.54	0.34	0.31
RUNOFF						
TOTALS	0.001	0.009	0.000	0.000	0.006	0.106
	0.001	0.025	0.001	0.000	0.000	0.002
STD. DEVIATIONS	0.004	0.030	0.001	0.000	0.025	0.439
	0.003	0.106	0.002	0.001	0.000	0.007
EVAPOTRANSPIRATION						
TOTALS	0.241	0.400	0.752	0.818	1.435	2.448
	4.034	1.721	2.480	0.718	0.313	0.275
STD. DEVIATIONS	0.166	0.207	0.286	0.388	0.527	0.832
	1.034	0.523	0.932	0.507	0.147	0.156

PERCOLATION/LEAKAGE THROUGH LAYER 2

TOTALS	0.0093	0.0191	0.0423	0.0415	0.0496	0.0547
	0.0632	0.0663	0.0451	0.0282	0.0169	0.0117
STD. DEVIATIONS	0.0142	0.0257	0.0383	0.0225	0.0263	0.0289
	0.0252	0.0257	0.0232	0.0229	0.0135	0.0226

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 2

AVERAGES	0.0003	0.0006	0.0012	0.0013	0.0016	0.0019
	0.0029	0.0026	0.0018	0.0009	0.0005	0.0004
STD. DEVIATIONS	0.0004	0.0009	0.0012	0.0009	0.0009	0.0012
	0.0016	0.0016	0.0013	0.0008	0.0007	0.0009

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES		CU. FEET	PERCENT
PRECIPITATION	16.25	(2.501)	58983.9	100.00
RUNOFF	0.152	(0.4439)	551.05	0.934
EVAPOTRANSPIRATION	15.636	(2.3997)	56759.56	96.229
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.44799	(0.07695)	1626.191	2.75701
AVERAGE HEAD ON TOP OF LAYER 2	0.001	(0.000)		
CHANGE IN WATER STORAGE	0.013	(0.5994)	47.06	0.080

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 30

	(INCHES)	(CU. FT.)
PRECIPITATION	4.20	15245.999
RUNOFF	2.378	8630.5244
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.017047	61.88000
AVERAGE HEAD ON TOP OF LAYER 2	0.067	
SNOW WATER	0.80	2894.1995

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.2678
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1040

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FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	5.2175	0.1449
2	10.5850	0.3650
SNOW WATER	0.000	

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.04    (10 APRIL 1995)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:     C:\HELP3\ftc\100YR.D4
TEMPERATURE DATA FILE:       C:\HELP3\ftc\DATA7.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\ftc\DATA13.D13
EVAPOTRANSPIRATION DATA:     C:\HELP3\ftc\DATA11.D11
SOIL AND DESIGN DATA FILE:   C:\HELP3\ftc\lf2\90%\TOPSOIL.D10
OUTPUT DATA FILE:            C:\HELP3\ftc\lf2\90%\topsoil.OUT


TIME:  13:51     DATE:   4/23/1996


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     TITLE:  Landfill No.2:  5.0E-7 Clay Cap Option with Topsoil

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   7
          THICKNESS                  =      4.00   INCHES
          POROSITY                   =      0.4730 VOL/VOL
          FIELD CAPACITY             =      0.2220 VOL/VOL
          WILTING POINT              =      0.1040 VOL/VOL
          INITIAL SOIL WATER CONTENT =      0.1040 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.520000001000E-03 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  3.00
                 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	26.00	INCHES
POROSITY	=	0.4730	VOL/VOL
FIELD CAPACITY	=	0.2220	VOL/VOL
WILTING POINT	=	0.1040	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1076	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.499999987000E-04	CM/SEC

LAYER 3

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	24.00	INCHES
POROSITY	=	0.3650	VOL/VOL
FIELD CAPACITY	=	0.3050	VOL/VOL
WILTING POINT	=	0.2020	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3650	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.499999999000E-06	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	79.00	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	30.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	3.214	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	14.190	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	3.120	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	11.974	INCHES
TOTAL INITIAL WATER	=	11.974	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
COLORADO SPRINGS COLORADO

STATION LATITUDE	=	38.49	DEGREES
MAXIMUM LEAF AREA INDEX	=	2.00	

START OF GROWING SEASON (JULIAN DATE)	=	126
END OF GROWING SEASON (JULIAN DATE)	=	282
EVAPORATIVE ZONE DEPTH	=	30.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	10.20 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	49.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	47.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	51.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	48.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR COLORADO SPRINGS COLORADO

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.29	0.40	0.94	1.19	2.15	2.25
2.90	3.02	1.33	0.84	0.47	0.46

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR COLORADO SPRINGS COLORADO

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
28.80	32.00	37.30	46.40	55.40	65.00
70.80	68.00	60.40	49.90	37.80	29.80

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR COLORADO SPRINGS COLORADO
AND STATION LATITUDE = 38.49 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.26	0.45	0.89	1.12	2.28	2.28
	2.79	2.93	1.40	0.90	0.51	0.45
STD. DEVIATIONS	0.22	0.29	0.48	0.70	1.10	1.12
	0.93	1.42	0.80	0.54	0.34	0.31
RUNOFF						

TOTALS	0.001	0.008	0.000	0.000	0.001	0.030
	0.000	0.005	0.000	0.000	0.000	0.001
STD. DEVIATIONS	0.003	0.029	0.000	0.000	0.008	0.146
	0.000	0.025	0.000	0.000	0.000	0.005

EVAPOTRANSPIRATION

TOTALS	0.326	0.418	0.832	0.972	2.175	2.483
	2.923	2.596	1.691	0.842	0.581	0.364
STD. DEVIATIONS	0.257	0.298	0.454	0.588	1.008	1.107
	0.977	1.005	0.800	0.495	0.409	0.222

PERCOLATION/LEAKAGE THROUGH LAYER 3

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 3

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES		CU. FEET	PERCENT
PRECIPITATION	16.25	(2.501)	58983.9	100.00
RUNOFF	0.047	(0.1476)	170.21	0.289
EVAPOTRANSPIRATION	16.202	(2.4740)	58814.93	99.714
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.00000	(0.00000)	0.000	0.00000
AVERAGE HEAD ON TOP OF LAYER 3	0.000	(0.000)		
CHANGE IN WATER STORAGE	0.000	(0.4565)	-1.28	-0.002

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 30

	(INCHES)	(CU. FT.)
PRECIPITATION	4.20	15245.999
RUNOFF	0.798	2896.8511
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.000000	0.00000
AVERAGE HEAD ON TOP OF LAYER 3	0.000	
SNOW WATER	0.80	2894.1995

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.2353
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1040

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FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	0.4160	0.1040
2	2.7870	0.1072
3	8.7600	0.3650
SNOW WATER	0.000	

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CLIENT USACE SUBJECT Subtitle C Cap Prepared By MWW Date 4-23-96
PROJECT Fort Carson Landfill 2 HELP Analysis Reviewed By MJY Date 4/29/96
Approved By ____ Date ____

Recommended Subtitle C Cap per EPA Guidance - Help Analysis

Objective

For comparison purposes, the recommended Subtitle C cap per EPA guidance has been analyzed to check for leakage. The recommended Subtitle C cap section was evaluated for a 100 year, 24 hour storm event. The purpose of the computer simulation was to determine the amount of leakage through the recommended Subtitle C cap section over 30 years during post closure conditions.

Design Criteria, Assumptions, and Methodology

- The following are the components of the recommended Subtitle C cap section:

  6" topsoil
  12" miscellaneous cover soils
  12" gravel drainage layer
  30 mil pvc liner
  2' barrier layer (k max=1 x 10^{-7} cm/sec)
  existing subgrade

- Default soil #21 was used for the gravel drainage layer.
- The following was assumed for the placement of the pvc:
  pinhole density = 4 1 mm diameter holes per acre
  installation defect density = 4 defects per acre (a defect is a hole diameter of 1 cm)
  pvc placement quality = 3 (quality ranges from 1 to 5, 1 being excellent)
- No geotextiles were included for cushion or separation.
- Colorado Springs, Colorado was used as a reference point for synthetic weather data (rainfall and temperature) input to aid in generation of climatological data for use with this model (see attachment 1).
- 100 year, 24 hour storm event of 4.2 inches used as input. Source: "City of Colorado Springs/El Paso County Drainage Criteria Manual", Revised 1991.
- SCS curve number for rainfall runoff assumed to be 79.
- One acre design area used for modeling purposes.
- The evapotranspiration depth used was 30 inches.
- The maximum leaf area index used was 2.0.
- Soil texture #12 was used to represent the existing subgrade. The default permeability was

changed to 4.5 x 10-5 cm/sec. This value represents an average permeability computed from soil boring lab data contained in the appendix. Only the first two inches of existing subgrade was used in the model. It is not certain where the waste layer is relative to the first two inches below subgrade.

HELP Model Summary

Average Annual

Precip (in)	Runoff (in)	Evapotrans. (in)	Leakage (in)	Ave. Head (in)
16.25	0.05	16.16	0.00	0.00

Peak Daily

Precip (in)	Runoff (in)	Leakage (in)	Ave. Head (in)
4.20	0.80	0.00	0.54

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**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.04    (10 APRIL 1995)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:     C:\HELP3\ftc\100YR.D4
TEMPERATURE DATA FILE:       C:\HELP3\ftc\DATA7.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\ftc\DATA13.D13
EVAPOTRANSPIRATION DATA:     C:\HELP3\ftc\DATA11.D11
SOIL AND DESIGN DATA FILE:   C:\HELP3\ftc\lf2\90%\SUBTITLC.D10
OUTPUT DATA FILE:            C:\HELP3\ftc\lf2\90%\UBTITLC.OUT


TIME:  14:37     DATE:   4/23/1996


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     TITLE:  FORT CARSON LANDFILL 2:  SUBTITLE C FINAL CAP

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   7
          THICKNESS                    =      6.00   INCHES
          POROSITY                     =      0.4730 VOL/VOL
          FIELD CAPACITY               =      0.2220 VOL/VOL
          WILTING POINT                =      0.1040 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.1040 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.520000001000E-03 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  3.00
                 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	12.00	INCHES
POROSITY	=	0.4730	VOL/VOL
FIELD CAPACITY	=	0.2220	VOL/VOL
WILTING POINT	=	0.1040	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0949	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.499999987000E-04	CM/SEC

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

THICKNESS	=	12.00	INCHES
POROSITY	=	0.3970	VOL/VOL
FIELD CAPACITY	=	0.0320	VOL/VOL
WILTING POINT	=	0.0130	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0231	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000012000	CM/SEC
SLOPE	=	2.50	PERCENT
DRAINAGE LENGTH	=	350.0	FEET

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 37

THICKNESS	=	0.03	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999999000E-10	CM/SEC
FML PINHOLE DENSITY	=	4.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	4.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 5

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	24.00	INCHES
POROSITY	=	0.4450	VOL/VOL
FIELD CAPACITY	=	0.3930	VOL/VOL
WILTING POINT	=	0.2770	VOL/VOL

```
INITIAL SOIL WATER CONTENT  =      0.4450 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000001000E-06 CM/SEC
```

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

```
THICKNESS                   =      2.00   INCHES
POROSITY                    =      0.4710 VOL/VOL
FIELD CAPACITY              =      0.3420 VOL/VOL
WILTING POINT               =      0.2100 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2752 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.450000007000E-04 CM/SEC
```

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

```
SCS RUNOFF CURVE NUMBER              =     79.00
FRACTION OF AREA ALLOWING RUNOFF     =    100.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE   =      1.000  ACRES
EVAPORATIVE ZONE DEPTH               =     30.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE    =      2.040  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE   =     13.278  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE   =      2.028  INCHES
INITIAL SNOW WATER                   =      0.000  INCHES
INITIAL WATER IN LAYER MATERIALS     =     13.270  INCHES
TOTAL INITIAL WATER                  =     13.270  INCHES
TOTAL SUBSURFACE INFLOW              =      0.00   INCHES/YEAR
```

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
COLORADO SPRINGS COLORADO

```
STATION LATITUDE                          =  38.49 DEGREES
MAXIMUM LEAF AREA INDEX                   =   2.00
START OF GROWING SEASON (JULIAN DATE)     =    126
END OF GROWING SEASON (JULIAN DATE)       =    282
EVAPORATIVE ZONE DEPTH                    =  30.0  INCHES
AVERAGE ANNUAL WIND SPEED                 =  10.20 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY     =  49.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY     =  47.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY     =  51.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY     =  48.00 %
```

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR COLORADO SPRINGS COLORADO

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.29	0.40	0.94	1.19	2.15	2.25
2.90	3.02	1.33	0.84	0.47	0.46

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR COLORADO SPRINGS COLORADO

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
28.80	32.00	37.30	46.40	55.40	65.00
70.80	68.00	60.40	49.90	37.80	29.80

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR COLORADO SPRINGS COLORADO
AND STATION LATITUDE = 38.49 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.26	0.45	0.89	1.12	2.28	2.28
	2.79	2.93	1.40	0.90	0.51	0.45
STD. DEVIATIONS	0.22	0.29	0.48	0.70	1.10	1.12
	0.93	1.42	0.80	0.54	0.34	0.31
RUNOFF						
TOTALS	0.001	0.008	0.000	0.000	0.001	0.030
	0.000	0.005	0.000	0.000	0.000	0.001
STD. DEVIATIONS	0.003	0.029	0.000	0.000	0.004	0.146
	0.000	0.024	0.000	0.000	0.000	0.005
EVAPOTRANSPIRATION						
TOTALS	0.325	0.425	0.845	0.989	2.238	2.369

	2.846	2.622	1.672	0.867	0.576	0.387
STD. DEVIATIONS	0.259	0.306	0.461	0.607	1.048	1.103
	0.971	1.049	0.782	0.521	0.415	0.252

LATERAL DRAINAGE COLLECTED FROM LAYER 3

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0135
	0.0001	0.0109	0.0179	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0740
	0.0005	0.0598	0.0981	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 5

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 6

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0007
	0.0000	0.0002	0.0008	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0037
	0.0000	0.0029	0.0049	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0203
	0.0002	0.0159	0.0270	0.0000	0.0000	0.0000

****

****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES		CU. FEET	PERCENT
PRECIPITATION	16.25	(2.501)	58983.9	100.00
RUNOFF	0.046	(0.1476)	167.17	0.283
EVAPOTRANSPIRATION	16.160	(2.4677)	58661.73	99.454
LATERAL DRAINAGE COLLECTED	0.04243	(0.17225)	154.008	0.26110

FROM LAYER 3				
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00001	(0.00004)	0.034	0.00006
AVERAGE HEAD ON TOP OF LAYER 4	0.001	(0.004)		
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00029	(0.00114)	1.070	0.00181
CHANGE IN WATER STORAGE	0.000	(0.2573)	-0.10	0.000

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 30

	(INCHES)	(CU. FT.)
PRECIPITATION	4.20	15245.999
RUNOFF	0.798	2896.8511
DRAINAGE COLLECTED FROM LAYER 3	0.06603	239.69342
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000014	0.05253
AVERAGE HEAD ON TOP OF LAYER 4	0.544	
MAXIMUM HEAD ON TOP OF LAYER 4	5.356	
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000185	0.67048
SNOW WATER	0.80	2894.1995

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.1978
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0676

*** MAXIMUM HEADS ARE COMPUTED USING THE MOUND EQUATION. ***

****

****

FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	0.6240	0.1040
2	1.1388	0.0949
3	0.2846	0.0237
4	0.0000	0.0000
5	10.6800	0.4450
6	0.5419	0.2709
SNOW WATER	0.000	

****
****

ATTACHMENT 1

NOAA RAINFALL AND TEMPERATURE DATA FOR COLORADO SPRINGS, CO.

Precipitation Data:

Month	1993 Precipitation	Departure from Normal	Normal
January	0.52"	0.23"	0.29"
February	0.21"	-0.19"	0.40"
March	0.79"	-0.15"	0.94"
April	1.02"	-0.17"	1.19"
May	1.60"	-0.55"	2.15"
June	1.27"	-0.98"	2.25"
July	2.38"	-0.52"	2.90"
August	2.17"	-0.85"	3.02"
September	1.44"	0.11"	1.33"
October	0.90"	0.06"	0.84"
November	0.97"	0.50"	0.47"
December	0.11"	-0.35"	0.46"

Temperature Data (in degrees F)

Month	1993 Temperature	Departure from Normal	Normal
January	26.7	-2.1	28.8
February	29.4	-2.6	32.0
March	39.8	2.5	37.3
April	46.1	-0.3	46.4
May	55.6	0.2	55.4
June	65.0	0.0	65.0
July	70.7	-0.1	70.8
August	67.3	-1.0	68.0
September	58.1	-2.3	60.4
October	47.9	-2.0	49.9
November	32.3	-5.5	37.8
December	32.3	2.5	29.8

Ref: "Climatological Data Annual Summary Colorado 1993", vol 98, no.13. National Oceanic and Atmospheric Administration. ISSN 0145-0506. Normals are derived form weather data collected at the Colorado Springs, CO station between 1961 and 1990.

ATTACHMENT 2

United States
Department of
Agriculture

Soil
Conservation
Service

Engineering
Division

Technical
Release 55

June 1986

Urban Hydrology for Small Watersheds

Table 2-2c.—Runoff curve numbers for other agricultural lands[1]

Cover description		Curve numbers for hydrologic soil group—			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing.[2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element.[3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	[4]30	48	65	73
Woods—grass combination (orchard or tree farm).[5]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods.[6]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	[4]30	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

[1]Average runoff condition, and $I_a = 0.2S$.

[2]*Poor:* <50% ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: >75% ground cover and lightly or only occasionally grazed.

[3]*Poor:* <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.

[4]Actual curve number is less than 30; use CN = 30 for runoff computations.

[5]CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

[6]*Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

ATTACHMENT 3

CITY OF COLORADO SPRINGS/EL PASO COUNTY

DRAINAGE CRITERIA MANUAL

OCTOBER 1987

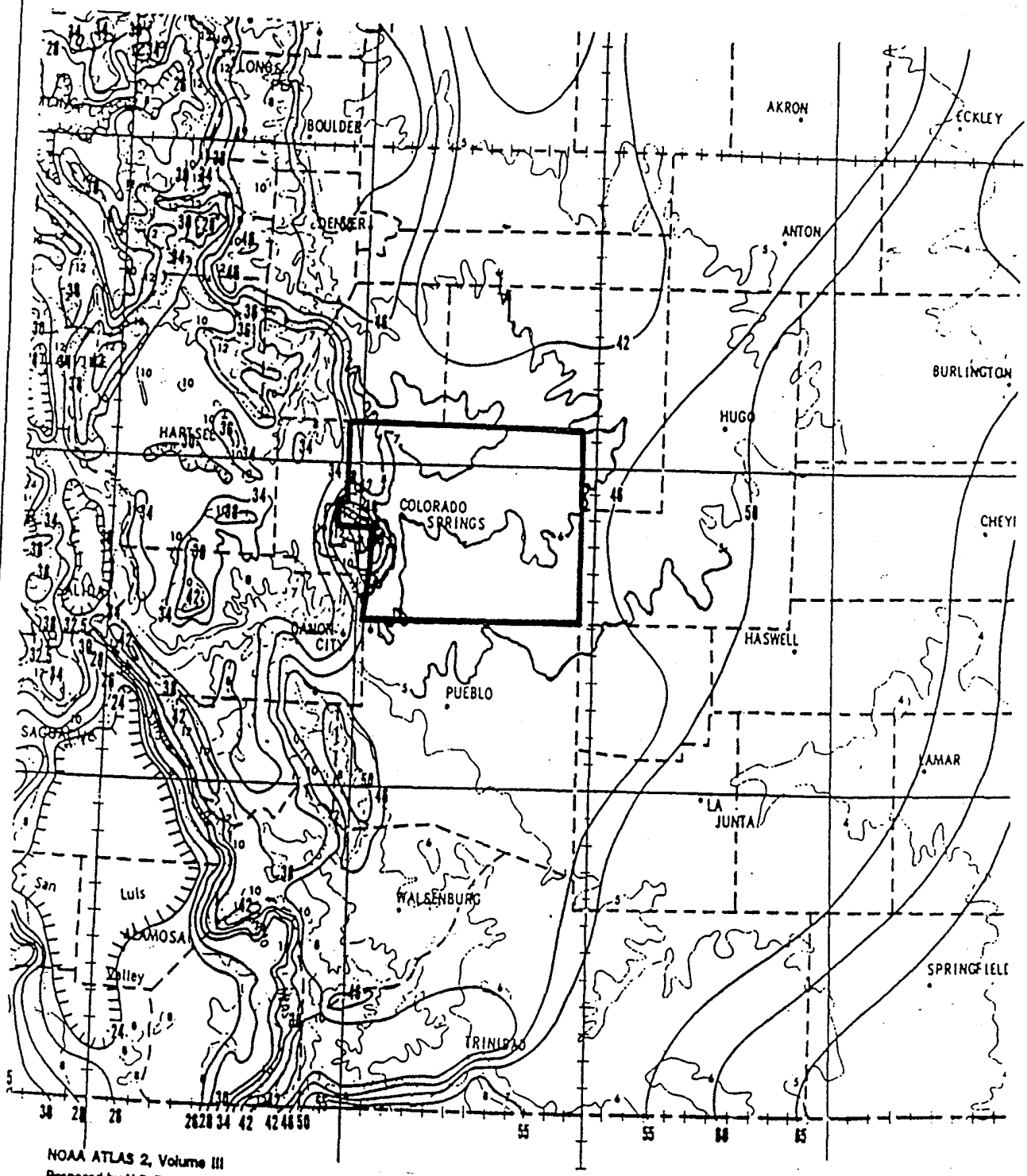
REVISED: NOVEMBER 1991

PREPARED JOINTLY BY:

CITY OF COLORADO SPRINGS
Department of Public Works
Engineering Division

HDR INFRASTRUCTURE, INC.
Denver, Colorado

EL PASO COUNTY
Department of Public Works
Engineering Division



NOAA ATLAS 2, Volume III

Prepared by U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service, Office of Hydrology

Prepared for U.S. Department of Agriculture,
Soil Conservation Service, Engineering Division

ISOPLUVIALS OF 100-YR 24-HR PRECIPITATION
IN TENTHS OF AN INCH

HDR Infrastructure, Inc.
A Centerra Company

The City of Colorado Springs / El Paso County
Drainage Criteria Manual

Date
OCT. 1987

Figure
5-4e

ATTACHMENT 4

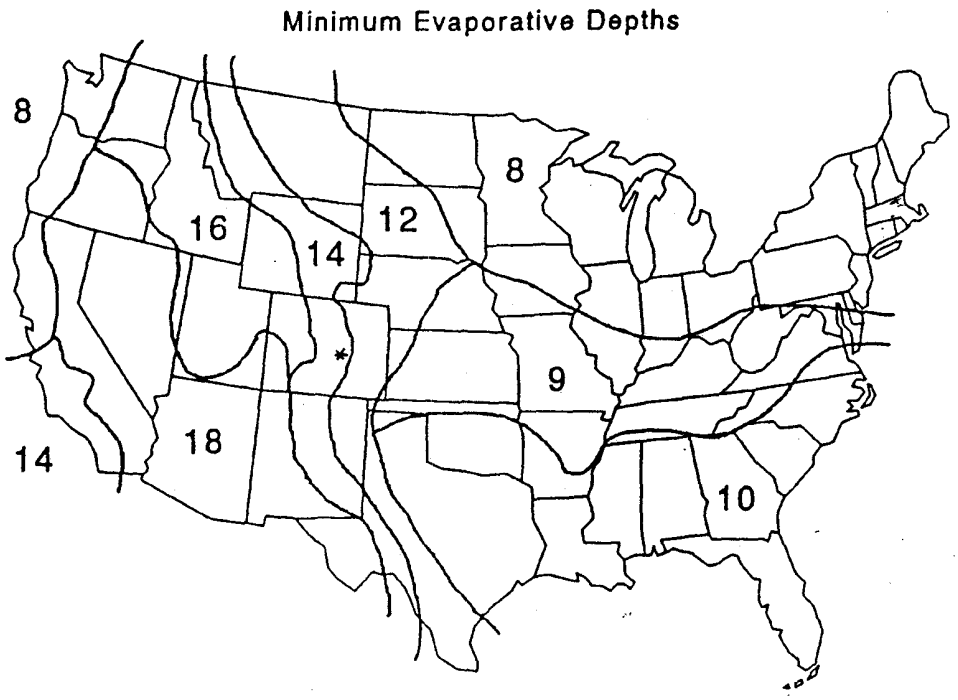


Figure 4. Geographic Distribution of Minimum Evaporative Depth = 14"

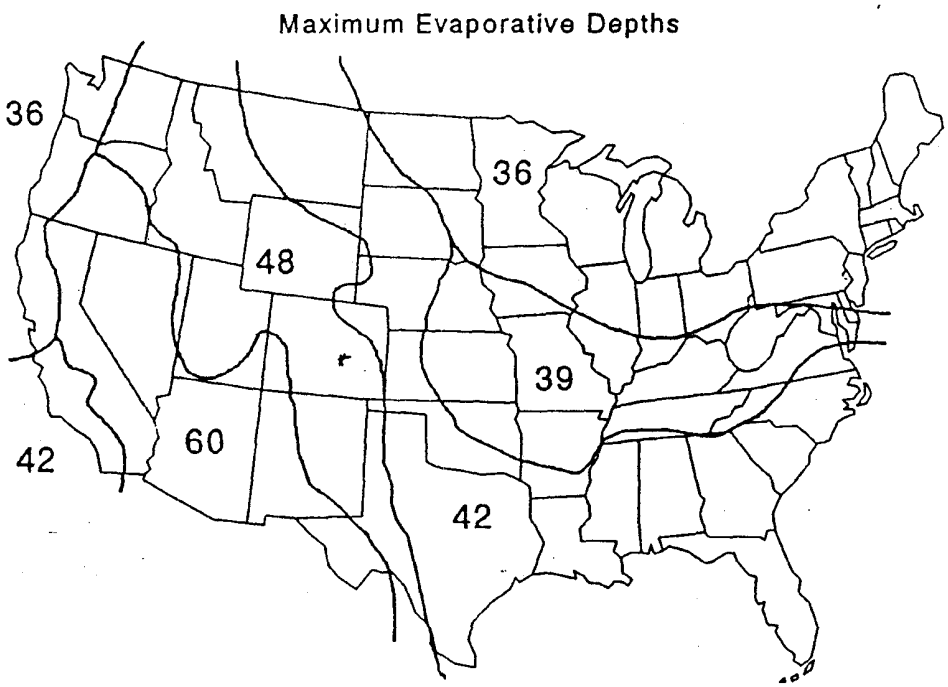


Figure 5. Geographic Distribution of Maximum Evaporative Depth = 48"

REF: "THE HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE MODEL ENGINEERING DOCUMENTATION FOR VERSION 3." USEPA, SEPT, 1994.

ATTACHMENT 5

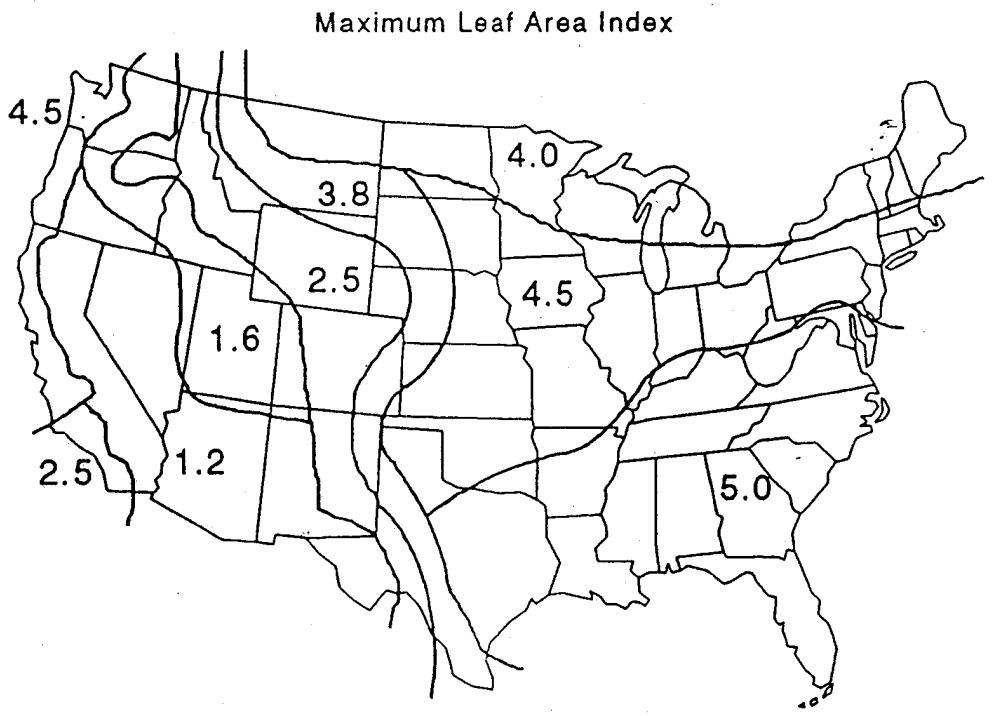


Figure 3. Geographic Distribution of Maximum Leaf Area Index

REF: "THE HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE MODEL ENGINEERING DOCUMENTATION FOR VERSION 3", USEPA, SEPT, 1994.

APPENDIX F
GEOTECHNICAL CHARACTERIZATION AND SETTLEMENT AND STABILITY CALCULATIONS

RUST **Rust Environment & Infrastructure**

Table F-1

CALCULATION SHEET

PAGE ___ OF ___

PROJECT NO. 69868.300

CLIENT USA-COE SUBJECT _____ Prepared By EEV Date 10/OCT/95

PROJECT FCLF Nos 2, 5, 6 _____ Reviewed By _____ Date _____

_____ _____ Approved By _____ Date _____

Summary of Geologic Material Characteristics

Material	Unified Soil Classification	Thickness (feet)	Description
Existing Cover Material	CH and CL to SM/SP	2.7 to 15	Predominantly fat and lean clay with sand, very stiff, brown to grayish-brown, moist, with angular clasts of shale, with occasional debris.
Alluvium	CH, CL, SP	0 to 17	Ranging from sandy fat and lean clay to poorly graded sand. Located in the lower-lying southeastern area of Landfill No. 2. Clay is soft to stiff, dark grayish and yellowish brown and moist.
Colluvium	CH and CL	0 to 8	Sandy fat and lean clay, stiff to hard, dry to moist, with occasional little fine gravel.
Pierre Shale	CL to CH	—	Severely weathered claystone, with near-horizontal thinly-laminated bedding; hard, damp to moist.

RUST **Rust Environment & Infrastructure**

Table F-2 (Sheet 1 of 2)

CALCULATION SHEET

PAGE ___ OF ___

PROJECT NO. 89868.300

CLIENT USA-COE

PROJECT Carson Landfill No. 2

SUBJECT Summary of Thickness of Various

Prepared By EEV Date 9/OCT/95

Reviewed By _____ Date _____

Approved By _____ Date _____

BORING LOCATION (No.)	THICKNESS OF EXISTING FILL (feet) Cover (F_m)	Waste (F_f)	Total (F_m+F_f)	ESTIMATED THICKNESS OF ALLUVIUM/COLLUVIUM (feet)
SB-1	4.5	>3.5 <15	>8	N/A
SB-2	2	0	2	0
SB-3	2	0	2	0
SB-4	0	0	0	10
SB-5	7	0	0	>4 <15
SB-6	6	>4 <15	>10 <21	N/A
SB-7	15	>4 <12	>19 <27	N/A
SB-8	4	>2 <15	>6 <19	N/A
SB-9	4.5	>3.5 <10	>8 <14.5	N/A
SB-10	6.5	>2.5 <8	>9 <14.5	N/A
SB-11	0	0	0	0
SB-12	2	0	2	6
SB-13	0	0	0	17
SB-14	4	0	4	N/A

RUST **Rust Environment & Infrastructure**

Table F-2 (Sheet 2 of 2)

CALCULATION SHEET

PAGE ___ OF ___

PROJECT NO. 89868.400

CLIENT USA-COE

SUBJECT Summary of Thickness of Various Materials

PROJECT Landfill No.2 Fort Carson, CO

Prepared By EEV Date 5/1/96

Reviewed By ___ Date ___

Approved By ___ Date ___

BORING LOCATION (No.)	ESTIMATED THICKNESS (feet)				Total Depth of Boring (feet)
	Cover (F_m)	Waste (F_{lf})	Total Fill (F_m+F_{lf})	Alluvium (Q_{al})	
CVT-1	5.5	>1.5	>7	—	7
-2	>9	—	>9	—	9
-3	>9.5	—	>9.5	—	9.5
-4	5.5	>0.5	>6	—	6
-5	3.5	>1.5	>5	—	5
-6	5.5	>1.5	>7	—	7
-7	>8	—	>8	—	8
-8	>8	—	>8	—	8
-9	>9	—	>9	—	9
-10	9	>1	>10	—	10
-11	4.5	>1	>5.5	—	5.5
-12	6	>1	>7	—	7
-13	5	>1	>6	—	6
-14	5.5	>2.5	>8	—	8
-15	>10	—	>10	—	10
-16	5.5	>0.5	>6	—	6
-17	3	>0.5	>3.5	—	3.5
-18	>10	—	>10	—	10
-19	>9	—	>9	—	9
-20	4.5	>0.5	>5	—	5
-21	3.5	>1.5	>5	—	5
-22	9.5	>0.5	>10	—	10
-23	8.5	>0.5	>9	—	9
-24	3.5	>1.5	>5	—	5
-25	>9.5	—	>9.5	—	9.5
-26	3.9	>0.1	>4	—	4
-27	4.8	>0.2	>5	—	5
-28	3.5	>2.5	>6	—	6
29	6	—	6	(P.S. at 6')	7

RUST **Rust Environment & Infrastructure**

Table F-3(a)

CALCULATION SHEET

PAGE ___ OF ___

PROJECT NO. 89868.300

CLIENT USA-COE SUBJECT _____ Prepared By EEV Date 10/OCT/95

PROJECT F.C.L.F. #2,5,6 _____ Reviewed By _____ Date _____

_____ _____ Approved By _____ Date _____

MATERIAL COMPRESSIBILITY PARAMETERS

(1) GEOLOGIC MATERIALS

$C_c^{(1)}$: Virgin Compression Index (normally-consolidated soils)
$C_{c\varepsilon} = C_c/(1+e)$: compression ratio

$C_r^{(1)}$: Recompression Index (over consolidated soils)
$C_{r\varepsilon} = C_r(1+e)$: recompression ratio

C_α: Secondary Compression coefficient

(1) slope of "e-log p'" plots, for geologic materials.

(2) SOLID WASTE MATERIALS:

a : primmary waste compressibility in ksf^{-1} (Edil, Ranguette, and Wuelner, 1990)

b : Secondary waste compressibility (Edil et al, 1990) in ksf^{-1}

λ/b: Rate factor of secondary waste compressibility (Edil et al, 1990)

$$a \approx \frac{0.5 \text{ to } 2}{100 \text{ ksf}} \qquad (\Delta\sigma \lesssim 1 \text{ ksf})$$

$$b \approx \frac{0.1 \text{ to } 0.3}{\text{ksf}} \qquad (\Delta\sigma \lesssim 1 \text{ ksf})$$

$$\frac{\lambda}{b} \approx 0.001 \qquad \text{(average)}$$

RUST **Rust Environment & Infrastructure**

Table F-3 (b)

CALCULATION SHEET

PAGE 4 OF ___

PROJECT NO. 89868.300

CLIENT USA-COE SUBJECT ___ Prepared By EEV Date 9/OCT/95

PROJECT Carson LF #2 Reviewed By ___ Date ___

Approved By ___ Date ___

Summary of Fill and Native Material Properties

	Material	SPT-N	Total Unit Weight γ_t (pcf)	In-Situ Moisture Content, W_n (%)	Void Ratio, e	Compression Parameters C_c	C_r	C_α
1	Proposed Cover:							
	1a) Protective Soil	—	~100	~25	~1.0	~0.2	—	—
	1b) Clay Liner	—	~120	~20	~0.65	—	~0.02	—
2	Existing Fill:							
	2a) F_m (Cover)	6-26	~120	~24	~0.71	~0.15 (±0.07)	—	≲0.002
	2b) F_{lf} (Waste)	5-29	~50	—	—	a (4)	—	b, λ/c (4)
3	Alluvium (1)	7-14	~125	~27	~0.68	~0.13 (±0.06)	—	≲0.005
4	Colluvium (2)	11-15	~125	~21	~0.60	—	~0.03	≲0.005
5	Pierre Shale (Bedrock)	23-65 (3)	~125	~19	~0.57	—	≲0.02	—

NOTES:

(1) Alluvium assumed normally-consolidated

(2) Colluvium assumed overconsolidated

(3) Upper 12' of Pierre Shale (higher SPT-N values at greater depth)

(4) Typical solid waste parameters (see next page)

RUST **Rust Environment & Infrastructure**

Table F-4 (a)

CALCULATION SHEET

PAGE ___ OF ___

PROJECT NO. 89868.300

CLIENT USA-COE SUBJECT _____ Prepared By EEY Date 11/OCT/95

PROJECT Fort Carson Landfill No. 2 Reviewed By _____ Date _____

Approved By _____ Date _____

ESTIMATED FINAL COVER SETTLEMENTS

Boring Location No.	Short Term (Construction + First Year)	Long Term (Following 15 years)	
SB-1	< 3" to 7"	~ 5"	
SB-2	—	—	No cap
SB-3	—	—	No cap
SB-4	~ 1"	~ 0"	
SB-5	≲ 3"	~ 0"	
SB-6	< 4" to 8"	~ 4"	
SB-7	< 5" to 10"	~ 3"	
SB-8	< 3" to 7"	~ 4"	
SB-9	< 3" to 5"	~ 3"	
SB-10	< 3" to 6"	~ 2"	
SB-11	—	—	No cap
SB-12	~ 2" to 3"	~ 0"	
SB-13	≈ 1" to 2"	~ 0"	
SB-14	≈ 2"	~ 0"	

POST SETTLEMENT LANDFILL SLOPES
Fort Carson Landfill No.2
Table F-4(b)

Boring No.	Proposed Final El. (ft)	Estimated Settlement (ft)	Post Settlement El. (ft)	Distance Between Borings (ft)	Post Settlement Slope (%)
6	5876.5	1.00	5875.5	580	6.47
9	5838	0.00	5838		
7	5873.5	1.08	5872.42	530	8.38
10	5828	0.00	5828		
10	5828	0.67	5827.33	275	3.76
12	5817	0.00	5817		
1	5907	1.00	5906	350	9.71
6	5872	0.00	5872		

Note: Post settlement slopes were calculated by using the upslope boring's maximum combined short and long term settlement value. Each downslope boring used a settlement value of 0.00 to produce a conservative estimate of post settlement slopes. Estimated settlement values were obtained from calculations presented in Appendix F.

RUST Rust Environment & Infrastructure

Table F-5

CALCULATION SHEET

PAGE 1 OF ___

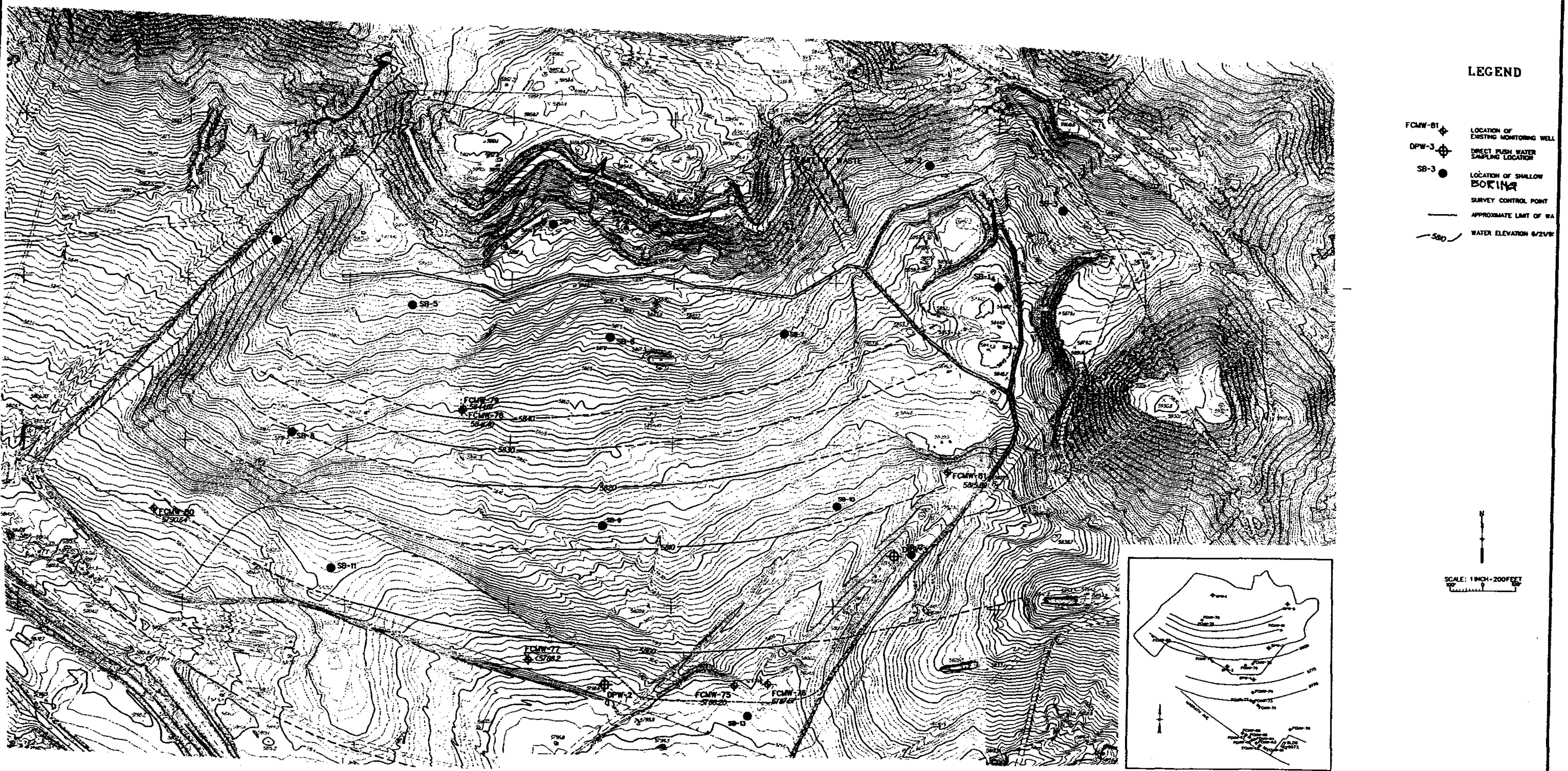
PROJECT NO. 89868.400

CLIENT USA-COE, Omaha
PROJECT Landfill No. 2, Fort Carson, CO

SUBJECT Summary of Slope Gradients

Prepared By EEV Date 5/1/96
Reviewed By ___ Date ___
Approved By ___ Date ___

SECTION	Slope Gradient		Fig. No.
	Proposed Cap	Upper Slope	
A-A'	5 to 12%	4:1 (H:V)	F-3
B-B'	15%	4:1 (H:V)	F-4
C-C'	6.5%	4.3:1 (H:V)	F-5
D-D'	4% (5% max)	5:1 (H:V)	F-6
E-E'	5 to 6.5%	5:1 to 3:1 (H:V)	F-7
F-F'	5%	5:1 (H:V)	F-8
G-G'	5%	4:1 (H:V)	F-9



PREPARED BY:

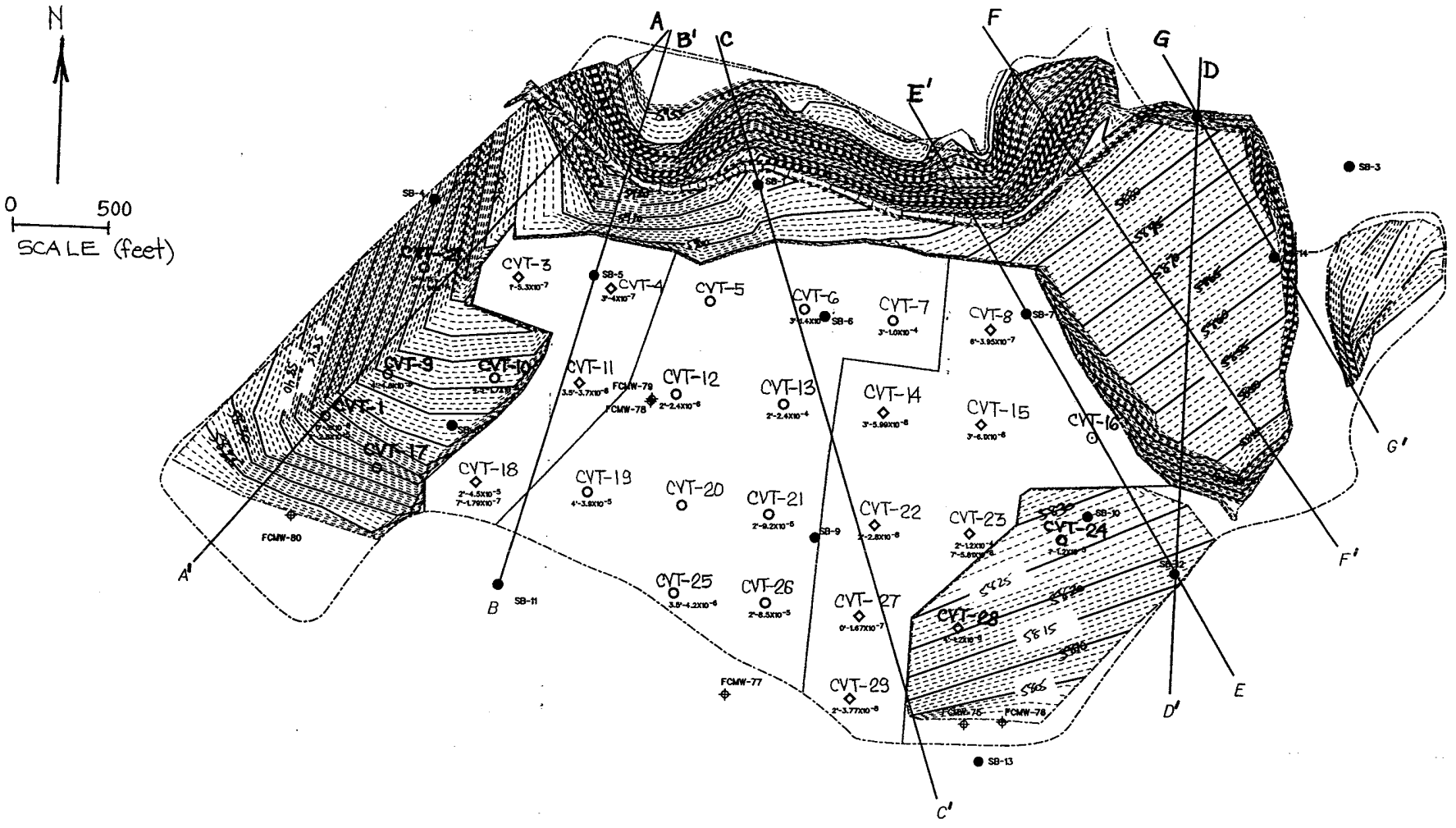
RUST ENVIRONMENT & INFRASTRUCTURE

PRESENT TOPOGRAPHY AND GROUND WATER ELEVATION

Landfill No. 2 (FTC-006)
Fort Carson, Colorado

FIGURE F-1

89868.400



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RUST ENVIRONMENT & INFRASTRUCTURE

PROPOSED FINAL CAP AND BORING/CROSS-SECTION LOCATIONS

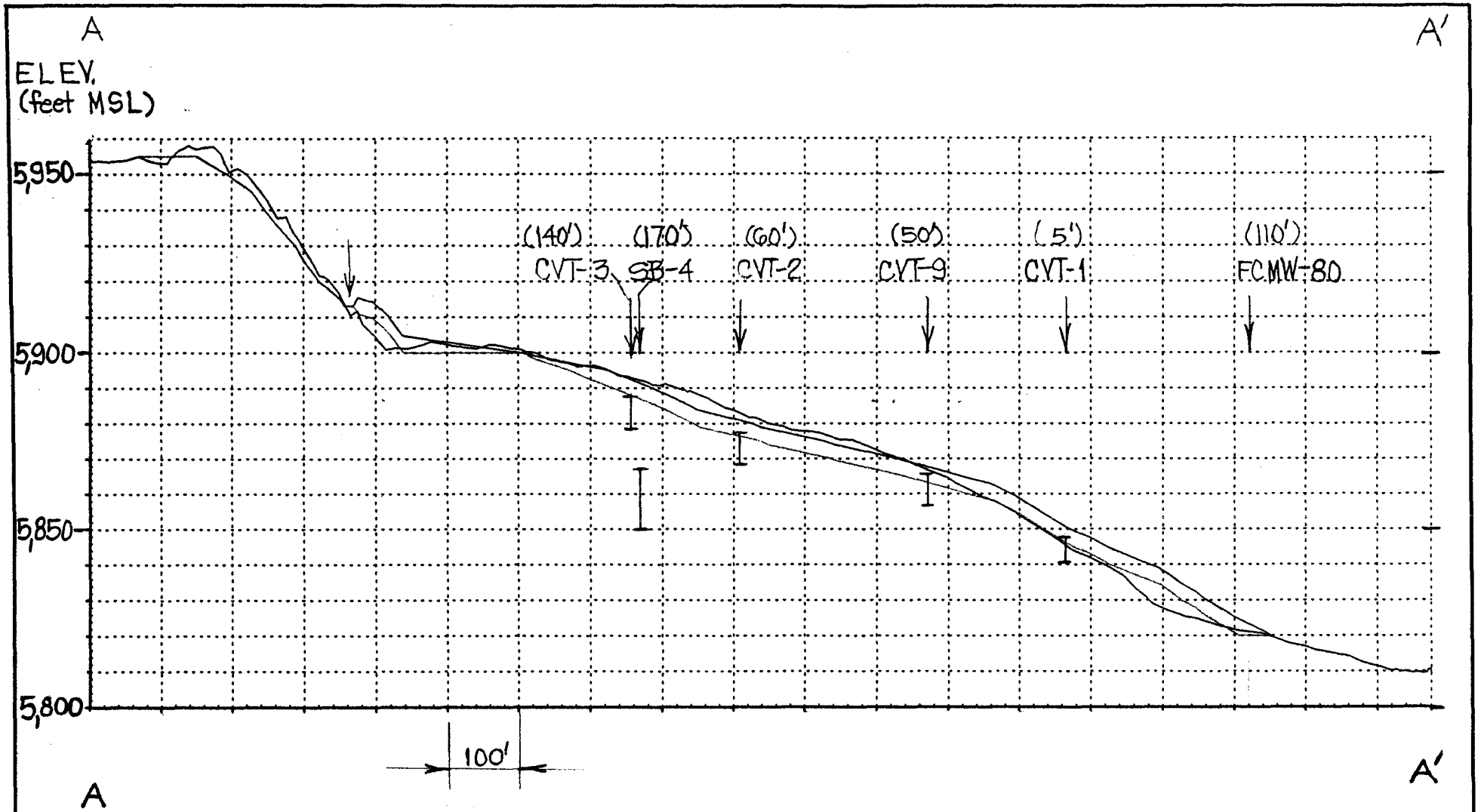
Landfill No. 2 (FTC-006)

Fort Carson, Colorado

FIGURE

F-2

99868.400



PREPARED BY:

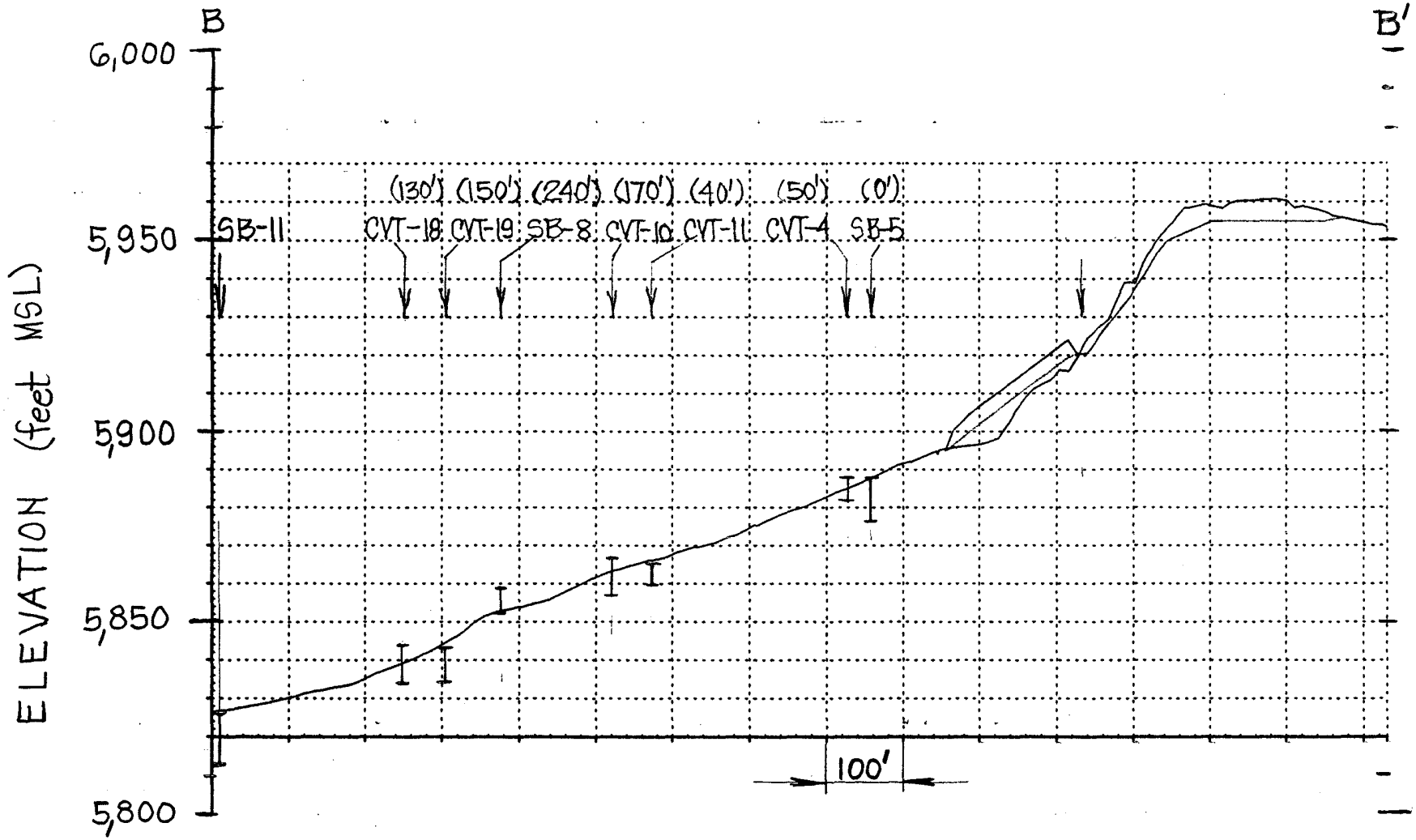
RUST ENVIRONMENT & INFRASTRUCTURE

CROSS SECTION A-A'

Landfill No. 2 (FTC-006)
Fort Carson, Colorado

F-3

89868.400



PREPARED BY:

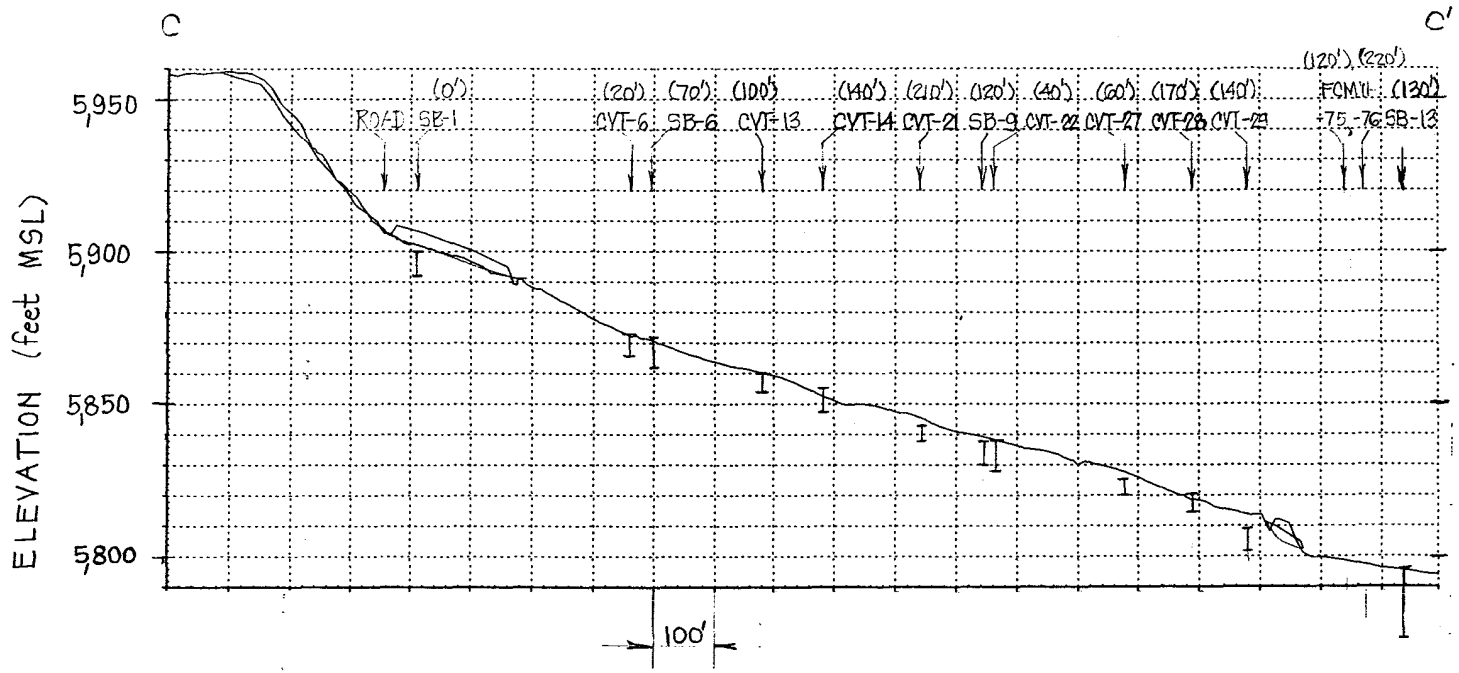
RUST ENVIRONMENT & INFRASTRUCTURE

CROSS SECTION B-B'

Landfill No. 2 (FTC-006)
Fort Carson, Colorado

F-4

89868A00



PREPARED BY:

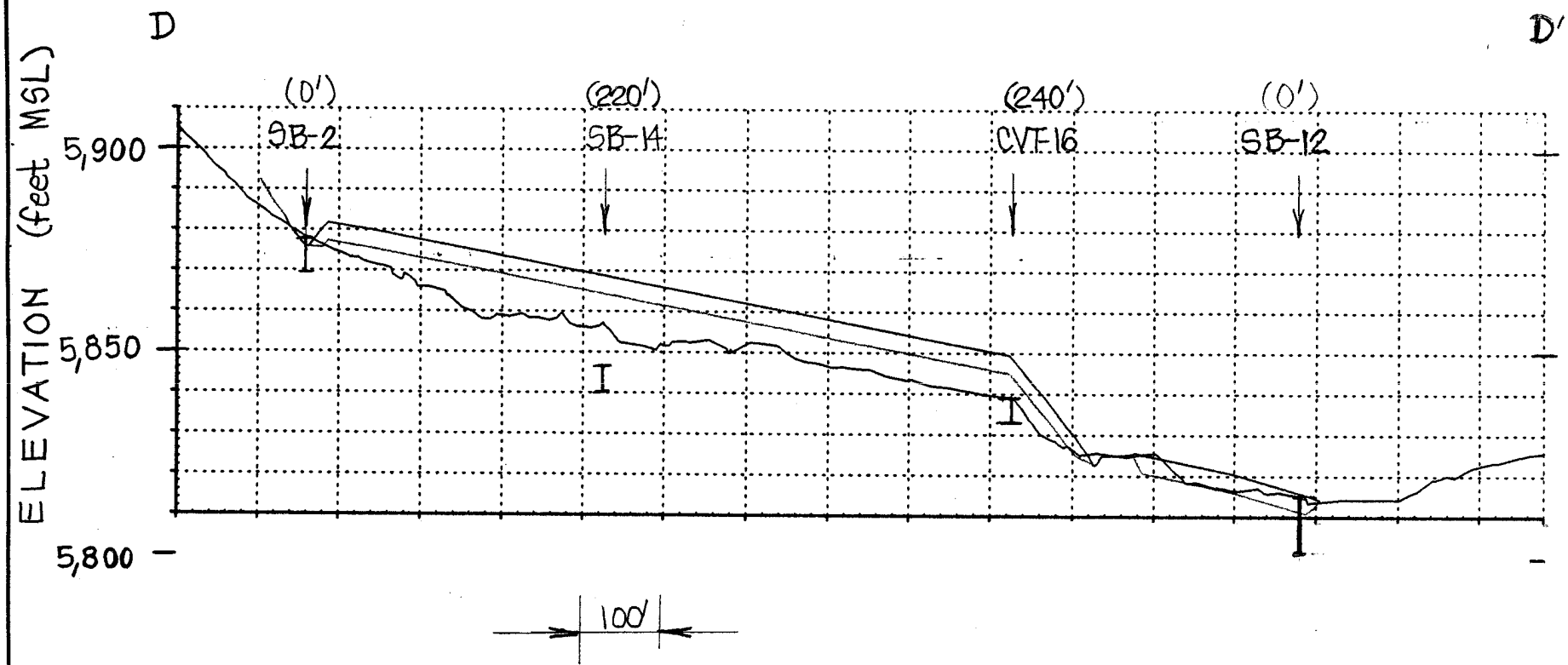
RUST ENVIRONMENT & INFRASTRUCTURE

CROSS SECTION C-C'

Landfill No. 2 (FTC-006)
Fort Carson, Colorado

FIGURE
F-5

89868.400



PREPARED BY:

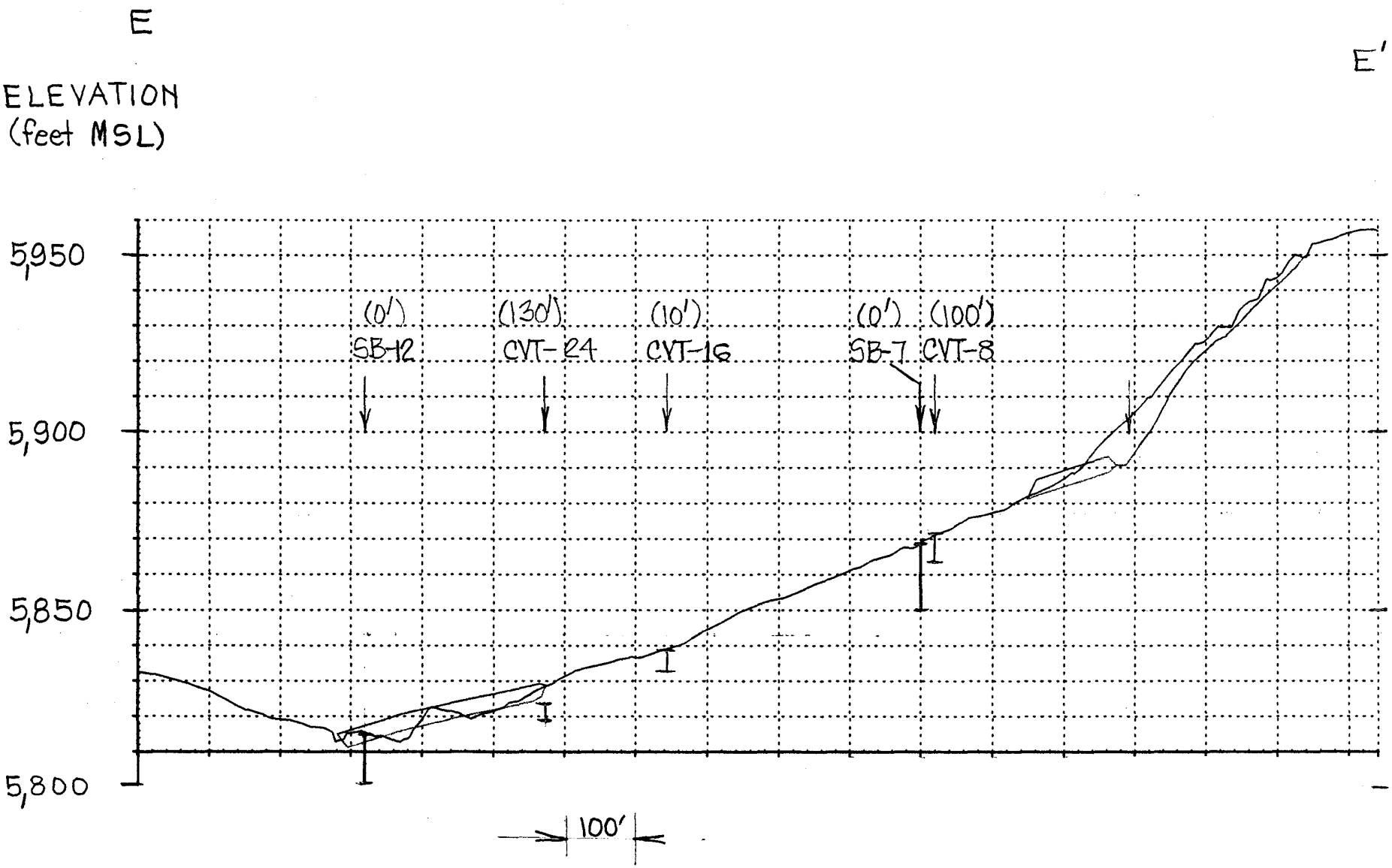
RUST ENVIRONMENT & INFRASTRUCTURE

CROSS SECTION D-D'

Landfill No. 2 (FTC-006)
Fort Carson, Colorado

F-6

89868.400



PREPARED BY:

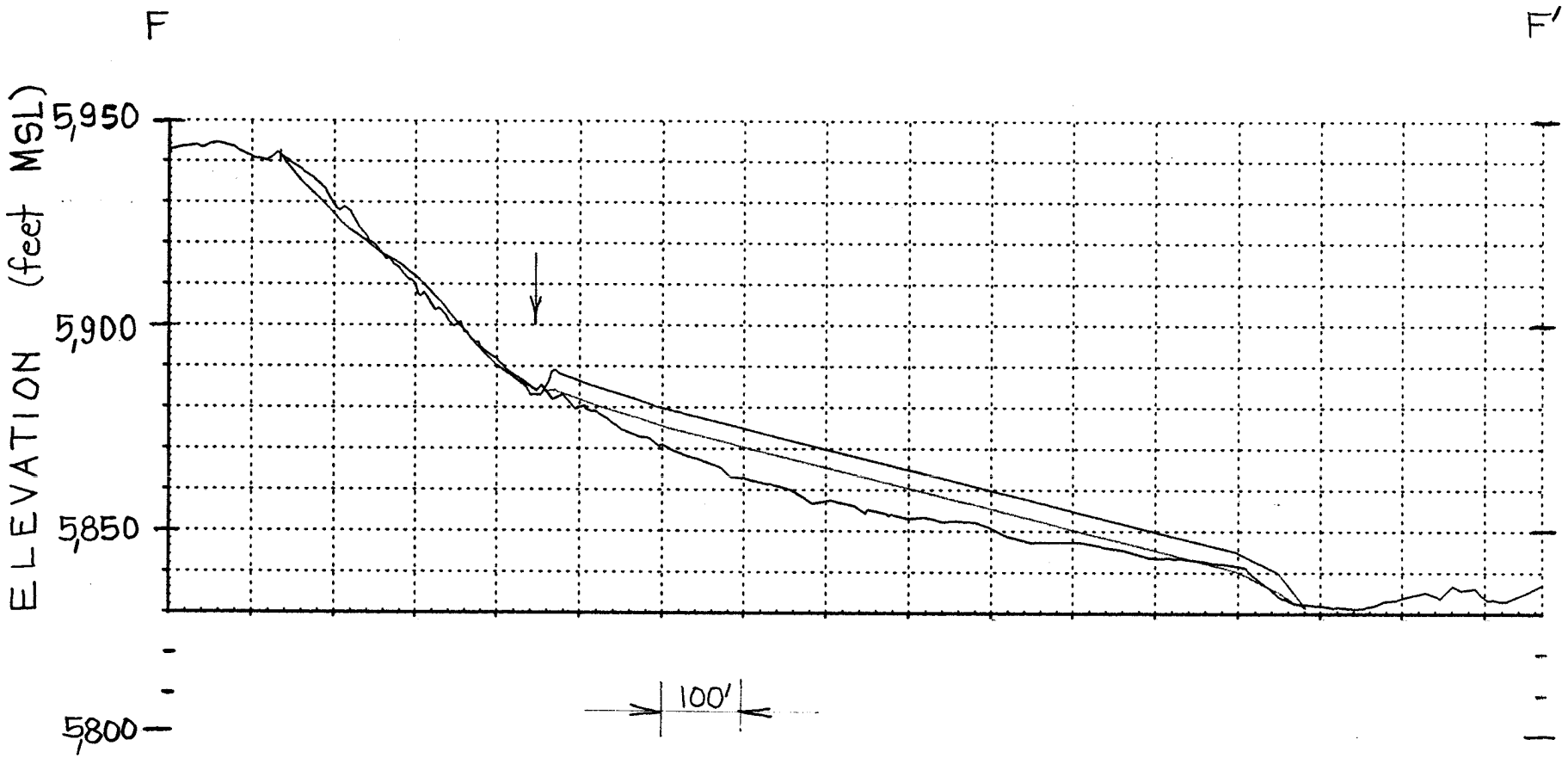
RUST ENVIRONMENT & INFRASTRUCTURE

CROSS SECTION E-E'

Landfill No. 2 (FTC-006)
Fort Carson, Colorado

F-7

89868.400



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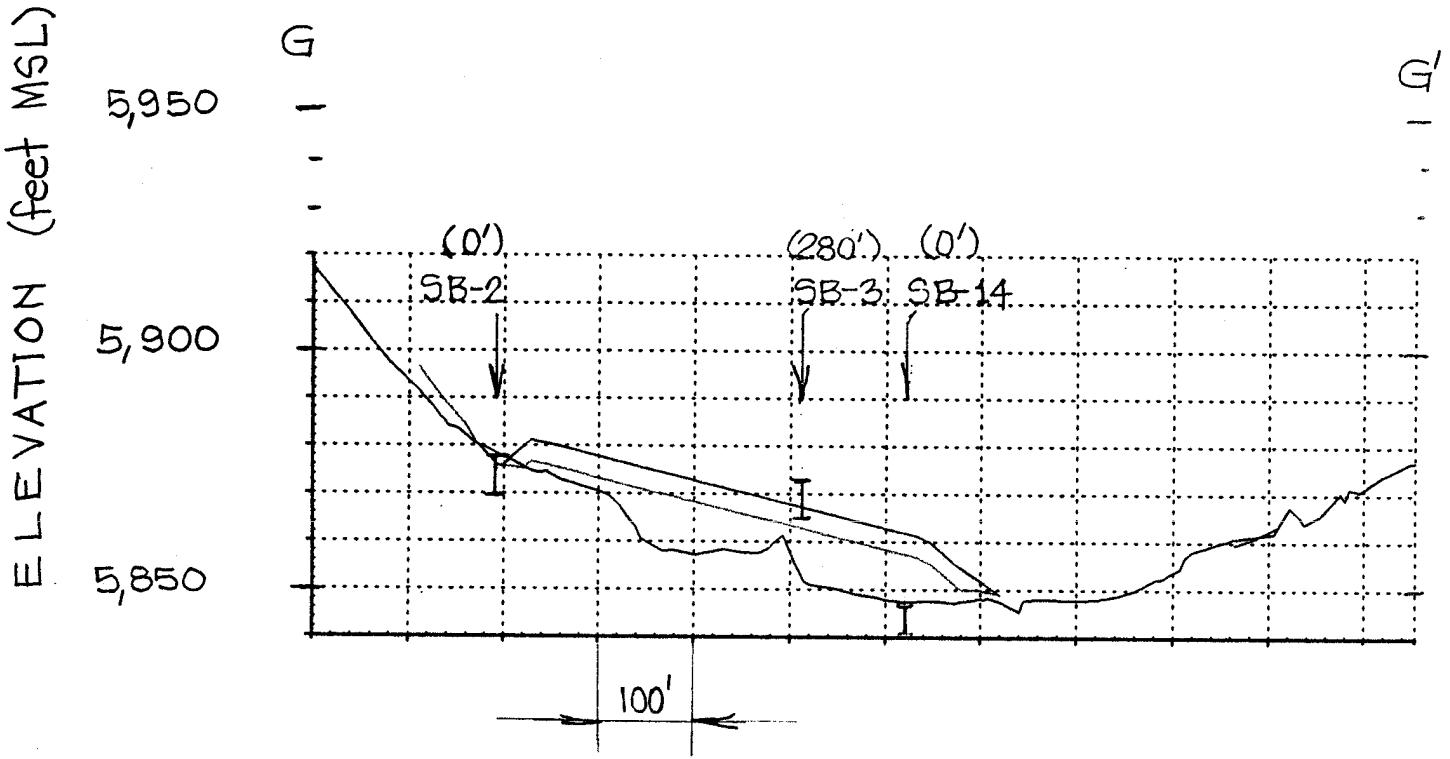
CROSS SECTION F-F'

Landfill No. 2 (FTC-006)
Fort Carson, Colorado

F-8

89868.400



PREPARED BY:

RUST ENVIRONMENT & INFRASTRUCTURE

CROSS SECTION G-G'

Landfill No. 2 (FTC-006)
Fort Carson, Colorado

F-9

89868.400

DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

REFERENCE: Algermissen et al (1990) - USGS Map 2120

PREPARED BY:

RUST ENVIRONMENT & INFRASTRUCTURE

PEAK HORIZONTAL ACCELERATION MAP - 2400-YEAR RETURN PERIOD
Fort Carson Landfills, CO

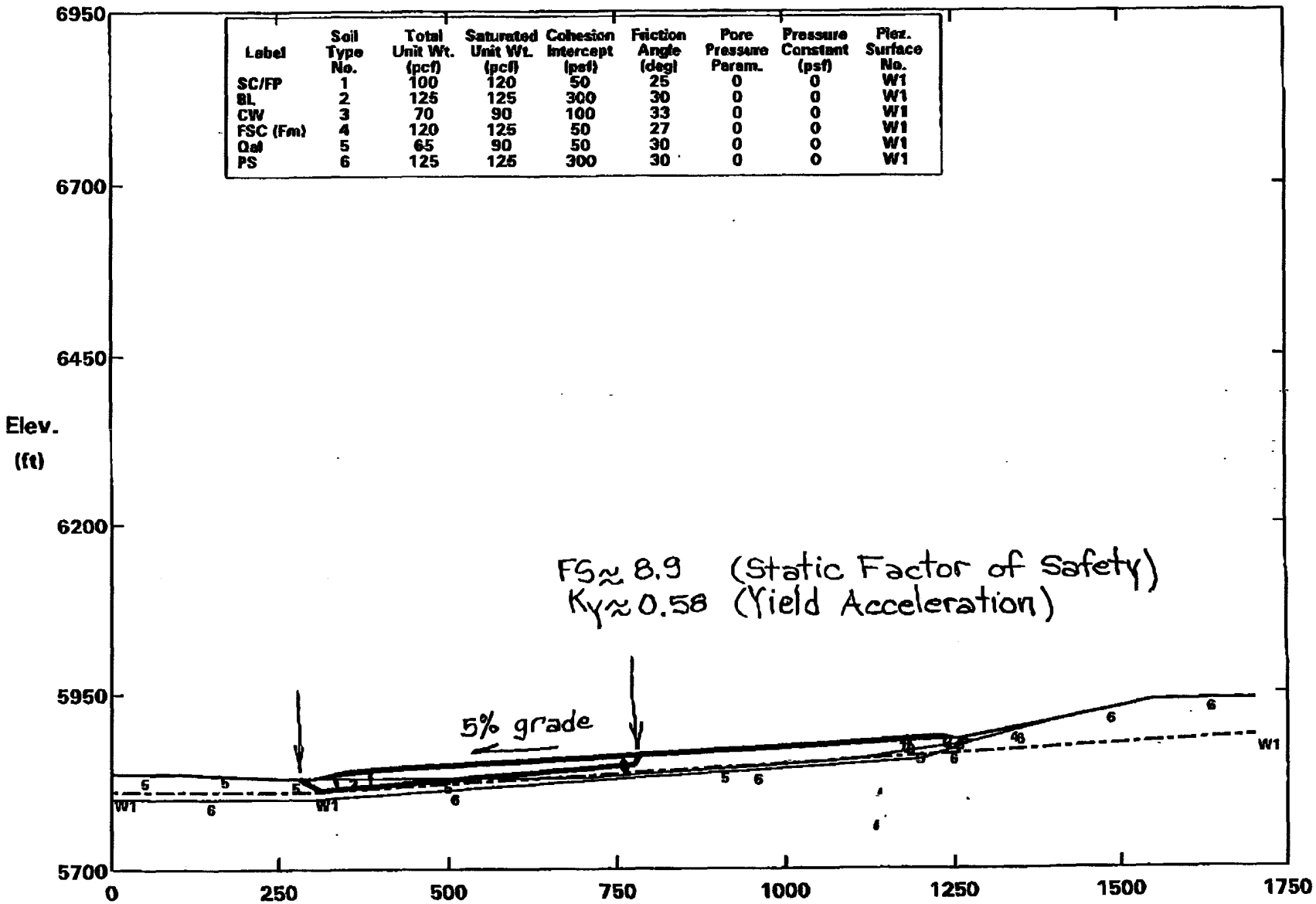
F-10

89868

Landfill No. 2, Section F-F' Stability Fort Carson, Colorado (89868.400)

Surface #1-FC2.OUT. C:FC2.PLT By: EEV 05-03-96 4:43pm

Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
SC/FP	1	100	120	50	25	0	0	W1
BL	2	125	125	300	30	0	0	W1
CW	3	70	90	100	33	0	0	W1
FSC (Fm)	4	120	125	50	27	0	0	W1
Qal	5	65	90	50	30	0	0	W1
PS	6	125	125	300	30	0	0	W1



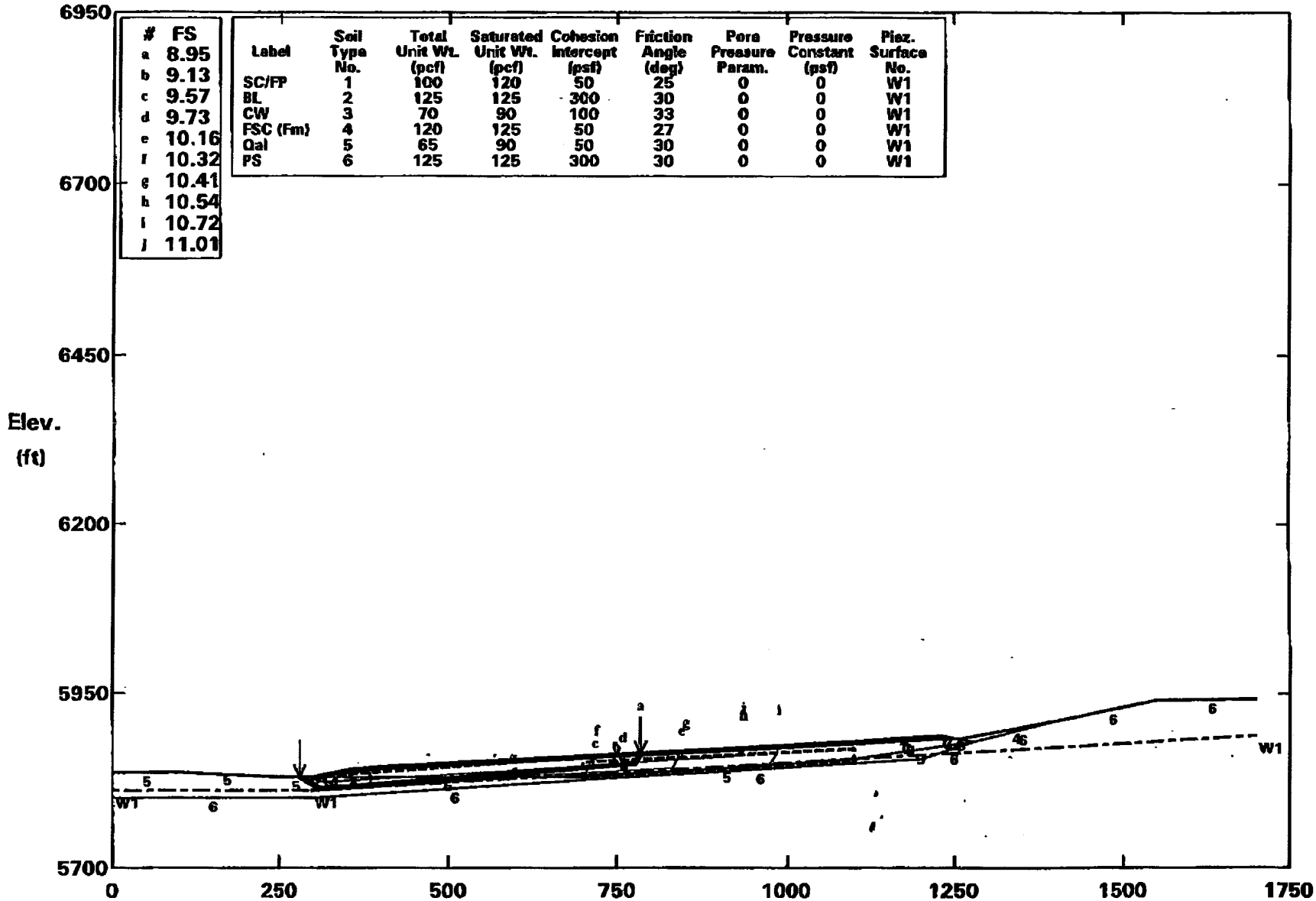
PCSTABL5M/SI FS = 8.95 X-Axis (ft)

Factors Of Safety Calculated By The Modified Janbu Method

Figure F-11

Landfill No. 2, Section F-F' Stability Fort Carson, Colorado (89868.400)

Ten Most Critical. C:FC2.PLT By: EEV 05-03-96 4:48pm



#	FS
a	8.95
b	9.13
c	9.57
d	9.73
e	10.16
f	10.32
g	10.41
h	10.54
i	10.72
j	11.01

Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
SC/FP	1	100	120	50	25	0	0	W1
BL	2	125	125	300	30	0	0	W1
CW	3	70	90	100	33	0	0	W1
FSC (Fm)	4	120	125	50	27	0	0	W1
Qal	5	65	90	50	30	0	0	W1
PS	6	125	125	300	30	0	0	W1

PCSTABL5M/SI FSmin=8.95 X-Axis (ft)

Factors Of Safety Calculated By The Modified Janbu Method

Figure F-12

c. Finite Element Method. This method is extensively used in more complex problems of slope stability and where earthquake and vibrations are part of total loading system. This procedure accounts for deformation and is useful where significantly different material properties are encountered.

2. FAILURE CHARACTERISTICS. Table 1 shows some situations that may arise in natural slopes. Table 2 shows situations applicable to man-made slopes. Strength parameters, flow conditions, pore water pressure, failure modes, etc. should be selected as described in Section 4.

3. SLOPE STABILITY CHARTS.

a. Rotational Failure in Cohesive Soils ($\phi = 0$)

(1) For slopes in cohesive soils having approximately constant strength with depth use Figure 2 (Reference 4, Stability Analysis of Slopes with Dimensionless Parameters, by Janbu) to determine the factor of safety.

(2) For slope in cohesive soil with more than one soil layer, determine centers of potentially critical circles from Figure 3 (Reference 4). Use the appropriate shear strength of sections of the arc in each stratum. Use the following guide for positioning the circle.

(a) If the lower soil layer is weaker, a circle tangent to the base of the weaker layer will be critical.

(b) If the lower soil layer is stronger, two circles, one tangent to the base of the upper weaker layer and the other tangent to the base of the lower stronger layer, should be investigated.

(3) With surcharge, tension cracks, or submergence of slope, apply corrections of Figure 4 to determine safety factor.

(4) Embankments on Soft Clay. See Figure 5 (Reference 5, The Design of Embankments on Soft Clays, by Jakobsen) for approximate analysis of embankment with stabilizing berms on foundations of constant strength. Determine the probable form of failure from relationship of berm and embankment widths and foundation thickness in top left panel of Figure 5.

4. TRANSLATIONAL FAILURE ANALYSIS. In stratified soils, the failure surface may be controlled by a relatively thin and weak layer. Analyze the stability of the potentially translating mass as shown in Figure 6 by comparing the destabilizing forces of the active pressure wedge with the stabilizing force of the passive wedge at the toe plus the shear strength along the base of the central soil mass. See Figure 7 for an example of translational failure analysis in soil and Figure 8 for an example of translational failure in rock.

Jointed rocks involve multiple planes of weakness. This type of problem cannot be analyzed by two-dimensional cross-sections. See Reference 6, The Practical and Realistic Solution of Rock Slope Stability, by Von Thun.

5. REQUIRED SAFETY FACTORS. The following values should be provided for reasonable assurance of stability:

NAVAL FACILITIES ENGINEERING COMMAND
DESIGN MANUAL 7.1
"SOIL MECHANICS", 1982

(1) Safety factor no less than 1.5 for permanent or sustained loading conditions.

(2) For foundations of structures, a safety factor no less than 2.0 is desirable to limit critical movements at foundation edge. See DM-7.2, Chapter 4 for detailed requirements for safety factors in bearing capacity analysis.

(3) For temporary loading conditions or where stability reaches a minimum during construction, safety factors may be reduced to 1.3 or 1.25 if controls are maintained on load application.

(4) For transient loads, such as earthquake, safety factors as low as 1.2 or 1.15 may be tolerated.

6. EARTHQUAKE LOADING. Earthquake effects can be introduced into the analysis by assigning a disturbing force on the sliding mass equal to kW where W is the weight of the sliding mass and k is the seismic coefficient. For the analyses of stability shown in Figure 9a, k_sW is assumed to act parallel to the slope and through the center of mass of the sliding mass. Thus, for a factor of safety of 1.0:

$$Wb + k_sWh = FR$$

The factor of safety under an earthquake loading then becomes

$$F_{Se} = \frac{FR}{Wb + k_sWh}$$

To determine the critical value of the seismic efficient (k_{cs}) which will reduce a given factor of safety for a stable static condition (F_{So}) to a factor of safety of 1.0 with an earthquake loading ($F_{Se} = 1.0$), use

$$k_{cs} = \frac{b}{h}(F_{So} - 1) = (F_{So} - 1)\sin\theta$$

If the seismic force is in the horizontal direction and denoting such force as k_{ch} W, then $k_{ch} = (F_{So}-1)\tan\theta$.

For granular, free-draining material with plane sliding surface (Figure 9b): $F_{So} = \tan\emptyset/\tan\theta$, and $k_{cs} = (F_{So}-1)\sin\theta$.

Based on several numerical experiments reported in Reference 7, Critical Acceleration Versus Static Factor of Safety in Stability Analysis of Earth Dams and Embankments, by Sarma and Bhave, k_{ch} may be conservatively represented as $k_{ch} \approx (F_{So}-1)0.25$.

The downslope movement U may be conservatively predicted based on Reference 8, Effect of Earthquakes on Dams and Embankments, by Newmark as:

$$U = \frac{V^2}{2g\,k_{cs}} \cdot \frac{A}{k_{cs}}$$

RECOMMENDED

ATTACHMENT 1 TO APPENDIX F

INDEX AND ENGINEERING PROPERTY CHARACTER

RUST **Rust Environment & Infrastructure**

CALCULATION SHEET

PAGE 1 OF ___

PROJECT NO. 89868.300

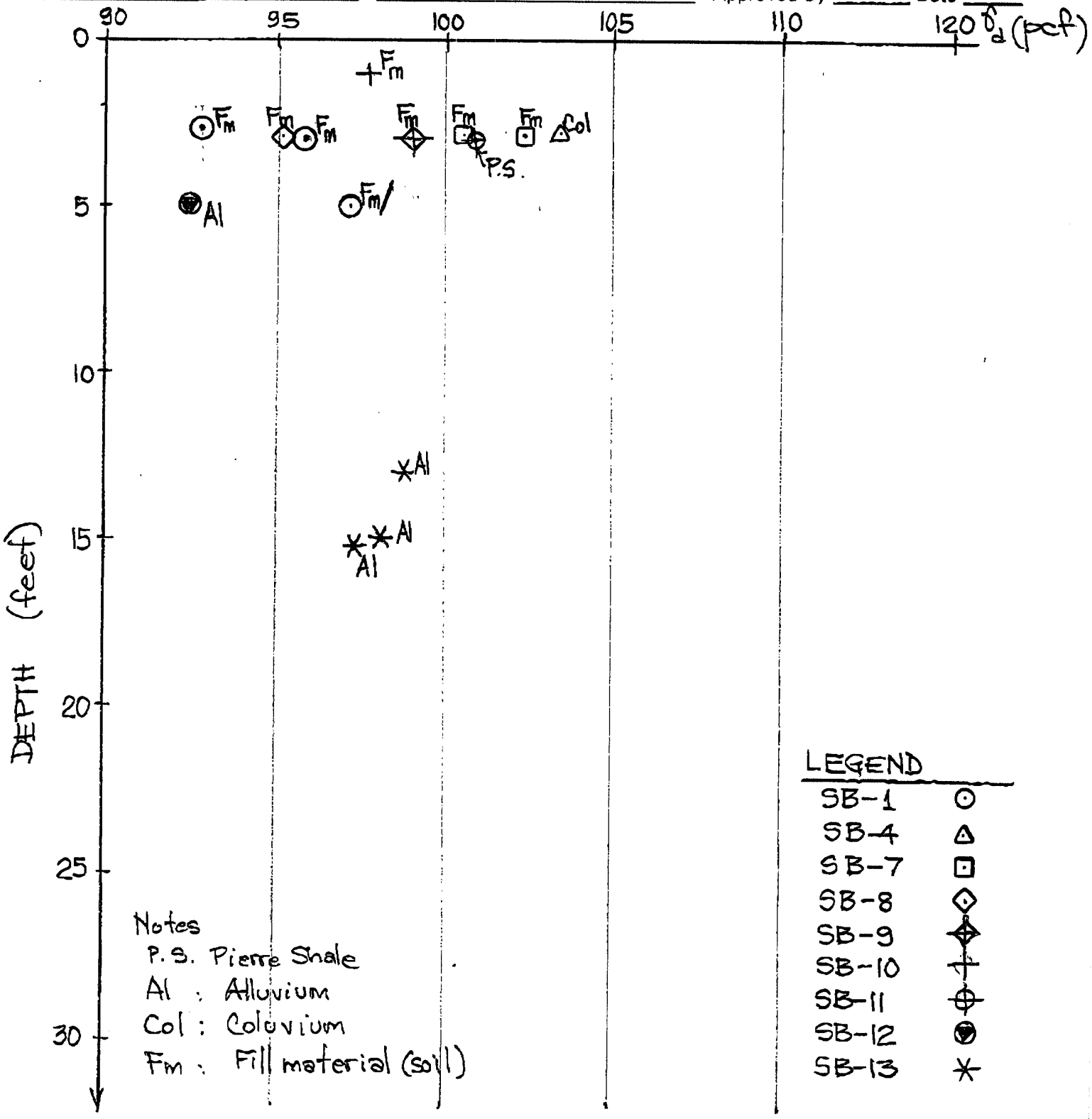
CLIENT U.S.A.-COE (Omaha) SUBJECT ___

Prepared By SEV Date 9/OCT/95

PROJECT Fort Carson Landfill No. 2 Dry Density Data

Reviewed By ___ Date ___

Approved By ___ Date ___



Notes
P.S. Pierre Shale
Al : Alluvium
Col : Colluvium
Fm : Fill material (soil)

RUST **Rust Environment & Infrastructure**

CALCULATION SHEET

PAGE 2 OF ___

PROJECT NO. 89868.300

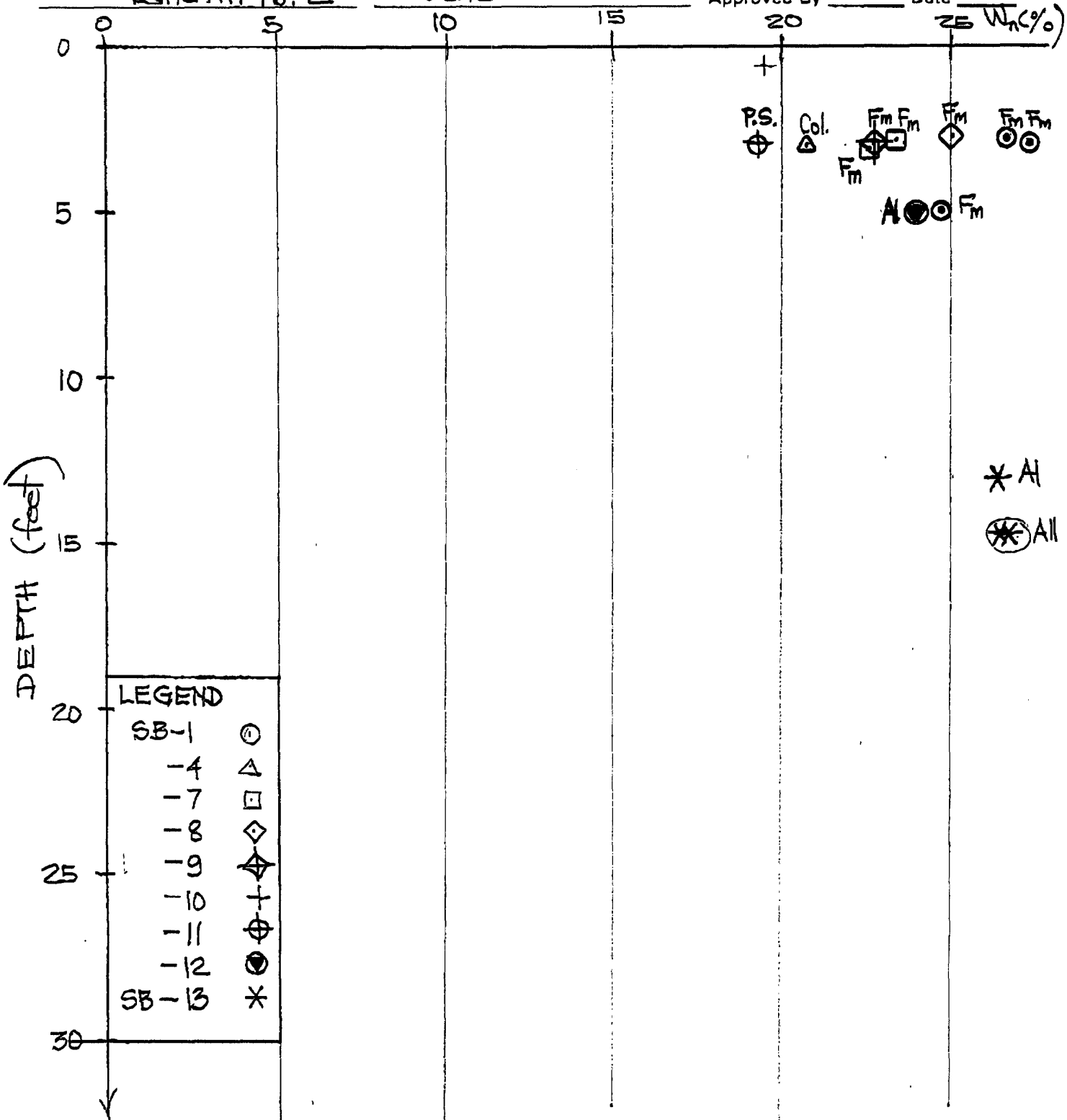
CLIENT USA- COE (Omaha) SUBJECT Moisture Content Data

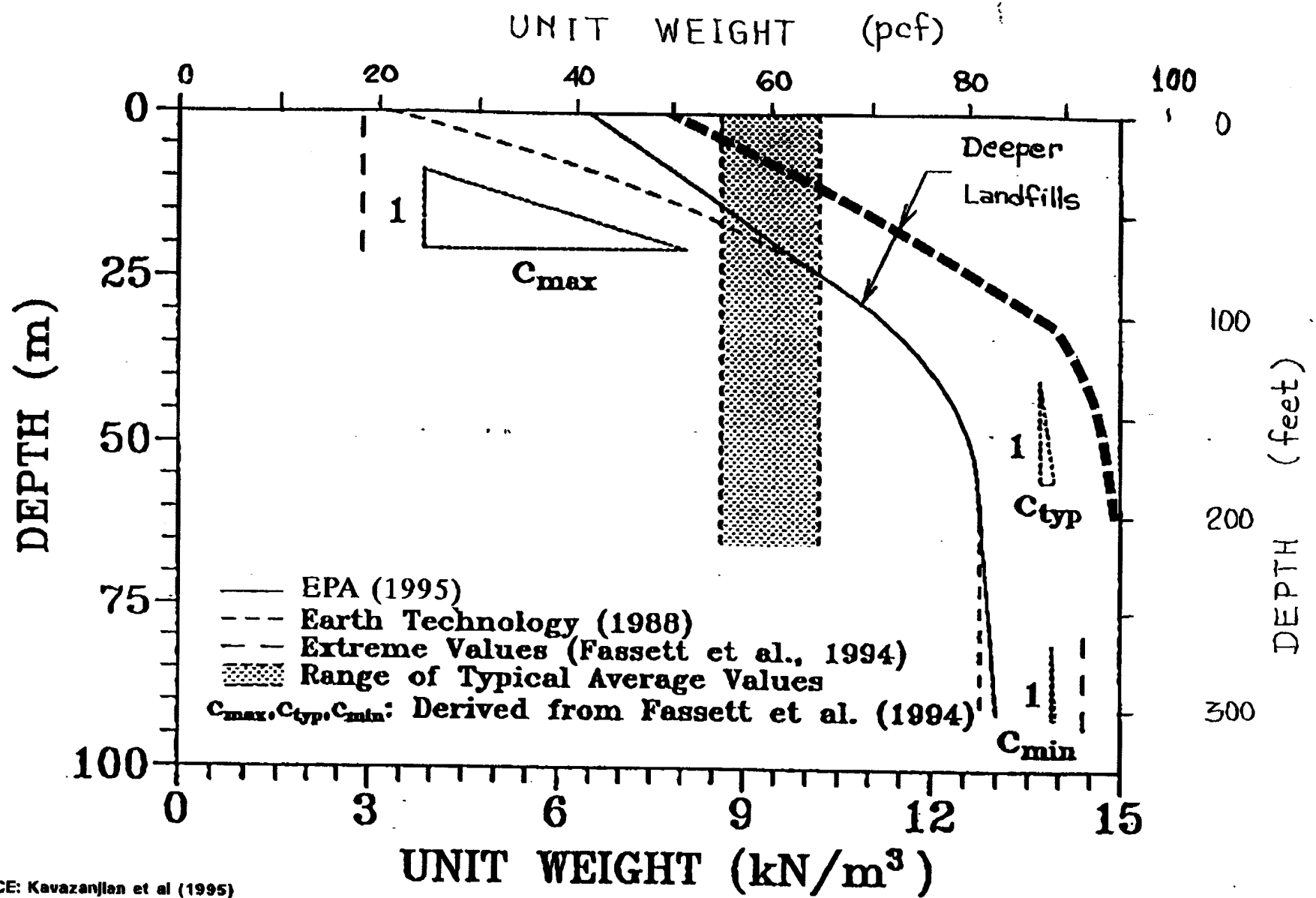
PROJECT Fort Carson Landfill No. 2

Prepared By EEV Date 3/OCT/95

Reviewed By ___ Date ___

Approved By ___ Date ___





REFERENCE: Kavazanjian et al (1995)

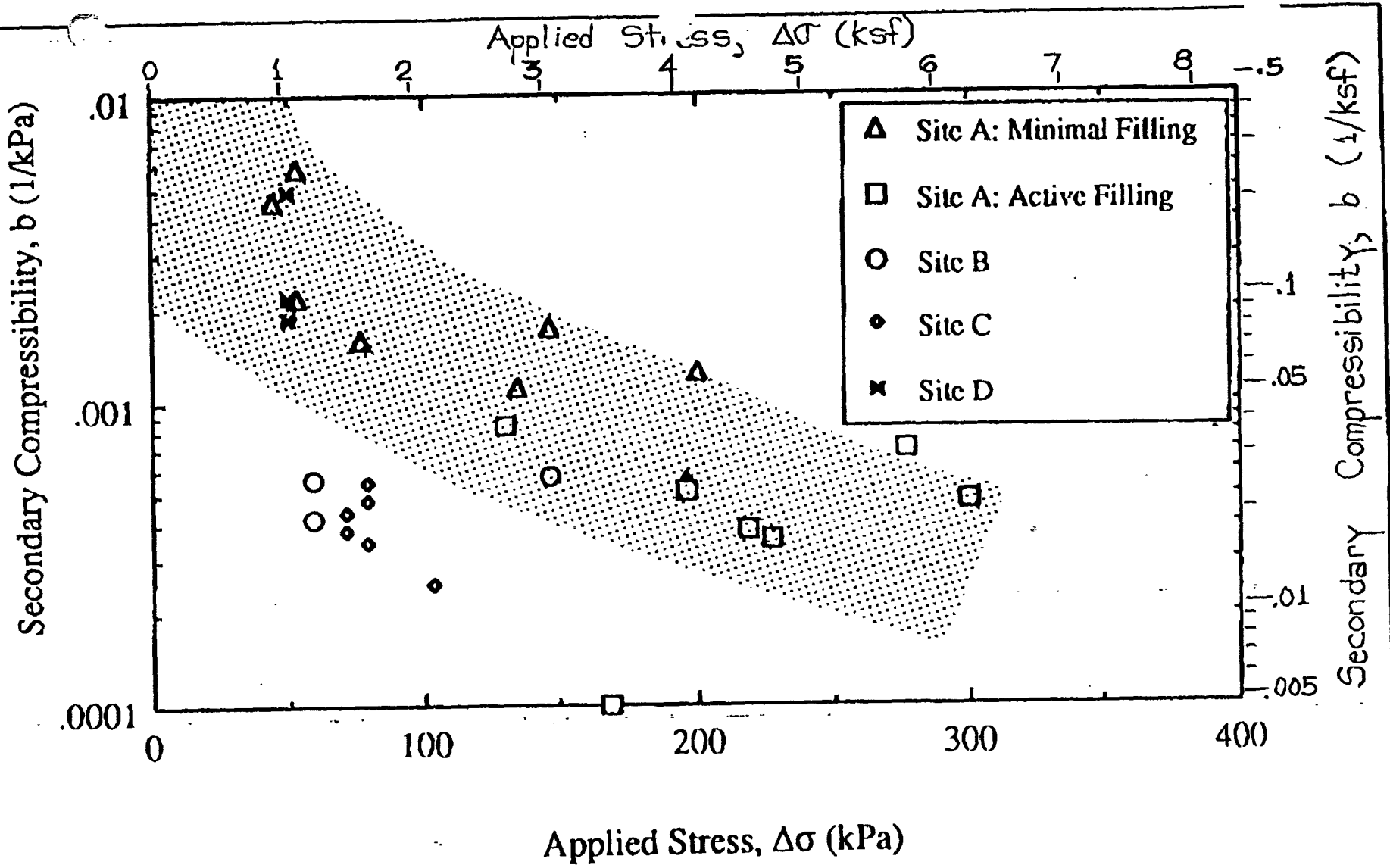
PREPARED BY:

RUST ENVIRONMENT & INFRASTRUCTURE

UNIT WEIGHT PROFILE FOR MSW

Fort Carson Landfills, Colorado

89868



REFERENCE: Edil, Ranguette, Wuelner (1990).

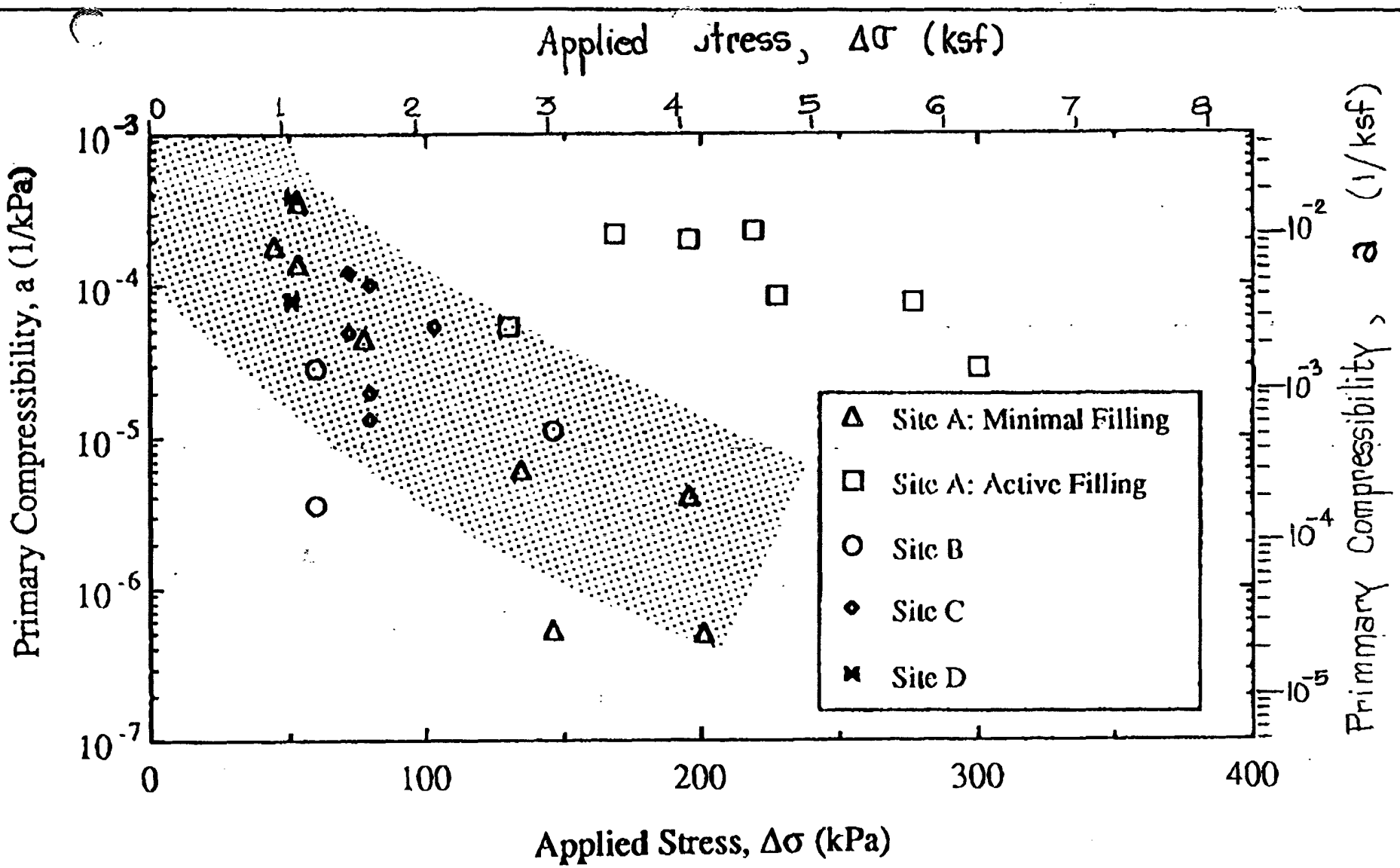
PREPARED BY:

RUST ENVIRONMENT & INFRASTRUCTURE

SECONDARY COMPRESSIBILITY OF MSW

FIGURE

33506



REFERENCE: Edil, Ranguette, Wuelner (1990).

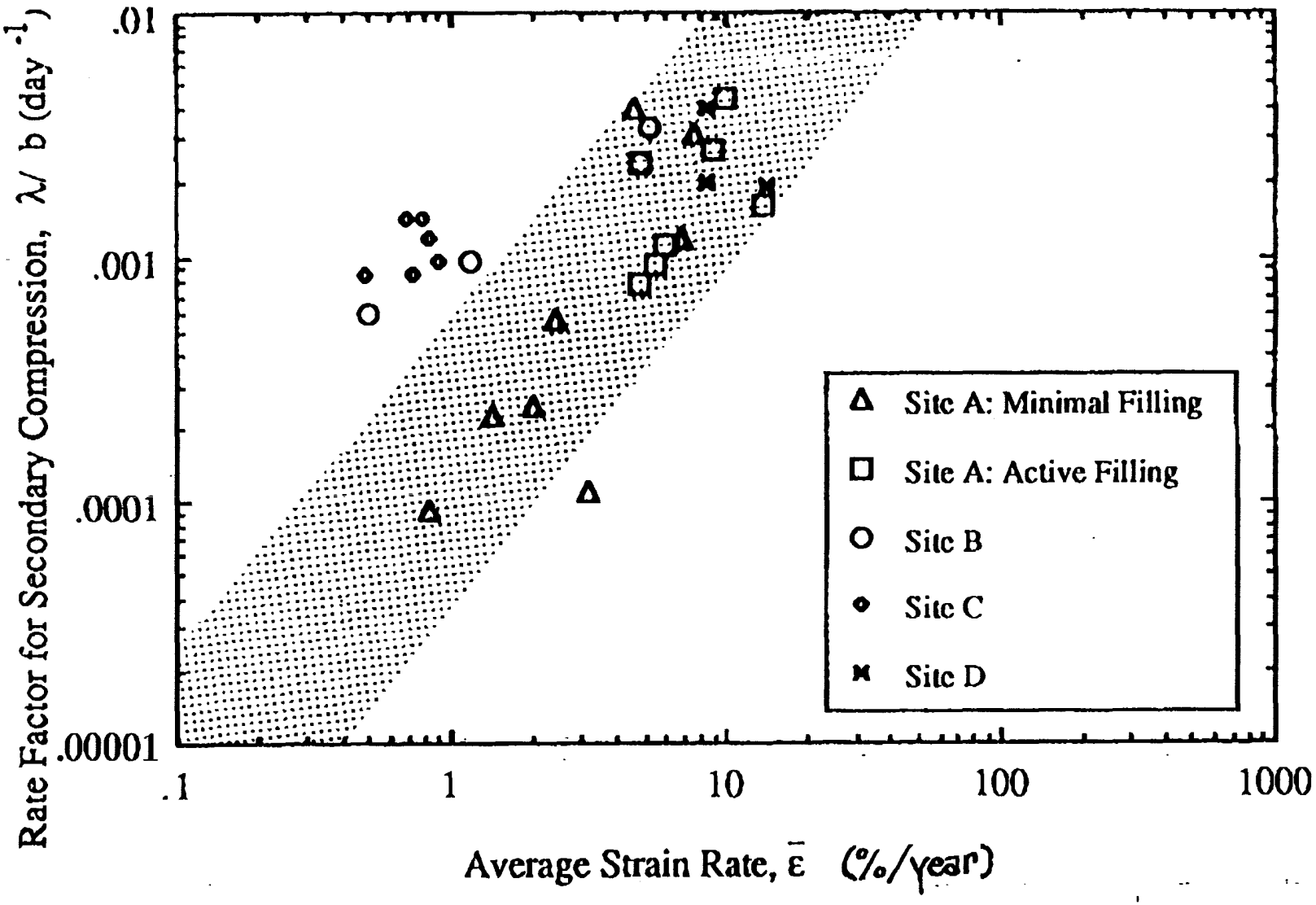
PREPARED BY:

RUST ENVIRONMENT & INFRASTRUCTURE

PRIMMARY COMPRESSIBILITY OF MSW

FIGURE

34107.500



REFERENCE: Edil, Ranguette, Wuelner (1990).

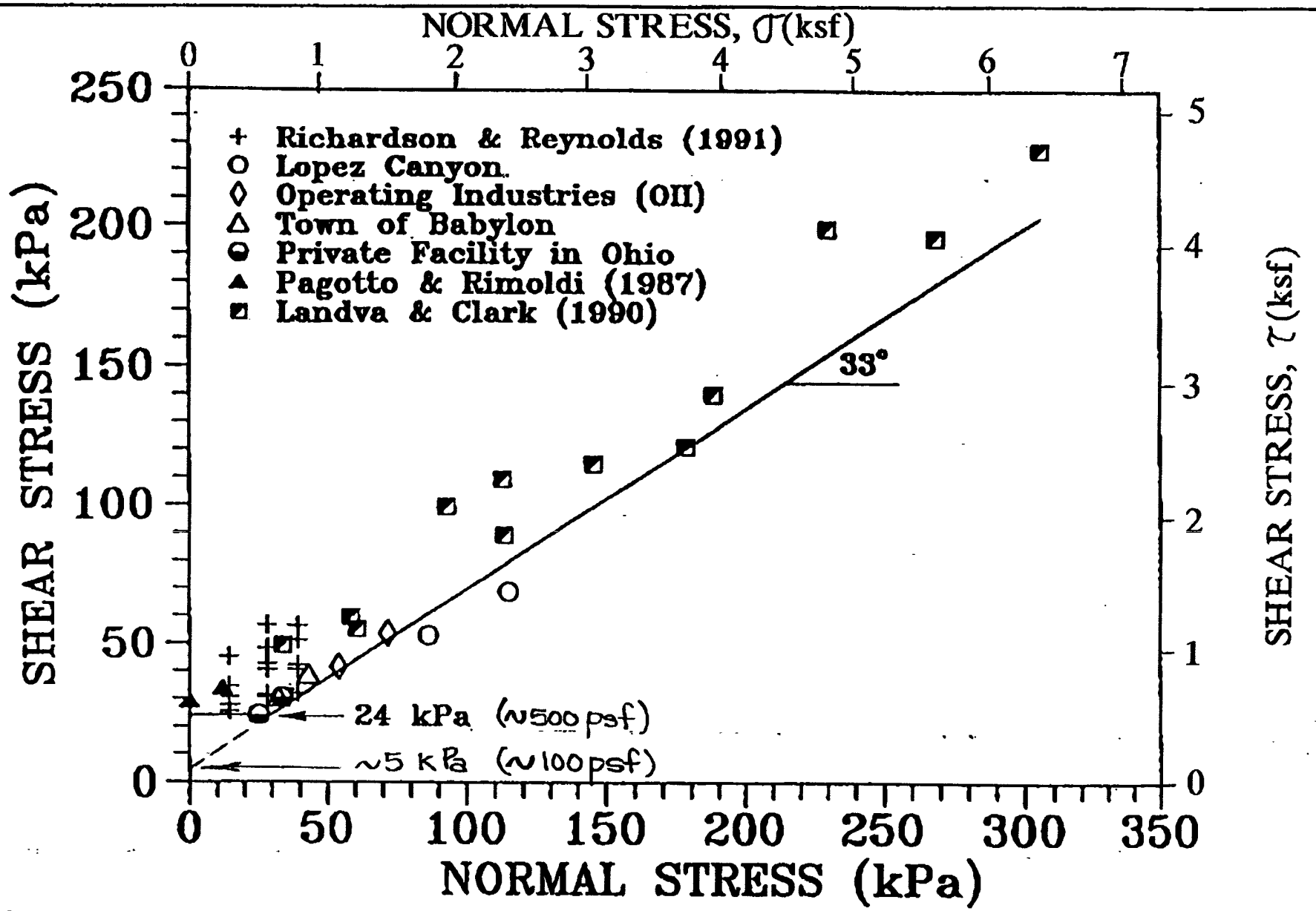
PREPARED BY:

RUST ENVIRONMENT & INFRASTRUCTURE

SECONDARY COMPRESSION RATE FACTOR OF MSW

FIGURE

34107.500



REFERENCE: Kavazanjian et al (1995)

PREPARED BY:

RUST ENVIRONMENT & INFRASTRUCTURE

MSW SHEAR STRENGTH

Fort Carson Landfills, Colorado

89868

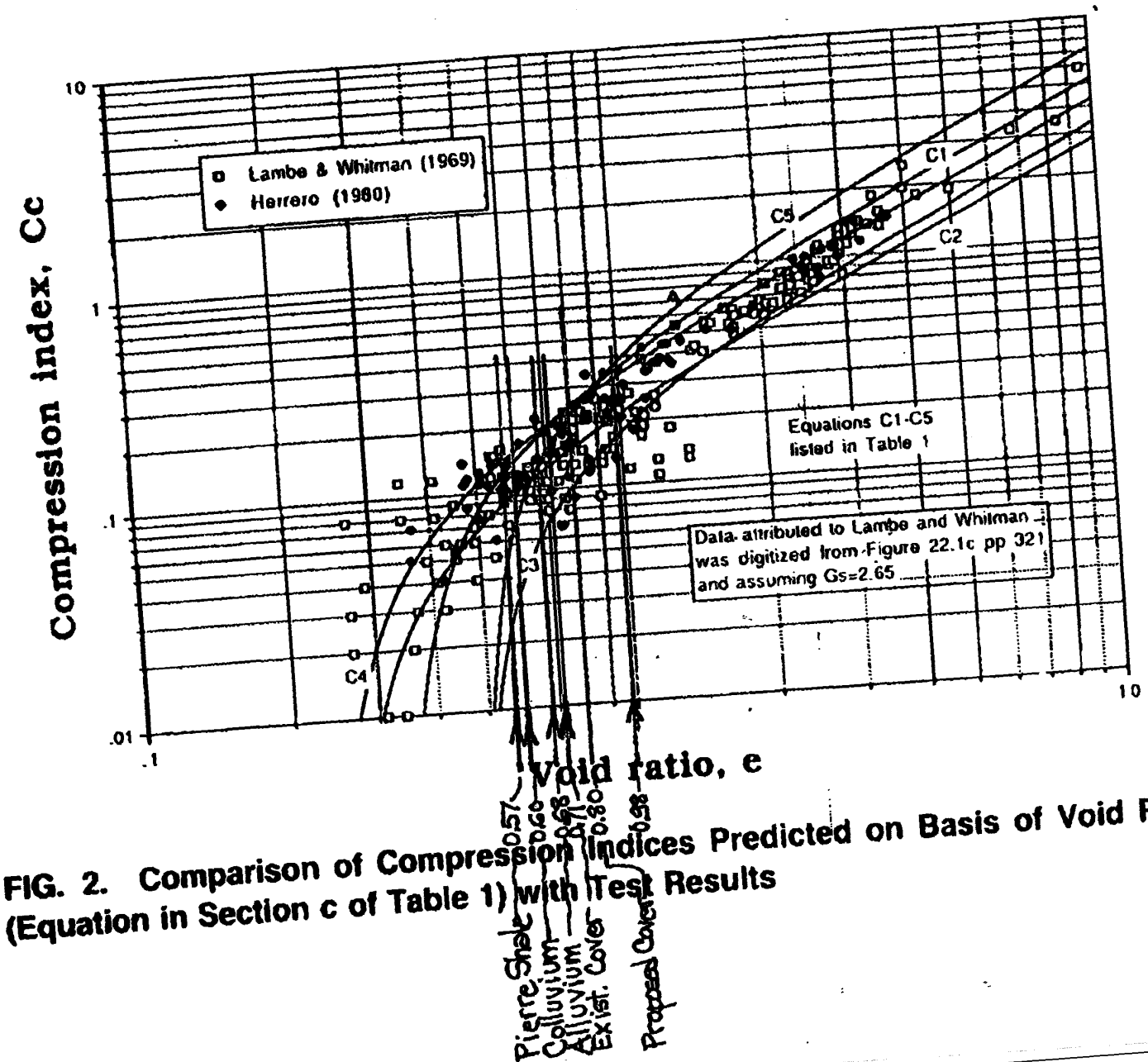


FIG. 2. Comparison of Compression Indices Predicted on Basis of Void Ratio (Equation in Section c of Table 1) with Test Results

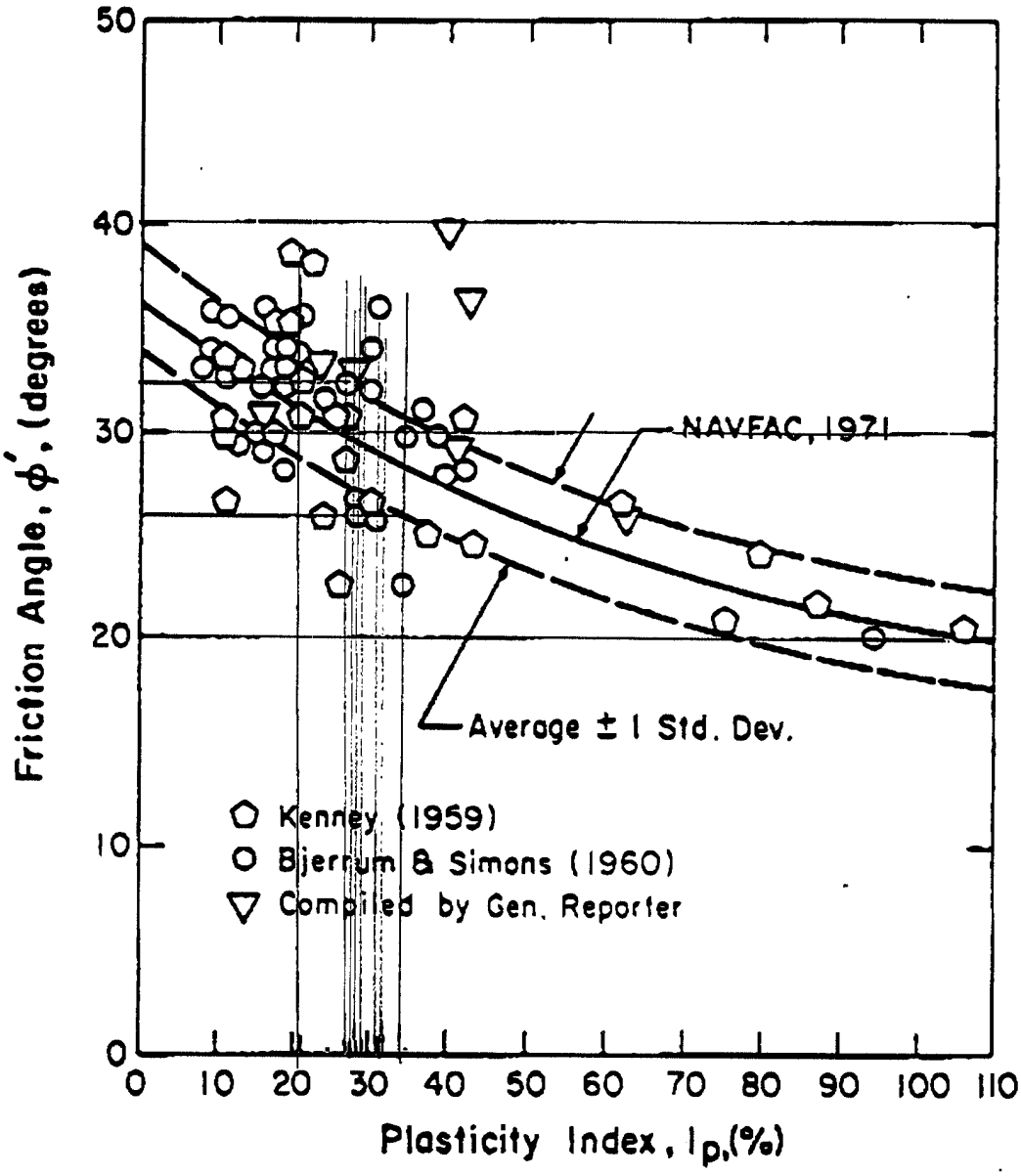


Fig. 42 Correlation between ϕ' at $(\sigma_1/\sigma_3)_{max}$ and I_p from Triaxial Tests on Normally Consolidated Clays, (After Ladd et al, 1977).

RUST Rust Environment & Infrastructure

CALCULATION SHEET

PAGE 1 OF 2
PROJECT NO. 89868.400

CLIENT U.S.A.C.O.E., Omaha SUBJECT Soil Cover Estim. Shear Strength Parameters.
PROJECT Fort Carson Landfills 2, 5 and 6

Prepared By EEV Date 2/2/96
Reviewed By _____ Date _____
Approved By _____ Date _____

SOIL MECHANICS IN FOUNDATION ENGINEERING 61

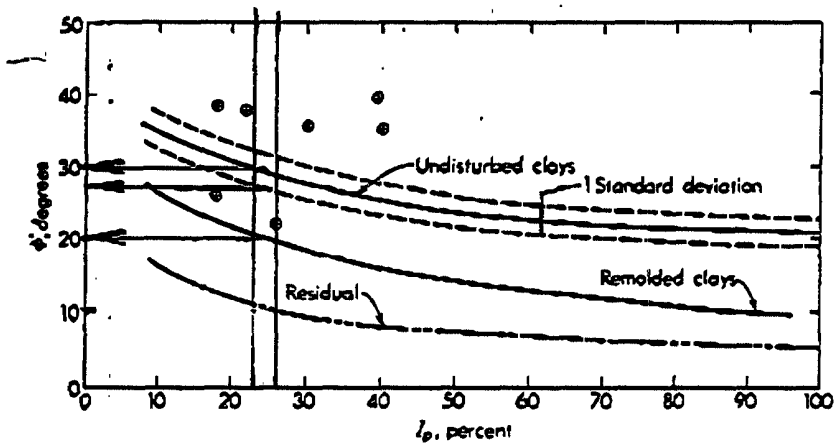


Figure 2-20 Correlation between ϕ' and plasticity index I_p for normally consolidated clays. Approximately 80 percent of data falls within one standard deviation. Typical extreme scatter values are shown. [*Data from several sources: DM-7, Ladd et al. (1977), Bjerrum and Simons (1960), Kenja and Wolle (1977).*]

(From "Foundation Analysis and Design" by Bowles)

1 Typical Undrained Shear Strength

$$\frac{S_u}{\sigma_v'} \approx 0.25\,(OCR)^{0.78}$$

"Equiv. ϕ_u" $\approx \tan(S_u/\sigma_v')$

OCR	"Equiv. ϕ_u"
1	~14°
2	~23°
3	~30°

Table 2-5 Representative values for angle of internal friction ϕ

Soil	Type of test* Unconsolidated-undrained U	Consolidated-undrained CU	Consolidated-drained CD
Gravel			
Medium size	40–55°		40–55°
Sandy	35–50°		35–50°
Sand			
Loose dry	28–34°		
Loose saturated	28–34°		
Dense dry	35–46°		43–50°
Dense saturated	1–2° less than dense dry		43–50°
Silt or silty sand			
Loose	20–22°		27–30°
Dense	25–30°		30–35°
Clay	0° if saturated	3–20°	20–42°

* See a laboratory manual on soil testing for a complete description of these tests, e.g., Bowles (1978).

APPENDIX G
PHONE MEMOS/FROST PROTECTION REFERENCE

PHONE MEMOS

RUST ENVIRONMENT & INFRASTRUCTURE

NOTES OF TELEPHONE CONVERSATION

RUST E&I Personnel making (or receiving) call: MARK WITCZAK

To (or from): RON FORLINA - GEOLOGIST

of: COL. DEPT. HEALTH - HMWMD - SWIM-B2

Address: 4300 CHERRY CREEK DRIVE SOUTH

Telephone number: 303-692-3439 Date: 11/1/95

Subject of Conversation: MINIMUM FINAL COVER SLOPE REQMTS

Project Number: 89868.300

Comments: WE DISCUSSED MIN SLOPE REQS FOR FINAL CAPS. RON STATED THAT HE WOULD BE FLEXIBLE ON THE 5% MINIMUM PROVIDED THAT RUST CAN SHOW THAT THE FINAL CAP WILL PROMOTE DRAINAGE. HE STRESSED THAT IT WAS IMPORTANT NOT TO ALLOW PONDING ON THE CAP. RON STATED THAT EDGAR MARTINEZ WOULD BE MAKING THE FINAL DECISION FOR ALLOWABLE MINIMUM SLOPES. EDGAR DEALS WITH "RCRA "B" SITES AND RON MAINLY DEALS WITH SUBTITLE D SITES. RON WAS ALSO CONCERNED ABOUT HOW LONG THE SLOPE LENGTHS WOULD BE FOR A FLATTER SLOPE.

Next Action Date: _____

Next Action: _____

Comments: _____

CC: _____

2GAAD\TELECON.NEW[1]
March 9, 1993

RUST ENVIRONMENT & INFRASTRUCTURE

NOTES OF TELEPHONE CONVERSATION

RUST E&I Personnel making (or receiving) call: MARK WITCZAK

To (or from): DAVID SCHMIDT

of: COLORADO SPRINGS BUILDING INSPECTOR

Address: COLORADO SPRINGS

Telephone number: 719-578-6800 Date: 8/23/95

Subject of Conversation: FROST DEPTH

Project Number: 89 968.300

Comments:

DAVE SAID FROST DEPTH IS AT 30 INCHES BELOW GRADE FOR THE COLORADO SPRINGS AREA.

200 ft

30 in

Next Action Date: —

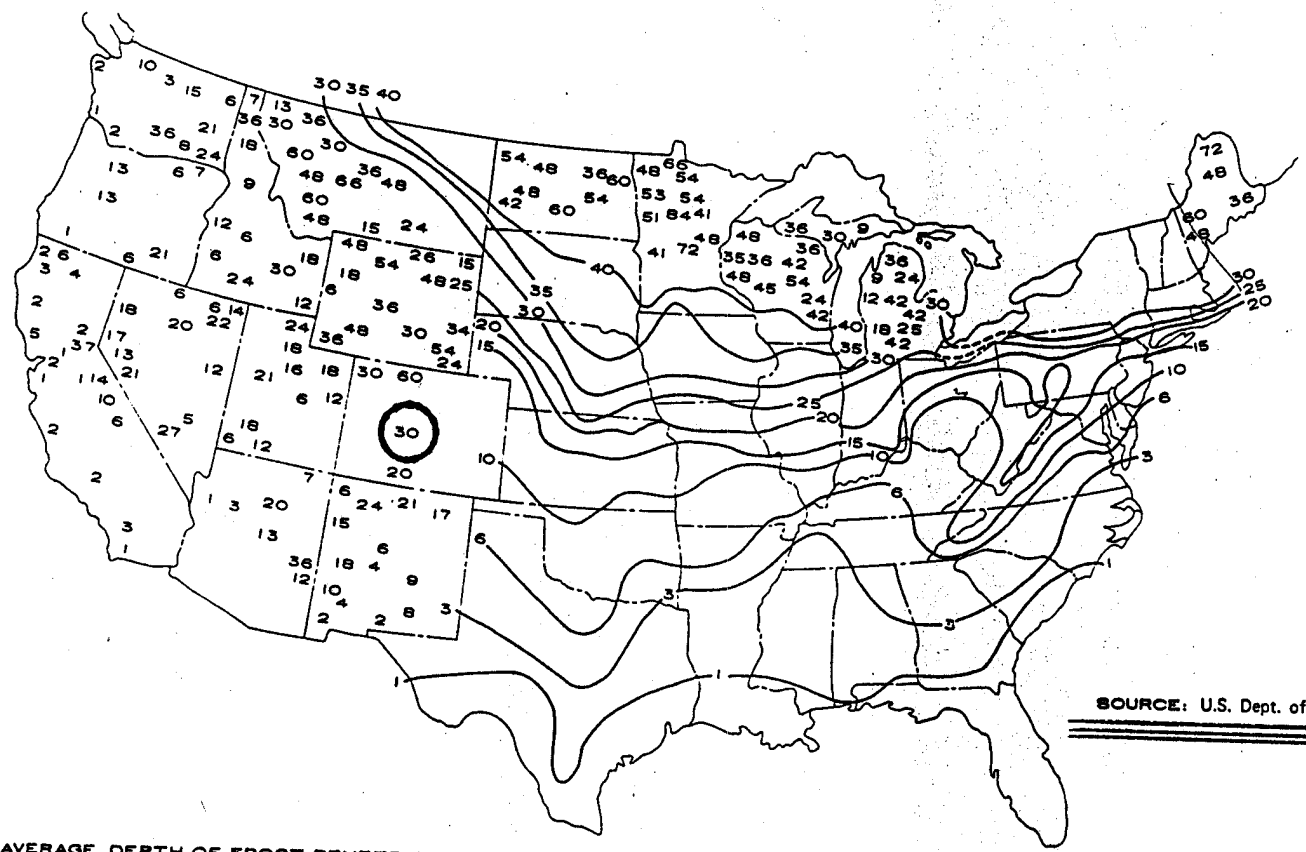
Next Action: —

Comments: —

CC:

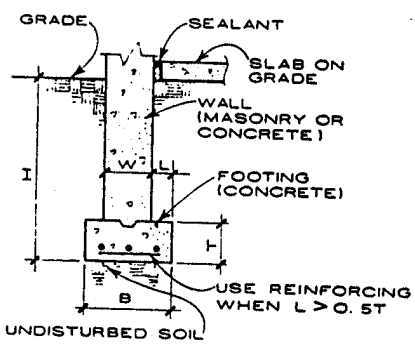
2GAAD\TELECON.NEW'
March 9, 1993

FROST PROTECTION REFERENCES

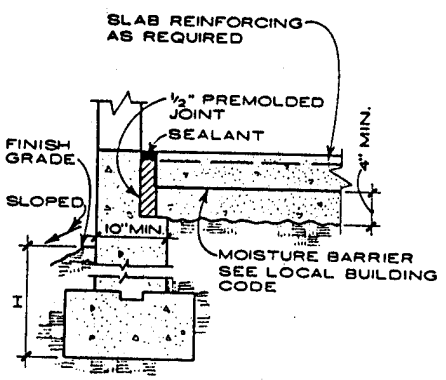


SOURCE: U.S. Dept. of Commerce Weather Bureau

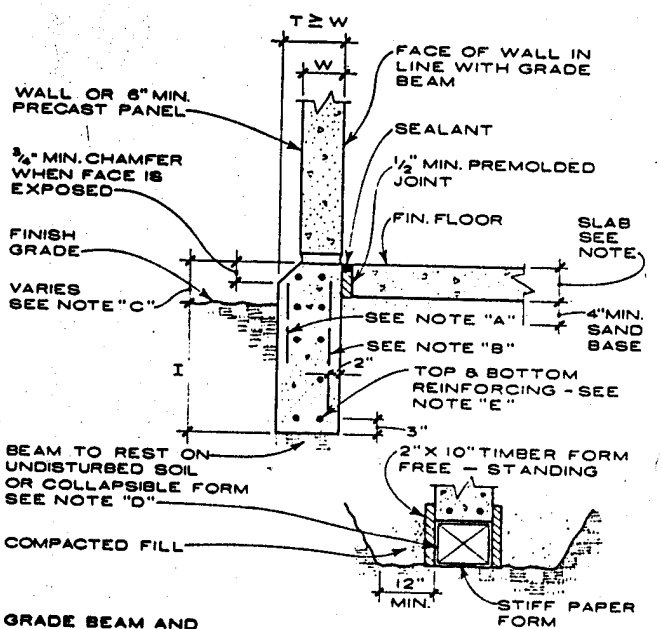
AVERAGE DEPTH OF FROST PENETRATION – H INCHES



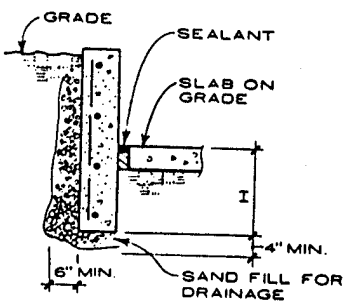
WALL FOOTINGS



PERIMETER WALL



GRADE BEAM AND COLLAPSIBLE FORM



AREA WALLS

GENERAL NOTES:

1. Adjoining ground to slope away from foundation in all directions and underlying soil to be preferably sand or gravel to reduce to a minimum heaving due to frost action.
2. It is good practice for foundations to extend 12" below frost line; consult local codes.

TYPICAL GRADE BEAMS

NOTES:

A. Use temperature reinforcing only when face of grade beam is exposed over 18" to weather.
B. Use main reinforcing only when finish grade is below 24" and/or finish floor surcharge load so dictates.
C. When finish grade is below finish floor, design grade beam for vertical and horizontal forces.
D. Use collapsible form when soil under beam is expansive or fat clay (CH). This provides a void which allows for periodic heaving of the soil due to increased moisture content, without lifting the grade beam.
E. Use top & bottom reinforcing for all grade beams.

Smith, Hinchman & Grylls Associates, Inc.; Detroit, Michigan

FOUNDATION ENGINEERING HANDBOOK

Edited by

HANS F. WINTERKORN Dr. phil. nat.
Professor of Civil Engineering and Geophysics, Emeritus,
Princeton University

HSAI-YANG FANG Ph.D.
Associate Professor of Civil Engineering and Director, Geotechnical Engineering Division,
Fritz Engineering Laboratory, Lehigh University

VAN NOSTRAND REINHOLD COMPANY
NEW YORK CINCINNATI ATLANTA DALLAS SAN FRANCISCO
LONDON TORONTO MELBOURNE

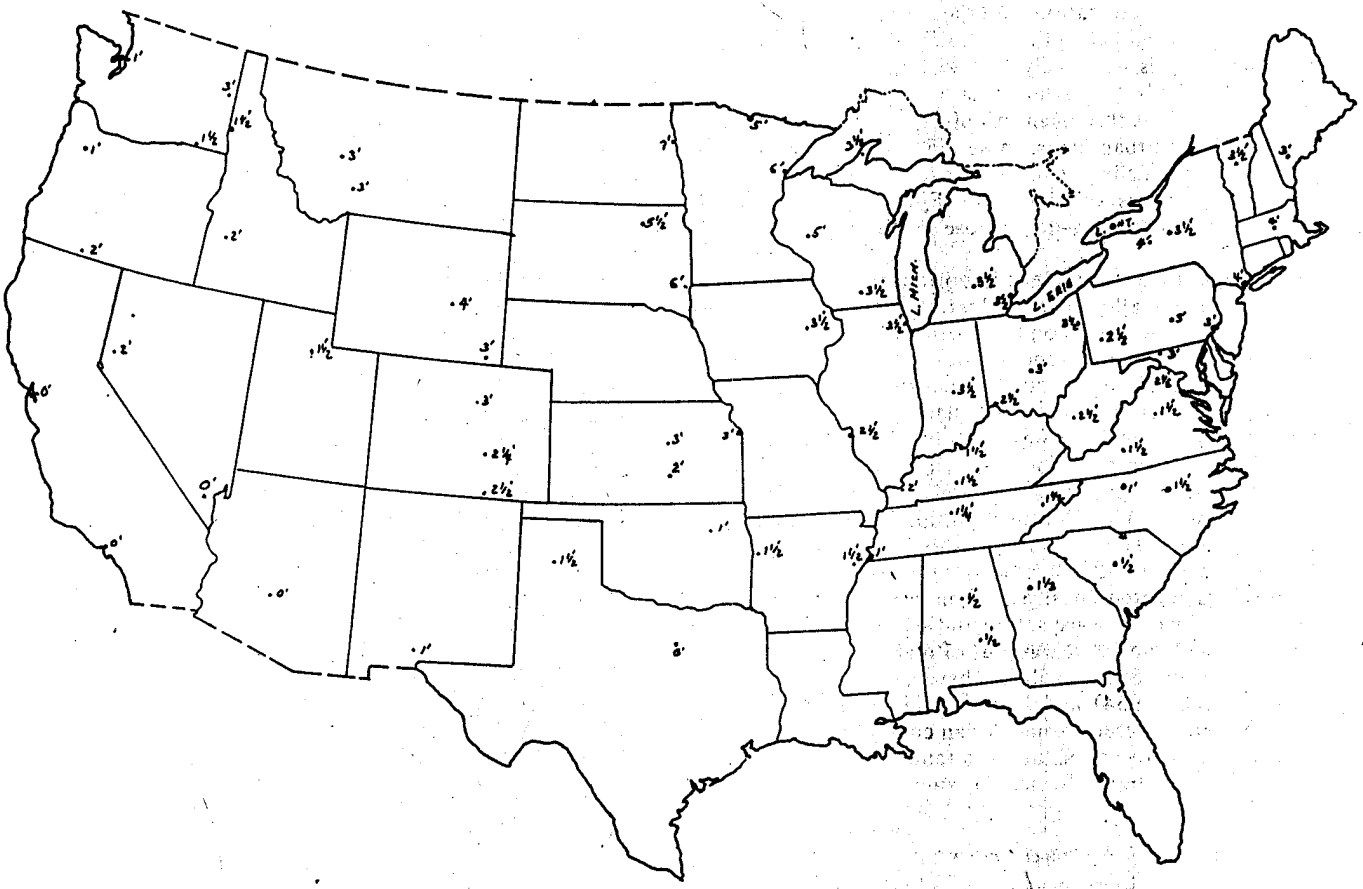


Fig. 15.8 Building Code frost depths at selected cities in the United States. Footings may be placed at lower depths in southern areas. All depths are shown in feet and fractions thereof.

imity to the buildings can cause seasonal moisture changes, i.e., desiccation during the growing season and excess moisture during dormancy. Studies have been reported by Perpich, Lukas, and Baker (1965) and Hammer and Thompson (1966) with some solutions to the tree desiccation problem. Generally it appears that it is desirable to locate trees away from shallow foundations a distance at least equal to the eventual height of the tree. Other factors which change the moisture content of the soil, such as leaking plumbing, may cause problems.

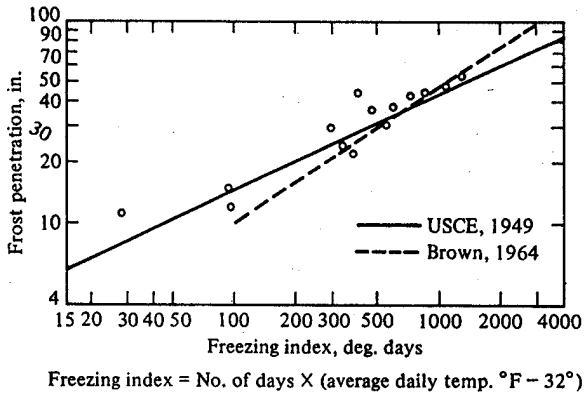


Fig. 15.9 Design curves for maximum frost penetration based on the freezing index.

Footings should be located below the layer of topsoil since (a) the organic material will eventually decompose leaving a porous base and (b) the topsoil is the zone of seasonal volume change and in moderate to cold climates will be subject to freezing.

Peat and muck will have to be replaced as it is completely

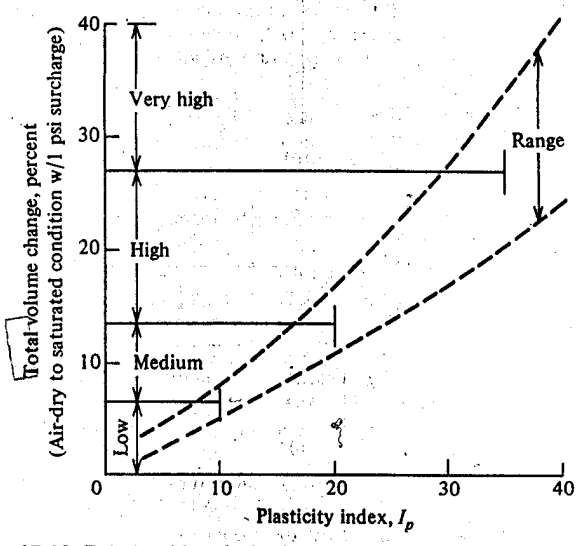


Fig. 15.10 Relationship of plasticity index to swell potential of a soil. (After Holtz and Gibbs, 1956.)

APPENDIX H
ANALYTICAL GROUNDWATER DATA

SUMMARY OF ANALYTICAL METHODS
LANDFILL AREA SITES
FT. CARSON, COLORADO

Sample ID	Method	Method Group
LF2-WO	160.1	TDS
	300.0	CL
	310.1	Alk
	405.1	BOD
	410.4	COD
	9060	TOC
LF2FCMW73	300.0	NO2
	353.2	NO2/NO3
	6010	Metal
	7041	Metal
	7060	Metal
	7421	Metal
	7470	Metal
	7740	Metal
	7841	Metal
	8080	Pest/PCB
	8260	VOC
	8270	SVOC
LF2FCMW74	300.0	NO2
	353.2	NO2/NO3
	6010	Metal
	7041	Metal
	7060	Metal
	7421	Metal
	7470	Metal
	7740	Metal
	7841	Metal
	8080	Pest/PCB
	8260	VOC
	8270	SVOC
LF2FCMW74TRIP	8260	VOC

SUMMARY OF ANALYTICAL METHODS
LANDFILL AREA SITES
FT. CARSON, COLORADO

Sample ID	Method	Method Group
LF2FCMW75	300.0	NO2
	353.2	NO2/NO3
	6010	Metal
	7041	Metal
	7060	Metal
	7421	Metal
	7470	Metal
	7740	Metal
	7841	Metal
	8080	Pest/PCB
	8260	VOC
	8270	SVOC
LF2FCMW76	300.0	NO3
	6010	Metal
	7041	Metal
	7060	Metal
	7421	Metal
	7470	Metal
	7740	Metal
	7841	Metal
	8080	Pest/PCB
	8260	VOC
	8270	SVOC
LF2FCMW78	8260	VOC
LF2FCMW81	300.0	NO3
	6010	Metal
	7041	Metal
	7060	Metal
	7421	Metal
	7470	Metal
	7740	Metal
	7841	Metal

SUMMARY OF ANALYTICAL METHODS
LANDFILL AREA SITES
FT. CARSON, COLORADO

Sample ID	Method	Method Group
LF2FCMW81	8080	Pest/PCB
	8260	VOC
	8270	SVOC
LF2FCMW81TRIP	8260	VOC
LF5-WO	160.1	TDS
	300.0	CL
	310.1	Alk
	405.1	BOD
	410.4	COD
	9060	TOC
LF5FCMW82	300.0	NO3
	6010	Metal
	7041	Metal
	7060	Metal
	7421	Metal
	7470	Metal
	7740	Metal
	7841	Metal
	8080	Pest/PCB
	8260	VOC
	8270	SVOC
LF5FCMW84	300.0	NO3
	6010	Metal
	7041	Metal
	7060	Metal
	7421	Metal
	7470	Metal
	7740	Metal
	7841	Metal
	8080	Pest/PCB
	8260	VOC

SUMMARY OF DETECTED COMPOUNDS in Groundwater
LANDFILL AREA SITES
FT. CARSON, COLORADO

Site Group	Sample ID	Analyte	Method		MCL	State	Result	Units	Dil'n	Flag	Site Type
Landfill 2	LF2-WQ	Alkalinity	310.1				799.0000	mg/L	1		WELL
Landfill 2		Bicarbonate	310.1				799.0000	mg/L	1		WELL
Landfill 2		Nitrate	300.0		10	10	97.0000	mg/L	25		WELL
Landfill 2		Nitrite	300.0	LT			0.4000	mg/L	25		WELL
Landfill 2		Sulfate	300.0		400	250	10900.0000	mg/L	1000	B	WELL
Landfill 2		TDS	160.1				18200.0000	mg/L	1		WELL
Landfill 2		Total Organic Carbon	9060				12.0000	mg/L	1		WELL
Landfill 2	LF2FCMW73	Nitrite	300.0	LT			0.1600	mg/L	10		WELL
Landfill 2		Antimony (diss.)	7041		.006	.006	0.0215	mg/L	5	J	WELL
Landfill 2		Arsenic (diss.)	7060	LT			0.0015	mg/L	2		WELL
Landfill 2		Barium (diss.)	6010				0.0063	mg/L	1	J	WELL
Landfill 2		Calcium (diss.)	6010				407.0000	mg/L	1		WELL
Landfill 2		Lead (diss.)	7421	LT			0.0045	mg/L	5		WELL
Landfill 2		Magnesium (diss.)	6010				970.0000	mg/L	1		WELL
Landfill 2		Manganese (diss.)	6010		—	0.05	0.0064	mg/L	1	J	WELL
Landfill 2		Potassium (diss.)	6010				5.5700	mg/L	1		WELL
Landfill 2		Selenium (diss.)	7740	LT			0.0037	mg/L	5		WELL
Landfill 2		Silver (diss.)	6010				0.0039	mg/L	1	J	WELL
Landfill 2		Sodium (diss.)	6010				3760.0000	mg/L	5		WELL
Landfill 2		Thallium (diss.)	7841				0.0013	mg/L	1	J	WELL
Landfill 2		Nitrate + Nitrite	353.2		10	10	83.0000	mg/L	100		WELL
Landfill 2	LF2FCMW74	Nitrite	300.0	LT			0.1600	mg/L	10		WELL
Landfill 2		Antimony (diss.)	7041		.006	.006	0.0360	mg/L	10	J	WELL
Landfill 2		Arsenic (diss.)	7060	LT			0.0073	mg/L	10		WELL
Landfill 2		Barium (diss.)	6010				0.0081	mg/L	1	J	WELL
Landfill 2		Calcium (diss.)	6010				423.0000	mg/L	1		WELL
Landfill 2		Cobalt (diss.)	6010				0.0110	mg/L	1	J	WELL
Landfill 2		Lead (diss.)	7421	LT			0.0089	mg/L	10		WELL

LT values represent samples which have been diluted prior to analysis, yielding a higher detection limit.
Site Type: DP = Direct Push, WELL = Monitoring Well
All data preliminary.

SUMMARY OF DETECTED COMPOUNDS
LANDFILL AREA SITES
FT. CARSON, COLORADO

Site Group	Sample ID	Analyte	Method		MCL	State	Result	Units	Dil'n	Flag	Site Type
Landfill 2	LF2FCMW74	Magnesium (diss.)	6010				2170.0000	mg/L	5		WELL
Landfill 2		Manganese (diss.)	6010		—	0.05	8.4300	mg/L	1		WELL
Landfill 2		Nickel (diss.)	6010				0.0247	mg/L	1		WELL
Landfill 2		Potassium (diss.)	6010				73.0000	mg/L	1		WELL
Landfill 2		Selenium (diss.)	7740		0.05	0.01	0.0520	mg/L	20	J	WELL
Landfill 2		Silver (diss.)	6010				0.0045	mg/L	1	J	WELL
Landfill 2		Sodium (diss.)	6010				9740.0000	mg/L	10		WELL
Landfill 2		Thallium (diss.)	7841		.002	.002	0.0046	mg/L	1	J	WELL
Landfill 2		Nitrate + Nitrite	353.2		10	10	113.0000	mg/L	100		WELL
Landfill 2		Bis(2-ethylhexyl) phthalate	8270				98.0000	ug/L	1	B	WELL
Landfill 2	LF2FCMW75	Nitrite	300.0	LT			0.1600	mg/L	10		WELL
Landfill 2		Antimony (diss.)	7041		.006	.006	0.0140	mg/L	5	J	WELL
Landfill 2		Arsenic (diss.)	7060	LT			0.0150	mg/L	20		WELL
Landfill 2		Barium (diss.)	6010				0.0150	mg/L	1	J	WELL
Landfill 2		Calcium (diss.)	6010				491.0000	mg/L	1		WELL
Landfill 2		Cobalt (diss.)	6010				0.0075	mg/L	1	J	WELL
Landfill 2		Iron (diss.)	6010				0.4580	mg/L	1		WELL
Landfill 2		Lead (diss.)	7421	LT			0.0018	mg/L	2		WELL
Landfill 2		Magnesium (diss.)	6010				646.0000	mg/L	1		WELL
Landfill 2		Manganese (diss.)	6010		—	0.05	6.8000	mg/L	1		WELL
Landfill 2		Mercury (diss)	7470				0.0007	mg/L	1		WELL
Landfill 2		Nickel (diss.)	6010				0.0221	mg/L	1		WELL
Landfill 2		Potassium (diss.)	6010				9.7200	mg/L	1		WELL
Landfill 2		Selenium (diss.)	7740				0.0076	mg/L	2	J	WELL
Landfill 2		Silver (diss.)	6010				0.0045	mg/L	1	J	WELL
Landfill 2		Nitrate + Nitrite	353.2				0.2400	mg/L	2		WELL
Landfill 2	LF2FCMW76	Nitrate	300.0	LT			0.5300	mg/L	10		WELL
Landfill 2		Nitrite	300.0	LT			0.1600	mg/L	10		WELL
Landfill 2		Antimony (diss.)	7041		.006	0.006	0.0220	mg/L	5	J	WELL

LT values represent samples which have been diluted prior to analysis, yielding a higher detection limit.
Site Type: DP = Direct Push, WELL = Monitoring Well
All data preliminary.

SUMMARY OF DETECTED COMPOUNDS
LANDFILL AREA SITES
FT. CARSON, COLORADO

Site Group	Sample ID	Analyte	Method		MCL	State	Result	Units	Dil'n	Flag	Site Type
Landfill 2	LF2FCMW76	Arsenic (diss.)	7060	LT			0.0150	mg/L	20		WELL
Landfill 2		Barium (diss.)	6010				0.0110	mg/L	1	J	WELL
Landfill 2		Calcium (diss.)	6010				422.0000	mg/L	1		WELL
Landfill 2		Lead (diss.)	7421	LT			0.0045	mg/L	5		WELL
Landfill 2		Manganese (diss.)	6010		—	0.05	4.7800	mg/L	1		WELL
Landfill 2		Nickel (diss.)	6010				0.0447	mg/L	1		WELL
Landfill 2		Potassium (diss.)	6010				13.6000	mg/L	1		WELL
Landfill 2		Selenium (diss.)	7740	LT			0.0037	mg/L	5		WELL
Landfill 2		Silver (diss.)	6010				0.0026	mg/L	1	J	WELL
Landfill 2		1,2-Dichloroethane	8260		5	0.4	2.9000	ug/L	1		WELL
Landfill 2		1,2-Dichloropropane	8260		5	0.56	3.8000	ug/L	1		WELL
Landfill 2		cis-1,2-Dichloroethene	8260				2.4000	ug/L	1		WELL
Landfill 2	LF2FCMW81	Nitrate	300.0	LT			0.5300	mg/L	10		WELL
Landfill 2		Nitrite	300.0	LT			0.1600	mg/L	10		WELL
Landfill 2		Antimony (diss.)	7041		.006	0.006	0.0210	mg/L	5	J	WELL
Landfill 2		Arsenic (diss.)	7060	LT			0.0073	mg/L	10		WELL
Landfill 2		Barium (diss.)	6010				0.0051	mg/L	1	J	WELL
Landfill 2		Calcium (diss.)	6010				385.0000	mg/L	1		WELL
Landfill 2		Lead (diss.)	7421	LT			0.0045	mg/L	5		WELL
Landfill 2		Manganese (diss.)	6010		—	0.05	1.0200	mg/L	1		WELL
Landfill 2		Potassium (diss.)	6010				18.8000	mg/L	1		WELL
Landfill 2		Selenium (diss.)	7740	LT			0.0037	mg/L	5		WELL
Landfill 2		Silver (diss.)	6010				0.0030	mg/L	1	J	WELL
Landfill 5	LF5-WQ	Alkalinity	310.1				515.0000	mg/L	1		WELL
Landfill 5		Bicarbonate	310.1				515.0000	mg/L	1		WELL
Landfill 5		Chloride	300.0				83.8000	mg/L	25		WELL
Landfill 5		Nitrate	300.0		10	10	42.2000	mg/L	10		WELL
Landfill 5		Nitrite	300.0	LT			0.1600	mg/L	10		WELL
Landfill 5		TDS	160.1				7450.0000	mg/L	1		WELL

LT values represent samples which have been diluted prior to analysis, yielding a higher detection limit.
Site Type: DP = Direct Push, WELL = Monitoring Well
All data preliminary.

TABLE 2-1
SUMMARY OF DETECTED COMPOUNDS
RCRA FACILITY INVESTIGATIONS AT LANDFILL SITES
FORT CARSON, COLORADO

MCL State

Sample ID	Sample Date	Test Method	Analyte	Result	Lab Flag	Qualifier	Units	Dilution Factor	Lab
LF2DP03	06/23/95		Barium	0.12			mg/L	1	HY
LF2DP03	06/23/95		Chromium	0.01	J		mg/L	1	HY
LF2DP03	06/23/95	7470	Mercury	0.00			mg/L	1	HY
LF2DP03	06/23/95	7740	Selenium	0.00	J		mg/L	2	HY
LF2DP03	06/23/95		Silver	0.00	J		mg/L	1	HY
LF2DP03	06/23/95	353	Nitrate + Nitrite	0.48			mg/L	2	HY
LF2DP04	06/23/95	3520	Di-n-butyl phthalate	6.00	J		ug/L	1	HY
LF5DP02	06/23/95	3520	Bis(2-ethylhexyl) phthalate	29.00	B		ug/L	1	HY
LF5DP03	06/22/95		Barium	0.03			mg/L	1	HY
LF5DP03	06/22/95	7421	Lead	0.00	J		mg/L	1	HY
LF5DP03	06/22/95	7740	Selenium (if dissolved) .05 .01	0.02			mg/L	1	HY
LF5DP03	06/22/95	353	Nitrate + Nitrite	7.30			mg/L	20	HY

J Analyte detected at a concentration greater than the MDL but less than the PQL.
B Analyte detected in the corresponding method blank

ND = Not Detected. PQL value is shown.
LT = Less Than. MDL value is shown.

Volatile Organics
Target Compound List (TCL)
Method 8260

Client Name: Rust Environment and Infrastructure
Client ID: LF2DPW6 (0.00,0.00,WELL,267,P)
Lab ID: 047964-0001-SA
Matrix: AQUEOUS Sampled: 21 MAR 96 Received: 22 MAR 96
Authorized: 22 MAR 96 Prepared: 25 MAR 96 Analyzed: 28 MAR 96

Parameter	Result	Units	Reporting Limit	
Acetone	11	ug/L	10	
Benzene	4.3	ug/L	5.0	J
Bromodichloromethane	ND	ug/L	5.0	
Bromoform	ND	ug/L	5.0	
Bromomethane	ND	ug/L	10	
2-Butanone (MEK)	ND	ug/L	10	
Carbon disulfide	ND	ug/L	5.0	
Carbon tetrachloride	ND	ug/L	5.0	
Chlorobenzene	1.1	ug/L	5.0	J
Chloroethane	ND	ug/L	10	
Chloroform	ND	ug/L	5.0	
Chloromethane	ND	ug/L	10	
Dibromochloromethane	ND	ug/L	5.0	
1,1-Dichloroethane	ND	ug/L	5.0	
1,2-Dichloroethane	ND	ug/L	5.0	
1,1-Dichloroethene	ND	ug/L	5.0	
cis-1,2-Dichloroethene	ND	ug/L	5.0	
trans-1,2-Dichloroethene	ND	ug/L	5.0	
1,2-Dichloropropane	ND	ug/L	5.0	
cis-1,3-Dichloropropene	ND	ug/L	5.0	
trans-1,3-Dichloropropene	ND	ug/L	5.0	
Ethylbenzene	5.8	ug/L	5.0	
2-Hexanone	ND	ug/L	10	
Methylene chloride	ND	ug/L	5.0	
4-Methyl-2-pentanone (MIBK)	ND	ug/L	10	
Styrene	ND	ug/L	5.0	
1,1,2,2-Tetrachloroethane	ND	ug/L	5.0	
Tetrachloroethene	ND	ug/L	5.0	
Toluene	3.5	ug/L	5.0	J
1,1,1-Trichloroethane	ND	ug/L	5.0	
1,1,2-Trichloroethane	ND	ug/L	5.0	
Trichloroethene	ND	ug/L	5.0	
Vinyl acetate	ND	ug/L	10	
Vinyl chloride	5.1	ug/L	10	J
Xylenes (total)	8.3	ug/L	5.0	

Surrogate	Recovery	
Toluene-d8	101	%
4-Bromofluorobenzene	100	%

(continued on following page)

ND = Not detected
NA = Not applicable

Reported By: Sandra Jones Approved By: Dawn M. Basko

Volatile Organics
Target Compound List (TCL)
Method 8260

Client Name: Rust Environment and Infrastructure
Client ID: LF2DPW6 (0.00,0.00,WELL,267,P)
Lab ID: 047964-0001-SA
Matrix: AQUEOUS Sampled: 21 MAR 96 Received: 22 MAR 96
Authorized: 22 MAR 96 Prepared: 25 MAR 96 Analyzed: 28 MAR 96

Surrogate	Recovery	
1,2-Dichloroethane-d4	99	%

Note J : Result is detected below the reporting limit or is an estimated concentration.

ND = Not detected
NA = Not applicable

Reported By: Sandra Jones Approved By: Dawn M. Basko

Volatiles Library Search (10 Compound TID)

Method 8260

Client Name: Rust Environment and Infrastructure
Client ID: LF2DPW6 (0.00,0.00,WELL,267,P)
Lab ID: 047964-0001-SA
Matrix: AQUEOUS Sampled: 21 MAR 96 Received: 22 MAR 96
Authorized: 22 MAR 96 Prepared: NA Analyzed: 28 MAR 96

Parameter	Result	Units	Reporting Limit
Ethane, 1,1'-oxybis-	5.2	ug/L	2
1,3,5-Trimethylbenzene	14	ug/L	2
Isocineole	6.2	ug/L	2
Benzene, 1-ethyl-3-methyl-	7.5	ug/L	2
Benzene, 1-ethenyl-4-methyl-	6.4	ug/L	2
Bicyclo[2.2.1]heptan-2-one, 1,3,3-trimethyl-	70	ug/L	2
None Detected	ND	ug/L	
None Detected	ND	ug/L	
None Detected	ND	ug/L	
None Detected	ND	ug/L	

Note 2 : Confident Identification

ND = Not detected
NA = Not applicable

Reported By: Sandra Jones Approved By: Dawn M. Basko

Semivolatile Organics

Method 8270

Client Name: Rust Environment and Infrastructure
Client ID: LF2DPW6 (0.00,0.00,WELL,267,P)
Lab ID: 047964-0001-SA
Matrix: AQUEOUS Sampled: 21 MAR 96 Received: 22 MAR 96
Authorized: 22 MAR 96 Prepared: 26 MAR 96 Analyzed: 01 APR 96

Parameter	Result	Units	Reporting Limit	
Acenaphthene	ND	ug/L	40	
Acenaphthylene	ND	ug/L	40	
Anthracene	ND	ug/L	40	
Benzoic acid	ND	ug/L	200	
Benzo(a)anthracene	ND	ug/L	40	
Benzo(b)fluoranthene	ND	ug/L	40	
Benzo(k)fluoranthene	ND	ug/L	40	
Benzo(g,h,i)perylene	ND	ug/L	40	
Benzo(a)pyrene	ND	ug/L	40	
Benzyl alcohol	ND	ug/L	40	
bis(2-Chloroethoxy) methane	ND	ug/L	40	
bis(2-Chloroethyl) ether	ND	ug/L	40	
bis(2-Chloroisopropyl) ether	ND	ug/L	40	
bis(2-Ethylhexyl) phthalate	ND	ug/L	40	
4-Bromophenyl phenyl ether	ND	ug/L	40	
Butyl benzyl phthalate	ND	ug/L	40	
4-Chloroaniline	ND	ug/L	40	
2-Chloronaphthalene	ND	ug/L	40	
4-Chloro-3-methylphenol	65	ug/L	40	
2-Chlorophenol	ND	ug/L	40	
4-Chlorophenyl phenyl ether	ND	ug/L	40	
Chrysene	ND	ug/L	40	
Dibenz(a,h)anthracene	ND	ug/L	40	
Dibenzofuran	ND	ug/L	40	
Di-n-butyl phthalate	ND	ug/L	40	
1,2-Dichlorobenzene	ND	ug/L	40	
1,3-Dichlorobenzene	ND	ug/L	40	
1,4-Dichlorobenzene	ND	ug/L	40	
3,3'-Dichlorobenzidine	ND	ug/L	80	
2,4-Dichlorophenol	ND	ug/L	40	
Diethyl phthalate	ND	ug/L	40	
2,4-Dimethylphenol	5.0	ug/L	40	J
Dimethyl phthalate	ND	ug/L	40	
4,6-Dinitro-2-methylphenol	ND	ug/L	200	
2,4-Dinitrophenol	ND	ug/L	200	

(continued on following page)

ND = Not detected
NA = Not applicable

Reported By: Lisa Burgesser Approved By: Audrey Cornell

Semivolatile Organics (CONT.)

Method 8270

Client Name: Rust Environment and Infrastructure
Client ID: LF2DPW6 (0.00,0.00,WELL,267,P)
Lab ID: 047964-0001-SA
Matrix: AQUEOUS Sampled: 21 MAR 96 Received: 22 MAR 96
Authorized: 22 MAR 96 Prepared: 26 MAR 96 Analyzed: 01 APR 96

Parameter	Result	Units	Reporting Limit
2,4-Dinitrotoluene	ND	ug/L	40
2,6-Dinitrotoluene	ND	ug/L	40
Di-n-octyl phthalate	ND	ug/L	40
Fluoranthene	ND	ug/L	40
Fluorene	ND	ug/L	40
Hexachlorobenzene	ND	ug/L	40
Hexachlorobutadiene	ND	ug/L	40
Hexachlorocyclopentadiene	ND	ug/L	40
Hexachloroethane	ND	ug/L	20
Indeno(1,2,3-cd)pyrene	ND	ug/L	40
Isophorone	ND	ug/L	40
2-Methylnaphthalene	ND	ug/L	40
2-Methylphenol	ND	ug/L	40
3/4-Methylphenol	ND	ug/L	40
Naphthalene	130	ug/L	40
2-Nitroaniline	ND	ug/L	200
3-Nitroaniline	ND	ug/L	200
4-Nitroaniline	ND	ug/L	200
Nitrobenzene	ND	ug/L	40
2-Nitrophenol	ND	ug/L	40
4-Nitrophenol	ND	ug/L	200
N-Nitrosodiphenylamine	ND	ug/L	40
N-Nitrosodimethylamine	ND	ug/L	40
N-Nitroso-di-n-propylamine	ND	ug/L	40
Pentachlorophenol	ND	ug/L	100
Phenanthrene	ND	ug/L	40
Phenol	ND	ug/L	40
Pyrene	ND	ug/L	40
Pyridine	ND	ug/L	40
1,2,4-Trichlorobenzene	ND	ug/L	40
2,4,5-Trichlorophenol	ND	ug/L	100
2,4,6-Trichlorophenol	ND	ug/L	20

Surrogate	Recovery	
Nitrobenzene-d5	75	%
2-Fluorobiphenyl	70	%
Terphenyl-d14	43	%
Phenol-d5	83	%
2-Fluorophenol	77	%

(continued on following page)

ND = Not detected
NA = Not applicable

Reported By: Lisa Burgesser Approved By: Audrey Cornell

Semivolatile Organics (CONT.)

Method 8270

Client Name: Rust Environment and Infrastructure
Client ID: LF2DPW6 (0.00,0.00,WELL,267,P)
Lab ID: 047964-0001-SA
Matrix: AQUEOUS Sampled: 21 MAR 96 Received: 22 MAR 96
Authorized: 22 MAR 96 Prepared: 26 MAR 96 Analyzed: 01 APR 96

Surrogate	Recovery	
2,4,6-Tribromophenol	92	%

Note J : Result is detected below the reporting limit or is an estimated concentration.

ND = Not detected
NA = Not applicable

Reported By: Lisa Burgesser Approved By: Audrey Cornell

Semivolatiles Library Search (20 Compound TID)

Method 8270

Client Name: Rust Environment and Infrastructure
Client ID: LF2DPW6 (0.00,0.00,WELL,267,P)
Lab ID: 047964-0001-SA
Matrix: AQUEOUS Sampled: 21 MAR 96 Received: 22 MAR 96
Authorized: 22 MAR 96 Prepared: NA Analyzed: 01 APR 96

Parameter	Result	Units	Reporting Limit	
1-Propene, 2-fluoro-	44	ug/L		1
Camphene	43	ug/L		2
Cyclohexane, 4-methyl-1-(1-methylethyl)-	35	ug/L		2
Benzene, 1,2,3-trimethyl-	61	ug/L		1
Alcohol	41	ug/L		
Bicyclo[2.2.1]heptan-2-one, 1,7,7-trimethyl-, (1S!	240	ug/L		2z
Cyclic Hydrocarbon	52	ug/L		
Cyclic Hydrocarbon	40	ug/L		
Unknown	41	ug/L		
Benzoic acid, 3,5-dimethyl-	60	ug/L		2
Unsaturated Hydrocarbon	49	ug/L		
Sulfur, mol. (S8)	42	ug/L		1
2(3H)-Benzothiazolone	57	ug/L		2
Oxygenated Hydrocarbon	55	ug/L		
Aromatic Hydrocarbon	48	ug/L		
s-Indacen-1(2H)-one, 3,5,6,7-tetrahydro-3,3,4,5!	48	ug/L		1z
Citric acid, trimethyl ester	51	ug/L		1
Unknown	47	ug/L		
Sterol	49	ug/L		
Unknown	42	ug/L		

Note 1 : Tentative Identification

Note 2 : Confident Identification

Note z : Compound name contains more characters than the database will allow.

ND = Not detected
NA = Not applicable

Reported By: Lisa Burgesser Approved By: Audrey Cornell

General Inorganics

Client Name: Rust Environment and Infrastructure
Client ID: LF2DPW6 (0.00,0.00,WELL,267,P)
Lab ID: 047964-0001-SA
Matrix: AQUEOUS Sampled: 21 MAR 96 Received: 22 MAR 96
Authorized: 22 MAR 96 Prepared: See Below Analyzed: See Below

Parameter	Result	Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Nitrite as N	ND	mg/L	0.010	354.1	NA	22 MAR 96
Nitrate plus Nitrite as N	ND	mg/L	0.10	353.2	NA	26 MAR 96

ND = Not detected
NA = Not applicable

Reported By: Mark Foster Approved By: Roxanne Sullivan

Metals

Dissolved Metals

Client Name: Rust Environment and Infrastructure
Client ID: LF2DPW6 (0.00,0.00,WELL,267,P)
Lab ID: 047964-0001-SA
Matrix: AQUEOUS Sampled: 21 MAR 96 Received: 22 MAR 96
Authorized: 22 MAR 96 Prepared: See Below Analyzed: See Below

Parameter	Result	Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Antimony	0.074		0.060	6010	NA	01 APR 96
Arsenic	0.0064	mg/L	0.0050	7060	NA	02 APR 96
Barium	0.33		0.010	6010	NA	01 APR 96
Cadmium	ND		0.0054	6010	NA	01 APR 96 G
Chromium	0.050		0.010	6010	NA	01 APR 96
Copper	ND		0.020	6010	NA	01 APR 96
Lead	0.0045	mg/L	0.0050	7421	NA	05 APR 96 J
Manganese	0.26		0.010	6010	NA	01 APR 96
Mercury	ND	mg/L	0.00020	7470	27 MAR 96	01 APR 96
Selenium	0.0029	mg/L	0.010	7740	NA	02 APR 96 J

Note G : Reporting limit raised due to the matrix of the sample.

Note J : Result is detected below the reporting limit or is an estimated concentration.

ND = Not detected
NA = Not applicable

Reported By: Norma Baier Approved By: Richard Persichitte

Volatile Organics
Target Compound List (TCL)
Method 8260

Client Name: Rust Environment and Infrastructure
Client ID: LF2DPW7 (0.00,0.00,WELL,268,P)
Lab ID: 047964-0002-SA
Matrix: AQUEOUS Sampled: 21 MAR 96 Received: 22 MAR 96
Authorized: 22 MAR 96 Prepared: 25 MAR 96 Analyzed: 28 MAR 96

Parameter	Result	Units	Reporting Limit	
Acetone	9.8	ug/L	10	J
Benzene	2.1	ug/L	5.0	J
Bromodichloromethane	ND	ug/L	5.0	
Bromoform	ND	ug/L	5.0	
Bromomethane	ND	ug/L	10	
2-Butanone (MEK)	ND	ug/L	10	
Carbon disulfide	ND	ug/L	5.0	
Carbon tetrachloride	ND	ug/L	5.0	
Chlorobenzene	2.2	ug/L	5.0	J
Chloroethane	ND	ug/L	10	
Chloroform	ND	ug/L	5.0	
Chloromethane	ND	ug/L	10	
Dibromochloromethane	ND	ug/L	5.0	
1,1-Dichloroethane	ND	ug/L	5.0	
1,2-Dichloroethane	ND	ug/L	5.0	
1,1-Dichloroethene	ND	ug/L	5.0	
cis-1,2-Dichloroethene	ND	ug/L	5.0	
trans-1,2-Dichloroethene	ND	ug/L	5.0	
1,2-Dichloropropane	ND	ug/L	5.0	
cis-1,3-Dichloropropene	ND	ug/L	5.0	
trans-1,3-Dichloropropene	ND	ug/L	5.0	
Ethylbenzene	3.4	ug/L	5.0	J
2-Hexanone	ND	ug/L	10	
Methylene chloride	ND	ug/L	5.0	
4-Methyl-2-pentanone (MIBK)	ND	ug/L	10	
Styrene	ND	ug/L	5.0	
1,1,2,2-Tetrachloroethane	ND	ug/L	5.0	
Tetrachloroethene	ND	ug/L	5.0	
Toluene	3.1	ug/L	5.0	J
1,1,1-Trichloroethane	ND	ug/L	5.0	
1,1,2-Trichloroethane	ND	ug/L	5.0	
Trichloroethene	ND	ug/L	5.0	
Vinyl acetate	ND	ug/L	10	
Vinyl chloride	14	ug/L	10	
Xylenes (total)	9.6	ug/L	5.0	

Surrogate	Recovery	
Toluene-d8	101	%
4-Bromofluorobenzene	102	%

(continued on following page)

ND = Not detected
NA = Not applicable

Reported By: Sandra Jones Approved By: Dawn M. Basko

Volatile Organics
Target Compound List (TCL)
Method 8260

Client Name: Rust Environment and Infrastructure
Client ID: LF2DPW7 (0.00,0.00,WELL,268,P)
Lab ID: 047964-0002-SA
Matrix: AQUEOUS Sampled: 21 MAR 96 Received: 22 MAR 96
Authorized: 22 MAR 96 Prepared: 25 MAR 96 Analyzed: 28 MAR 96

Surrogate	Recovery	
1,2-Dichloroethane-d4	97	%

Note J : Result is detected below the reporting limit or is an estimated concentration.

ND = Not detected
NA = Not applicable

Reported By: Sandra Jones Approved By: Dawn M. Basko

Volatiles Library Search (10 Compound TID)

Method 8260

Client Name: Rust Environment and Infrastructure
Client ID: LF2DPW7 (0.00,0.00,WELL,268,P)
Lab ID: 047964-0002-SA
Matrix: AQUEOUS Sampled: 21 MAR 96 Received: 22 MAR 96
Authorized: 22 MAR 96 Prepared: NA Analyzed: 28 MAR 96

Parameter	Result	Units	Reporting Limit
Benzene, 1-ethyl-2-methyl-	13	ug/L	2
1,3,5-Trimethylbenzene	22	ug/L	2
Isocineole	9.8	ug/L	2
Benzene, methyl(1-methylethyl)-	8.3	ug/L	2
1,2,4-Trimethylbenzene	9.2	ug/L	1
Benzene, 2-propenyl-	13	ug/L	2
Ethanone, 1-(methylphenyl)-	9.9	ug/L	2
2,3-Dihydro-1-methylindene	13	ug/L	2
Bicyclo[2.2.1]heptan-2-one, 1,3,3-trimethyl-	85	ug/L	2
Benzene, 1,2,3,4-tetramethyl-	12	ug/L	2

Note 2 : Confident Identification

Note 1 : Tentative Identification

ND = Not detected
NA = Not applicable

Reported By: Sandra Jones Approved By: Dawn M. Basko

Semivolatile Organics

Method 8270

Client Name: Rust Environment and Infrastructure
Client ID: LF2DPW7 (0.00,0.00,WELL,268,P)
Lab ID: 047964-0002-SA
Matrix: AQUEOUS Sampled: 21 MAR 96 Received: 22 MAR 96
Authorized: 22 MAR 96 Prepared: 26 MAR 96 Analyzed: 02 APR 96

Parameter	Result	Units	Reporting Limit	
Acenaphthene	ND	ug/L	20	
Acenaphthylene	ND	ug/L	20	
Anthracene	ND	ug/L	20	
Benzoic acid	ND	ug/L	100	
Benzo(a)anthracene	ND	ug/L	20	
Benzo(b)fluoranthene	ND	ug/L	20	
Benzo(k)fluoranthene	ND	ug/L	20	
Benzo(g,h,i)perylene	ND	ug/L	20	
Benzo(a)pyrene	ND	ug/L	20	
Benzyl alcohol	ND	ug/L	20	
bis(2-Chloroethoxy) methane	ND	ug/L	20	
bis(2-Chloroethyl) ether	ND	ug/L	20	
bis(2-Chloroisopropyl) ether	ND	ug/L	20	
bis(2-Ethylhexyl) phthalate	2.4	ug/L	20	JB
4-Bromophenyl phenyl ether	ND	ug/L	20	
Butyl benzyl phthalate	ND	ug/L	20	
4-Chloroaniline	ND	ug/L	20	
2-Chloronaphthalene	ND	ug/L	20	
4-Chloro-3-methylphenol	44	ug/L	20	
2-Chlorophenol	ND	ug/L	20	
4-Chlorophenyl phenyl ether	ND	ug/L	20	
Chrysene	ND	ug/L	20	
Dibenz(a,h)anthracene	ND	ug/L	20	
Dibenzofuran	ND	ug/L	20	
Di-n-butyl phthalate	ND	ug/L	20	
1,2-Dichlorobenzene	ND	ug/L	20	
1,3-Dichlorobenzene	ND	ug/L	20	
1,4-Dichlorobenzene	ND	ug/L	20	
3,3'-Dichlorobenzidine	ND	ug/L	40	
2,4-Dichlorophenol	ND	ug/L	20	
Diethyl phthalate	3.1	ug/L	20	J
2,4-Dimethylphenol	ND	ug/L	20	
Dimethyl phthalate	ND	ug/L	20	
4,6-Dinitro-2-methylphenol	ND	ug/L	100	
2,4-Dinitrophenol	ND	ug/L	100	

(continued on following page)

ND = Not detected
NA = Not applicable

Reported By: Lisa Burgesser Approved By: Audrey Cornell

Semivolatile Organics (CONT.)

Method 8270

Client Name: Rust Environment and Infrastructure
Client ID: LF2DPW7 (0.00,0.00,WELL,268,P)
Lab ID: 047964-0002-SA
Matrix: AQUEOUS Sampled: 21 MAR 96 Received: 22 MAR 96
Authorized: 22 MAR 96 Prepared: 26 MAR 96 Analyzed: 02 APR 96

Parameter	Result	Units	Reporting Limit
2,4-Dinitrotoluene	ND	ug/L	20
2,6-Dinitrotoluene	ND	ug/L	20
Di-n-octyl phthalate	ND	ug/L	20
Fluoranthene	ND	ug/L	20
Fluorene	ND	ug/L	20
Hexachlorobenzene	ND	ug/L	20
Hexachlorobutadiene	ND	ug/L	20
Hexachlorocyclopentadiene	ND	ug/L	20
Hexachloroethane	ND	ug/L	10
Indeno(1,2,3-cd)pyrene	ND	ug/L	20
Isophorone	ND	ug/L	20
2-Methylnaphthalene	ND	ug/L	20
2-Methylphenol	ND	ug/L	20
3/4-Methylphenol	ND	ug/L	20
Naphthalene	23	ug/L	20
2-Nitroaniline	ND	ug/L	100
3-Nitroaniline	ND	ug/L	100
4-Nitroaniline	ND	ug/L	100
Nitrobenzene	ND	ug/L	20
2-Nitrophenol	ND	ug/L	20
4-Nitrophenol	ND	ug/L	100
N-Nitrosodiphenylamine	ND	ug/L	20
N-Nitrosodimethylamine	ND	ug/L	20
N-Nitroso-di-n-propylamine	ND	ug/L	20
Pentachlorophenol	ND	ug/L	50
Phenanthrene	ND	ug/L	20
Phenol	ND	ug/L	20
Pyrene	ND	ug/L	20
Pyridine	ND	ug/L	20
1,2,4-Trichlorobenzene	ND	ug/L	20
2,4,5-Trichlorophenol	ND	ug/L	50
2,4,6-Trichlorophenol	ND	ug/L	10

Surrogate	Recovery	
Nitrobenzene-d5	77	%
2-Fluorobiphenyl	63	%
Terphenyl-d14	21	%
Phenol-d5	82	%
2-Fluorophenol	78	%

(continued on following page)

ND = Not detected
NA = Not applicable

Reported By: Lisa Burgesser Approved By: Audrey Cornell

Semivolatile Organics (CONT.)

Method 8270

Client Name: Rust Environment and Infrastructure
Client ID: LF2DPW7 (0.00,0.00,WELL,268,P)
Lab ID: 047964-0002-SA
Matrix: AQUEOUS Sampled: 21 MAR 96 Received: 22 MAR 96
Authorized: 22 MAR 96 Prepared: 26 MAR 96 Analyzed: 02 APR 96

Surrogate	Recovery	
2,4,6-Tribromophenol	99	%

Note J : Result is detected below the reporting limit or is an estimated concentration.

Note B : Compound is also detected in the blank.

ND = Not detected
NA = Not applicable

Reported By: Lisa Burgesser Approved By: Audrey Cornell

Semivolatiles Library Search (20 Compound TID)

Method 8270

Client Name: Rust Environment and Infrastructure
Client ID: LF2DPW7 (0.00,0.00,WELL,268,P)
Lab ID: 047964-0002-SA
Matrix: AQUEOUS Sampled: 21 MAR 96 Received: 22 MAR 96
Authorized: 22 MAR 96 Prepared: NA Analyzed: 02 APR 96

Parameter	Result	Units	Reporting Limit	
Alcohol	94	ug/L		
Bicyclo[2.2.1]heptan-2-one, 1,7,7-trimethyl-, (1R!	160	ug/L		2z
Bicyclo[2.2.1]heptan-2-ol, 2,3,3-trimethyl-	67	ug/L		1
Alcohol	37	ug/L		
Oxygenated Hydrocarbon	43	ug/L		
Cyclohexane, 1-methyl-4-(1-methylethyl)-	38	ug/L		1
Oxygenated Hydrocarbon	34	ug/L		
Unknown	25	ug/L		
Cyclic Hydrocarbon	38	ug/L		
Phthalic anhydride	28	ug/L		2
Benzoic acid, 3,5-dimethyl-	32	ug/L		2
2-Methyl-2-pentenoic acid	22	ug/L		1
Benzenesulfonamide, 4-methyl-	22	ug/L		2
Benzenesulfonamide, N-ethyl-4-methyl-	31	ug/L		2
Oxygenated Hydrocarbon	29	ug/L		
Aromatic Hydrocarbon	25	ug/L		
Aromatic Hydrocarbon	62	ug/L		
Piperidine, 1-(1-cyclopenten-1-yl)-	36	ug/L		1
1,8-Naphthalic anhydride	28	ug/L		2
Citric acid, trimethyl ester	120	ug/L		1

Note 2 : Confident Identification

Note z : Compound name contains more characters than the database will allow.

Note 1 : Tentative Identification

ND = Not detected
NA = Not applicable

Reported By: Lisa Burgesser Approved By: Audrey Cornell

General Inorganics

Client Name: Rust Environment and Infrastructure
Client ID: LF2DPW7 (0.00,0.00,WELL,268,P)
Lab ID: 047964-0002-SA
Matrix: AQUEOUS Sampled: 21 MAR 96 Received: 22 MAR 96
Authorized: 22 MAR 96 Prepared: See Below Analyzed: See Below

Parameter	Result	Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Nitrite as N	ND	mg/L	0.010	354.1	NA	22 MAR 96
Nitrate plus Nitrite as N	ND	mg/L	0.10	353.2	NA	26 MAR 96

ND = Not detected
NA = Not applicable

Reported By: Mark Foster Approved By: Roxanne Sullivan

Metals

Dissolved Metals

Client Name: Rust Environment and Infrastructure
Client ID: LF2DPW7 (0.00,0.00,WELL,268,P)
Lab ID: 047964-0002-SA
Matrix: AQUEOUS Sampled: 21 MAR 96 Received: 22 MAR 96
Authorized: 22 MAR 96 Prepared: See Below Analyzed: See Below

Parameter	Result	Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Antimony	0.062	mg/L	0.060	6010	NA	01 APR 96
Arsenic	ND	mg/L	0.020	7060	NA	02 APR 96
Barium	0.39	mg/L	0.010	6010	NA	01 APR 96
Cadmium	ND	mg/L	0.0050	6010	NA	01 APR 96
Chromium	0.060	mg/L	0.010	6010	NA	01 APR 96
Copper	ND	mg/L	0.020	6010	NA	01 APR 96
Lead	0.0026	mg/L	0.0050	7421	NA	05 APR 96 J
Manganese	0.19	mg/L	0.010	6010	NA	01 APR 96
Mercury	ND	mg/L	0.00020	7470	27 MAR 96	01 APR 96
Selenium	ND	mg/L	0.020	7740	NA	02 APR 96

Note J : Result is detected below the reporting limit or is an estimated concentration.

ND = Not detected
NA = Not applicable

Reported By: Norma Baier Approved By: Richard Persichitte

Volatile Organics
Target Compound List (TCL)
Method 8260

Client Name: Rust Environment and Infrastructure
Client ID: LF2DPW9 (0.00,0.00,WELL,270,P)
Lab ID: 047983-0003-SA
Matrix: AQUEOUS Sampled: 22 MAR 96 Received: 23 MAR 96
Authorized: 23 MAR 96 Prepared: 28 MAR 96 Analyzed: 28 MAR 96

Parameter	Result	Units	Reporting Limit	
Acetone	16	ug/L	10	
Benzene	ND	ug/L	5.0	
Bromodichloromethane	ND	ug/L	5.0	
Bromoform	ND	ug/L	5.0	
Bromomethane	ND	ug/L	10	
2-Butanone (MEK)	ND	ug/L	10	
Carbon disulfide	ND	ug/L	5.0	
Carbon tetrachloride	ND	ug/L	5.0	
Chlorobenzene	ND	ug/L	5.0	
Chloroethane	ND	ug/L	10	
Chloroform	ND	ug/L	5.0	
Chloromethane	ND	ug/L	10	
Dibromochloromethane	ND	ug/L	5.0	
1,1-Dichloroethane	ND	ug/L	5.0	
1,2-Dichloroethane	ND	ug/L	5.0	
1,1-Dichloroethene	ND	ug/L	5.0	
cis-1,2-Dichloroethene	ND	ug/L	5.0	
trans-1,2-Dichloroethene	ND	ug/L	5.0	
1,2-Dichloropropane	ND	ug/L	5.0	
cis-1,3-Dichloropropene	ND	ug/L	5.0	
trans-1,3-Dichloropropene	ND	ug/L	5.0	
Ethylbenzene	ND	ug/L	5.0	
2-Hexanone	ND	ug/L	10	
Methylene chloride	ND	ug/L	5.0	
4-Methyl-2-pentanone (MIBK)	ND	ug/L	10	
Styrene	ND	ug/L	5.0	
1,1,2,2-Tetrachloroethane	ND	ug/L	5.0	
Tetrachloroethene	ND	ug/L	5.0	
Toluene	2.3	ug/L	5.0	J
1,1,1-Trichloroethane	ND	ug/L	5.0	
1,1,2-Trichloroethane	ND	ug/L	5.0	
Trichloroethene	ND	ug/L	5.0	
Vinyl acetate	ND	ug/L	10	
Vinyl chloride	ND	ug/L	10	
Xylenes (total)	ND	ug/L	5.0	

Surrogate	Recovery	
Toluene-d8	101	%
4-Bromofluorobenzene	100	%

(continued on following page)

ND = Not detected
NA = Not applicable

Reported By: Sandra Jones Approved By: Audrey Cornell

Volatile Organics
Target Compound List (TCL)
Method 8260

Client Name: Rust Environment and Infrastructure
Client ID: LF2DPW9 (0.00,0.00,WELL,270,P)
Lab ID: 047983-0003-SA
Matrix: AQUEOUS Sampled: 22 MAR 96 Received: 23 MAR 96
Authorized: 23 MAR 96 Prepared: 28 MAR 96 Analyzed: 28 MAR 96

Surrogate	Recovery	
1,2-Dichloroethane-d4	100	%

Note J : Result is detected below the reporting limit or is an estimated concentration.

ND = Not detected
NA = Not applicable

Reported By: Sandra Jones Approved By: Audrey Cornell

Volatiles Library Search (10 Compound TID)

Method 8260

Client Name: Rust Environment and Infrastructure
Client ID: LF2DPW9 (0.00,0.00,WELL,270,P)
Lab ID: 047983-0003-SA
Matrix: AQUEOUS Sampled: 22 MAR 96 Received: 23 MAR 96
Authorized: 23 MAR 96 Prepared: NA Analyzed: 28 MAR 96

Parameter	Result	Units	Reporting Limit	
tert-Butyl methyl ether	13	ug/L		3
None Detected	ND	ug/L		
None Detected	ND	ug/L		
None Detected	ND	ug/L		
None Detected	ND	ug/L		
None Detected	ND	ug/L		
None Detected	ND	ug/L		
None Detected	ND	ug/L		
None Detected	ND	ug/L		
None Detected	ND	ug/L		

Note 3 : Confirmed Identification

ND = Not detected
NA = Not applicable

Reported By: Sandra Jones Approved By: Audrey Cornell

General Inorganics

Client Name: Rust Environment and Infrastructure
Client ID: LF2DPW9 (0.00,0.00,WELL,270,P)
Lab ID: 047964-0003-SA
Matrix: AQUEOUS Sampled: 21 MAR 96 Received: 22 MAR 96
Authorized: 22 MAR 96 Prepared: See Below Analyzed: See Below

Parameter	Result	Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Nitrate plus Nitrite as N	0.51	mg/L	0.10	353.2	NA	26 MAR 96

ND = Not detected
NA = Not applicable

Reported By: Mark Foster Approved By: Roxanne Sullivan

General Inorganics

Client Name: Rust Environment and Infrastructure
Client ID: LF2DPW9 (0.00,0.00,WELL,270,P)
Lab ID: 048004-0001-SA
Matrix: AQUEOUS Sampled: 25 MAR 96 Received: 26 MAR 96
Authorized: 26 MAR 96 Prepared: See Below Analyzed: See Below

Parameter	Result	Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Nitrite as N	0.73	mg/L	0.10	354.1	NA	26 MAR 96

ND = Not detected
NA = Not applicable

Reported By: Damon Lona Approved By: Roxanne Sullivan

Metals

Dissolved Metals

Client Name: Rust Environment and Infrastructure
Client ID: LF2DPW9 (0.00,0.00,WELL,270,P)
Lab ID: 048004-0001-SA
Matrix: AQUEOUS Sampled: 25 MAR 96 Received: 26 MAR 96
Authorized: 26 MAR 96 Prepared: See Below Analyzed: See Below

Parameter	Result	Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Antimony	ND	mg/L	0.30	6010	NA	09 APR 96
Arsenic	ND	mg/L	0.025	7060	NA	08 APR 96
Barium	0.044	mg/L	0.050	6010	NA	09 APR 96 J
Cadmium	ND	mg/L	0.025	6010	NA	09 APR 96
Chromium	ND	mg/L	0.050	6010	NA	09 APR 96
Copper	ND	mg/L	0.10	6010	NA	09 APR 96
Lead	ND	mg/L	1.0	7421	NA	08 APR 96
Manganese	1.2	mg/L	0.050	6010	NA	09 APR 96
Selenium	ND	mg/L	0.20	7740	NA	08 APR 96

Note J : Result is detected below the reporting limit or is an estimated concentration.

ND = Not detected
NA = Not applicable

Reported By: Robin Tipton Approved By:

Volatile Organics
Target Compound List (TCL)
Method 8260

Client Name: Rust Environment and Infrastructure
Client ID: LF2DPW10 (0.00,0.00,WELL,271,P)
Lab ID: 048004-0002-SA
Matrix: AQUEOUS Sampled: 25 MAR 96 Received: 26 MAR 96
Authorized: 26 MAR 96 Prepared: 28 MAR 96 Analyzed: 28 MAR 96

Parameter	Result	Units	Reporting Limit	
Acetone	ND	ug/L	10	
Benzene	ND	ug/L	5.0	
Bromodichloromethane	ND	ug/L	5.0	
Bromoform	ND	ug/L	5.0	
Bromomethane	ND	ug/L	10	
2-Butanone (MEK)	ND	ug/L	10	
Carbon disulfide	ND	ug/L	5.0	
Carbon tetrachloride	ND	ug/L	5.0	
Chlorobenzene	ND	ug/L	5.0	
Chloroethane	ND	ug/L	10	
Chloroform	ND	ug/L	5.0	
Chloromethane	ND	ug/L	10	
Dibromochloromethane	ND	ug/L	5.0	
1,1-Dichloroethane	ND	ug/L	5.0	
1,2-Dichloroethane	ND	ug/L	5.0	
1,1-Dichloroethene	ND	ug/L	5.0	
cis-1,2-Dichloroethene	ND	ug/L	5.0	
trans-1,2-Dichloroethene	ND	ug/L	5.0	
1,2-Dichloropropane	ND	ug/L	5.0	
cis-1,3-Dichloropropene	ND	ug/L	5.0	
trans-1,3-Dichloropropene	ND	ug/L	5.0	
Ethylbenzene	ND	ug/L	5.0	
2-Hexanone	ND	ug/L	10	
Methylene chloride	1.3	ug/L	5.0	J
4-Methyl-2-pentanone (MIBK)	ND	ug/L	10	
Styrene	ND	ug/L	5.0	
1,1,2,2-Tetrachloroethane	ND	ug/L	5.0	
Tetrachloroethene	ND	ug/L	5.0	
Toluene	3.5	ug/L	5.0	J
1,1,1-Trichloroethane	ND	ug/L	5.0	
1,1,2-Trichloroethane	ND	ug/L	5.0	
Trichloroethene	ND	ug/L	5.0	
Vinyl acetate	ND	ug/L	10	
Vinyl chloride	ND	ug/L	10	
Xylenes (total)	ND	ug/L	5.0	

Surrogate	Recovery	
Toluene-d8	102	%
4-Bromofluorobenzene	98	%

(continued on following page)

ND = Not detected
NA = Not applicable

Reported By: Sandra Jones Approved By: Dawn M. Basko

Volatile Organics
Target Compound List (TCL)
Method 8260

Client Name: Rust Environment and Infrastructure
Client ID: LF2DPW10 (0.00,0.00,WELL,271,P)
Lab ID: 048004-0002-SA
Matrix: AQUEOUS Sampled: 25 MAR 96 Received: 26 MAR 96
Authorized: 26 MAR 96 Prepared: 28 MAR 96 Analyzed: 28 MAR 96

Surrogate	Recovery	
1,2-Dichloroethane-d4	100	%

Note J : Result is detected below the reporting limit or is an estimated concentration.

ND = Not detected
NA = Not applicable

Reported By: Sandra Jones Approved By: Dawn M. Basko

Volatiles Library Search (10 Compound TID)

Method 8260

Client Name: Rust Environment and Infrastructure
Client ID: LF2DPW10 (0.00,0.00,WELL,271,P)
Lab ID: 048004-0002-SA
Matrix: AQUEOUS Sampled: 25 MAR 96 Received: 26 MAR 96
Authorized: 26 MAR 96 Prepared: NA Analyzed: 28 MAR 96

Parameter	Result	Units	Reporting Limit
None Detected	ND	ug/L	
None Detected	ND	ug/L	
None Detected	ND	ug/L	
None Detected	ND	ug/L	
None Detected	ND	ug/L	
None Detected	ND	ug/L	
None Detected	ND	ug/L	
None Detected	ND	ug/L	
None Detected	ND	ug/L	
None Detected	ND	ug/L	

ND = Not detected
NA = Not applicable

Reported By: Sandra Jones Approved By: Dawn M. Basko

Volatile Organics
Target Compound List (TCL)
Method 8260

Client Name: Rust Environment and Infrastructure
Client ID: LF2DPW11 (0.00,0.00,WELL,272,P)
Lab ID: 047983-0004-SA
Matrix: AQUEOUS Sampled: 22 MAR 96 Received: 23 MAR 96
Authorized: 23 MAR 96 Prepared: 28 MAR 96 Analyzed: 28 MAR 96

Parameter	Result	Units	Reporting Limit	
Acetone	ND	ug/L	10	
Benzene	ND	ug/L	5.0	
Bromodichloromethane	ND	ug/L	5.0	
Bromoform	ND	ug/L	5.0	
Bromomethane	ND	ug/L	10	
2-Butanone (MEK)	ND	ug/L	10	
Carbon disulfide	ND	ug/L	5.0	
Carbon tetrachloride	ND	ug/L	5.0	
Chlorobenzene	ND	ug/L	5.0	
Chloroethane	ND	ug/L	10	
Chloroform	ND	ug/L	5.0	
Chloromethane	ND	ug/L	10	
Dibromochloromethane	ND	ug/L	5.0	
1,1-Dichloroethane	ND	ug/L	5.0	
1,2-Dichloroethane	ND	ug/L	5.0	
1,1-Dichloroethene	ND	ug/L	5.0	
cis-1,2-Dichloroethene	ND	ug/L	5.0	
trans-1,2-Dichloroethene	ND	ug/L	5.0	
1,2-Dichloropropane	ND	ug/L	5.0	
cis-1,3-Dichloropropene	ND	ug/L	5.0	
trans-1,3-Dichloropropene	ND	ug/L	5.0	
Ethylbenzene	ND	ug/L	5.0	
2-Hexanone	ND	ug/L	10	
Methylene chloride	ND	ug/L	5.0	
4-Methyl-2-pentanone (MIBK)	ND	ug/L	10	
Styrene	ND	ug/L	5.0	
1,1,2,2-Tetrachloroethane	ND	ug/L	5.0	
Tetrachloroethene	ND	ug/L	5.0	
Toluene	2.2	ug/L	5.0	J
1,1,1-Trichloroethane	ND	ug/L	5.0	
1,1,2-Trichloroethane	ND	ug/L	5.0	
Trichloroethene	ND	ug/L	5.0	
Vinyl acetate	ND	ug/L	10	
Vinyl chloride	ND	ug/L	10	
Xylenes (total)	ND	ug/L	5.0	

Surrogate	Recovery	
Toluene-d8	100	%
4-Bromofluorobenzene	102	%

(continued on following page)

ND = Not detected
NA = Not applicable

Reported By: Sandra Jones Approved By: Audrey Cornell

Volatile Organics
Target Compound List (TCL)
Method 8260

Client Name: Rust Environment and Infrastructure
Client ID: LF2DPW11 (0.00,0.00,WELL,272,P)
Lab ID: 047983-0004-SA
Matrix: AQUEOUS Sampled: 22 MAR 96 Received: 23 MAR 96
Authorized: 23 MAR 96 Prepared: 28 MAR 96 Analyzed: 28 MAR 96

Surrogate	Recovery	
1,2-Dichloroethane-d4	99	%

Note J : Result is detected below the reporting limit or is an estimated concentration.

ND = Not detected
NA = Not applicable

Reported By: Sandra Jones Approved By: Audrey Cornell

Volatiles Library Search (10 Compound TID)

Method 8260

Client Name: Rust Environment and Infrastructure
Client ID: LF2DPW11 (0.00,0.00,WELL,272,P)
Lab ID: 047983-0004-SA
Matrix: AQUEOUS Sampled: 22 MAR 96 Received: 23 MAR 96
Authorized: 23 MAR 96 Prepared: NA Analyzed: 28 MAR 96

Parameter	Result	Units	Reporting Limit
None Detected	ND	ug/L	
None Detected	ND	ug/L	
None Detected	ND	ug/L	
None Detected	ND	ug/L	
None Detected	ND	ug/L	
None Detected	ND	ug/L	
None Detected	ND	ug/L	
None Detected	ND	ug/L	
None Detected	ND	ug/L	
None Detected	ND	ug/L	

ND = Not detected
NA = Not applicable

Reported By: Sandra Jones Approved By: Audrey Cornell

General Inorganics

Client Name: Rust Environment and Infrastructure
Client ID: LF2DPW11 (0.00,0.00,WELL,272,P)
Lab ID: 048004-0003-SA
Matrix: AQUEOUS Sampled: 25 MAR 96 Received: 26 MAR 96
Authorized: 26 MAR 96 Prepared: See Below Analyzed: See Below

Parameter	Result	Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Nitrate plus Nitrite as N	1.8	mg/L	0.20	353.2	NA	27 MAR 96

ND = Not detected
NA = Not applicable

Reported By: Mark Foster Approved By: Roxanne Sullivan

Volatile Organics
Target Compound List (TCL)
Method 8260

Client Name: Rust Environment and Infrastructure
Client ID: LF2DPW12 (0.00,0.00,WELL,273,P)
Lab ID: 047983-0005-SA
Matrix: AQUEOUS Sampled: 22 MAR 96 Received: 23 MAR 96
Authorized: 23 MAR 96 Prepared: 28 MAR 96 Analyzed: 28 MAR 96

Parameter	Result	Units	Reporting Limit	
Acetone	8.0	ug/L	10	J
Benzene	ND	ug/L	5.0	
Bromodichloromethane	ND	ug/L	5.0	
Bromoform	ND	ug/L	5.0	
Bromomethane	ND	ug/L	10	
2-Butanone (MEK)	ND	ug/L	10	
Carbon disulfide	ND	ug/L	5.0	
Carbon tetrachloride	ND	ug/L	5.0	
Chlorobenzene	ND	ug/L	5.0	
Chloroethane	ND	ug/L	10	
Chloroform	ND	ug/L	5.0	
Chloromethane	ND	ug/L	10	
Dibromochloromethane	ND	ug/L	5.0	
1,1-Dichloroethane	ND	ug/L	5.0	
1,2-Dichloroethane	ND	ug/L	5.0	
1,1-Dichloroethene	ND	ug/L	5.0	
cis-1,2-Dichloroethene	ND	ug/L	5.0	
trans-1,2-Dichloroethene	ND	ug/L	5.0	
1,2-Dichloropropane	ND	ug/L	5.0	
cis-1,3-Dichloropropene	ND	ug/L	5.0	
trans-1,3-Dichloropropene	ND	ug/L	5.0	
Ethylbenzene	ND	ug/L	5.0	
2-Hexanone	ND	ug/L	10	
Methylene chloride	ND	ug/L	5.0	
4-Methyl-2-pentanone (MIBK)	ND	ug/L	10	
Styrene	ND	ug/L	5.0	
1,1,2,2-Tetrachloroethane	ND	ug/L	5.0	
Tetrachloroethene	ND	ug/L	5.0	
Toluene	2.9	ug/L	5.0	J
1,1,1-Trichloroethane	ND	ug/L	5.0	
1,1,2-Trichloroethane	ND	ug/L	5.0	
Trichloroethene	ND	ug/L	5.0	
Vinyl acetate	ND	ug/L	10	
Vinyl chloride	ND	ug/L	10	
Xylenes (total)	ND	ug/L	5.0	

Surrogate	Recovery	
Toluene-d8	101	%
4-Bromofluorobenzene	101	%

(continued on following page)

ND = Not detected
NA = Not applicable

Reported By: Sandra Jones Approved By: Audrey Cornell

Volatile Organics
Target Compound List (TCL)
Method 8260

Client Name: Rust Environment and Infrastructure
Client ID: LF2DPW12 (0.00,0.00,WELL,273,P)
Lab ID: 047983-0005-SA
Matrix: AQUEOUS Sampled: 22 MAR 96 Received: 23 MAR 96
Authorized: 23 MAR 96 Prepared: 28 MAR 96 Analyzed: 28 MAR 96

Surrogate	Recovery	
1,2-Dichloroethane-d4	98	%

Note J : Result is detected below the reporting limit or is an estimated concentration.

ND = Not detected
NA = Not applicable

Reported By: Sandra Jones Approved By: Audrey Cornell

Volatiles Library Search (10 Compound TID)

Method 8260

Client Name: Rust Environment and Infrastructure
Client ID: LF2DPW12 (0.00,0.00,WELL,273,P)
Lab ID: 047983-0005-SA
Matrix: AQUEOUS Sampled: 22 MAR 96 Received: 23 MAR 96
Authorized: 23 MAR 96 Prepared: NA Analyzed: 28 MAR 96

Parameter	Result	Units	Reporting Limit
None Detected	ND	ug/L	
None Detected	ND	ug/L	
None Detected	ND	ug/L	
None Detected	ND	ug/L	
None Detected	ND	ug/L	
None Detected	ND	ug/L	
None Detected	ND	ug/L	
None Detected	ND	ug/L	
None Detected	ND	ug/L	
None Detected	ND	ug/L	

ND = Not detected
NA = Not applicable

Reported By: Sandra Jones Approved By: Audrey Cornell

Semivolatile Organics

Method 8270

Client Name: Rust Environment and Infrastructure
Client ID: LF2DPW12 (0.00,0.00,WELL,273,P)
Lab ID: 048004-0004-SA
Matrix: AQUEOUS Sampled: 25 MAR 96 Received: 26 MAR 96
Authorized: 26 MAR 96 Prepared: 01 APR 96 Analyzed: 04 APR 96

Parameter	Result	Units	Reporting Limit	
Acenaphthene	ND	ug/L	18	
Acenaphthylene	ND	ug/L	18	
Anthracene	ND	ug/L	18	
Benzoic acid	ND	ug/L	92	
Benzo(a)anthracene	ND	ug/L	18	
Benzo(b)fluoranthene	ND	ug/L	18	
Benzo(k)fluoranthene	ND	ug/L	18	
Benzo(g,h,i)perylene	ND	ug/L	18	
Benzo(a)pyrene	ND	ug/L	18	
Benzyl alcohol	ND	ug/L	18	
bis(2-Chloroethoxy) methane	ND	ug/L	18	
bis(2-Chloroethyl) ether	ND	ug/L	18	
bis(2-Chloroisopropyl) ether	ND	ug/L	18	
bis(2-Ethylhexyl) phthalate	2.2	ug/L	18	J
4-Bromophenyl phenyl ether	ND	ug/L	18	
Butyl benzyl phthalate	ND	ug/L	18	
4-Chloroaniline	ND	ug/L	18	
2-Chloronaphthalene	ND	ug/L	18	
4-Chloro-3-methylphenol	ND	ug/L	18	
2-Chlorophenol	ND	ug/L	18	
4-Chlorophenyl phenyl ether	ND	ug/L	18	
Chrysene	ND	ug/L	18	
Dibenz(a,h)anthracene	ND	ug/L	18	
Dibenzofuran	ND	ug/L	18	
Di-n-butyl phthalate	ND	ug/L	18	
1,2-Dichlorobenzene	ND	ug/L	18	
1,3-Dichlorobenzene	ND	ug/L	18	
1,4-Dichlorobenzene	ND	ug/L	18	
3,3'-Dichlorobenzidine	ND	ug/L	37	
2,4-Dichlorophenol	ND	ug/L	18	
Diethyl phthalate	ND	ug/L	18	
2,4-Dimethylphenol	ND	ug/L	18	
Dimethyl phthalate	ND	ug/L	18	
4,6-Dinitro-2-methylphenol	ND	ug/L	92	
2,4-Dinitrophenol	ND	ug/L	92	

(continued on following page)

ND = Not detected
NA = Not applicable

Reported By: Dan Albritton Approved By: Audrey Cornell

Semivolatile Organics (CONT.)

Method 8270

Client Name: Rust Environment and Infrastructure
Client ID: LF2DPW12 (0.00,0.00,WELL,273,P)
Lab ID: 048004-0004-SA
Matrix: AQUEOUS Sampled: 25 MAR 96 Received: 26 MAR 96
Authorized: 26 MAR 96 Prepared: 01 APR 96 Analyzed: 04 APR 96

Parameter	Result	Units	Reporting Limit	
2,4-Dinitrotoluene	ND	ug/L	18	
2,6-Dinitrotoluene	ND	ug/L	18	
Di-n-octyl phthalate	ND	ug/L	18	
Fluoranthene	ND	ug/L	18	
Fluorene	ND	ug/L	18	
Hexachlorobenzene	ND	ug/L	18	
Hexachlorobutadiene	ND	ug/L	18	
Hexachlorocyclopentadiene	ND	ug/L	18	
Hexachloroethane	ND	ug/L	9.2	
Indeno(1,2,3-cd)pyrene	ND	ug/L	18	
Isophorone	ND	ug/L	18	
2-Methylnaphthalene	ND	ug/L	18	
2-Methylphenol	ND	ug/L	18	
3/4-Methylphenol	ND	ug/L	18	
Naphthalene	ND	ug/L	18	
2-Nitroaniline	ND	ug/L	92	
3-Nitroaniline	ND	ug/L	92	
4-Nitroaniline	ND	ug/L	92	
Nitrobenzene	ND	ug/L	18	
2-Nitrophenol	ND	ug/L	18	
4-Nitrophenol	ND	ug/L	92	
N-Nitrosodiphenylamine	ND	ug/L	18	
N-Nitrosodimethylamine	ND	ug/L	18	
N-Nitroso-di-n-propylamine	ND	ug/L	18	
Pentachlorophenol	3.6	ug/L	46	J
Phenanthrene	ND	ug/L	18	
Phenol	ND	ug/L	18	
Pyrene	ND	ug/L	18	
Pyridine	ND	ug/L	18	
1,2,4-Trichlorobenzene	ND	ug/L	18	
2,4,5-Trichlorophenol	ND	ug/L	46	
2,4,6-Trichlorophenol	ND	ug/L	9.2	

Surrogate	Recovery	
Nitrobenzene-d5	74	%
2-Fluorobiphenyl	68	%
Terphenyl-d14	70	%
Phenol-d5	83	%
2-Fluorophenol	75	%

(continued on following page)

ND = Not detected
NA = Not applicable

Reported By: Dan Albritton Approved By: Audrey Cornell

Semivolatile Organics (CONT.)

Method 8270

Client Name: Rust Environment and Infrastructure
Client ID: LF2DPW12 (0.00,0.00,WELL,273,P)
Lab ID: 048004-0004-SA
Matrix: AQUEOUS Sampled: 25 MAR 96 Received: 26 MAR 96
Authorized: 26 MAR 96 Prepared: 01 APR 96 Analyzed: 04 APR 96

Surrogate	Recovery	
2,4,6-Tribromophenol	77	%

Note J : Result is detected below the reporting limit or is an estimated concentration.

ND = Not detected
NA = Not applicable

Reported By: Dan Albritton Approved By: Audrey Cornell

Semivolatiles Library Search (20 Compound TID)

Method 8270

Client Name: Rust Environment and Infrastructure
Client ID: LF2DPW12 (0.00,0.00,WELL,273,P)
Lab ID: 048004-0004-SA
Matrix: AQUEOUS Sampled: 25 MAR 96 Received: 26 MAR 96
Authorized: 26 MAR 96 Prepared: NA Analyzed: 04 APR 96

Parameter	Result	Units	Reporting Limit
Nitrogen compound	9.7	ug/L	
TID Compound 2	ND	ug/L	
TID Compound 3	ND	ug/L	
TID Compound 4	ND	ug/L	
TID Compound 5	ND	ug/L	
TID Compound 6	ND	ug/L	
TID Compound 7	ND	ug/L	
TID Compound 8	ND	ug/L	
TID Compound 9	ND	ug/L	
TID Compound 10	ND	ug/L	
TID Compound 11	ND	ug/L	
TID Compound 12	ND	ug/L	
TID Compound 13	ND	ug/L	
TID Compound 14	ND	ug/L	
TID Compound 15	ND	ug/L	
TID Compound 16	ND	ug/L	
TID Compound 17	ND	ug/L	
TID Compound 18	ND	ug/L	
TID Compound 19	ND	ug/L	
TID Compound 20	ND	ug/L	

ND = Not detected
NA = Not applicable

Reported By: Dan Albritton Approved By: Audrey Cornell

General Inorganics

Client Name: Rust Environment and Infrastructure
Client ID: LF2DPW12 (0.00,0.00,WELL,273,P)
Lab ID: 047983-0005-SA
Matrix: AQUEOUS Sampled: 22 MAR 96 Received: 23 MAR 96
Authorized: 23 MAR 96 Prepared: See Below Analyzed: See Below

Parameter	Result	Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Nitrate plus Nitrite as N	0.60	mg/L	0.10	353.2	NA	26 MAR 96

ND = Not detected
NA = Not applicable

Reported By: Mark Foster Approved By: Roxanne Sullivan

APPENDIX I
PERTINENT COLORADO LANDFILL CLOSURE REGULATIONS

STATE OF COLORADO

Roy Romer, Governor
Patricia A. Nolan, MD, MPH, Executive Director

Dedicated to protecting and improving the health and environment of the people of Colorado

HAZARDOUS MATERIALS AND WASTE MANAGEMENT DIVISION

4300 Cherry Creek Dr. S.
Denver, Colorado 80222-1530
Phone (303) 692-3300
Fax (303) 759-5355

222 S. 6th Street, Room 232
Grand Junction, Colorado 81501-2768
Phone (303) 248-7164
Fax (303) 248-7198

Colorado Department of Public Health and Environment

REGULATIONS PERTAINING TO SOLID WASTE DISPOSAL SITES AND FACILITIES 6 CCR 1007-2

TABLE OF CONTENTS

PART A

GENERAL REQUIREMENTS AND INFORMATION CONCERNING ALL SOLID WASTE DISPOSAL SITES AND FACILITIES IN THE STATE OF COLORADO

SECTION 1 ADMINISTRATIVE INFORMATION
- 1.1 General information
- 1.2 Definitions
- 1.3 Scope and effective date
- 1.4 Exemptions
- 1.5 Waiver processes and procedures
- 1.6 Application for certificate of designation
- 1.7 Solid waste authorization and fees
- 1.8 Financial assurance
- 1.9 Inspections and enforcement

SECTION 2 MINIMUM STANDARDS
- 2.1 Site and facility standards
- 2.2 Ground water monitoring
- 2.3 Explosive gas monitoring
- 2.4 Recordkeeping
- 2.5 Closure standards
- 2.6 Post-closure standards

REVISED NOVEMBER 30, 1994

PART B

REQUIREMENTS AND INFORMATION CONCERNING
ALL SOLID WASTE DISPOSAL SITES AND FACILITIES
IN THE STATE OF COLORADO

SECTION 3 STANDARDS FOR SOLID WASTE DISPOSAL LANDFILL SITES AND FACILITIES
- 3.0 Purpose Scope and effective date
- 3.1 Location restriction/site standards
- 3.2 Design requirements
- 3.3 Operations requirements
- 3.4 Recordkeeping
- 3.5 Closure requirements
- 3.6 Post-closure care and maintenance

SECTION 4 CONSTRUCTION DEBRIS AND INERT MATERIAL LANDFILL SITES AND FACILITIES [RESERVED]

SECTION 5 ASBESTOS WASTE DISPOSAL SITES
Applicable to all new and existing asbestos waste disposal sites
- 5.1 General provisions
- 5.2 Standards for non-friable asbestos waste disposal sites
- 5.3 Standards for non-friable asbestos waste disposal sites
- 5.4 Standards for on-site storage of asbestos wastes

SECTION 6 INCINERATOR ASH DISPOSAL SITES AND FACILITIES
- 6.1 General provisions
- 6.2 Municipal solid waste incinerator ash disposal standards

SECTION 7 TRANSFER STATIONS
- 7.1 Purpose, scope and applicability
- 7.2 Operating criteria

SECTION 8 RECYCLING [RESERVED]

SECTION 9 WASTE IMPOUNDMENTS
Applicable to all existing or new waste impoundments
- 9.1 Regulated facilities
- 9.2 Impoundment classification
- 9.3 Class design standards
- 9.4 Liner data
- 9.5 General design standards
- 9.6 Liner installation
- 9.7 Operation standards
- 9.8 Monitoring
- 9.9 Recordkeeping and calculations
- 9.10 Closure

REVISED NOVEMBER 30, 1994

SECTION 10 SCRAP TIRE DISPOSAL
Applicable to all new and existing scrap tire disposal sites and facilities
10.1 General provisions
10.2 Standards for scrap tire recycling facilities

SECTION 11 SOLID WASTE INCINERATION FACILITIES
Applicable to all solid waste incineration facilities and privately operated Solid Waste-to-Energy facilities not under contract to a county and/or municipality
11.1 General provisions
11.2 Engineering design and operation requirements
11.3 Operating requirements
11.4 Records
11.5 Requirements for management of residual ash

SECTION 12 WATER TREATMENT PLANT SLUDGE
Applicable to all water treatment plant sludge disposal sites and facilities
12.1 General provisions
12.2 Application information alternatives
12.3 Sludge acceptance criteria

SECTION 13 INFECTIOUS WASTE DISPOSAL
Applicable to all infectious waste facilities
13.1 Regulated facilities
13.2 Exemptions
13.3 Certificate of designation required
13.4 Appropriate treatment methods
13.5 Recordkeeping
13.6 Engineering design and operational requirements
13.7 Operating requirements
13.8 Transportation requirements

APPENDICES
APPENDIX A - Financial work sheet
APPENDIX B - Ground water monitoring
APPENDIX I - Detection monitoring parameters
APPENDIX II- Assessment monitoring parameters

REVISED NOVEMBER 30, 1994

terms of the certificate of designation, the facility operator and the governing body having jurisdiction shall be notified of the violation by certified mail sent by the Department.

1.9.4 If, after the facility operator's response, the Department determines that some or all of the violations did not occur, it shall inform the operator in writing. If the Department determines that some or all of its original determination is correct, it shall conduct a follow-up compliance inspection or other review to determine whether the violations have been corrected or corrective measures have been implemented. If they have, the Department shall inform the operator in writing.

1.9.5 If the facility operator fails to respond to a notice of violation from the Department within thirty (30) days, said operator may become subject to statutory and other remedies as appropriate including:

(A) Fines, imprisonment, or both, under C.R.S. 30-20-114 of the Act;

(B) Temporary suspension or revocation of the certificate of designation, under C.R.S. 30-20-112, of the Act; or

(C) If a facility is deemed a public nuisance for violation of the Act or these regulations, the violation may be enjoined by a district court under Section C.R.S. 30-20-113 of the act and C.R.S. 16-13-301 et seq.

1.9.6 The local governing authority, at its option, may inspect solid waste disposal sites and facilities for compliance with these regulations and applicable local ordinances and requirements per 30-20-113(3).

SECTION 2

MINIMUM STANDARDS

2.1 SITE AND FACILITY STANDARDS All solid waste disposal sites and facilities shall comply with the following standards:

2.1.1 Sites and facilities shall comply with the health laws, standards, rules, and regulations of the Department, the Water Quality Control Commission, the Air Quality Control Commission, and all applicable local laws and ordinances.

2.1.2 (A) Sites and facilities shall not knowingly receive any hazardous waste.

(B) Owners and operators of all solid waste disposal sites and facilities shall implement a program at the facility for detection and the prevention of the disposal of polychlorinated biphenyl (PCB) wastes and hazardous wastes. This program must include:

(1) Random inspections of incoming loads unless the owner or operator takes other steps to ensure that incoming loads do not contain such wastes;

(2) Records of any inspections;

(3) Training of facility personnel to recognize these wastes; and

(4) Notification of the Department if these wastes are discovered at the site and facility. Upon receipt of such notification, the Department, after consultation with the local governing body having jurisdiction, may require that the ground water monitoring program of the site and facility be altered to include adequate monitoring for parameters that would detect the release of the hazardous waste or wastes disposed of on site.

2.1.3 Nuisance conditions shall not exist at or beyond the site boundary. All reasonable measures shall be employed to collect, properly contain, and dispose of scattered litter including frequent policing of the area, and the use of wind screens where necessary. The facility shall be managed in such a manner that noise, dust and odors do not constitute a hazard to human health. The facility shall be managed in such a manner that the attraction, breeding and emergence of birds, insects, rodents and other vectors do not constitute a health hazard.

2.1.4 Water pollution shall not occur at or beyond the point of compliance.

2.1.5 No significant aquifer recharge areas, as may be designated by the Colorado State Engineer's office or the Department's Water Quality Control Commission, shall be adversely impacted by solid waste disposal.

2.1.6 Sites and facilities shall, design, construct, and maintain: (a) A run-on control system to prevent flow onto the active facility during the peak discharge from a 25-year, 24-hour storm, and (b) A run-off control system to: (1) collect the water volume resulting from a 25-year, 24-hour storm event and (2) control the water volume resulting from a 100-year, 24-hour storm event. (See also Section 2.5.7).

2.1.7 Sites and facilities shall be adequately fenced or secured to prevent waste material and debris from leaving

the site. Waste material and debris shall not accumulate along the fence line and shall be collected regularly and placed into the fill.

2.1.8 Sites and facilities shall control public access, prevent unauthorized vehicular traffic, provide for site security both during and after hours, and prevent illegal dumping of wastes. Effective artificial barriers, or natural barriers, or both may be used in lieu of fencing.

2.1.9 Solid wastes deposited at any site and facility shall not be burned, other than by incineration in accordance with a certificate of designation issued pursuant to C.R.S. 30-20-110(f) of the Act. The Department may authorize, in extreme emergencies, the supervised burning of large quantities of combustible materials, such as agricultural wastes, silvicultural wastes, land clearing debris, diseased trees, or debris from emergency cleanup operations.

2.1.10 Sites and facilities for final disposal shall provide adequate cover as described in Section 3.3.5, prevent ponding of water, wind erosion and water pollution. In the operation of a site and facility, the solid wastes shall be distributed in the smallest area consistent with handling traffic to be unloaded. The solid wastes shall be placed in the most dense volume practicable using compaction or another method approved by the Department.

2.1.11 Sites and facilities shall have a minimum of windblown debris. The facility shall cease operations during periods when high wind warnings as defined in Section 1.2 are verified on-site. If the facility has no wind velocity measuring device, closure decisions shall be based on readings obtained hourly by the facility operator from the nearest national weather service office or other location approved by the Department with concurrence from the local governing body having jurisdiction.

2.1.12 Landfills shall not accept raw sludges from wastewater treatment plants, septic tank pumpings, or chemical toilet wastes, without approval from the governing body having jurisdiction and the Department.

2.1.13 Sludges shall not be co-disposed with other solid wastes at the working face of sanitary landfills without approval from the governing body having jurisdiction and the Department.

2.1.14 No facility may accept for disposal, liquid wastes or wastes containing free liquids without approval from the governing body having jurisdiction and the Department.

2.1.15 Solid waste disposal sites and facilities shall comply with the ground water protection standards at the relevant point of compliance as defined in Section 1.2 and the owner/operator shall make a demonstration of compliance.

2.1.16 Sites and facilities where final disposal is performed shall, upon being filled, be left in a condition of orderliness and good aesthetic appearance and capable of blending with the surrounding area.

2.1.17 Solid waste disposal sites and facilities shall not place wastes below or into surface or ground water. This practice is prohibited on and after the effective date of these regulations.

2.1.18 (A) If the owner or operator of a solid waste disposal site and facility observes, or is made aware of a condition or event which is likely to cause a release or has caused a release of a substance containing a parameter identified in the facility detection monitoring program pursuant to Appendix B4 and that such condition or event is likely to cause a statistically significant increase over background, the owner or operator shall notify the department and the local governing body having jurisdiction in writing within ten (10) days.
(B) Notifications made under this subsection shall be made part of the operating record of each solid waste disposal site and facility.
(C) The procedure and timing for activities after the initial notification per 2.1.18(A) shall follow Appendix B4(C) and Appendix B5."

2.2 GROUND WATER MONITORING

2.2.1 A solid waste disposal site and facility which has not received a specific waiver from ground water monitoring requirements of these regulations as provided in Appendix B or Section 1.5, shall implement a ground water monitoring program in conformance with Appendix B, Sections B1 through B8 of these regulations. The monitoring requirements shall be developed and implemented at the solid waste disposal site and facility. After consultation with the local governing body having jurisdiction, the Department shall review and may approve or deny the monitoring program developed as

a result of the requirements set forth in Appendix B. Once approved, the owner or operator shall implement the monitoring plan at the site.

(A) A ground water monitoring system shall be installed in conformance with Appendix B, Section B2.

(B) The ground water shall be sampled and analyzed in conformance with Appendix B, Section B3.

(C) A detection monitoring system shall be implemented in conformance with Appendix B, Section B4.

(D) If statistically significant increases over background have been determined, in conformance with Appendix B, Section B3, assessment monitoring shall be implemented in conformance with Appendix B, Section B5.

(E) Statistically significant increases of Appendix I and Appendix II constituents shall trigger an assessment of interim measures and corrective measures in conformance with Appendix B, Section B6.

(F) Selection of remedy and implementation of the corrective action program shall be implemented in conformance with Appendix B, Sections B7 and B8.

(G) The list of chemical constituents which shall form the basis of monitoring and analyses during detection, assessment and corrective action at solid waste disposal sites and facilities other than MSWLFs will be determined on a case-by-case basis depending on the wastes received by the facility. To have an alternate list of chemical constituents approved for a site and facility, the owner or operator must demonstrate to the Department that the utilization of the alternate list during detection, assessment or corrective action will be as protective for that specific site and the waste streams received as the requirements specified for MSWLFs in these regulations.

2.3 EXPLOSIVE GASES The owners or operators of all solid waste disposal sites and facilities which may generate explosive gases shall monitor for explosive gases.

2.3.1 The concentration of explosive gases generated by the facility for solid waste disposal shall not exceed:

(A) Twenty-five percent [25%] of the lower explosive limit (LEL) (one percent [1%] by volume in air for methane) within facility structures (excluding gas control or recovery systems); and

(B) At the boundary, the lower explosive limit which is five percent (5%) by volume in air for methane.

2.3.2 Owners or operators shall implement a routine monitoring program for explosive gases. The type and frequency of

monitoring must be determined based on the following factors:
(A) Soil conditions;
(B) The hydrogeologic conditions surrounding the facility;
(C) The hydraulic conditions surrounding the facility; and
(D) The location of facility structures and property boundaries.
(E) The minimum frequency of monitoring shall be quarterly.

2.3.3 If explosive gas levels are detected exceeding the limits specified in Section 2.3.1, the owner or operator shall notify the Department and the local governing body having jurisdiction and:
(A) Immediately take all necessary steps to ensure protection of human health;
(B) Within seven (7) days of detection, place in the operating record documentation of the explosive gas levels detected and a description of the actions taken; and
(C) Within sixty (60) days of detection, implement an approved remediation plan, place an approved copy of the plan in the operating record, and notify the Department and the local governing body having jurisdiction that the plan has been implemented. The plan shall describe the nature and extent of the problem and the proposed remedy.
(D) The Department after consultation with the local governing body having jurisdiction may establish alternative schedules for demonstrating compliance with Subsection 2.3.1 (A) and (B) of this section.

2.3.4 All explosive gas monitoring points shall be installed in accordance with applicable rules and regulations of the "Water Well and Pump Installation Contractor's Act", Title 37, Article 91, Part 1, CRS as amended.

2.4 RECORDKEEPING

2.4.1 All operating records shall be part of the engineering design and operation report and shall be maintained at the facility, unless otherwise approved by the Department.

2.4.2 The owner or operator of a solid waste disposal site and facility shall record and retain in an operating record the following information as it becomes available:
(A) Location restriction demonstration required under Subsection 3.1;

(B) Inspection records, and training procedures;
(C) Gas monitoring results from monitoring and any remediation plans required by Section 2.3;
(D) Design documentation for controlling leachate or gas condensate;
(E) Demonstrations, certifications, findings, data or documents required by Subsection 2.2;
(F) Closure and post-closure care plans and any monitoring, testing, or analytical data as required by Subsection 2.5 And 2.6;
(H) Cost estimates and financial assurance documentation required by Subsection 1.8; and
(I) Information demonstrating compliance with waivers as required by Section 1.5.

2.4.3 The owner or operator must notify the Department and the local governing body having jurisdiction when the documents required by this section have been placed or added to the operating record. All information contained in the operating record must be furnished upon request or be made available at all reasonable times for inspection by the governing body having jurisdiction or the Department.

2.5 CLOSURE OF SOLID WASTE DISPOSAL SITES AND FACILITIES

2.5.1 Sites and facilities shall be closed in accordance with the Act, and these regulations.

2.5.2 No person shall close a solid waste disposal site and facility without notifying the Department and the governing body having jurisdiction in writing at least sixty (60) days in advance of the closure date.

2.5.3 The operator of a solid waste disposal site and facility shall notify the general public at least sixty (60) days in advance of the proposed closure date by placing signs of suitable size at the entrance to the site and facility.

2.5.4 Precautions shall be taken to prevent further use of the site and facility for unauthorized disposal.

2.5.5 Water pollution shall not occur at or beyond the point of compliance after closure.

2.5.6 Nuisance conditions shall not exist at or beyond the site boundary after closure (see also 2.1.3).

2.5.7 Permanent surface water diversion structures remaining after closure shall control run-on and run-off from the 100 year, 24-hour storm event.

2.5.8 The owner or operator shall prepare a closure plan for approval by the Department after consultation with the local governing body having jurisdiction. The approved plan shall be placed in the operating record.

2.5.9 The owner or operator must begin closure activities of each disposal phase no later than thirty (30) days after final waste grades are reached. Extensions beyond the thirty (30) day deadline for beginning closure may be granted by the Department and the local governing authority if the owner or operator demonstrates that all steps necessary to prevent threats to human health and the environment from the active disposal phase will be taken.

2.6 POST-CLOSURE CARE AND MAINTENANCE STANDARDS

2.6.1 The owner or operator of all solid waste disposal sites and facilities shall prepare a written post-closure plan to be approved by the Department after consultation with the local governing body having jurisdiction and shall place it in the operating record.

2.6.2 For MSWLFs, the post-closure care period shall be established by the Department and the governing body having jurisdiction per Section 3.6, shall be based on the operating history of the site, and shall be at least thirty (30) years. The post-closure care period for solid waste disposal sites and facilities other than MSWLFs will be established by the Department and the governing body having jurisdiction.

PART B

SECTION 3

STANDARDS FOR SOLID WASTE DISPOSAL LANDFILL SITES AND FACILITIES

3.0 PURPOSE, SCOPE AND APPLICABILITY

3.0.1 It is the purpose and intent of these regulations as they apply to solid waste landfills (MSWLFs) to be equivalent to but not more stringent than the 40 CFR Part 258 while allowing the maximum flexibility of interpretation and application based upon the characteristics of the chosen site.

3.0.2 This Section 3 also applies to non-MSWLF sites and facilities. On a case-by-case demonstration basis, the application of these requirements to non-MSWLFs may be altered provided that the alternative standard is as protective of the environment and public health as the requirement specified in these regulations.

3.1 LOCATION RESTRICTIONS AND SITE STANDARDS

3.1.1 Landfills that accept putrescible wastes which occur within 10,000 feet (3048 meters) of any airport runway used by turbojet, or within 5,000 feet (1,523 meters) of any airport runway used only by piston-type aircraft shall not pose a bird hazard to aircraft. The applicant shall submit reasonable ~~evidence~~ regarding the ability to mitigate a bird hazard, to the Department and the local governing authority having jurisdiction for their review. Owners or operators proposing to site new facilities or expand existing facilities within a five (5) Mile radius of an airport runway that is used by turbojet or piston-type aircraft shall notify the Department and the local governing body having jurisdiction and the Federal Aviation Administration (FAA).

3.1.2 New landfills and expansions of existing landfills shall not be located in wetlands, unless the owner or operator can demonstrate that the proposed operation can meet the restrictions set forth in 40 CFR 258.12.

3.1.3 New landfills and expansions of existing landfills shall not be located within 200 feet (60 meters) of a fault that has had a displacement in holocene time unless the owner or operator demonstrates to the Department that an alternate setback distance of less than 200 feet (60 meters) will be effective or equally effective in the prevention of damage to the structural integrity of the facility and will be protective of human health and the environment.

3.1.4 New landfills and expansion of existing landfills shall not be located in seismic impact zones, unless the owner or operator demonstrates to the Department that all components, including liners, leachate collection systems, and surface water control systems, are designed to resist the maximum horizontal acceleration in lithified earth material for the site. The owner or operator shall place the demonstration in the operating record of the facility and submit it to the Department and local governing body having jurisdiction.

3.1.5 Owners or operators of new landfills, existing landfills and expansions of existing landfills located in an unstable area must demonstrate that engineering measures have been incorporated into the facility's design to ensure that the integrity of the structural components of the facility will not be disrupted. The owner or operator shall place the demonstration in the operating record of the facility and submitted to the Department and the local governing body having jurisdiction. The owner or operator shall consider the following factors, at a minimum, when determining whether an area is unstable:

(A) On-site or local soil conditions that may result in significant differential settling;

(B) On-site or local geologic or geomorphologic features; and

(C) On-site or local human-made features or events (both surface and subsurface).

3.1.6 The topography of the site shall maximize protection against prevailing winds on-site and minimize the amount of precipitation catchment area upgradient of the site.

3.1.7 Landfills shall not be located in a floodplain as defined herein.

3.1.8 Landfills shall isolate wastes from the public and the environment. Sites and facilities shall demonstrate suitable isolation to the Department and governing body having jurisdiction by, at a minimum, addressing all Sections in 3.2 and CFR 258.40 in sufficient detail and clarity to justify to the Department and governing body having jurisdiction that wastes and any potential leachate will be controlled within the fill area. Emphasis will be placed on favorable geologic conditions over engineered improvements of marginal geological conditions.

3.1.9 Landfills shall not place wastes below or into surface water or ground water. The operation of sites and facilities that place waste into ground water after the effective date of these regulations is prohibited.

3.2 DESIGN REQUIREMENTS All portions of the facility design and investigations must be reviewed and sealed by a Colorado professional engineer or reviewed by a professional geologist, as appropriate.

3.2.1 Geologic data The engineering design and operations report shall include, as a minimum, the following geologic data:

(A) Types and regional thickness of unconsolidated soils materials;

(B) Types and regional thickness of consolidated bedrock materials;

(C) Regional and local geologic structure, including bedrock strike and dip, and fracture patterns; and

(D) Geologic hazards, including but not limited to slope stability, faulting, folding, rockfall, landslides, subsidence or erosion potential, that may affect the design and operation of the facility for solid wastes disposal.

3.2.2 Hydrologic data The engineering design and operations report shall include, as a minimum, the following hydrological data:

(A) Lakes, rivers, streams, springs, or bogs, on-site or within two miles of the site boundary;

(B) Depth to and thickness of perched zones and uppermost aquifers;

(C) Ground water wells within one mile of the site boundary, including well depth, depth to water, screened intervals, yields and the aquifers tapped;

(D) Hydrologic properties of the perched zones and uppermost aquifer, including flow directions, flow rates, porosity, coefficient of storage, permeability, and potentiometric surface;

(E) Site location in relation to the base floodplain of nearby drainages;

(F) An evaluation of the potential for impacts to existing surface water and ground water quality from the proposed facility for solid waste disposal; and

(G) The existing quality of ground water beneath the proposed facility.

3.2.3 Engineering data The engineering design and operations report shall contain, as a minimum, the following engineering data:

(1) The type, quantity and location of material that will be required for use as a daily and intermediate cover over the life of the site and facility;

(2) The type and quantity of material that will be required for use as liner material or final cover, including its compaction density and moisture content specifications, and the design permeability;

(3) Maps and plans, drawn to a convenient common scale, that show the following:

(a) The location and depth of cut for liners;

(b) The daily or intermediate cover, and final cover;
(c) The location and depths of proposed fill or processing areas;
(d) The location, dimensions, and grades of all surface water diversion structures;
(e) The location and dimensions of all surface water containment structures, including those designed to impound contaminated runoff leachate, sludge, or liquids for evaporative treatment;
(f) The spatial distribution of engineering, geologic and hydrologic data, and relationship to the proposed facility;
(g) The location of all proposed facility structures and access roads;
(h) The location of all proposed monitoring points for surface water and ground water quality and explosive gases;
(i) The final contours and grades of the fill surface after closure;
(j) The location of fencing to be placed on-site;
(k) The location of each discrete phase of development; and
(l) The design details of the final cap, liner and leachate collection system.

3.2.4 Construction details for all proposed monitoring points for surface water and ground water quality and explosive gases.

3.2.5 Liner/design components

(A) Demonstration shall be made, to the Department and the local governing body having jurisdiction, that the design developed for the facility will comply with Section 2.1.15 at the relevant point of compliance. The owner/operator shall consider at least the following factors:

(1) Barrier layer permeability;
(2) Barrier layer thickness;
(3) Barrier layer porosity;
(4) Slope of the barrier layer;
(5) Hydraulic head on the barrier layer;
(6) Distance to relevant point of compliance;
(7) Distance and characteristics, including quality, of the uppermost aquifer or monitored unit;
(8) Climatic factors;
(9) The estimated volume, physical characteristics and chemical characteristics of the leachate, and
(10) The chemical compatibility of the barrier layer to estimated leachate chemical characteristics;
(11) The distance ground water beneath the site would flow during the facility's operating life and post-closure care

period. Distance to domestic wells or springs shown to tap the uppermost aquifer downgradient of the site shall be presented.

(B) The design shall consist of two components: the barrier layer and the leachate collection/removal system. When approving a design that complies with this section, the Department shall consider the ability of the design to comply with Subsection 2.1.15 at the relevant point of compliance taking into consideration site characteristics and site operations.

(C) Barrier layer: the barrier layer shall be an engineered improvement that meets the performance standard of 40 CFR Part 258.40(a)(1) and shall be one of the following:

(1) Natural lithology with recompaction

natural lithology with recompaction can be used as a barrier layer when:

(a) A minimum thickness of 20 feet of soils and/or bedrock with in-situ hydraulic conductivity demonstrated through field testing to be less than or equal to $1.0 * 10^{-6}$ cm/sec, are present at the base of an excavation of a sanitary landfill; and

(b) The upper 12-inches is recompacted to achieve a hydraulic conductivity of less than or equal to $1 * 10^{-7}$ cm/sec.

(2) Soil liner: a soil liner shall consist of at least 3-foot of compacted soil with an adequate moisture content and with a hydraulic conductivity less than or equal to $1 * 10^{-7}$ cm/sec.

(3) Composite liner: a composite liner shall consist of two components: The upper component shall consist of a minimum 30-mil flexible membrane line (FML), and the lower component shall consist of at least a two-foot layer of compacted soil with a hydraulic conductivity less than or equal to $1 * 10^{-7}$ cm/sec. FML components consisting of high density polyethylene (HDPE) shall be at least 60-mil thick. The FML component shall be installed in direct and uniform contact with the compacted soil component.

(4) Alternative designs: alternatives to the above designs may be approved by the Department based on waste type and site specific technical information. Proposals for alternative designs shall demonstrate that the facility can comply with Subsection 2.1.15 at the relevant point of compliance and for MSWLF with 40 CFR Part 258.40(a)(1). A alternative designs include, but are not limited to the following:

(1) Geosynthetic clay liners;
(2) Natural lithology without recompaction;
(3) Soil admixtures;
(4) Geomembranes;
(5) Polymers, and

(6) Variations of design components described in this Section 3.2.5.

(D) Leachate collection and leachate removal system

(1) A leachate collection system shall be designed and constructed to maintain less than a twelve (12) inch depth of leachate over the barrier layer, and to promote transport of leachate from the most distant point of the leachate collection system to the leachate removal system in less than twelve (12) months (assuming a saturated drainage media). Factors to be considered in the design of a leachate collection system include, but are not limited to, the following:

(a) Waste type;
(b) Anticipated leachate generation rate;
(c) Slope length;
(d) Percent slope;
(e) Barrier layer;
(f) Hydraulic conductivity of the drainage layer, and
(g) Long term performance during the active life and post-closure care period.

(2) A leachate removal system shall be designed, constructed and operated to:

(I) Allow the leachate collection system to perform as designed; and

(II) Account for potential increased hydraulic head in the removal system.

3.2.6 Surface water control systems shall be designed, constructed and maintained to:

(a) Restrict flow onto the active portion of the landfill during peak discharge from a 25-year, 24-hour storm; and

(b) Control the water volume resulting from a 25-year, 24-hour storm from the active portion of the landfill. (See also Section 2.5.7).

3.2.7 Prior to the acceptance of waste, the owner or operator must submit a report to the Department and the local governing body having jurisdiction documenting that the designed construction has been completed in accordance with the approved plan. The report shall be signed by a Colorado registered professional engineer, approved by the Department and placed in the operating record.

3.3 OPERATING CRITERIA

3.3.1 General data The engineering design and operations report shall include, as a minimum, the following general data:

(A) Mailing address, county and legal description of the landfill for solid wastes disposal, township, section, quarter section and range;
(B) Area site, in acres;
(C) Type of landfill for solid waste disposal proposed for the site; and
(D) Discussion of landfills service area, including transportation corridors and surrounding access.

3.3.2 Operational data The engineering design and operations report shall include, as a minimum, the following operational data:
(A) The qualifications, names, and addresses of the persons operating the landfill and having the authority to take corrective action in the event of noncompliance;
(B) The hours of the day and days of the week that the landfill will be operating;
(C) The types and daily volumes in yards per day and/or gallons per month of wastes to be received; expected life of site. If sludge is to be received, its quality should be determined in accordance with Department technical guidelines. A listing of the waste stream types to be approved for routine receipt;
(D) The number, classification, and job descriptions of personnel projected to be employed at the landfill when operating at full capacity;
(E) Number, description, and uses of all equipment projected to be employed at the landfill when operating at full capacity;
(F) The size and types of disposal cells or processing areas to be constructed;
(G) The frequency of the application of adequate cover;
(H) The types and heights of fencing to be placed on-site;
(I) Provisions to minimize nuisance conditions on-site;
(J) Provisions for fire protection to eliminate open burning on-site, and to prevent the spread of open burning to adjoining property;
(K) Provisions for the retrieval of windblown solid wastes, on or off-site;
(L) Conceptual plans to be implemented if the contamination of surface waters or ground waters occur, or if nuisance conditions are confirmed beyond the site boundary; and
(M) The amounts and sources of water to be used on site for the control of nuisance conditions, fire protection, construction purposes and personnel use.

3.3.3 Quality assurance and quality control reports shall be developed and implemented for all engineered structures at the landfill.

3.3.4 Cover material requirements

(A) The owners or operators of all landfills must cover disposed solid waste with six (6) inches of earthen material at the end of each operating day, or at more frequent intervals if necessary, to control disease vectors, fires, odors, blowing litter, and scavenging.

(B) Alternative materials of an alternative thickness (other than at least six (6) inches of earthen material) may be approved by the Department and the governing body having jurisdiction, if the owner or operator demonstrates that the alternative ~~material~~ and thickness control nuisance conditions and scavenging without presenting a threat to human health and the environment.

(C) The Department and the governing body having jurisdiction may grant a temporary waiver from the requirement of daily and intermediate cover requirements, if the owner or operator demonstrates that there are extreme seasonal climatic conditions that make meeting such requirements impractical. Alternate approaches to daily cover as described above will be considered on a case-by-case basis for non-MSWLF's.

3.3.5 Sufficient amounts of adequate cover shall be readily available for use throughout the site's life and for closure to minimize nuisance conditions as necessary.

3.3.6 Adequate amounts of water shall be available for construction purposes and to minimize nuisance conditions, as necessary.

3.3.7 Leachate and landfill gas condensate may be recirculated over the landfill with specific approval by the Department and the local governing authority.

3.4 RECORDKEEPING An operating record shall be maintained and include, as a minimum, the following:

(A) Incoming waste volumes,
(B) Water quality monitoring results,
(C) Explosive gas monitoring results,
(D) Construction as-built details, and
(E) Variations from approved operations procedures.
(F) Any demonstration and waiver documentation required in these regulations.

3.4.1 Following closure of landfills, the owner or operator shall:

(A) Record a notation on the deed to the facility property, or some other instrument that is normally examined during title search; and
(B) Notify the Department and the local governing body having jurisdiction that notation has been recorded and a copy has been placed in the operating record.

The notation on the deed must in perpetuity notify any potential purchaser of the property that:
(1) The land has been used as a landfill facility; and
(2) Its use is restricted under Section 3.6.1(7)
The Department after consultation with the local governing body having jurisdiction may grant permission to remove the notation from the deed if all wastes are removed from the facility.

3.5 CLOSURE The owner or operator of a solid waste site and facility shall develop a closure plan which meets the following minimum criteria.

3.5.1 (A) The closure plan shall be prepared and submitted to the Department for approval. The closure plan shall describe the steps necessary to close the landfill at any point during its active life. The closure plan, at a minimum, shall include the following information:
(1) A description of the final cover system, designed in accordance with Section 3.5.2 and 3.5.3, And the methods and procedures to be used to install the cover;
(2) An estimate of the largest area of the landfill ever requiring a final cover during the active life; and
(3) A schedule for completing all activities necessary to satisfy the closure criteria of this section.
(B) Discrete units of a landfill may be closed independently of closure of the entire facility.

3.5.2 The final grades shall promote surface water run-off and minimize erosion, and shall have slopes no less than 5% (20:1) and no greater than 25% (4:1). Variations from these standards may be acceptable if demonstrations of the adequacy of proposed variance are made to the Department by the owner or operator.

3.5.3 The final cover permeability shall not exceed that of the liner; and the final cover design shall be comprised of one (1) of the following types:
(A) A soil final cover design shall consist of the following:
(1) An infiltration layer consisting of a minimum of 18 inches of earthen material that has a permeability of

less than or equal to the permeability of any bottom liner system or natural subsoils present, or a permeability no greater than 1 x 10^{-5} cm/sec, whichever is less, and

(2) An erosion layer of earthen material a minimum of 6 inches in thickness that is capable of sustaining native plant growth.

(B) A composite final cover design shall consist of the following components:

(1) foundation layer to be comprised of a minimum six (6) inch soil layer, located immediately above the refuse , to provide a suitable foundation for placement of the geomembrane.

(2) The barrier layer shall consist of a geomembrane which has a minimum 30-mil thickness and displays properties adequate for its intended purpose.

Factors to be considered in determining barrier adequacy shall include, but are not limited to the following:

(1) The effects of landfill settlement,

(2) Permeability,

(3) Seam strength,

(4) Friction properties, and

(5) Puncture resistance.

(6) Rooting layer comprised of a soil capable of supporting a root system and of sufficient thickness to protect the barrier layer and a seed bed layer of soil capable of supporting plant germination. The minimum thickness of the former layer shall be eighteen inches and the latter layer shall be six inches.

(C) Alternatives to the above designs may be approved by the Department based on waste type and site specific technical information. Proposals for alternative designs shall demonstrate that the final cover system will minimize infiltration and erosion, and comply with Subsection 2.1.15 at the relevant point of compliance. Alternative designs include, but are not limited to the following:

(1) Geocomposite materials,

(2) Soil admixtures,

(3) Polymers and

(4) Variations of design components described in this Section 3.5.3.

3.5.4 The final cover shall be designed so that landfill gases will not adversely affect cover performance as described in this Section 3.5.

3.5.5 Upon approval, and prior to beginning closure of each landfill phase, an owner or operator must notify the

Department and place notice of the intent to close the phase in the operating record.

3.5.6 The owner or operator must commence closure activities of each landfill phase no later than 30 days after final refuse grades are reached. Extensions beyond the 30-day deadline for beginning closure may be granted by the Department if the owner or operator demonstrates that all steps necessary to prevent threats to human health and the environment from the active landfill phase will be taken.

3.5.7 The owner or operator must complete closure activities of each landfill phase, in accordance with the closure plan, within one hundred eighty (180) days ~~following~~ the beginning of closure as specified in this section. Extensions of the closure period may be granted by the Department if the owner or operator demonstrates that closure will of necessity, take longer than one hundred eighty (180) days and the owner/operator has taken and will continue to take all steps to prevent threats to human health and the environment.

3.5.8 Following closure of each landfill phase, the owner or operator must submit a report to the Department documenting that closure has been completed in accordance with the approved closure plan. The report, which must be signed by a Colorado registered professional engineer, shall be approved by the Department and placed in the operating record.

3.6 POST-CLOSURE CARE AND MAINTENANCE

3.6.1 (A) Following closure of each landfill or landfill phase, the owner or operator must conduct post-closure care which shall consist of at least the following:
(1) Provisions to prevent nuisance conditions;
(2) Maintaining the integrity and effectiveness of the final cover, including making repairs to the cover as necessary to correct the effects of settlement, subsidence, erosion, or other events, and preventing run-on and run-off from eroding or otherwise damaging the final cover;
(3) Monitoring the ground water in accordance with the requirements of Subsection 2.2 And maintaining the ground water monitoring system, if applicable;
(4) Maintaining and operating the leachate collection system in accordance with the requirements in Section 3.2.5 (C). The Department may allow the owner or operator to stop managing leachate if the owner or operator

demonstrates that leachate no longer poses a threat to human health and the environment;

(5) Maintaining and operating the gas monitoring system in accordance with the requirements Subsection 2.3.

(6) Name, address, and telephone number of the person or office to contact about the facility during the post-closure period; and

(7) A description of the planned uses of the property during the post-closure period. Post-closure use of the property shall not disturb the integrity of the final cover, liner(s), or any other components of the containment system, or the function of the monitoring systems unless necessary to comply with the requirements in the Department's regulations. The Department may approve any other disturbance if the owner or operator demonstrates that disturbance of the final cover, liner or other component of the containment system, including any removal of waste, will not increase the potential threat to human health or the environment.

3.6.1 (B) Discrete landfill units that can be monitored and maintained separately may be allowed to begin and end the post-closure period independent of closure of the entire facility.

3.6.2 Following completion of the post-closure care period the owner or operator must notify the Department that a certification signed by an independent Colorado registered professional engineer or approved by the Department and the local governing body having jurisdiction, verifying that post-closure care has been completed in accordance with the post-closure plan, has been placed in the operating record.

3.6.3 Post-closure care must be conducted for a minimum of thirty (30) years.

The length of the post-closure care period may be:

(A) Decreased by the Department after consultation with the local governing body having jurisdiction if the owner or operator demonstrates that the reduced period is sufficient to protect human health and the environment; or

(B) Increased by the Department after consultation with the local governing body having jurisdiction if it is determined that the lengthened period is necessary to protect human health and the environment.

SECTION 4

CONSTRUCTION DEBRIS AND INERT MATERIAL LANDFILL SITES AND FACILITIES [RESERVED]

§ 264.282 Special requirements for incompatible wastes.

The owner or operator must not place incompatible wastes, or incompatible wastes and materials (see Appendix V of this part for examples), in or on the same treatment zone, unless § 264.17(b) is complied with.

§ 264.283 Special requirements for hazardous wastes F020, F021, F022, F023, F026, and F027.

(a) Hazardous Wastes F020, F021, F022, F023, F026, F027 must not be placed in a land treatment unit unless the owner or operator operates the facility in accordance with a management plan for these wastes that is approved by the Department pursuant to the standards set out in this paragraph, and in accord with all other applicable requirements of this Part. The factors to be considered are:

(1) The volume, physical, and chemical characteristics of the wastes, including their potential to migrate through soil or to volatilize or escape into the atmosphere;

(2) The attenuative properties of underlying and surrounding soils or other materials;

(3) The mobilizing properties of other materials co-disposed with these wastes; and

(4) The effectiveness of additional treatment, design, or monitoring techniques.

(b) The Department may determine that additional design, operating, and monitoring requirements are necessary for land treatment facilities managing hazardous wastes F020, F021, F022, F023, F026, and F027 in order to reduce the possibility of migration of these wastes to ground water, surface water, or air so as to protect human health and the environment.

§§ 264.284 through 264.299 [Reserved]

Subpart N -- Landfills

§ 264.300 Applicability.

The regulations in this subpart apply to owners or operators of facilities that dispose of hazardous waste in landfills, except as § 264.1 provides otherwise.

§ 264.301 Design and operating requirements.

(a) Any landfill that is not covered by paragraph (c) of this section or § 265.301(a) of these regulations must have a liner system for all portions of the landfill (except for existing portions of such landfill). The liner system must have:

(1) A liner that is designed, constructed, and installed to prevent any migration of wastes out of the landfill to the adjacent subsurface soil or ground water or surface water at anytime during the active life (including the closure period) of the landfill. The liner must be constructed of materials that prevent wastes from passing into the liner during the active life of the facility. The liner must be:

(i) Constructed of materials that have appropriate chemical properties and sufficient strength and thickness to prevent failure due to pressure gradients (including static head and external hydrogeologic forces), physical contact with the waste or leachate to which they are exposed, climatic conditions, the stress of installation, and the stress of daily operation;

(ii) Placed upon a foundation or base capable of providing support to the liner and resistance to pressure gradients above and below the liner to prevent failure of the liner due to settlement, compression, or uplift; and

(iii) Installed to cover all surrounding earth likely to be in contact with the waste or leachate; and

(2) A leachate collection and removal system immediately above the liner that is designed, constructed, maintained, and operated to collect and remove leachate from the landfill. The Department will specify design and operating conditions in the permit to ensure that the leachate depth over the liner does not exceed 30 cm (one foot). The leachate collection and removal system must be:

(i) Constructed of materials that are:

(A) Chemically resistant to the waste managed in the landfill and the leachate expected to be generated; and

(B) Of sufficient strength and thickness to prevent collapse under the pressures exerted by overlying wastes, waste cover materials, and by any equipment used at the landfill; and

(ii) Designed and operated to function without clogging through the scheduled closure of the landfill.

(b) The owner or operator will be exempted from the requirements of paragraph (a) of this section if the Department finds, based on a demonstration by the owner or operator, that alternative design and operating practices, together with location characteristics, will prevent the migration of any hazardous constituents (see Sec. 264.93) into the ground water or surface water at any future time. In deciding whether to grant an exemption, the Department will consider:

(1) The nature and quantity of the wastes;

(2) The proposed alternate design and operation;

(3) The hydrogeologic setting of the facility, including the attenuative capacity and thickness of the liners and soils present between the landfill and ground water or surface water; and

(4) All other factors which would influence the quality and mobility of the leachate produced and the potential for it to migrate to ground water or surface water.

(c) The owner or operator of each new landfill unit on which construction commences after January 29, 1992, each lateral expansion of a landfill unit on which construction commences after July 29, 1992, and each replacement of an existing landfill unit that is to commence reuse after July 29, 1992 must install two or more liners and a leachate collection and removal system above and between such liners. "Construction commences" is as defined in § 260.10 of these regulations under "existing facility".

(1)(i) The liner system must include:

(A) A top liner designed and constructed of materials (e.g., a geomembrane) to prevent the migration of hazardous constituents into such liner during the active life and post-closure care period; and

(B) A composite bottom liner, consisting of at least two components. The upper component must be designed and constructed of materials (e.g., a geomembrane) to prevent the migration of hazardous constituents into this component during the active life and post-closure care period. The lower component must be designed and constructed of materials to minimize the migration of hazardous constituents if a breach in the upper component were to occur. The lower component must be constructed of at least 3 feet (91 cm) of compacted soil material with a hydraulic conductivity of no more than 1×10^{-7} cm/sec.

(ii) The liners must comply with paragraphs (a)(1)(i), (ii), and (iii) of this section.

(2) The leachate collection and removal system immediately above the top liner must be designed, constructed, operated, and maintained to collect and remove leachate from the landfill during the active life and post-closure care period. The Department will specify design and operating conditions in the permit to ensure that the leachate depth over the liner does not exceed 30 cm (one foot). The leachate collection and removal system must comply with paragraphs (c)(3)(iii) and (iv) of this section.

(3) The leachate collection and removal system between the liners, and immediately above the bottom composite liner in the case of multiple leachate collection and removal systems, is also a leak detection system. This leak detection system must be capable of detecting, collecting, and removing leaks of hazardous constituents at the earliest practicable time through all areas of the top liner likely to be exposed to waste or leachate during the active life and post-closure care period. The requirements for a leak detection system in this paragraph are satisfied by installation of a system that is, at a minimum:

(i) Constructed with a bottom slope of one percent or more;

(ii) Constructed of granular drainage materials with a hydraulic conductivity of 1×10^{-2} cm/sec or more and a thickness of 12 inches (30.5 cm) or more; or constructed of synthetic or geonet drainage materials with a transmissivity of 3×10^{-5} m^2/sec or more;

(iii) Constructed of materials that are chemically resistant to the waste managed in the landfill and the leachate expected to be generated, and of sufficient strength and thickness to prevent collapse under the pressures exerted by overlying wastes, waste cover materials, and equipment used at the landfill;

(iv) Designed and operated to minimize clogging during the active life and post-closure care period; and

(v) Constructed with sumps and liquid removal methods (e.g., pumps) of sufficient size to collect and remove liquids from the sump and prevent liquids from backing up into the drainage layer. Each unit must have its own sump(s). The design of each sump and removal system must provide a method for measuring and recording the volume of liquids present in the sump and of liquids removed.

(4) The owner or operator shall collect and remove pumpable liquids in the leak detection system sumps to minimize the head on the bottom liner.

(5) The owner or operator of a leak detection system that is not located completely above the seasonal high water table must demonstrate that the operation of the leak detection system will not be adversely affected by the presence of ground water.

(d) The Department may approve alternative design or operating practices to those specified in paragraph (c) of this section if the owner or operator demonstrates to the Department that such design and operating practices, together with location characteristics:

(1) Will prevent the migration of any hazardous constituent into the ground water or surface water at least as effectively as the liners and leachate collection and removal systems specified in paragraph (c) of this section; and

(2) Will allow detection of leaks of hazardous constituents through the top liner at least as effectively.

(e) The double liner requirement set forth in paragraph (c) of this section may be waived by the Department for any monofill, if:

(1) The monofill contains only hazardous wastes from foundry furnace emission controls or metal casting molding sand, and such wastes do not contain constituents which would render the wastes hazardous for reasons other than the Toxicity Characteristic in § 261.24 of these regulations, with EPA Hazardous Waste Numbers D004 through D017; and

(2)(i)(A) The monofill has at least one liner for which there is no evidence that the liner is leaking;

(B) The monofill is located more than one-quarter mile from an underground source of drinking water (as that term is defined in 40 CFR 144.3); and

(C) The monofill is in compliance with generally applicable ground water monitoring requirements for facilities with permits under RCRA 3005(c) [42 U.S.C. § 6925(c)]; or

(ii) The owner or operator demonstrates that the monofill is located, designed, and operated so as to assure that there will be no migration of any hazardous constituent into ground water or surface water at any future time.

(f) The owner or operator of any replacement landfill unit is exempt from paragraph (c) of this section if:

(1) The existing unit was constructed in compliance with the design standards of section 3004(o)(1)(A)(i) and (o)(5) of the Resource Conservation and Recovery Act [42 U.S.C. § 6924(o)]; and

(2) There is no reason to believe that the liner is not functioning as designed.

(g) The owner or operator must design, construct, operate, and maintain a run-on control system capable of preventing flow onto the active portion of the landfill during peak discharge from at least a 100-year storm.

(h) The owner or operator must design, construct, operate, and maintain a run-off management system to collect and control at least the water volume resulting from a 24-hour, 100-year storm.

(i) Collection and holding facilities(e.g., tanks or basins) associated with run-on and run-off control systems must be emptied or otherwise managed expeditiously after storms to maintain design capacity of the system.

(j) If the landfill contains any particulate matter which may be subject to wind dispersal, the owner or operator must cover or otherwise manage the landfill to control wind dispersal.

(k) The Department will specify in the permit all design and operating practices that are necessary to ensure that the requirements of this section are satisfied.

§ 264.302 Action leakage rate.

(a) The Department shall approve an action leakage rate for landfill units subject to § 264.301(c) or (d). The action leakage rate is the maximum design flow rate that the leak detection system (LDS) can remove without the fluid head on the bottom liner exceeding 1 foot. The action leakage rate must include an adequate safety margin to allow for uncertainties in the design (e.g., slope, hydraulic conductivity, thickness of drainage material), construction, operation, and location of the LDS, waste and leachate characteristics, likelihood and amounts of other sources of liquids in the LDS, and proposed response actions (e.g., the action leakage rate must consider decreases in the flow capacity of the system over time resulting from siltation and clogging, rib layover and creep of synthetic components of the system, overburden pressures, etc.).

(b) To determine if the action leakage rate has been exceeded, the owner or operator must convert the weekly or monthly flow rate from the monitoring data obtained under § 264.303(c), to an average daily flow rate (gallons per acre per day) for each sump. Unless the Department approves a different calculation, the average daily flow rate for each sump must be calculated weekly during the active life and closure period, and monthly during the post-closure care period when monthly monitoring is required under § 264.303(c).

§ 264.303 Monitoring and inspection.

(a) During construction or installation, liners (except in the case of existing portions of landfills exempt from § 264.301(a)) and cover systems (e.g., membranes, sheets, or coatings) must be inspected for uniformity, damage and imperfections (e.g., holes, cracks, thin spots, or foreign materials). Immediately after construction or installation:

(1) Synthetic liners and covers must be inspected to ensure tight seams and joints and the absence of tears, punctures, or blisters; and

(2) Soil-based and admixed liners and covers must be inspected for imperfections including lenses, cracks, channels, root holes, or other structural non-uniformities that may cause an increase in the permeability of the liner or cover.

(b) While a landfill is in operation, it must be inspected weekly and after storms to detect evidence of any of the following:

(1) Deterioration, malfunctions, or improper operation of run-on and run-off control systems;

(2) Proper functioning of wind dispersal control systems, where present; and

(3) The presence of leachate in and proper functioning of leachate collection and removal systems, where present.

(c)(1) An owner or operator required to have a leak detection system under § 264.301(c) or (d) must record the amount of liquids removed from each leak detection system sump at least once each week during the active life and closure period.

(2) After the final cover is installed, the amount of liquids removed from each leak detection system sump must be recorded at least monthly. If the liquid level in the sump stays below the pump operating level for two consecutive months, the amount of liquids in the sumps must be recorded at least quarterly. If the liquid level in the sump stays below the pump operating level for two consecutive quarters, the amount of liquids in the sumps must be recorded at least semi-annually. If at any time during the post-closure care period the pump operating level is exceeded at units on quarterly or semi-annual recording schedules, the owner or operator must return to monthly recording of amounts of liquids removed from each sump until the liquid level again stays below the pump operating level for two consecutive months.

(3) "Pump operating level" is a liquid level proposed by the owner or operator and approved by the Department based on pump activation level, sump dimensions, and level that avoids backup into the drainage layer and minimizes head in the sump.

§ 264.304 Response actions.

(a) The owner or operator of landfill units subject to § 264.301(c) or (d) must have an approved response action plan before receipt of waste. The response action plan must set forth the actions to be taken if the action leakage rate has been exceeded. At a minimum, the response action plan must describe the actions specified in paragraph (b) of this section.

(b) If the flow rate into the leak detection system exceeds the action leakage rate for any sump, the owner or operator must:

(1) Notify the Department in writing of the exceedence within 7 days of the determination;

(2) Submit a preliminary written assessment to the Department within 14 days of the determination, as to the amount of liquids, likely sources of liquids, possible location, size, and cause of any leaks, and short-term actions taken and planned;

(3) Determine to the extent practicable the location, size, and cause of any leak;

(4) Determine whether waste receipt should cease or be curtailed, whether any waste should be removed from the unit for inspection, repairs, or controls, and whether or not the unit should be closed;

(5) Determine any other short-term and longer-term actions to be taken to mitigate or stop any leaks; and

(6) Within 30 days after the notification that the action leakage rate has been exceeded, submit to the Department the results of the analyses specified in paragraphs (b)(3), (4), and (5) of this section, the results of actions taken, and actions planned. Monthly thereafter, as long as the flow rate in the leak detection system exceeds the action leakage rate, the owner or operator must submit to the Department a report summarizing the results of any remedial actions taken and actions planned.

(c) To make the leak and/or remediation determinations in paragraphs (b)(3), (4), and (5) of this section, the owner or operator must:

(1)(i) Assess the source of liquids and amounts of liquids by source,

(ii) Conduct a fingerprint, hazardous constituent, or other analyses of the liquids in the leak detection system to identify the source of liquids and possible location of any leaks, and the hazard and mobility of the liquid; and

(iii) Assess the seriousness of any leaks in terms of potential for escaping into the environment; or

(2) Document why such assessments are not needed.

§§ 264.305 through 264.308 [Reserved]

§ 264.309 Surveying and recordkeeping.

The owner or operator of a landfill must maintain the following items in the operating record required under § 264.73:

(a) On a map, the exact location and dimensions, including depth, of each cell with respect to permanently surveyed benchmarks; and

(b) The contents of each cell and the approximate location of each hazardous waste type within each cell.

§ 264.310 Closure and post-closure care.

(a) At final closure of the landfill or upon closure of any cell, the owner or operator must cover the landfill or cell with a final cover designed and constructed to:

(1) Provide long-term minimization of migration of liquids through the closed landfill;

(2) Function with minimum maintenance;

(3) Promote drainage and minimize erosion or abrasion of the cover;

(4) Accommodate settling and subsidence so that the cover's integrity is maintained; and

(5) Have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present.

(b) After the final closure, the owner or operator must comply with all post-closure requirements contained in §§ 264.117 through 264.120, including maintenance and monitoring throughout the post-closure care period (specified in the permit under § 264.117). The owner or operator must:

(1) Maintain the integrity and effectiveness of the final cover, including making repairs to the cap as necessary to correct the effects of settling, subsidence, erosion, or other events;

(2) Continue to operate the leachate collection and removal system until leachate is no longer detected;

(3) Maintain and monitor the leak detection system in accordance with §§ 264.301(c)(3)(iv) and (4) and 264.303(c), and comply with all other applicable leak detection system requirements of this part;

(4) Maintain and monitor the ground-water monitoring system and comply with all other applicable requirements of Subpart F of this Part;

(5) Prevent run-on and run-off from eroding or otherwise damaging the final cover; and

(6) Protect and maintain surveyed benchmarks used in complying with § 264.309.

§ 264.311 [Reserved]

§ 264.312 Special requirements for ignitable or reactive waste.

(a) Except as provided in paragraph (b) of this section, and in § 264.316, ignitable or reactive waste must not be placed in a landfill, unless the waste and landfill meet all applicable requirements of part 268, and:

(1) The resulting waste, mixture, or dissolution of material no longer meets the definition of ignitable or reactive waste under § 261.21 or § 261.23 of these regulations, and

(2) Section 264.17(b) is complied with.

(b) Except for prohibited wastes which remain subject to treatment standards in subpart D of part 268, ignitable wastes in containers may be landfilled without meeting the requirements of paragraph (a) of this section, provided that the wastes are disposed of in such a way that they are protected from any material or conditions which may cause them to ignite. At a minimum, ignitable wastes must be disposed of in non-leaking containers which are carefully handled and placed so as to avoid heat, sparks, rupture, or any other condition that might cause ignition of the wastes; must be covered daily with soil or other non-combustible material to minimize the potential for ignition of the wastes; and must not be disposed of in cells that contain or will contain other wastes which may generate heat sufficient to cause ignition of the waste.

§ 264.313 Special requirements for incompatible wastes.

Incompatible wastes, or incompatible wastes and materials, (see Appendix V of this part for examples) must not be placed in the same landfill cell, unless § 264.17(b) is complied with.

§ 264.314 Special requirements for bulk and containerized liquids.

(a) The placement of bulk or non-containerized liquid hazardous waste or hazardous waste containing free liquids (whether or not sorbents have been added) in any landfill is prohibited.

(b) [Reserved.]

(c) Containers holding free liquids must not be placed in a landfill unless:

(1) All free-standing liquid: (i) has been removed by decanting, or other methods; (ii) has been mixed with sorbent or solidified so that free-standing liquid is no longer observed; or (iii) has been otherwise eliminated; or

(2) The container is very small, such as an ampule; or

(3) The container is designed to hold free liquids for use other than storage, such as a battery or capacitor; or

(4) The container is a lab pack as defined in § 264.316 and is disposed of in accordance with § 264.316.

(d) To demonstrate the absence or presence of free liquids in either a containerized or a bulk waste, the following test must be used: Method 9095 (Paint Filter Liquids Test) as described in "Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods." (EPA Publication No. SW - 846).

(e) Sorbents used to treat free liquids to be disposed of in landfills must be nonbiodegradable. Nonbiodegradable sorbents are: materials listed or described in paragraph (e)(1) of this section; materials that pass one of the tests in paragraph (e)(2) of this section; or materials that are determined by EPA to be nonbiodegradable through the part 260 petition process.

(1) Nonbiodegradable sorbents.

(i) Inorganic minerals, other inorganic materials, and elemental carbon (e.g., aluminosilicates, clays, smectites, Fuller's earth, bentonite, calcium bentonite, montmorillonite, calcined montmorillonite, kaolinite, micas (illite), vermiculites, zeolites; calcium carbonate (organic free limestone); oxides/hydroxides, alumina, lime, silica (sand), diatomaceous earth; perlite (volcanic glass); expanded volcanic rock; volcanic ash; cement kiln dust; fly ash; rice hull ash; activated charcoal/activated carbon); or

(ii) High molecular weight synthetic polymers (e.g., polyethylene, high density polyethylene (HDPE), polypropylene, polystyrene, polyurethane, polyacrylate, polynorborene, polyisobutylene, ground synthetic rubber, cross-linked allylstyrene and tertiary butyl copolymers). This does not include polymers derived from biological material or polymers specifically designed to be degradable; or

(iii) Mixtures of these nonbiodegradable materials.

(2) Tests for nonbiodegradable sorbents.

(i) The sorbent material is determined to be nonbiodegradable under ASTM Method G21-70 (1984a)-Standard Practice for Determining Resistance of Synthetic Polymer Materials to Fungi; or

(ii) The sorbent material is determined to be nonbiodegradable under ASTM Method G22-76 (1984b)-Standard Practice for Determining Resistance of Plastics to Bacteria.

APPENDIX J
FINAL CAP EROSION CALCULATIONS

CLIENT USACE SUBJECT SOIL EROSION ESTIMATE Prepared By MWW Date 5/2/96
PROJECT FORT CARSON Reviewed By MJ Date 5/2/96
LANDFILL NO.2 Approved By ____ Date ____

OBJECTIVE:

Determine the average annual soil loss for the soil final cover at Landfill No. 2 during post-closure conditions.

DESIGN CRITERIA AND ASSUMPTIONS:

- Use Revised Universal Soil Loss Equation for calculations.
- Compute soil loss based on an average slope lengths and slopes for various areas of the final cap. The landfill was broken up into 7 zones as shown on the accompanying figure. The zones are based upon locations of proposed and existing drainage structures.
- Assume that the cover soil is representative of soil boring no.10 for Landfill 2. The particle distribution test for SB10 stated the following: 44.7% clay, 37.5 % silt, and 17.8 % for sand/gravel.
- Assume that final cover is established with good vegetative cover (between 80% and 95%).

CALCULATIONS:

$A = R \times K \times LS_R \times C \times P$

where A = average annual soil loss, tons/ac/yr
R = average rainfall erosivity factor
LS_R = revised slope length factor
C = cover factor
P = practice factor
K = soil erodibility factor

$*LS_R = (\lambda/72.6)^m \times S_f$

where λ = slope length, feet
m = 0.6 → s > 10%
0.5 → 4% < s < 10%
0.4 → s = 4%
0.3 → s < 4%
$S_f = 10.8\sin\phi + 0.03$ → s < 9%
$16.8\sin\phi - 0.50$ → s ≥ 9%
ϕ = slope angle

*reference: "Revised Slope Steepness Factor for the Universal Soil Loss Equation", McCool et al; Transactions of the American Society of Agricultural Engineers(ASAE), Vol.30(5):Sept-Oct, 1987.

CLIENT USACE SUBJECT SOIL EROSION ESTIMATE Prepared By MWW Date 5/2/96
PROJECT FORT CARSON Reviewed By MLV Date 5/2/96
LANDFILL NO.2 Approved By ____ Date ____

For the calculations: R = 50 (see attached soil map)
K = 0.29 (see attached table)
P = 1.0 (see attached table)
C = 0.01 (see attached table)

Zone	Ave. Slope Length, ft	Ave. Slope, %	ϕ	S_f	LS_R	A, tons/acre/yr
1	217	24	13.496	3.421	6.60	0.96
2	150	11	6.277	1.337	2.07	0.30
3	650	5	2.862	0.569	1.70	0.25
4	510	8	4.574	0.891	2.36	0.34
5	430	6	3.434	0.677	1.65	0.24
6	254	13	7.407	1.666	3.53	0.51
7	622	7	4.004	0.784	2.30	0.33

Example calculation for zone 1:

$LS_R = (217\ ft/72.6)^{0.6}(16.8\sin(13.496\ deg.)-0.50) = 6.60$

A = 50 x 0.29 x 6.60 x 0.01 x 1.0 = 0.96 tons/acre/year

CONCLUSIONS:

Based on the above calculations, the average annual soil loss for Landfill 2 ranges from approximately 0.24 to 0.96 tons/acre/year. The low values of erosion reflect the use of diversion channels and diversion berms on the final cover to reduce slope lengths.

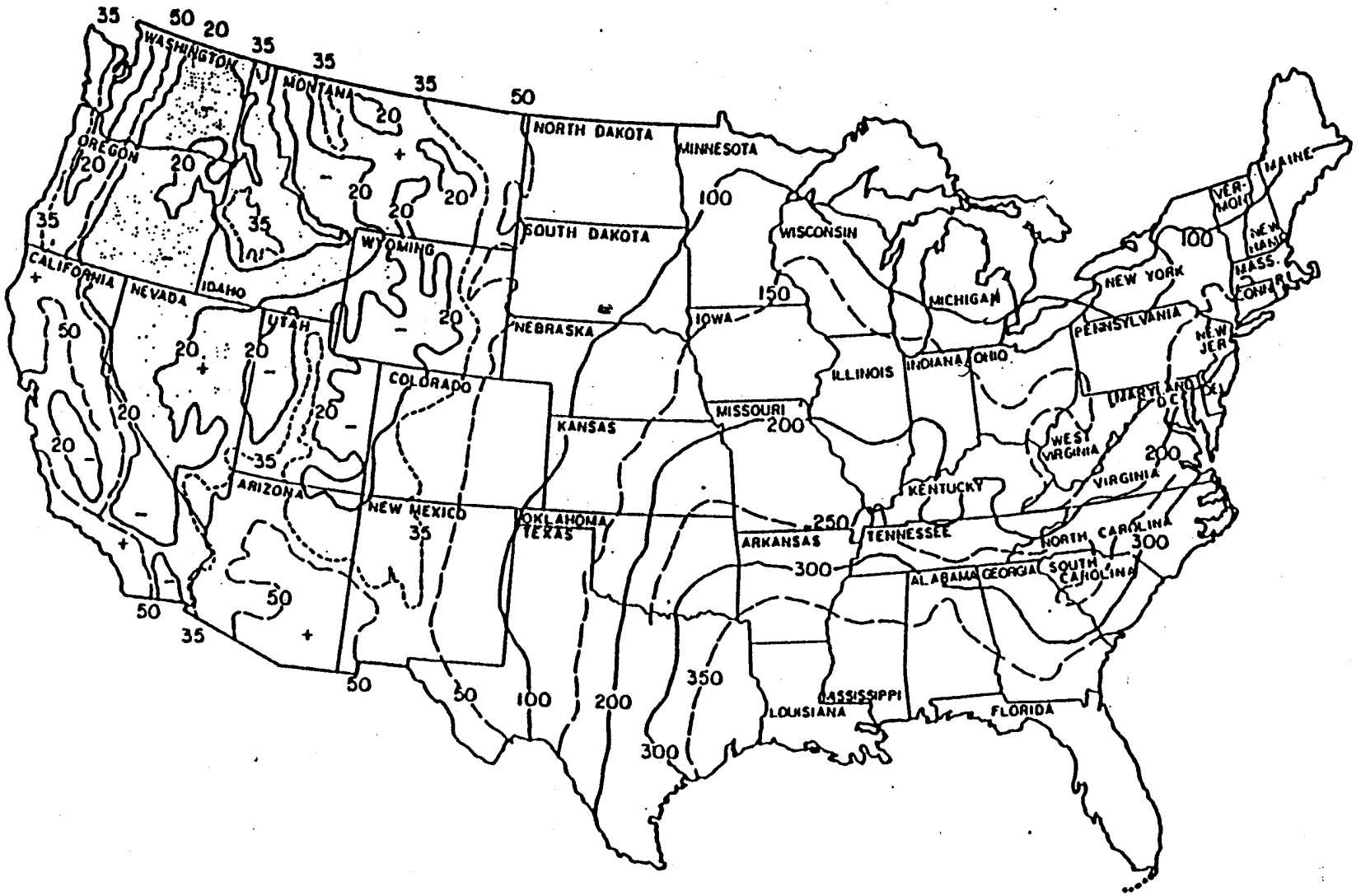


Figure 5.3. Average annual values of the rainfall-erosivity factor, R. (Stewart et al., 1975)

REF: "APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS"
BARFIELD ET AL. 1981

TABLE 7.3 Typical Soil Erodibility Factors for Use with the Universal Soil Loss Equation (K)

Soil	Soil Erodibility Factor, *K* (tons/acre per erosion index unit)
Sands and gravels	0.10
Loamy coarse sand, sand and fine sand	0.15
Loamy fine sand and loamy sand	0.17
Fine sandy loam and sandy loam, mollic	0.20
Fine sandy loam and sandy loam, nonmollic	0.24
Loam, clay loam and sandy clay loam, mollic	0.28
Loam, clay loam and sandy clay loam, nonmollic	0.32
Silt loam and silty clay loam, mollic	0.32
Silt loam and silty clay loam, nonmollic	0.37
Silt loam and silty clay loam, subsoil	0.43
Clay and silty clay, less than 50 percent clay	0.32
Clay and silty clay over 50 percent clay	0.28

Source: Wylie (1979).

TABLE 7.5 Erosion Control Practice Factor for Use with the Universal Soil Loss Equation (P)

Land Slope (percent)	Erosion Control Practice and Resulting Factor, *P* (dimensionless)		
	No Erosion Control Practice	Contouring	Terracing
1–2	1.0	0.6	0.12
3–8	1.0	0.5	0.10
9–12	1.0	0.6	0.12
13–16	1.0	0.7	0.14
17–20	1.0	0.8	0.16

Source: Wischmeier and Smith (1978) and Wylie (1979).

REF: "URBAN SURFACE WATER MANAGEMENT"
WALESH, STUART G.

TABLE 10.—*Factor C for permanent pasture, range, and idle land*[1]

Vegetative canopy		Cover that contacts the soil surface						
			Percent ground cover					
Type and height[2]	Percent cover[3]	Type[4]	0	20	40	60	80	95+
No appreciable canopy		G	0.45	0.20	0.10	0.042	0.013	0.003
		W	.45	.24	.15	.091	.043	.011
Tall weeds or short brush with average drop fall height of 20 in	25	G	.36	.17	.09	.038	.013	.003
		W	.36	.20	.13	.083	.041	.011
	50	G	.26	.13	.07	.035	.012	.003
		W	.26	.16	.11	.076	.039	.011
	75	G	.17	.10	.06	.032	.011	.003
		W	.17	.12	.09	.068	.038	.011
Appreciable brush or bushes, with average drop fall height of 6½ ft	25	G	.40	.18	.09	.040	.013	.003
		W	.40	.22	.14	.087	.042	.011
	50	G	.34	.16	.08	.038	.012	.003
		W	.34	.19	.13	.082	.041	.011
	75	G	.28	.14	.08	.036	.012	.003
		W	.28	.17	.12	.078	.040	.011
Trees, but no appreciable low brush. Average drop fall height of 13 ft	25	G	.42	.19	.10	.041	.013	.003
		W	.42	.23	.14	.089	.042	.011
	50	G	.39	.18	.09	.040	.013	.003
		W	.39	.21	.14	.087	.042	.011
	75	G	.36	.17	.09	.039	.012	.003
		W	.36	.20	.13	.084	.041	.011

[1] The listed C values assume that the vegetation and mulch are randomly distributed over the entire area.

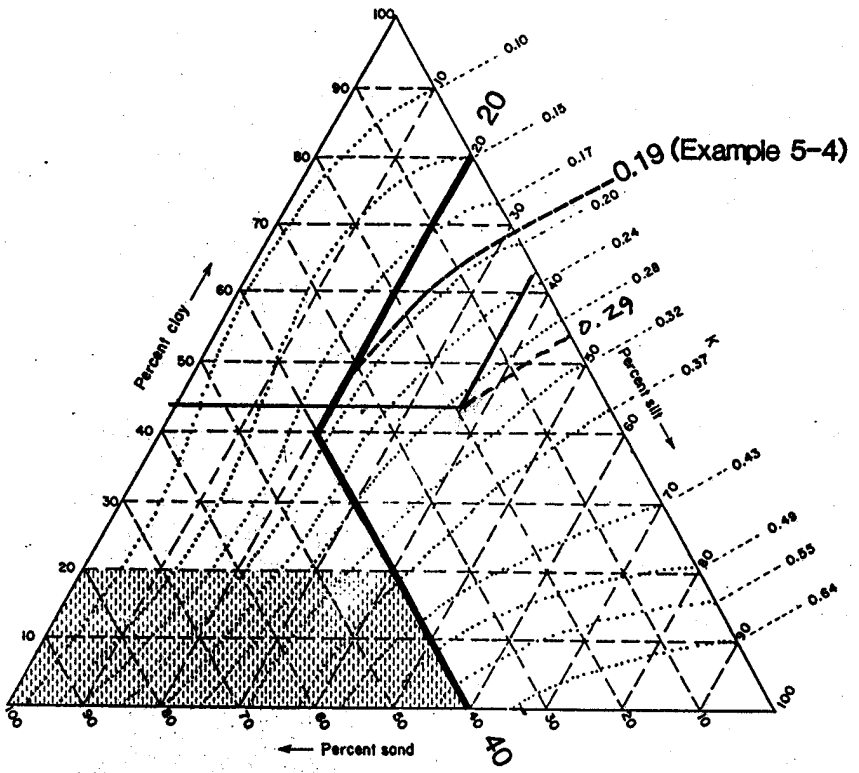
[2] Canopy height is measured as the average fall height of water drops falling from the canopy to the ground. Canopy effect is inversely proportional to drop fall height and is negligible if fall height exceeds 33 ft.

[3] Portion of total-area surface that would be hidden from view by canopy in a vertical projection (a bird's-eye view).

[4] G: cover at surface is grass, grasslike plants, decaying compacted duff, or litter at least 2 in deep.

W: cover at surface is mostly broadleaf herbaceous plants (as weeds with little lateral-root network near the surface) or undecayed residues or both.

REF: "PREDICTING RAINFALL EROSION LOSSES"
USDA, AG HANDBOOK #537, 1978

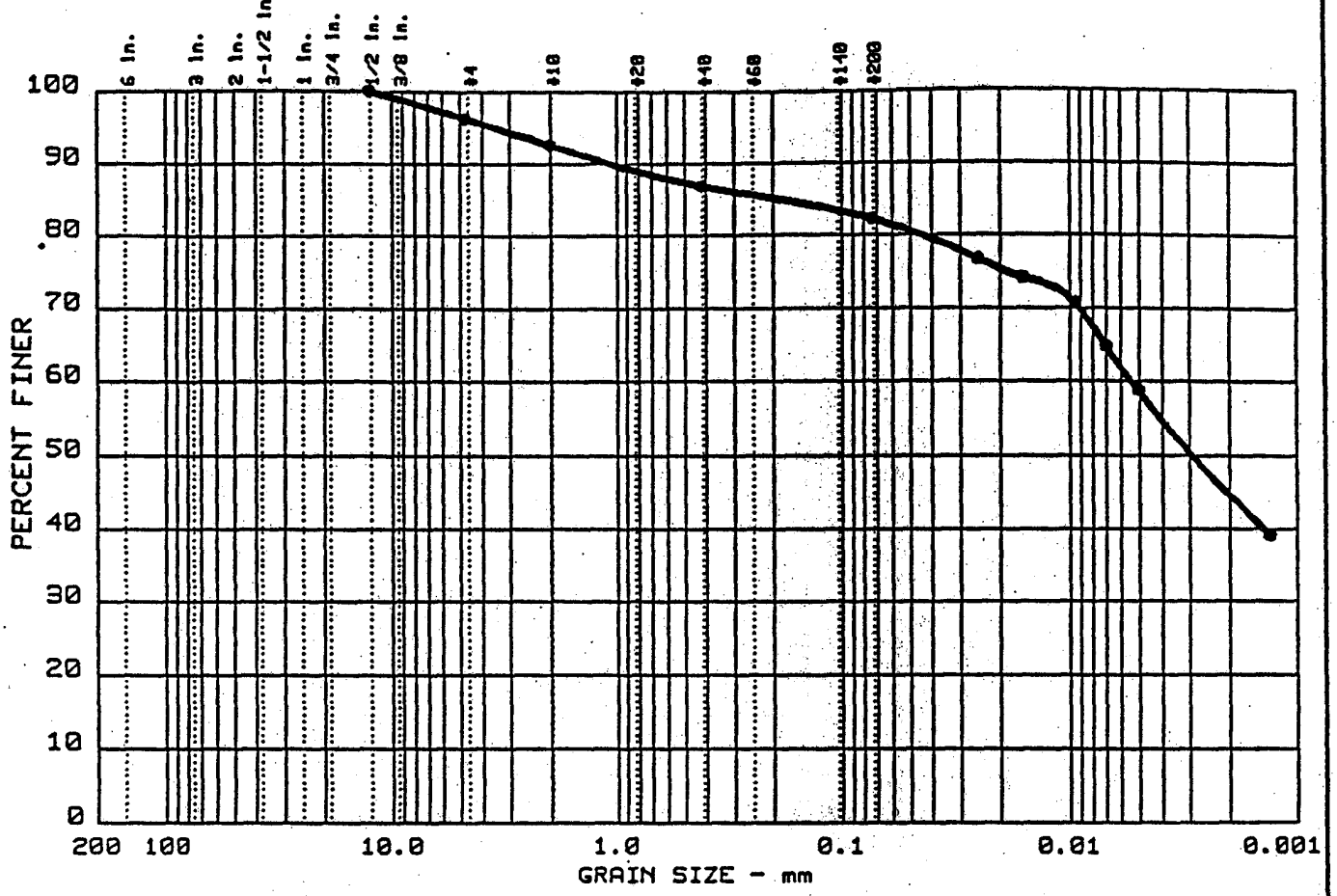


SB10
CLAY = 44.7%
SILT = 37.5%
SAND & GRAV = 17.8%

Fig. 5.6 Triangular nomograph for estimating K value. (6) See Table 5.3 for adjustments to K value under certain conditions.

REF: "EROSION & SEDIMENT CONTROL HANDBOOK"
BY GOLDMAN, JACKSON, BURSZTYNSKY, 1986.

PARTICLE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	3.8	14.0	37.5	44.7	CH	57.8	34.5

SIEVE inches size	PERCENT FINER ●		
0.5	100.0		
GRAIN SIZE			
D_{60}			
D_{30}			
D_{10}			
COEFFICIENTS			
C_c			
C_u			

SIEVE number size	PERCENT FINER ●		
4	96.2		
10	92.5		
40	86.7		
200	82.2		

Sample Information:
● SB10-0 @ 0-1'
BROWN FAT CLAY WITH SAND

Remarks:
LF-2

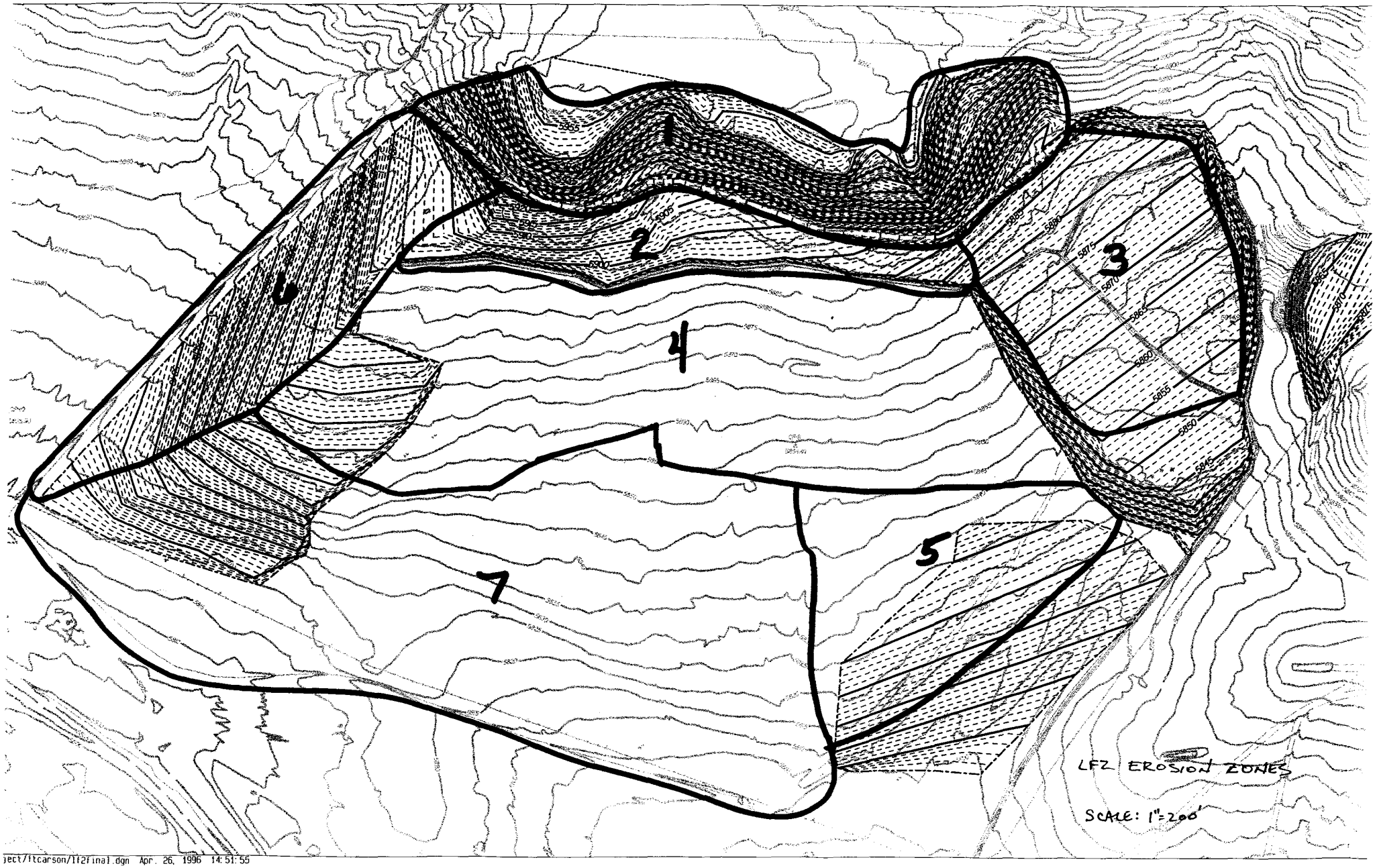
RAN BY: KLR
OTHERS-GR01

RUST ENVIRONMENT & INFRASTRUCTURE

Project No.: 89868.300
Project: FORT CARSON

Date: 07.28.95 Lab. No.430

Fig. C-5



ject/ftcarson/lf2final.dgn Apr. 26, 1996 14:51:55

APPENDIX K
REAL TIME AIR MONITORING

OHM Corporation

REAL TIME AIR MONITORING LOG

F.T. CARSON

PROJECT # 18504

DATE: 2-5-96
DAY: MONDAY
BACKGROUND: Ø
PID: Ø
MINI-RAM: Ø

TEMPERATURE: 50°
REL. HUMIDITY: 20%

MICROTIP - PID NO. R5555
GASTECH - CGI/O_2#: HCX 3Ø92/R6799
GASTECH - MONITOX#: H_2S/CO
MINI-RAM - RAM#: 5635
OTHER:

INSTRUMENT USED	TIME OF DAY	METER READING	SAMPLING DURATION	LOCATION	LINEAR DIST. DEPTH ~~PPE~~	TASK PERFORMED
GASTECH/MICROTIP MINI-RAM	13ØØ	BACKGROUND	6ØSEC	LF6/T12 SAMPLE 3	LD 0' 1½' Depth	TRENCHING
	1316			LF6/T13 Sample 1	LD 8' 1' depth	
	1318			LF6/T13 Sample 2	LD 0' 1' Depth	
	132Ø			LF6/T13 Sample 3	LD 8' BUCKET	
	14~~8~~45			LF2/TØ1 Sample 1	LD 0' 2' Depth	
	1447			LF2/TØ1 Sample 2	LD 50' 2' Depth	
	15Ø5			LF2/TØ1 Sample 3	LD 100' 2' Depth	
	15Ø8			LF2/TØ1 Sample 4	LD 135' 4' Depth	
	1537			LF2/TØ1 Sample 5	LD 200' 5' Depth	
	1619			LF2/TØ2 Sample 1	LD 0' 2' Depth	
	1621			LF2/TØ2 Sample 2	LD 5' 2' Depth	

PERFORMED BY:

SIGNATUR

NOTES:

OHM Corporation

REAL TIME AIR MONITORING LOG

FT. CARSON

PROJECT # 18504

DATE: 2-5-96
DAY: MONDAY
BACKGROUND: Ø
PID: Ø
MINI-RAM: Ø

TEMPERATURE: 50°
REL. HUMIDITY: 2Ø%

microTip - PID NO. R5555
GASTECH < CGI/O_2#: HCX 3ØØ2/R6799
MONITOX#: H_2S / CO
mini-RAM - RAM#: 5635
OTHER:

INSTRUMENT USED	TIME OF DAY	METER READING	SAMPLING DURATION	LOCATION	LINEAR DIST. DEPTH ~~PPE~~	TASK PERFORMED
GASTECH/mini-MICROTIP/ RAM	164Ø	BACKGROUND	6Ø SEC	LF2/TØ3 Sample 1	LD 0' 2½' Depth	TRENCHING
	1642			LF2/TØ3 Sample 2	LD 5' 2½' Depth	
	1644			LF2/TØ3 Sample 3	LD 21' 2½ Depth	

PERFORMED BY: _____

SIGNATUR _____

NOTES:

OHM Corporation

REAL TIME AIR MONITORING LOG

FT. CARSON

PROJECT # 18504

DATE: 6 FEB 96
DAY: Tues Sunny - Warm - dry
BACKGROUND: Ø
PID: Ø
MINI-RAM: Ø

TEMPERATURE: 60°
REL. HUMIDITY: 20%

MICROTIP — PID NO. R5555
GASTECH — CGI/O_2#: HCX30Ø2/R6799
MONITOX#: H_2S/CO
MINIRAM — RAM#: 5635
OTHER:

INSTRUMENT USED	TIME OF DAY	METER READING	SAMPLING DURATION	LOCATION	LINEAR DIST DEPTH	TASK PERFORMED
MICROTIP / MINI-RAM GASTECH	Ø822	Background	6ØSEC	LF2/TØ4 Sample 1	LD 0' 3' DEPTH	TRENCHING
	Ø824	Background		LF2/TØ4 Sample 2	LD 20' 3' depth	
	Ø842	Background		LF2/TØ4 Sample 3	LD 49' 1' depth (Trench bound)	
	Ø918	Background		LF2/TØ5 Sample 1	LD 0' 3' depth	
	Ø922	Background		LF2/TØ5 Sample 2	LD 20' 3' depth	
	Ø937	Background		LF2/TØ5 Sample 3	LD 40' 3' depth	
	Ø94Ø	Background		LF2/TØ5 Sample 4	LD 40' BUCKET	Trench 1' depth LD 40'
	Ø958	Background		LF2/TØ6 Sample 1	LD 0' 3' depth	
	1Ø15	Background		LF2/TØ6 Sample 2	LD 50' 4' Depth	
	1Ø3Ø	Background		LF2/TØ6 Sample 3	LD 66' 2' depth	Trench
	1Ø32	Background		LF2/TØ6 Sample 4	LD 66' BUCKET	

PERFORMED BY: GARY METZE 6653

NOTES:

OHM Corporation

REAL TIME AIR MONITORING LOG

FT. CARSON

PROJECT # 18504

DATE: 6 FEB 96
DAY: Sunny/Cool/Dry
BACKGROUND: Ø
PID: Ø
MINI-RAM: Ø

TEMPERATURE: 50°
REL. HUMIDITY: 20%

MICROTIP — PID NO. R5555
GASTECH — CGI/O_2#: HCX3002/R6799
MONITOX#: H2S/CO
MINI-RAM RAM#: 5635
OTHER: NA

INSTRUMENT USED	TIME OF DAY	METER READING	SAMPLING DURATION	LOCATION	LINEAR DIST DEPTH ~~PID~~	TASK PERFORMED
MICROTIP / MINI-GASTECH / MINI-RAM	1120	Background	60 SEC	LF2/TØ7 Sample 1	LD 0' 5' depth	TRENCHING
	1125	Background		LF2/TØ7 Sample 2	LD 20' 5' depth	
	1145	Background		LF2/TØ7 Sample 3 (From Fence)	LD 30' 2' depth	Trench
	1400	Background		LF2/TØ5 Sample 1	LD 0' 2' depth	
	1403	Background		LF2/TØ5 Sample 2	LD 30' 2' depth	
	1405	Background		LF2/TØ5 Sample 3	LD 65' 2' depth	
	1443	Background		LF2/TØ9 Sample 1	LD 0' 2½' depth	
	1445	Background		LF2/TØ9 Sample 2	LD 30' 2½' depth	
	1449	Background		LF2/TØ9 Sample 3	LD 60' 2½' depth	
	1540	Background		LF2/T10 Sample 1	LD 0' 5' depth	
	1545	Background		LF2/T10 Sample 2	LD 24' 1' depth	

PERFORMED BY: GARY METZE 6653

NOTES:

OHM Corporation

REAL TIME AIR MONITORING LOG

FT. CARSON

PROJECT # 18504

DATE: 7 FEB 96
DAY: WED. PC - COOL - DRY
BACKGROUND: Ø
PID: Ø
MINI-RAM: Ø

TEMPERATURE: 60°
REL. HUMIDITY: 20°

MICROTIP - PID NO. R5555
GASTECH < CGI/O_2#: HCX3002/R6799
MONITOX#: H_2S / CO
MINI-RAM RAM#: 5635
OTHER: NA

INSTRUMENT USED	TIME OF DAY	METER READING	SAMPLING DURATION	LOCATION	LINEAR DIST DEPTH	TASK PERFORMED
~~MICROTIP~~ GASTECH / ~~MINI RAM~~	Ø835	Background	6ØSEC	LF2/T11 Sample 1	LD 0' 2½ DEPTH	TRENCHING
	Ø837	Background		LF2/T11 Sample 2	LD 35' 2½ DEPTH	
	Ø839	Background		LF2/T11 Sample 3	LD 71' 2½ DEPTH	(NO TRASH)
GASTECH/MICROTIP	1Ø18	Background		LF2/T12 Sample 1	LD 0' 2½' Depth	
	1Ø2Ø	Background		LF2/T12 Sample 2	LD 25' 4' Depth	
	1Ø22	Background		LF2/T12 Sample 3	LD 50' 5' Depth	
	1Ø36	Background		LF2/T12 Sample 4	LD 100' 3' depth	(No Trash)
	1Ø55	Background		LF2/T12 Sample 5	LD 200' 3' depth	
	1355	Background		LF2/T13 Sample 1	LD 0' 2' Depth	
	14Ø5	Background		LF2/T13 Sample 2	LD 25' 2' Depth	
	1412	Background		LF2/T13 Sample 3	LD 59' 1' Depth	(Trash)

PERFORMED BY: GARY METZE 6653
1 mt

NOTES:- MICROTIP WILL NOT HOLD CHARGE. (BOTH BATTERIES DEAD)
MINI RAM WILL NOT

OHM Corporation

REAL TIME AIR MONITORING LOG

FT. CARSON

PROJECT # 18504

DATE: 7 FEB 96
DAY: WED SUNNY - WARM - DRY
BACKGROUND: Ø
PID: Ø
MINI-RAM: Ø

TEMPERATURE: 60°
REL. HUMIDITY: 20%

MICROTIP - PID NO. R5555
GASTECH < CGI/O_2#: HCX 3002/R6799
MONITOX#: H_2S / CO
MINIRAM - RAM#: 5635
OTHER: NA

INSTRUMENT USED	TIME OF DAY	METER READING	SAMPLING DURATION	LOCATION	LINEAR DIST. DEPTH ~~PPB~~	TASK PERFORMED
GASTECH / MICRO-TIP	1445	Background	60 SEC	LF2/T14 Sample 1	LD 0' 2' depth	TRENCHING
	1450	Background		LF2/T14 Sample 2	LD 20' 2' depth	
	1454	Background		LF2/T14 Sample 3	LD 41' 2' depth	(No Trash)
	1521	Background		LF2/T15 Sample 1	LD 0' 2' depth	
	1523	Background		LF2/T15 Sample 2	LD 25' ~~29~~ depth	
	1525	Background		LF2/T15 Sample 3	LD 54' 2' depth	(No Trash)
	1605	Background		LF2/T16 Sample 1	LD 0' 2½' Depth	(Trash)
	1635	Background		LF2/T16 Sample 2	LD 35' 2½ depth	
	1637	Background		LF2/T16 Sample 3	LD 35' Bucket	

PERFORMED BY: GARY METZE 6653
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NOTES:
see Page 1

OHM Corporation

REAL TIME AIR MONITORING LOG

FT. CARSON

PROJECT # 18504

DATE: 8 FEB 96
DAY: THURS - PC - COOL - DRY
BACKGROUND: Ø
PID: Ø
MINI-RAM: Ø

TEMPERATURE: 45°
REL. HUMIDITY: 17%

GASTECH
PID NO. NA
CGI/O_2#: NXC3ØØ2/R6799
MONITOX#: H2S / CO
RAM#: NA
OTHER: NA

INSTRUMENT USED	TIME OF DAY	METER READING	SAMPLING DURATION	LOCATION	LINEAR DIST DEPTH	TASK PERFORMED
GASTECH	Ø8Ø5	Background	6ØSEC	LF2/T17 Sample 1	LD 0' 4½' Depth	TRENCHING
	Ø811	Background		LF2/T17 Sample 2	LD 18' 4½' Depth	
	Ø813	Background		LF2/T17 Sample 3	LD 18' Bucket (Trash @ LD 15', 1' depth)	
	Ø9Ø3	Background		LF2/T18 Sample 1	LD 0' 4½ depth	
	Ø93Ø	Background		LF2/T18 Sample 2	LD 50' 4 depth	
	Ø95Ø	Background		LF2/T18 Sample 3	LD 100' 4 depth	
	1Ø25	Background		LF2/T18 Sample 4	LD 150' 4 depth	
	1Ø57	Background		LF2/T18 Sample 5	LD 200' 8 depth	
	1345	Background		LF2/T18 Sample 6	LD 250' 2½ depth (Trash)	
	1348	Background		LF2/T18 Sample 7	LD 250' Bucket	
	1435	Background		LF2T19 Sample 1	LD 0' 2½' depth	

PERFORMED BY: GARY METZE 6653

SIGNATURE: [signature]

NOTES:

OHM Corporation

REAL TIME AIR MONITORING LOG

FT. Carson

PROJECT # 18504

DATE: 8 FEB96
DAY: Thurs PC - Cool - Dry
BACKGROUND: Ø
PID: Ø
MINI-RAM: Ø

TEMPERATURE: 55°
REL. HUMIDITY: 17%

PID NO. NA
GASTECH CGI/O_2#: HCX3402/R6799
MONITOX#: H_2S/CO
RAM#: NA
OTHER: NA

INSTRUMENT USED	TIME OF DAY	METER READING	SAMPLING DURATION	LOCATION	DEPTH ~~PPM~~ (LINEAR DIST)	TASK PERFORMED
GASTECH	1455	Background	60SEC	LF2/T19 Sample 2	LD 50' 2½' Depth	TRENCHING
	1515	Background		LF2/T19 Sample 3	LD 100' 7' Depth	(Trench)

PERFORMED BY: GARY METZE 6653

SIGNATUR Gary Metze

NOTES:

OHM Corporation

REAL TIME AIR MONITORING LOG

FT. CARSON

PROJECT # 18504

DATE: 12 FEB 96
DAY: MON - SUNNY - COOL - DRY
BACKGROUND: Ø
PID: 3
MINI-RAM: Ø

TEMPERATURE: 50°
REL. HUMIDITY: 17%

GASTECH

PID NO. NA
CGI/O_2#: HCX 366/R6799
MONITOX#: H_2S / CO
RAM#: NA
OTHER: NA

INSTRUMENT USED	TIME OF DAY	METER READING	SAMPLING DURATION	LOCATION	LINEAR DIST DEPTH	TASK PERFORMED
GASTECH	Ø732	Background	60 SEC	LF6/TØ5A Sample 1	LD 11' 12' depth	TRENCHING
	Ø745	Background		LF6/TØ5A Sample 2	LD 0" 12' Depth	
	Ø758	Background		LF6/TØ6A Sample 1	LD 0' 10½ depth	
	Ø8Ø1	Background		LF6/TØ6A Sample 2	LD 11' 10½ depth	
	Ø812	Background		LF6/TØ7A Sample 1	LD 0" 12' depth	
	0815	Background		LF6/TØ7A Sample 2	LD 10" 12' depth	
	Ø83Ø	Background		LF6/TØ8A Sample 1	LD 0" 11' depth	
	Ø833	Background		LF6/TØ8A Sample 2	LD 10' 11' depth	
	Ø92Ø	Background		LF2/TØ2A Sample 1	LD 0" 3' depth	
	Ø925	Background		LF2/TØ2A Sample 2	LD 26' 18" depth	
	Ø933	Background		LF2/TØ2B Sample 1	LD 0' 2' depth	

PERFORMED BY: GARY METZE 6653

SIGNATURE: Gary Metze

NOTES:

OHM Corporation

REAL TIME AIR MONITORING LOG

FT. CARSON

PROJECT # 18504

DATE: 12 FEB 96
DAY: MON - SUNNY - COOL - DRY
BACKGROUND: Ø
PID: Ø
MINI-RAM: Ø

TEMPERATURE: 5Ø°
REL. HUMIDITY: 17%

GASTECH
PID NO. NA
CGI/O_2#: HCX 3ØØ2/R6799
MONITOX#: H_2S/ CO
RAM#: NA
OTHER: NA

INSTRUMENT USED	TIME OF DAY	METER READING	SAMPLING DURATION	LOCATION	LINEAR DIST DEPTH ~~PPB~~	TASK PERFORMED
GASTECH	0937	Background	6ØSEC	LF2/TØ2B Sample 2	LD 7' BUCKET	TRENCHING
	1ØØØ	Background		LF2/TØ2B Sample 3	LD 7' 8' depth	
	1ØØ2	Background		LF2/TØ2B Sample 4	LD 7' Bucket	
	1Ø15	Background		LF2/TØ3A - Sample 1	LD 0' Bucket	
	1Ø18	Background		LF2/TØ3A - Sample 2	LD 6' 5' depth	
	1Ø3Ø	Background		LF2/T2Ø Sample 1	LD 0' 1' depth	
	1Ø32	Background		LF2/T2Ø Sample 2	LD 14' 1' depth	
	1Ø4Ø	Background		LF2/T2Ø Sample 3	LD 0' 4½' depth	
	1Ø44	Background		LF2/T2Ø Sample 4	LD 0' Bucket	
	1112	Background		LF2/T21 Sample 1	LD 0' 4' depth	
	1116	Background		LF2/T21 Sample 2	LD 23 4' depth	

PERFORMED BY: GARY METZE 6653

SIGNATUR: Gary Metz

NOTES:

OHM Corporation

REAL TIME AIR MONITORING LOG

FT. CARSON

PROJECT # 18504

DATE: 12 Feb 96
DAY: MON - SUNNY - COOL - DRY
BACKGROUND: Ø
PID: Ø
MINI-RAM: Ø

TEMPERATURE: 50°
REL. HUMIDITY: 17%

GASTECH
PID NO. NA
CGI/O_2#: HCX 3ØØ2/R6799
MONITOX#: H_2S / CO
RAM#: NA
OTHER: NA

INSTRUMENT USED	TIME OF DAY	METER READING	SAMPLING DURATION	LOCATION	~~DEPTH~~ LINEAR DIST. ~~PPE~~	TASK PERFORMED
GASTECH	1119	Background	6Ø SEC	LF2/T21 Sample 3	LD 23' Bucket	TRENCHING
	1135	Background		LF2/T21 Sample 4	LD 25' 5' depth	
	134Ø	Background		LF2/T22 Sample 1	LD Ø' 4' Depth	
	1342	Background		LF2/T22 Sample 2	LD 16' 2' depth	
	1345	Background		LF2/T22 Sample 3	LD 26' Drum	
	14Ø5	Background		LF2/T22 Sample 4	LD 30' 4' depth	
	1415	Background		LF2/T22 Sample 5	LD 41' 5' Depth	
	1418	Background		LF2/T22 Sample 6	LD 41' Bucket	
	15ØØ	Background		T23 Sample 1	LD Ø' 4' depth	
	15Ø3	Background		/T23 Sample 2	LD 25' 5' depth	
	1518	Background		/T23 Sample 3	LD 50' 5½ depth	

PERFORMED BY: GARY METZE 6653

SIGNATUR Gary Metze

NOTES:

OHM Corporation

REAL TIME AIR MONITORING LOG

FT. CARSON

PROJECT # 18504

DATE: 12 FEB 96
DAY: MON - SUNNY - COOL - DRY
BACKGROUND: Ø
PID: Ø
MINI-RAM: Ø

TEMPERATURE: 55°
REL. HUMIDITY: 17%

PID NO. NA
CGI/O_2#: HCX3002/R6799
MONITOX#: H_2S / CO
RAM#: NA
OTHER: NA

INSTRUMENT USED	TIME OF DAY	METER READING	SAMPLING DURATION	LOCATION	LINEAR DIST DEPTH ~~PPM~~	TASK PERFORMED
GASTECH	1529	Background	60 SEC	LF2/T23 Sample 4	LD 75' 5' depth	TRENCHING
	1536	Background		LF2/T23 Sample 5	LD 100' 3' depth	
	1541	Background		LF2/T23 Sample 6	138' LD 1' depth (Trench)	
	1544	Background		LF2/T23 Sample 7	138' LD Bucket	
	1619	Background		LF2/T24 Sample 1	LD 0' 2' depth trench	
	1633	Background		LF2/T24 Sample 2	LD 0' 1-3' depth Trench	
	1650	Background		LF2/T24 Sample 3	LD 0' 7' depth (1-3' trench)	

PERFORMED BY: GARY METZE 6653

SIGNATUR Gary Metze

NOTES:

APPENDIX L
SURFACE WATER CALCULATIONS

L1: CONCRETE CHANNEL
PART A: PEAK FLOWS
PART B: CHANNEL DEPTHS AND VELOCITIES

L2: WEST DOWNSLOPE CHANNEL
PART A: PEAK FLOWS
PART B: CHANNEL DEPTHS AND VELOCITIES

L3: SOUTHEAST DIVERSION BERM
PART A: PEAK FLOWS
PART B: CHANNEL DEPTHS AND VELOCITIES

L4: REFERENCES

L5: EXISTING CONCRETE CHANNEL DESIGN

L1: CONCRETE CHANNEL
PART A: PEAK FLOWS

CLIENT USACE SUBJECT Concrete Channel Prepared By MNW Date 5/2/96
PROJECT Fort Carson Landfill 2 Peak Flows Reviewed By MK Date 5/2/96
Approved By ____ Date ____

Objective

Determine peak flows from the subwatersheds tributary to the existing concrete channel that discharges flow southeast of the final cap. Diversion berms, diversion channels, and downslope channels are included within the tributary areas.

Design Assumptions

- Design permanent drainage structures to handle the 10 yr-24hr and100 yr- 24 hr rainfall event of 3.0 inches and 4.6 inches, respectively.
- Use Soil Conservation Service (SCS) Type IIA storm distribution.
- Drainage areas delineated using proposed final cover grades and existing topography. The watershed for the drainage channel has been delineated into 12 subwatershed areas. The 12 areas were defined by determining what locations we needed to know peak flows for further design calculations (need for erosion protection, etc..).
- All drainage areas are assumed to have a SCS Curve Number of 79. See the attached curve number reference.
- SEDCAD, a surface water design program created at the University of Kentucky, was used to determine the peak flows. In summary, the software utilizes watershed characteristics (area, CN, time of concentrations,) to determine peak flow. The unit hydrograph method, SCS upland curve method to determine t_c, SCS curve number method to determine runoff volumes, and Muskingum's method for channel routing are all used within the program to determine peak flow.

Calculations

See the attached output for both storm events. The subwatershed/structure input/output page summarizes design information and states peak flows and runoff volumes. There is one page for each storm event. The detailed subwatershed input/output table shows individual watershed characteristics that were used to calculate time of concentrations and channel routing parameters. One page is representative of both storm events.

Conclusions

The peak flows for both storm events are summarized on the next page.

RUST **Rust Environment & Infrastructure**

CALCULATION SHEET

PROJECT NO. 89868

CLIENT USACE

PROJECT FTC LF2

SUBJECT SUMMARY OF DESIGN FLOWS

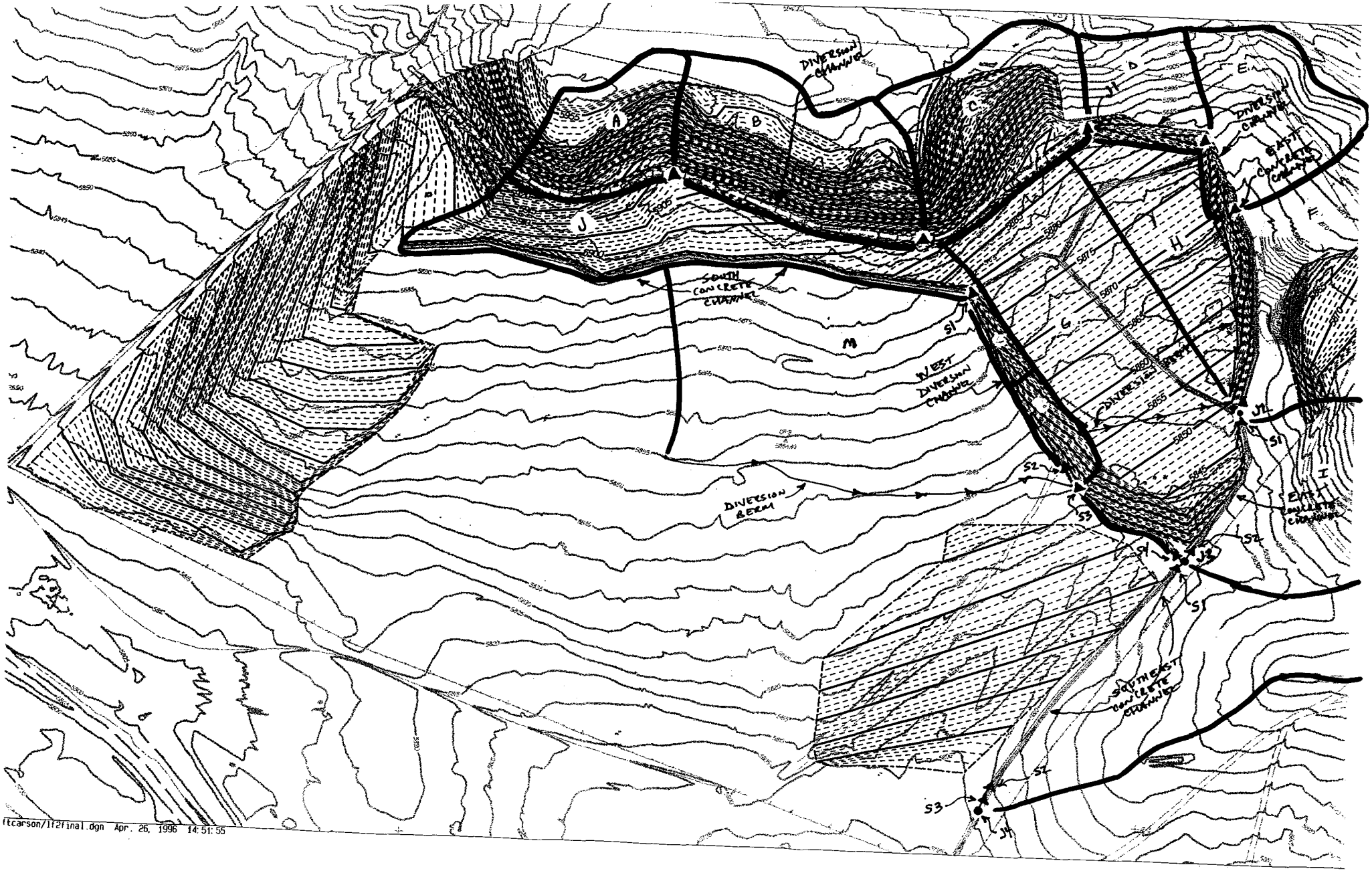
Prepared By MWW Date 5/2/96

Reviewed By MKV Date 5/2/96

Approved By _____ Date _____

DESIGN FLOWS

AREA	10 YR-24HR PEAK FLOW, CFS	100 YR-24HR PEAK FLOW, CFS	COMMENTS
j → n	23.76	49.76	DIVERSION CHANNEL
a → n	94.54	191.71	CONCRETE CHANNEL
a → o	115.97	233.64	CONCRETE CHANNEL


DIVERSION CHANNEL
A
B
C
D
E
F
G
H
I
J
M
P
5900
5895
5890
5885
5880
5875
5870
5865
5860
5855
5850
5845
SOUTH CONCRETE CHANNEL
WEST DIVERSION CHANNEL
DIVERSION BERM
EAST CONCRETE CHANNEL
SOUTHEAST CONCRETE CHANNEL
S1
S2
S3
J1
J2
J3
rtcarson/1f2final.dgn Apr. 26, 1996 14:51:55

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

WATERSHEDS TRIBUTARY TO CONCRETE CHANNEL

by

Name: mww

Company Name: RUST E & I
File Name: C:\SEDCAD3\FTC\LF2\CONC

Date: 05-01-1996

Civil Software Design -- SEDCAD+ Version 3.1
Copyright (C) 1987-1992. Pamela J. Schwab. All rights reserved.

Company Name: RUST E & I
Filename: C:\SEDCAD3\FTC\LF2\CONC User: mww
Date: 05-01-1996 Time: 12:14:12
Watersheds tributary to concrete channel
Storm: 3.00 inches, 10 year-24 hour, SCS Type IIA
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	4.20	79	M	0.080	0.000	0.000	0.0	0.42	8.65
		Type: Null Label: area a								
111	Structure	4.20							0.42	
111	Total IN/OUT	4.20							0.42	8.65
112	1	2.50	79	M	0.081	0.000	0.000	0.0	0.25	5.15
		Type: Null Label: area b								
112	Structure	2.50							0.66	
112	Total IN/OUT	6.70							0.66	13.09
111 to 112 Routing						0.052	0.284			
113	1	3.60	79	M	0.076	0.000	0.000	0.0	0.36	7.42
		Type: Null Label: area c								
113	Structure	3.60							1.02	
113	Total IN/OUT	10.30							1.02	19.00
112 to 113 Routing						0.061	0.281			
211	1	1.80	79	M	0.053	0.000	0.000	0.0	0.18	3.71
		Type: Null Label: area d								
211	Structure	1.80							1.20	
211	Total IN/OUT	12.10							1.20	22.71
113 to 211 Routing						0.034	0.295			
212	1	3.10	79	M	0.038	0.000	0.000	0.0	0.31	6.39
		Type: Null Label: area e								
212	Structure	3.10							1.51	
212	Total IN/OUT	15.20							1.51	29.10
211 to 212 Routing						0.010	0.365			
213	1	8.90	79	M	0.062	0.000	0.000	0.0	0.88	18.34

```
                          Type: Null   Label: area f
213 Structure        8.90                                          2.39
-----------------------------------------------------------------------------
213 Total IN/OUT    24.10                                          2.39    47.43
=============================================================================
212 to 213 Routing                          0.024 0.385
=============================================================================
214  1               5.30   79  M   0.150  0.000 0.000    0.0    0.52     7.72
214  2               2.80   79  M   0.124  0.000 0.000    0.0    0.28     5.77
                          Type: Null   Label: area g,h                    13.49
214 Structure        8.10                                          3.19
-----------------------------------------------------------------------------
214 Total IN/OUT    32.20                                          3.19    59.45
=============================================================================
213 to 214 Routing                          0.000 0.000
=============================================================================
311  1               0.00    0  M   0.000  0.000 0.000    0.0    0.00     0.00
                            Type: Null   Label:
311 Structure        0.00                                          3.19
-----------------------------------------------------------------------------
311 Total IN/OUT    32.20                                          3.19    59.45
=============================================================================
214 to 311 Routing                          0.000 0.000
=============================================================================
312  1               5.50   79  M   0.048  0.000 0.000    0.0    0.54    11.33
                          Type: Null   Label: area i
312 Structure        5.50                                          3.73
-----------------------------------------------------------------------------
312 Total IN/OUT    37.70                                          3.73    70.78
=============================================================================
311 to 312 Routing                          0.036 0.331
=============================================================================
321  1               4.30   79  M   0.098  0.000 0.000    0.0    0.43     8.86
                          Type: Null   Label: area j
321 Structure        4.30                                          0.43
-----------------------------------------------------------------------------
321 Total IN/OUT     4.30                                          0.43     8.86
=============================================================================
322  1               0.40   79  M   0.015  0.022 0.348    0.0    0.04     0.82
322  2               0.60   79  M   0.026  0.000 0.000    0.0    0.06     1.24
                          Type: Null   Label: area k,l
322 Structure        1.00                                          0.52
-----------------------------------------------------------------------------
322 Total IN/OUT     5.30                                          0.52    10.92
=============================================================================
321 to 322 Routing                          0.037 0.353
=============================================================================
323  1               9.40   79  M   0.197  0.000 0.000    0.0    0.93    12.75
                          Type: Null   Label: area m
323 Structure        9.40                                          1.46
-----------------------------------------------------------------------------
323 Total IN/OUT    14.70                                          1.46    21.49
=============================================================================
322 to 323 Routing                          0.000 0.000
=============================================================================
324  1               1.10   79  M   0.054  0.000 0.000    0.0    0.11     2.27
                          Type: Null   Label: area n
324 Structure        1.10                                          1.56
-----------------------------------------------------------------------------
324 Total IN/OUT    15.80                                          1.56    23.76
```

```
==============================================================================
323 to 324 Routing                          0.032 0.313
==============================================================================
411  1                0.00     0  M   0.000  0.000 0.000    0.0    0.00     0.00
                              Type: Null   Label:
411 Structure         0.00                                          5.30
------------------------------------------------------------------------------
411 Total IN/OUT     53.50                                          5.30    94.54
==============================================================================
312 to 411 Routing                          0.000 0.000
==============================================================================
412  1               10.40    79  M   0.115  0.000 0.000    0.0    1.03    21.43
                            Type: Null   Label: area o
412 Structure        10.40                                          6.33
------------------------------------------------------------------------------
412 Total IN/OUT     63.90                                          6.33   115.97
==============================================================================
411 to 412 Routing                          0.040 0.363
==============================================================================
413  1                0.00     0  M   0.000  0.000 0.000    0.0    0.00     0.00
                              Type: Null   Label:
413 Structure         0.00                                          6.33
------------------------------------------------------------------------------
413 Total IN/OUT     63.90                                          6.33   115.97
==============================================================================
412 to 413 Routing                          0.000 0.000
==============================================================================
```

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: RUST E & I
Filename: C:\SEDCAD3\FTC\LF2\CONC User: mww
Date: 05-01-1996 Time: 12:14:12
Watersheds tributary to concrete channel
Storm: 3.00 inches, 10 year-24 hour, SCS Type IIA
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	3	225.00	17.33	2.91	0.02			
				-b	6	600.00	3.50	2.81	0.06	0.080		
1	1	2	1	-a	3	310.00	18.71	3.03	0.03			
				-b	6	425.00	2.24	2.24	0.05	0.081		
1	1	3	1	-a	3	200.00	29.50	3.80	0.01			
				-b	6	490.00	2.14	2.20	0.06	0.076		
2	1	1	1	-a	3	240.00	22.92	3.35	0.02			
				-b	6	300.00	2.67	2.45	0.03	0.053		
2	1	2	1	-a	3	280.00	16.07	2.81	0.03			
				-b	6	180.00	9.44	4.61	0.01	0.038		
2	1	3	1	-a	3	270.00	11.85	2.41	0.03			
				-b	7	350.00	7.71	5.59	0.02			
				-c	8	200.00	1.85	4.08	0.01	0.062		
2	1	4	1	-a	3	590.00	5.00	1.57	0.10			
				-b	6	350.00	2.00	2.12	0.05	0.150		
2	1	4	2	-a	3	600.00	5.00	1.57	0.11			
				-b	6	140.00	2.00	2.12	0.02	0.124		
3	1	2	1	-a	3	450.00	21.11	3.22	0.04			
				-b	8	260.00	5.77	7.21	0.01	0.048		
3	2	1	1	-a	3	165.00	18.18	2.98	0.02			
				-b	8	1170.00	1.71	3.92	0.08	0.098		
3	2	2	1	-a	6	240.00	8.33	4.33	0.02	0.015		
3	2	2	1	-1	6	310.71	6.77	3.90	0.02		0.022	0.348
3	2	2	2	-a	3	50.00	25.00	3.50	0.00			
				-b	6	310.00	6.61	3.86	0.02	0.026		
3	2	3	1	-a	3	460.00	7.61	1.93	0.07			
				-b	6	1000.00	2.00	2.12	0.13	0.197		

3 2 4 1	-a	3	100.00	5.00	1.57	0.02	
	-b	3	100.00	25.00	3.50	0.01	
	-c	6	230.00	2.17	2.21	0.03	0.054
4 1 2 1	-a	3	530.00	16.04	2.80	0.05	
	-b	7	400.00	5.00	4.50	0.02	
	-c	8	620.00	2.26	4.51	0.04	0.115

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: RUST E & I
Filename: C:\SEDCAD3\FTC\LF2\CONC User: mww
Date: 05-01-1996 Time: 12:14:35
Watersheds tributary to concrete channel
Storm: 4.60 inches, 100 year-24 hour, SCS Type IIA
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	4.20	79	M	0.080	0.000	0.000	0.0	0.86	16.93
		Type: Null Label: area a								
111	Structure	4.20							0.86	
111	Total IN/OUT	4.20							0.86	16.93
112	1	2.50	79	M	0.081	0.000	0.000	0.0	0.51	10.08
		Type: Null Label: area b								
112	Structure	2.50							1.37	
112	Total IN/OUT	6.70							1.37	26.12
111 to 112 Routing						0.052	0.284			
113	1	3.60	79	M	0.076	0.000	0.000	0.0	0.74	14.51
		Type: Null Label: area c								
113	Structure	3.60							2.11	
113	Total IN/OUT	10.30							2.11	38.68
112 to 113 Routing						0.061	0.281			
211	1	1.80	79	M	0.053	0.000	0.000	0.0	0.37	7.26
		Type: Null Label: area d								
211	Structure	1.80							2.48	
211	Total IN/OUT	12.10							2.48	45.94
113 to 211 Routing						0.034	0.295			
212	1	3.10	79	M	0.038	0.000	0.000	0.0	0.64	12.50
		Type: Null Label: area e								
212	Structure	3.10							3.12	
212	Total IN/OUT	15.20							3.12	58.44
211 to 212 Routing						0.010	0.365			
213	1	8.90	79	M	0.062	0.000	0.000	0.0	1.82	35.88

```
                          Type: Null   Label: area f
213 Structure        8.90                                                4.94
-----------------------------------------------------------------------------
213 Total IN/OUT    24.10                                                4.94    94.32
=============================================================================
212 to 213 Routing                          0.024 0.385
=============================================================================
214  1               5.30   79  M   0.150  0.000 0.000    0.0    1.09    16.25
214  2               2.80   79  M   0.124  0.000 0.000    0.0    0.57    11.29
                         Type: Null   Label: area g,h                      27.54
214 Structure        8.10                                                6.60
-----------------------------------------------------------------------------
214 Total IN/OUT    32.20                                                6.60   119.77
=============================================================================
213 to 214 Routing                          0.000 0.000
=============================================================================
311  1               0.00    0  M   0.000  0.000 0.000    0.0    0.00     0.00
                            Type: Null   Label:
311 Structure        0.00                                                6.60
-----------------------------------------------------------------------------
311 Total IN/OUT    32.20                                                6.60   119.77
=============================================================================
214 to 311 Routing                          0.000 0.000
=============================================================================
312  1               5.50   79  M   0.048  0.000 0.000    0.0    1.13    22.17
                          Type: Null   Label: area i
312 Structure        5.50                                                7.73
-----------------------------------------------------------------------------
312 Total IN/OUT    37.70                                                7.73   141.94
=============================================================================
311 to 312 Routing                          0.036 0.331
=============================================================================
321  1               4.30   79  M   0.098  0.000 0.000    0.0    0.88    17.34
                          Type: Null   Label: area j
321 Structure        4.30                                                0.88
-----------------------------------------------------------------------------
321 Total IN/OUT     4.30                                                0.88    17.34
=============================================================================
322  1               0.40   79  M   0.015  0.022 0.348    0.0    0.08     1.61
322  2               0.60   79  M   0.026  0.000 0.000    0.0    0.12     2.42
                         Type: Null   Label: area k,l
322 Structure        1.00                                                1.09
-----------------------------------------------------------------------------
322 Total IN/OUT     5.30                                                1.09    21.37
=============================================================================
321 to 322 Routing                          0.037 0.353
=============================================================================
323  1               9.40   79  M   0.197  0.000 0.000    0.0    1.93    26.91
                          Type: Null   Label: area m
323 Structure        9.40                                                3.01
-----------------------------------------------------------------------------
323 Total IN/OUT    14.70                                                3.01    45.33
=============================================================================
322 to 323 Routing                          0.000 0.000
=============================================================================
324  1               1.10   79  M   0.054  0.000 0.000    0.0    0.23     4.43
                          Type: Null   Label: area n
324 Structure        1.10                                                3.24
-----------------------------------------------------------------------------
324 Total IN/OUT    15.80                                                3.24    49.76
```

```
==============================================================================
323 to 324 Routing                          0.032 0.313
==============================================================================
411  1                0.00     0  M   0.000  0.000 0.000    0.0    0.00     0.00
                              Type: Null   Label:
411 Structure         0.00                                          10.97
------------------------------------------------------------------------------
411 Total IN/OUT     53.50                                          10.97   191.71
==============================================================================
312 to 411 Routing                          0.000 0.000
==============================================================================
412  1               10.40    79  M   0.115  0.000 0.000    0.0    2.13    41.93
                           Type: Null   Label: area o
412 Structure        10.40                                          13.10
------------------------------------------------------------------------------
412 Total IN/OUT     63.90                                          13.10   233.64
==============================================================================
411 to 412 Routing                          0.040 0.363
==============================================================================
413  1                0.00     0  M   0.000  0.000 0.000    0.0    0.00     0.00
                              Type: Null   Label:
413 Structure         0.00                                          13.10
------------------------------------------------------------------------------
413 Total IN/OUT     63.90                                          13.10   233.64
==============================================================================
412 to 413 Routing                          0.000 0.000
==============================================================================
```

L1: CONCRETE CHANNEL
PART B: CHANNEL DEPTHS AND VELOCITIES

RUST ENVIRONMENT & INFRASTRUCTURE

CALCULATION SHEET

PROJECT NO. 89868

CLIENT USACE SUBJECT Channel Depths and Velocities

PROJECT Fort Carson Landfill 2

Prepared By MWW Date 5/2/96

Reviewed By [illegible] Date 5/2/96

Approved By ____ Date ____

Objectives

Determine depth and velocity of flow along the existing concrete channel, diversion channels, diversion berms, and downslope channels.

Design Assumptions

- Design for a 100 yr-24 hr storm event.
- Use peak flows calculated from SEDCAD.
- The concrete channel has a trapezoidal cross section, varies in depth from 2 feet to 4 feet, 3 foot wide bottom, and 1.25:1(h:v) sideslopes.
- Diversion channels vary in bottom width from 12 feet to 4 feet, have a minimum depth of 3 feet, and sideslopes vary from 2:1(h:v) to 4:1(h:v).
- Diversion berms form a triangular cross section with the final cap.
- Downslope channels are trapezoidal in section, are 6 feet wide, and have 3:1(h:v) sideslopes.
- SEDCAD was used to determine channel characteristics for the calculated peak flow. The program uses Manning's equation. When analyzing grass lined channels both stability and capacity are evaluated. Depth of flow is a concern for capacity and velocity is a concern for stability.
- Shear stresses were also calculated for earthen channels to determine if permanent erosion matting was needed.

Calculations

See the attached output for results.

Conclusions

See the attached output for results.

RUST **Rust Environment & Infrastructure**

CALCULATION SHEET

PROJECT NO. 89868

CLIENT USACE

PROJECT FTC LF2

SUBJECT Summary of Depths, Velocities, and Erosion Control Reqmts

Prepared By MWW Date 5/2/96

Reviewed By [illegible] Date 5/2/96

Approved By _____ Date _____

DRAINAGE STRUCTURE	TRIBUTARY AREAS	Q (CFS)	SLOPE ANALYZED (%)	MAX AVE DEPTH (FT)	MAX AVE VELOCITY (fps)	MAX AVE SHEAR STRESS psf	COMMENTS
NORTH DIV. CH.	a	16.93	2.5	0.62	2.44	0.96	TEMP LINING
" " "	a, b	26.12	1.17	0.88	2.43	0.64	" "
" " "	a, b, c	39.68	2.78	1.18	5.60	2.0	PERM. LINING
" " "	a→d	45.94	11.11	0.80	8.83	5.5	" "
" " "	a→e	58.44	4.00	1.52	8.40	3.8	" "
EAST CONC. CH.	a→e	58.44	1.79	1.17	11.20	—	—
" " "	a→f	94.32	1.79	1.51	12.77	—	—
DIVERSION BERM	g	16.25	2.00	1.06	1.87	1.3	TEMP LINING
EAST DOWNSLOPE CH.	g, h	27.54	25 %	0.23	17.54	3.6	PERM LINING
EAST CONC. CH.	a→h	119.77	7.14%	1.19	22.53	—	—
EAST CONC. CH.	a→i	141.94	5.00%	1.43	20.75	—	—
SOUTH CONC. CH	j	17.34	5.55	0.43	11.51	—	—
WEST DIV. CH	j	17.34	7.70	0.65	5.78	3.1	PERM LINING
" " "	j, k, l	21.37	5.55	0.77	5.66	2.7	" "
DIVERSION BERM	m	26.91	2.00	1.26	2.91	1.6	TEMP LINING
WEST DIV. CH.	j→m	45.33	8.33	0.92	8.95	4.8	PERM LINING
" " "	j→n	49.76	2.00	1.42	5.35	1.8	" "
SE CONC. CH	a→n	191.71	3.57	1.83	19.08	—	—
" " "	a→o	233.64	4.17	1.94	22.18	—	—

SEDCAD+ VEGETATED CHANNEL DESIGN

north diversion channnel (AREA a)

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	16.93 cfs	
Slope	2.50 %	
Sideslopes	3.00:1 (L)	3.00:1 (R)
Bottom Width	12.00 feet	
Max. Velocity	5.000fps	
Material	GRASS MIXTURE	
Freeboard	None	

RESULTS:

	STABILITY CLASS D	CAPACITY CLASS C	w/ FREEBOARD
Actual Discharge	16.89	16.51 cfs	
Depth	0.51	0.62	0.00 ft
Top Width	15.07	15.73	12.00 ft
Velocity	2.44	1.91 fps	
Cross Sectional Area	6.92	8.62 sq ft	
Hydraulic Radius	0.45	0.54 ft	
Manning's n	0.057	0.082	
Froude Number	0.64	0.46	

SHEAR STRESS = (62.4 pcf)(.025 FT/FT)(0.62 FT) = 0.96 psf

SEDCAD+ VEGETATED CHANNEL DESIGN

north diversion channnel (AREA a,b)

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	26.12 cfs	
Slope	1.17 %	
Sideslopes	3.00:1 (L)	3.00:1 (R)
Bottom Width	12.00 feet	
Max. Velocity	5.000fps	
Material	GRASS MIXTURE	
Freeboard	None	

RESULTS:

	STABILITY CLASS D	CAPACITY CLASS C	w/ FREEBOARD
Actual Discharge	26.08	25.49 cfs	
Depth	0.75	0.88	0.00 ft
Top Width	16.52	17.29	12.00 ft
Velocity	2.43	1.97 fps	
Cross Sectional Area	10.75	12.92 sq ft	
Hydraulic Radius	0.64	0.73 ft	
Manning's n	0.049	0.067	
Froude Number	0.53	0.40	

SHEAR STRESS $= \left(62.4 \frac{lbs}{FT^3}\right)(.0117\ FT/FT)(0.88\ FT) = 0.64$ psf

SEDCAD+ VEGETATED CHANNEL DESIGN

north diversion channnel (AREA a, b, c)

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	39.68 cfs	
Slope	2.78 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Bottom Width	4.00 feet	
Max. Velocity	6.000fps	
Material	GRASS MIXTURE	
Freeboard	None	

RESULTS:

	STABILITY CLASS D	CAPACITY CLASS C	w/ FREEBOARD
Actual Discharge	39.57	39.32 cfs	
Depth	1.13	1.18	0.00 ft
Top Width	8.52	8.72	4.00 ft
Velocity	5.60	5.24 fps	
Cross Sectional Area	7.07	7.50 sq ft	
Hydraulic Radius	0.78	0.81 ft	
Manning's n	0.038	0.041	
Froude Number	1.08	1.00	

NEED perm. REINFORCEMENT

SHEAR STRESS = (62.4 pcf)(0.0278 FT/FT)(1.18 FT) = 2.0 psf

SEDCAD+ VEGETATED CHANNEL DESIGN

north diversion channnel (AREA a→d)

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	45.94 cfs	
Slope	11.11 %	
Sideslopes	4.00:1 (L)	3.00:1 (R)
Bottom Width	4.00 feet	
Max. Velocity	9.000fps	
Material	GRASS MIXTURE	
Freeboard	None	

RESULTS:

	STABILITY CLASS D	CAPACITY CLASS C	w/ FREEBOARD
Actual Discharge	45.76	45.88 cfs	
Depth	0.77	0.80	0.00 ft
Top Width	9.41	9.62	4.00 ft
Velocity	8.83	8.39 fps	
Cross Sectional Area	5.18	5.47 sq ft	
Hydraulic Radius	0.54	0.56 ft	
Manning's n	0.037	0.040	
Froude Number	2.10	1.96	

NEED perm. REINFORCEMENT

SHEAR STRESS $= (62.4\ pcf)(0.1111\ FT/FT)(0.80\ FT) = 5.5\ psf$

SEDCAD+ VEGETATED CHANNEL DESIGN

north diversion channnel (AREA a→e)

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	58.44 cfs	
Slope	4.00 %	
Sideslopes	1.25:1 (L)	1.25:1 (R)
Bottom Width	3.00 feet	
Max. Velocity	9.000fps	
Material	GRASS MIXTURE	
Freeboard	None	

RESULTS:

	STABILITY CLASS D	CAPACITY CLASS C	w/ FREEBOARD
Actual Discharge	58.33	58.18 cfs	
Depth	1.45	1.52	0.00 ft
Top Width	6.61	6.79	3.00 ft
Velocity	8.40	7.85 fps	
Cross Sectional Area	6.95	7.41 sq ft	
Hydraulic Radius	0.91	0.94 ft	
Manning's n	0.033	0.037	
Froude Number	1.44	1.32	

NEED perm. REINFORCEMENT

SHEAR STRESS $= (62.4\,pcf)(0.04\,FT/FT)(1.52\,FT) = 3.8\,psf$

SEDCAD+ NONERODIBLE CHANNEL DESIGN

---

east concrete channel (AREA a→e)

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	58.44 cfs	
Slope	1.79 %	
Sideslopes	1.25:1 (L)	1.25:1 (R)
Bottom Width	3.00 ft	
Manning's n	0.015	
Material	CONCRETE	
Freeboard	None	

RESULTS:

Depth	1.17 ft
with Freeboard	0.00 ft
Top Width	5.92 ft
with Freeboard	3.00 ft
Velocity	11.20 fps
Cross Sectional Area	5.22 sq ft
Hydraulic Radius	0.77 ft
Froude Number	2.10

SEDCAD+ NONERODIBLE CHANNEL DESIGN

---

east concrete channel (AREA a→f)

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	94.32 cfs	
Slope	1.79 %	
Sideslopes	1.25:1 (L)	1.25:1 (R)
Bottom Width	3.00 ft	
Manning's n	0.015	
Material	CONCRETE	
Freeboard	None	

RESULTS:

Depth	1.51 ft
with Freeboard	0.00 ft
Top Width	6.78 ft
with Freeboard	3.00 ft
Velocity	12.77 fps
Cross Sectional Area	7.38 sq ft
Hydraulic Radius	0.94 ft
Froude Number	2.16

SEDCAD+ VEGETATED CHANNEL DESIGN

diversion berm (AREA 9)

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	16.25 cfs	
Slope	2.00 %	
Sideslopes	20.00:1 (L)	3.00:1 (R)
Max. Velocity	5.000fps	
Material		
Freeboard	None	

RESULTS:

	STABILITY CLASS D	CAPACITY CLASS C	w/ FREEBOARD
Actual Discharge	16.21	15.63 cfs	
Depth	0.87	1.06	0.00 ft
Top Width	19.96	24.36	0.00 ft
Velocity	1.87	1.21 fps	
Cross Sectional Area	8.66	12.90 sq ft	
Hydraulic Radius	0.43	0.53 ft	
Manning's n	0.064	0.114	
Froude Number	0.50	0.29	

SHEAR STRESS = (62.4 pcf)(0.02)(1.06 ft) = 1.32 psf

SEDCAD+ NONERODIBLE CHANNEL DESIGN

East Downslope channel (AREA g, h)

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	27.54 cfs	
Slope	25.00 %	
Sideslopes	3.00:1 (L)	3.00:1 (R)
Bottom Width	6.00 ft	
Manning's n	0.015	
Material	CONCRETE	
Freeboard	None	

RESULTS:

Depth	0.23 ft
with Freeboard	0.00 ft
Top Width	7.41 ft
with Freeboard	6.00 ft
Velocity	17.54 fps
Cross Sectional Area	1.57 sq ft
Hydraulic Radius	0.21 ft
Froude Number	6.71

SHEAR STRESS = (62.4 pcf)(0.23 FT)(0.25) = 3.6 psf

NOTE: A VEGETATED CHANNEL (WITHOUT EROSION PROTECTION) COULD NOT HANDLE THE FLOWRATE DUE TO HIGH VELOCITIES, THEREFORE A CONCRETE CHANNEL WAS MODELED TO OBTAIN A FLOW DEPTH TO USE IN A SHEAR STRESS CALCULATION. THE SHEAR STRESS IS A MAXIMUM VALUE WHEN COMPARING TO OTHER LINING MATERIALS. REINFORCEMENT OF AN EARTHEN CHANNEL (e.g. ENKAMAT) WOULD BE ADEQUATE FOR THIS LOCATION.

SEDCAD+ NONERODIBLE CHANNEL DESIGN

---

east concrete channel (AREA a→h)

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	119.77 cfs	
Slope	7.14 %	
Sideslopes	1.25:1 (L)	1.25:1 (R)
Bottom Width	3.00 ft	
Manning's n	0.015	
Material	CONCRETE	
Freeboard	None	

RESULTS:

Depth	1.19 ft
with Freeboard	0.00 ft
Top Width	5.96 ft
with Freeboard	3.00 ft
Velocity	22.53 fps
Cross Sectional Area	5.32 sq ft
Hydraulic Radius	0.78 ft
Froude Number	4.21

SEDCAD+ NONERODIBLE CHANNEL DESIGN

east concrete channel (AREA a→i)

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	141.94 cfs	
Slope	5.00 %	
Sideslopes	1.25:1 (L)	1.25:1 (R)
Bottom Width	3.00 ft	
Manning's n	0.015	
Material	CONCRETE	
Freeboard	None	

RESULTS:

Depth	1.43 ft
with Freeboard	0.00 ft
Top Width	6.57 ft
with Freeboard	3.00 ft
Velocity	20.75 fps
Cross Sectional Area	6.84 sq ft
Hydraulic Radius	0.90 ft
Froude Number	3.58

SEDCAD+ NONERODIBLE CHANNEL DESIGN

south concrete channel (Area. j)

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	17.34 cfs	
Slope	5.55 %	
Sideslopes	1.25:1 (L)	1.25:1 (R)
Bottom Width	3.00 ft	
Manning's n	0.015	
Material	CONCRETE	
Freeboard	None	

RESULTS:

Depth	0.43 ft
with Freeboard	0.00 ft
Top Width	4.07 ft
with Freeboard	3.00 ft
Velocity	11.51 fps
Cross Sectional Area	1.51 sq ft
Hydraulic Radius	0.35 ft
Froude Number	3.33

SEDCAD+ VEGETATED CHANNEL DESIGN

west diversion channel (AREA J)

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	17.34 cfs	
Slope	7.70 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Bottom Width	4.00 feet	
Max. Velocity	7.000fps	
Material	GRASS MIXTURE	
Freeboard	None	

RESULTS:

	STABILITY CLASS D	CAPACITY CLASS C	w/ FREEBOARD
Actual Discharge	17.18	17.18 cfs	
Depth	0.58	0.65	0.00 ft
Top Width	6.31	6.59	4.00 ft
Velocity	5.78	5.01 fps	
Cross Sectional Area	2.97	3.43 sq ft	
Hydraulic Radius	0.45	0.50 ft	
Manning's n	0.042	0.052	
Froude Number	1.48	1.22	

PERM.

NEED REINFORCEMENT

SHEAR STRESS: = (62.4 pcf)(0.077 FT/FT)(0.65 FT) = 3.0 psf

SEDCAD+ VEGETATED CHANNEL DESIGN

west diversion channel (AREA j, k, l)

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	21.37 cfs	
Slope	5.55 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Bottom Width	4.00 feet	
Max. Velocity	7.000fps	
Material	GRASS MIXTURE	
Freeboard	None	

RESULTS:

	STABILITY CLASS D	CAPACITY CLASS C	w/ FREEBOARD
Actual Discharge	21.24	21.22 cfs	
Depth	0.70	~~0.77~~	0.00 ft
Top Width	6.78	7.06	4.00 ft
Velocity	~~5.66~~	5.01 fps	
Cross Sectional Area	3.75	4.24 sq ft	
Hydraulic Radius	0.53	0.57 ft	
Manning's n	0.040	0.048	
Froude Number	1.34	1.14	

perm.

NEED REINFORCEMENT

SHEAR STRESS = (62.4 pcf)(0.0555)(0.77 FT) = 2.7 psf

SEDCAD+ VEGETATED CHANNEL DESIGN

diverson berm (AREA M)

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	26.91 cfs	
Slope	2.00 %	
Sideslopes	12.00:1 (L)	3.00:1 (R)
Max. Velocity	5.000fps	
Material	GRASS MIXTURE	
Freeboard	None	

RESULTS:

	STABILITY CLASS D	CAPACITY CLASS C	w/ FREEBOARD
Actual Discharge	26.84	26.33 cfs	
Depth	1.11	1.26	0.00 ft
Top Width	16.63	18.84	0.00 ft
Velocity	2.91	2.23 fps	
Cross Sectional Area	9.22	11.83 sq ft	
Hydraulic Radius	0.55	0.62 ft	
Manning's n	0.049	0.069	
Froude Number	0.69	0.49	

SHEAR STRESS = (62.4pcf)(0.02)(1.26 ft) = 1.6 psf

SEDCAD+ VEGETATED CHANNEL DESIGN

west diversion channel (Area j → m)

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	45.33 cfs	
Slope	8.33 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Bottom Width	4.00 feet	
Max. Velocity	9.000fps	
Material	GRASS MIXTURE	
Freeboard	None	

RESULTS:

	STABILITY CLASS D	CAPACITY CLASS C	w/ FREEBOARD
Actual Discharge	45.10	45.34 cfs	
Depth	0.88	0.92	0.00 ft
Top Width	7.50	7.66	4.00 ft
Velocity	8.95	8.49 fps	
Cross Sectional Area	5.04	5.34 sq ft	
Hydraulic Radius	0.64	0.66 ft	
Manning's n	0.036	0.038	
Froude Number	1.92	1.79	

NEED perm. REINFORCEMENT

SHEAR STRESS = (62.4pcf)(0.0833)(0.92) = 4.8 psf

SEDCAD+ VEGETATED CHANNEL DESIGN

west diversion channel (AREA j→n)

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	49.76 cfs	
Slope	2.00 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Bottom Width	4.00 feet	
Max. Velocity	9.000fps	
Material	GRASS MIXTURE	
Freeboard	None	

RESULTS:

	STABILITY CLASS D	CAPACITY CLASS C	w/ FREEBOARD
Actual Discharge	49.67	49.33 cfs	
Depth	1.38	1.42	0.00 ft
Top Width	9.50	9.66	4.00 ft
Velocity	5.35	5.10 fps	
Cross Sectional Area	9.28	9.67 sq ft	
Hydraulic Radius	0.91	0.94 ft	
Manning's n	0.037	0.040	
Froude Number	0.95	0.90	

NEED perm REINFORCEMENT

SHEAR STRESS = (62.4 pcf)(0.02)(1.42 ft) = 1.8

SEDCAD+ NONERODIBLE CHANNEL DESIGN

south east concrete channel (COMBINED FLOW FROM BOTH CHANNELS) a→n)

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	191.71 cfs	
Slope	3.57 %	
Sideslopes	1.25:1 (L)	1.25:1 (R)
Bottom Width	3.00 ft	
Manning's n	0.015	
Material	CONCRETE	
Freeboard	None	

RESULTS:

Depth	1.83 ft
with Freeboard	0.00 ft
Top Width	7.56 ft
with Freeboard	3.00 ft
Velocity	19.88 fps
Cross Sectional Area	9.64 sq ft
Hydraulic Radius	1.09 ft
Froude Number	3.10

SEDCAD+ NONERODIBLE CHANNEL DESIGN

south east concrete channel (AREA A→O)

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	233.64 cfs	
Slope	4.17 %	
Sideslopes	1.25:1 (L)	1.25:1 (R)
Bottom Width	3.00 ft	
Manning's n	0.015	
Material	CONCRETE	
Freeboard	None	

RESULTS:

Depth	1.94 ft
with Freeboard	0.00 ft
Top Width	7.85 ft
with Freeboard	3.00 ft
Velocity	22.18 fps
Cross Sectional Area	10.53 sq ft
Hydraulic Radius	1.14 ft
Froude Number	3.37

L2: WEST DOWNSLOPE CHANNEL
PART A: PEAK FLOWS

CLIENT USACE SUBJECT West Downslope Channel Prepared By MWJ Date 5/2/96
PROJECT Fort Carson Landfill 2 Peak Flows Reviewed By MKJ Date 5/2/96
Approved By ____ Date ____

Objective

Determine peak flows from the subwatersheds tributary to the diversion berms and downslope channel located on the western portion of the final cap. The downslope channel discharges flow into the existing south perimeter channel.

Design Assumptions

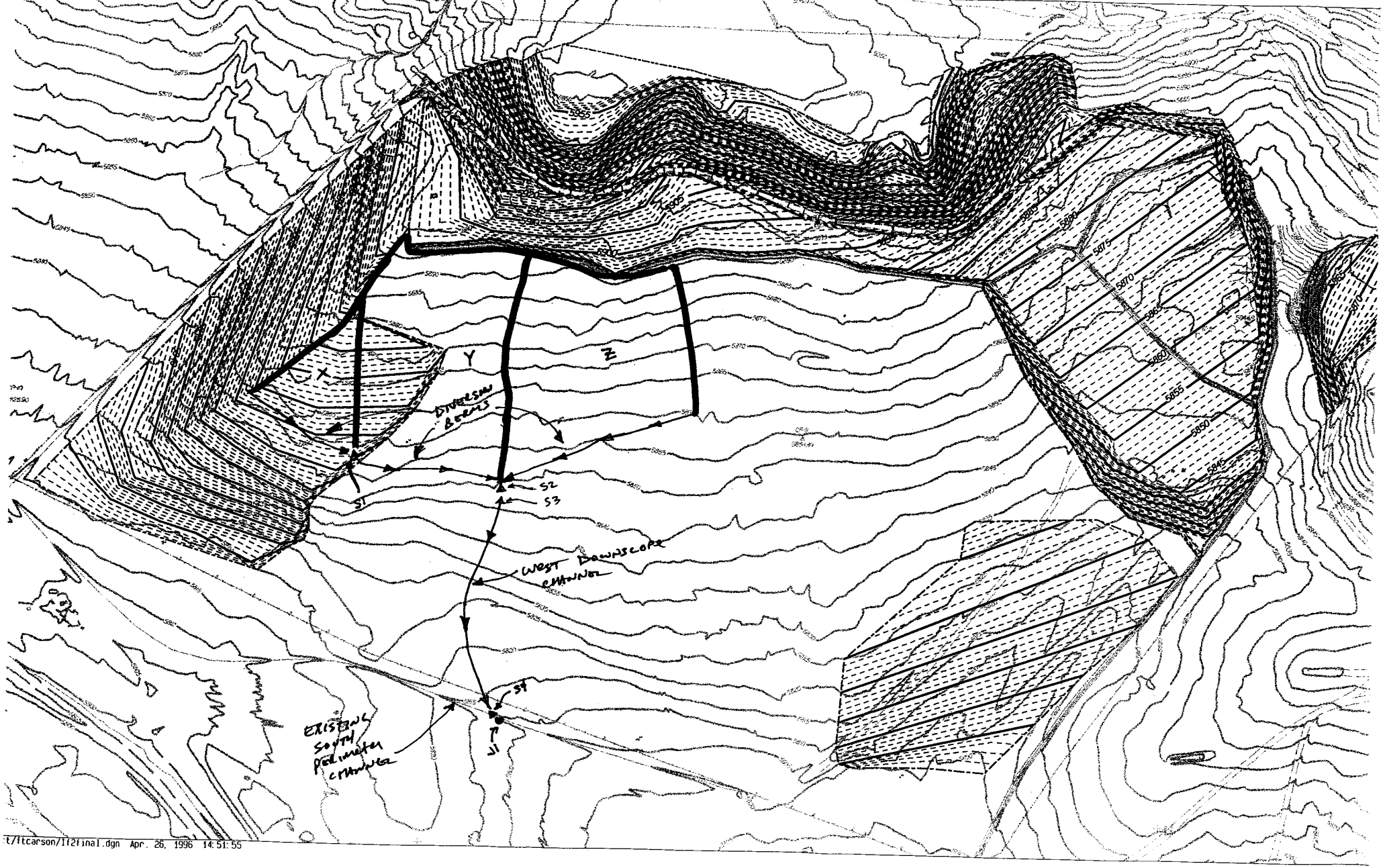
- Design permanent drainage structures to handle the 10 yr-24hr and100 yr- 24 hr rainfall event of 3.0 inches and 4.6 inches, respectively.
- Use Soil Conservation Service (SCS) Type IIA storm distribution.
- Drainage areas delineated using proposed final cover grades and existing topography. The watershed for the drainage channel has been delineated into 3 subwatershed areas. The 3 areas were defined by determining what locations we needed to know peak flows for further design calculations (need for erosion protection, etc..).
- All drainage areas are assumed to have a SCS Curve Number of 79.
  See the attached curve number reference.
- SEDCAD, a surface water design program created at the University of Kentucky, was used to determine the peak flows. In summary, the software utilizes watershed characteristics (area, CN, time of concentrations,) to determine peak flow. The unit hydrograph method, SCS upland curve method to determine t_c, SCS curve number method to determine runoff volumes, and Muskingum's method for channel routing are all used within the program to determine peak flow.

Calculations

See the attached output for both storm events. The subwatershed/structure input/output page summarizes design information and states peak flows and runoff volumes. There is one page for each storm event. The detailed subwatershed input/output table shows individual watershed characteristics that were used to calculate time of concentrations and channel routing parameters. One page is representative of both storm events.

Conclusions

The peak flows for both storm events are summarized on the next page.



t/ftcarson/lf2final.dgn Apr. 26, 1996 14:51:55

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

WATERSHED TRIBUTARY TO DOWNSLOPE CHANNEL

by

Name: mww

Company Name: RUST E & I
File Name: C:\SEDCAD3\FTC\LF2\DSC

Date: 05-01-1996

Civil Software Design -- SEDCAD+ Version 3.1
Copyright (C) 1987-1992. Pamela J. Schwab. All rights reserved.

Company Name: RUST E & I
Filename: C:\SEDCAD3\FTC\LF2\DSC User: mww
Date: 05-01-1996 Time: 12:14:59
watershed tributary to downslope channel
Storm: 3.00 inches, 10 year-24 hour, SCS Type IIA
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	1.20	79	M	0.067	0.000	0.000	0.0	0.12	2.47
		Type: Null Label: area x								
111	Structure	1.20							0.12	
111	Total IN/OUT	1.20							0.12	2.47
112	1	4.40	79	M	0.105	0.000	0.000	0.0	0.44	9.07
112	2	3.00	79	M	0.117	0.000	0.000	0.0	0.30	6.18
		Type: Null Label: area y,z								
112	Structure	7.40							0.85	
112	Total IN/OUT	8.60							0.85	17.72
111 to 112 Routing						0.045	0.277			
113	1	0.00	0	M	0.000	0.000	0.000	0.0	0.00	0.00
		Type: Null Label:								
113	Structure	0.00							0.85	
113	Total IN/OUT	8.60							0.85	17.72
112 to 113 Routing						0.000	0.000			
114	1	0.00	0	M	0.000	0.000	0.000	0.0	0.00	0.00
		Type: Null Label:								
114	Structure	0.00							0.85	
114	Total IN/OUT	8.60							0.85	17.72
113 to 114 Routing						0.043	0.347			

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: RUST E & I
Filename: C:\SEDCAD3\FTC\LF2\DSC User: mww
Date: 05-01-1996 Time: 12:14:59
watershed tributary to downslope channel
Storm: 3.00 inches, 10 year-24 hour, SCS Type IIA
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	3	300.00	6.67	1.81	0.05			
				-b	6	160.00	2.00	2.12	0.02	0.067		
1	1	2	1	-a	3	250.00	8.00	1.98	0.04			
				-b	6	340.00	6.76	3.90	0.02			
				-c	6	350.00	2.00	2.12	0.05	0.105		
1	1	2	2	-a	3	370.00	8.11	1.99	0.05			
				-b	6	500.00	2.00	2.12	0.07	0.117		

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: RUST E & I
Filename: C:\SEDCAD3\FTC\LF2\DSC User: mww
Date: 05-01-1996 Time: 12:15:06
watershed tributary to downslope channel
Storm: 4.60 inches, 100 year-24 hour, SCS Type IIA
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	1.20	79	M	0.067	0.000	0.000	0.0	0.25	4.84
		Type: Null Label: area x								
111	Structure	1.20							0.25	
111	Total IN/OUT	1.20							0.25	4.84
112	1	4.40	79	M	0.105	0.000	0.000	0.0	0.90	17.74
112	2	3.00	79	M	0.117	0.000	0.000	0.0	0.62	12.09
		Type: Null Label: area y,z								
112	Structure	7.40							1.76	
112	Total IN/OUT	8.60							1.76	34.67
111 to 112 Routing						0.045	0.277			
113	1	0.00	0	M	0.000	0.000	0.000	0.0	0.00	0.00
		Type: Null Label:								
113	Structure	0.00							1.76	
113	Total IN/OUT	8.60							1.76	34.67
112 to 113 Routing						0.000	0.000			
114	1	0.00	0	M	0.000	0.000	0.000	0.0	0.00	0.00
		Type: Null Label:								
114	Structure	0.00							1.76	
114	Total IN/OUT	8.60							1.76	34.67
113 to 114 Routing						0.043	0.347			

L2: WEST DOWNSLOPE CHANNEL
PART B: CHANNEL DEPTHS AND VELOCITIES

RUST ENVIRONMENT & INFRASTRUCTURE

CALCULATION SHEET

PROJECT NO. 89868

CLIENT USACE SUBJECT Channel Depths and Velocities

PROJECT Fort Carson Landfill 2

Prepared By MWW Date 5/2/96

Reviewed By MKW Date 5/2/96

Approved By ____ Date ____

Objectives

Determine depth and velocity of flow along the diversion berms and downslope channel located on the western portion of the cap. The downslope channel discharges into the existing south perimeter channel.

Design Assumptions

- Design for a 100 yr-24 hr storm event.
- Use peak flow calculated from SEDCAD.
- Diversion berm forms a triangular cross section with the final cap.
- Downslope channel has a trapezoidal cross section and is 2 feet deep, 6 feet wide and has 3:1(h:v) sideslopes. Various slopes are analyzed.
- SEDCAD was used to determine channel characteristics for the calculated peak flow. The program uses Manning's equation. When analyzing grass lined channels both stability and capacity are evaluated. Depth of flow is a concern for capacity and velocity is a concern for stability.
- Shear stresses were also calculated for earthen channels to determine if permanent erosion matting was needed.

Calculations

See the attached output for results.

Conclusions

See the attached output for results.

RUST **Rust Environment & Infrastructure**

CALCULATION SHEET

PROJECT NO. 89868

CLIENT USACE

PROJECT FTC LF2

SUBJECT VELOCITIES, DEPTH, EROSION LINING

Prepared By MWW Date 5-2-96

Reviewed By MKM Date 5/2/96

Approved By _____ Date _____

DRAINAGE STRUCTURE	TRIBUTARY AREAS	Q CFS	SLOPE ANALYZED %	MAX AVE VELOCITY fps	MAX AVE depth ft	MAX AVE SHEAR STRESS psf	COMMENTS
DIV. BERM	X	4.84	2	0.95	0.87	1.1	TEMP. LINING
" "	X	4.84	25	3.17	0.46	7.2	PERM LINING
" "	X, Y	22.58	2	2.28	1.13	1.4	TEMP LINING
DOWNSLOPE CHANNEL	X, Y, Z	34.67	3.8	5.18	0.87	2.1	PERM LINING
" "	X, Y, Z	"	4.5	5.51	0.82	2.3	" "
" "	X, Y, Z	"	10%	7.36	0.65	4.1	" "

SEDCAD+ VEGETATED CHANNEL DESIGN

diversion berm (area x)

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	4.84 cfs	
Slope	2.00 %	
Sideslopes	20.00:1 (L)	3.00:1 (R)
Max. Velocity	5.000fps	
Material	GRASS MIXTURE	
Freeboard	None	

RESULTS:

	STABILITY CLASS D	CAPACITY CLASS C	w/ FREEBOARD
Actual Discharge	4.80	4.41 cfs	
Depth	0.66	0.87	0.00 ft
Top Width	15.25	19.96	0.00 ft
Velocity	0.95	0.51 fps	
Cross Sectional Area	5.05	8.66 sq ft	
Hydraulic Radius	0.33	0.43 ft	
Manning's n	0.106	0.237	
Froude Number	0.29	0.14	

S.S. = 62.4 pcf x 0.87 FT x 0.02 = 1.1

SEDCAD+ VEGETATED CHANNEL DESIGN

---

diversion berm (area x)

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	4.84 cfs	
Slope	25.00 %	
Sideslopes	20.00:1 (L)	3.00:1 (R)
Max. Velocity	5.000fps	
Material	GRASS MIXTURE	
Freeboard	None	

RESULTS:

	STABILITY CLASS D	CAPACITY CLASS C	w/ FREEBOARD
Actual Discharge	4.67	4.77 cfs	
Depth	0.36	0.46	0.00 ft
Top Width	8.23	10.53	0.00 ft
Velocity	3.17	1.98 fps	
Cross Sectional Area	1.47	2.41 sq ft	
Hydraulic Radius	0.18	0.23 ft	
Manning's n	0.075	0.141	
Froude Number	1.32	0.73	

S.S. = 62.4 pcf × 0.46 × 0.25 = 7.2 psf

use permanent lining

SEDCAD+ VEGETATED CHANNEL DESIGN

---

diversion berm (area x,y)

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	22.58 cfs	
Slope	2.00 %	
Sideslopes	18.00:1 (L)	3.00:1 (R)
Max. Velocity	5.000fps	
Material	GRASS MIXTURE	
Freeboard	None	

RESULTS:

	STABILITY CLASS D	CAPACITY CLASS C	w/ FREEBOARD
Actual Discharge	22.53	21.93 cfs	
Depth	0.97	1.13	0.00 ft
Top Width	20.39	23.65	0.00 ft
Velocity	2.28	1.65 fps	
Cross Sectional Area	9.90	13.31 sq ft	
Hydraulic Radius	0.48	0.56 ft	
Manning's n	0.057	0.087	
Froude Number	0.58	0.39	

S.S. = 62.4pcf x 0.02 x 1.13 = 1.41

SEDCAD+ VEGETATED CHANNEL DESIGN

downslope channel (area x,y,z)

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	34.67 cfs	
Slope	3.80 %	
Sideslopes	3.00:1 (L)	3.00:1 (R)
Bottom Width	6.00 feet	
Max. Velocity	8.000fps	
Material	GRASS MIXTURE	
Freeboard	None	

RESULTS:

	STABILITY CLASS D	CAPACITY CLASS C	w/ FREEBOARD
Actual Discharge	34.56	34.56 cfs	
Depth	0.80	0.87	0.00 ft
Top Width	10.78	11.20	6.00 ft
Velocity	5.18	4.64 fps	
Cross Sectional Area	6.68	7.45 sq ft	
Hydraulic Radius	0.61	0.65 ft	
Manning's n	0.040	0.047	
Froude Number	1.16	1.00	

S.S. = 62.4 pcf x 0.87 x 0.038 = 2.1

USE PERM. LINING

SEDCAD+ VEGETATED CHANNEL DESIGN

downslope channel (area x,y,z)

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	34.67 cfs	
Slope	4.50 %	
Sideslopes	3.00:1 (L)	3.00:1 (R)
Bottom Width	6.00 feet	
Max. Velocity	8.000fps	
Material	GRASS MIXTURE	
Freeboard	None	

RESULTS:

	STABILITY CLASS D	CAPACITY CLASS C	w/ FREEBOARD
Actual Discharge	34.53	34.36 cfs	
Depth	0.76	0.82	0.00 ft
Top Width	10.55	10.93	6.00 ft
Velocity	5.51	4.95 fps	
Cross Sectional Area	6.27	6.95 sq ft	
Hydraulic Radius	0.58	0.62 ft	
Manning's n	0.040	0.047	
Froude Number	1.26	1.09	

S.S. = 62.4 pcf x 0.045 x 0.82 = 2.30

Use perm lining

SEDCAD+ VEGETATED CHANNEL DESIGN

downslope channel (area x,y,z)

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	34.67 cfs	
Slope	10.00 %	
Sideslopes	3.00:1 (L)	3.00:1 (R)
Bottom Width	6.00 feet	
Max. Velocity	8.000fps	
Material	GRASS MIXTURE	
Freeboard	None	

RESULTS:

	STABILITY CLASS D	CAPACITY CLASS C	w/ FREEBOARD
Actual Discharge	34.52	34.79 cfs	
Depth	0.60	0.65	0.00 ft
Top Width	9.61	9.91	6.00 ft
Velocity	7.36	6.72 fps	
Cross Sectional Area	4.69	5.18 sq ft	
Hydraulic Radius	0.48	0.51 ft	
Manning's n	0.039	0.045	
Froude Number	1.86	1.64	

SS = 62.4pcf x 0.65 x 0.10 = 4.1

use perm lining

L3: SOUTHEAST DIVERSION BERM
PART A: PEAK FLOWS

RUST ENVIRONMENT & INFRASTRUCTURE

CALCULATION SHEET

PROJECT NO. 89868

CLIENT USACE SUBJECT Southeast Diversion Berm Prepared By MWW Date 5/2/96

PROJECT Fort Carson Landfill 2 Peak Flow Reviewed By MKV Date 5/2/96

Approved By ____ Date ____

Objective

Determine peak flows from the subwatersheds tributary to the proposed diversion berm located at the southeast portion of the landfill cap. The diversion berm routes the run-off to an existing drainage swale shown on the attached figure.

Design Assumptions

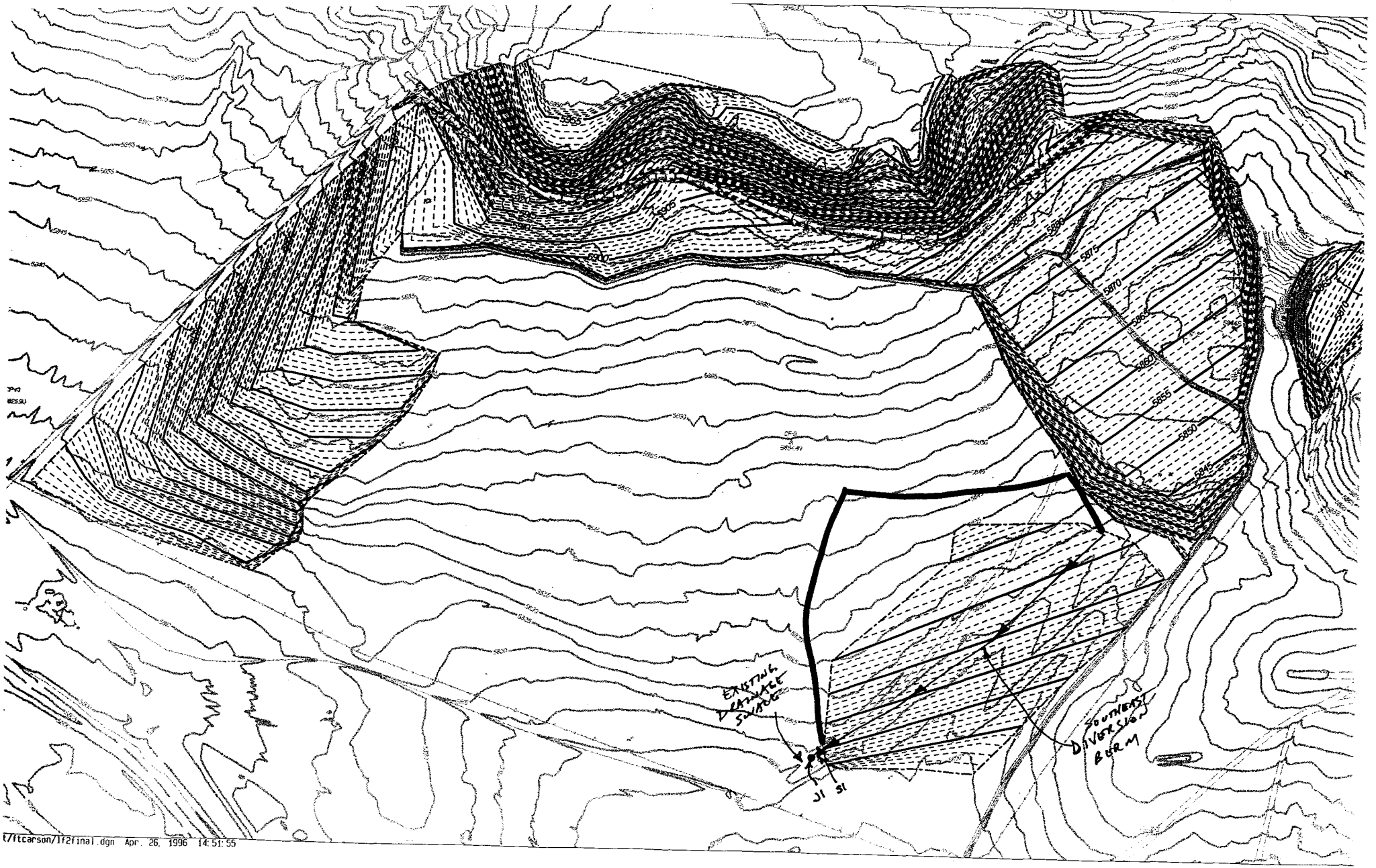
- Design permanent drainage structures to handle the 10 yr-24hr and100 yr- 24 hr rainfall event of 3.0 inches and 4.6 inches, respectively.
- Use Soil Conservation Service (SCS) Type IIA storm distribution.
- Drainage areas delineated using proposed final cover grades.
- All drainage areas are assumed to have a SCS Curve Number of 79.
  See the attached curve number reference.
- SEDCAD, a surface water design program created at the University of Kentucky, was used to determine the peak flows. In summary, the software utilizes watershed characteristics (area, CN, time of concentrations,) to determine peak flow. The unit hydrograph method, SCS upland curve method to determine t_c, SCS curve number method to determine runoff volumes, and Muskingum's method for channel routing are all used within the program to determine peak flow.

Calculations

See the attached output for both storm events. The subwatershed/structure input/output page summarizes design information and states peak flows and runoff volumes. There is one page for each storm event. The detailed subwatershed input/output table shows individual watershed characteristics that were used to calculate time of concentrations and channel routing parameters. One page is representative of both storm events.

Conclusions

The peak flows for both storm events are 8.88 cfs and 18.71 cfs for the 10 yr-24 hr and 100 yr-24 hr storm event, respectively.



t/ftcarson/1r2final.dgn Apr. 26, 1996 14:51:55

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

WATERSHED TRIBUTARY TO SOUTHEAST DIVERSON BERM

by

Name: mww

Company Name: RUST E & I
File Name: C:\SEDCAD3\FTC\LF2\DBSE

Date: 05-01-1996

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: RUST E & I
Filename: C:\SEDCAD3\FTC\LF2\DBSE User: mww
Date: 05-01-1996 Time: 12:15:14
watershed tributary to southeast diverson berm
Storm: 3.00 inches, 10 year-24 hour, SCS Type IIA
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	6.10	79	M	0.135	0.000	0.000	0.0	0.60	8.88
			Type: Null			Label:				
111	Structure	6.10							0.60	
111	Total IN/OUT	6.10							0.60	8.88

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Company Name: RUST E & I
Filename: C:\SEDCAD3\FTC\LF2\DBSE User: mww
Date: 05-01-1996 Time: 12:15:14
watershed tributary to southeast diverson berm
Storm: 3.00 inches, 10 year-24 hour, SCS Type IIA
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	3	245.00	5.51	1.64	0.04			
				-b	6	720.00	2.00	2.12	0.09	0.135		

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Company Name: RUST E & I
Filename: C:\SEDCAD3\FTC\LF2\DBSE User: mww
Date: 05-01-1996 Time: 12:15:17
watershed tributary to southeast diverson berm
Storm: 4.60 inches, 100 year-24 hour, SCS Type IIA
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	6.10	79	M	0.135	0.000	0.000	0.0	1.25	18.71
			Type: Null			Label:				
111	Structure	6.10							1.25	
111	Total IN/OUT	6.10							1.25	18.71

L3: SOUTHEAST DIVERSION BERM
PART B: CHANNEL DEPTHS AND VELOCITIES

RUST ENVIRONMENT & INFRASTRUCTURE

CALCULATION SHEET

PAGE 1 OF 1
PROJECT NO. 89868

CLIENT USACE SUBJECT Channel Depths and Velocities Prepared By [illegible] Date 5/2/96
PROJECT Fort Carson Landfill 2 Reviewed By [illegible] Date 5/2/96
Approved By ____ Date ____

Objectives

Determine depth and velocity of flow along the diversion berm.

Design Assumptions

- Design for a 100 yr-24 hr storm event.
- Use peak flow calculated from SEDCAD.
- Diversion berm forms a triangular cross section with the final cap.
- SEDCAD was used to determine channel characteristics for the calculated peak flow. The program uses Manning's equation. When analyzing grass lined channels both stability and capacity are evaluated. Depth of flow is a concern for capacity and velocity is a concern for stability.
- Shear stresses were also calculated for earthen channels to determine if permanent erosion matting was needed.

Calculations

See the attached output for results.

Conclusions

See the attached output for results.

SEDCAD+ VEGETATED CHANNEL DESIGN

diversion berm

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	18.71 cfs	
Slope	2.00 %	
Sideslopes	14.00:1 (L)	3.00:1 (R)
Max. Velocity	5.000fps	
Material	GRASS MIXTURE	
Freeboard	None	

RESULTS:

	STABILITY CLASS D	CAPACITY CLASS C	w/ FREEBOARD
Actual Discharge	18.66	18.20 cfs	
Depth	0.98	1.13	0.00 ft
Top Width	16.63	19.26	0.00 ft
Velocity	2.30	1.67 fps	
Cross Sectional Area	8.13	10.91 sq ft	
Hydraulic Radius	0.49	0.56 ft	
Manning's n	0.057	0.086	
Froude Number	0.58	0.39	

SHEAR STRESS = (62.4 pcf)(0.02)(1.13 ft) = 1.4 psf

USE TEMPORARY LINING

L4: REFERENCES

Table 2-2c.—Runoff curve numbers for other agricultural lands[1]

Cover description		Curve numbers for hydrologic soil group—			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing.[2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element.[3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	[4]30	48	65	73
Woods—grass combination (orchard or tree farm).[5]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods.[6]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	[4]30	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

[1]Average runoff condition, and $I_a = 0.2S$.

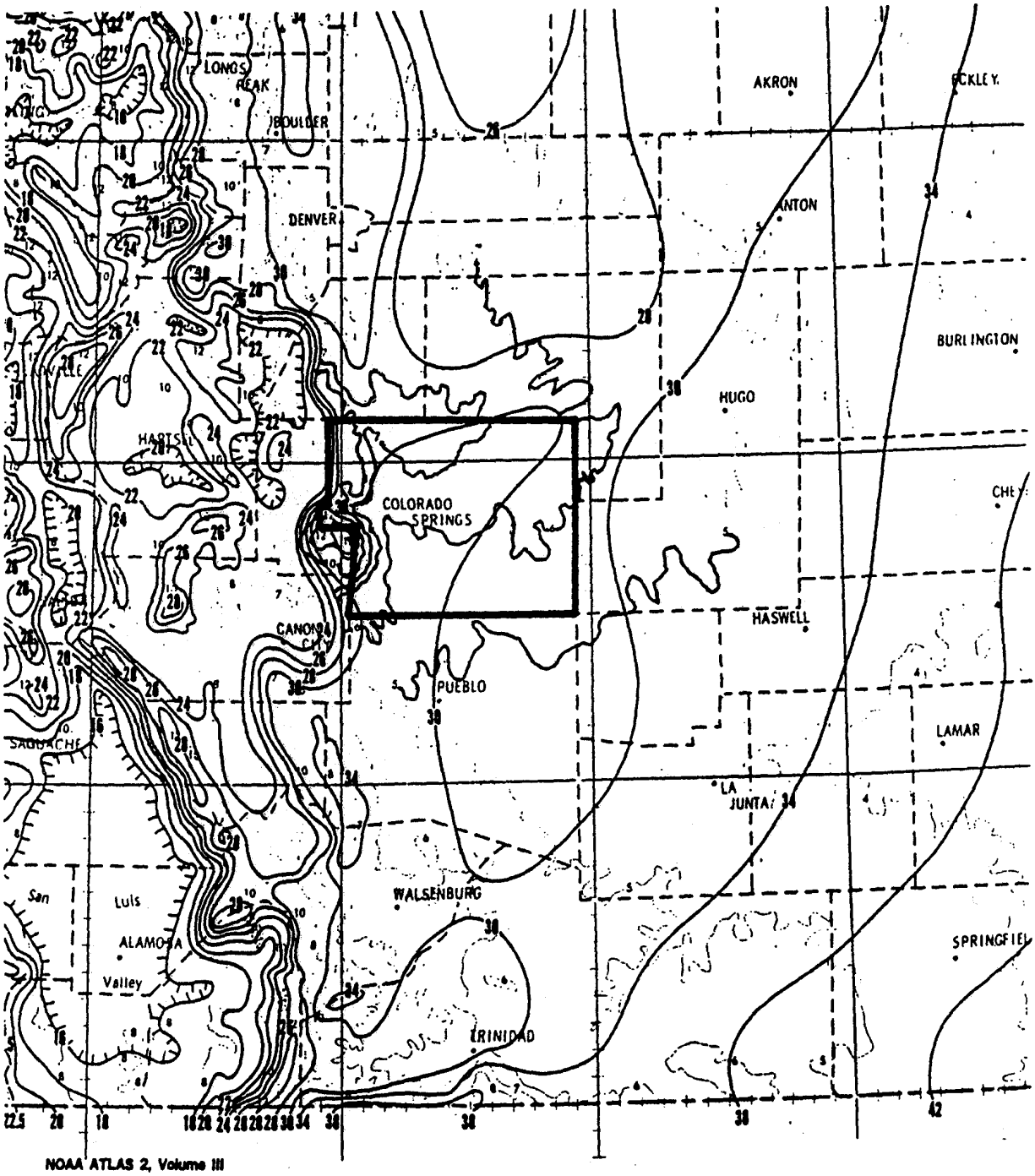
[2]*Poor:* <50% ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: >75% ground cover and lightly or only occasionally grazed.

[3]*Poor:* <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.

[4]Actual curve number is less than 30; use CN = 30 for runoff computations.

[5]CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

[6]*Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.



NOAA ATLAS 2, Volume III

Prepared by U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service, Office of Hydrology

Prepared for U.S. Department of Agriculture,
Soil Conservation Service, Engineering Division

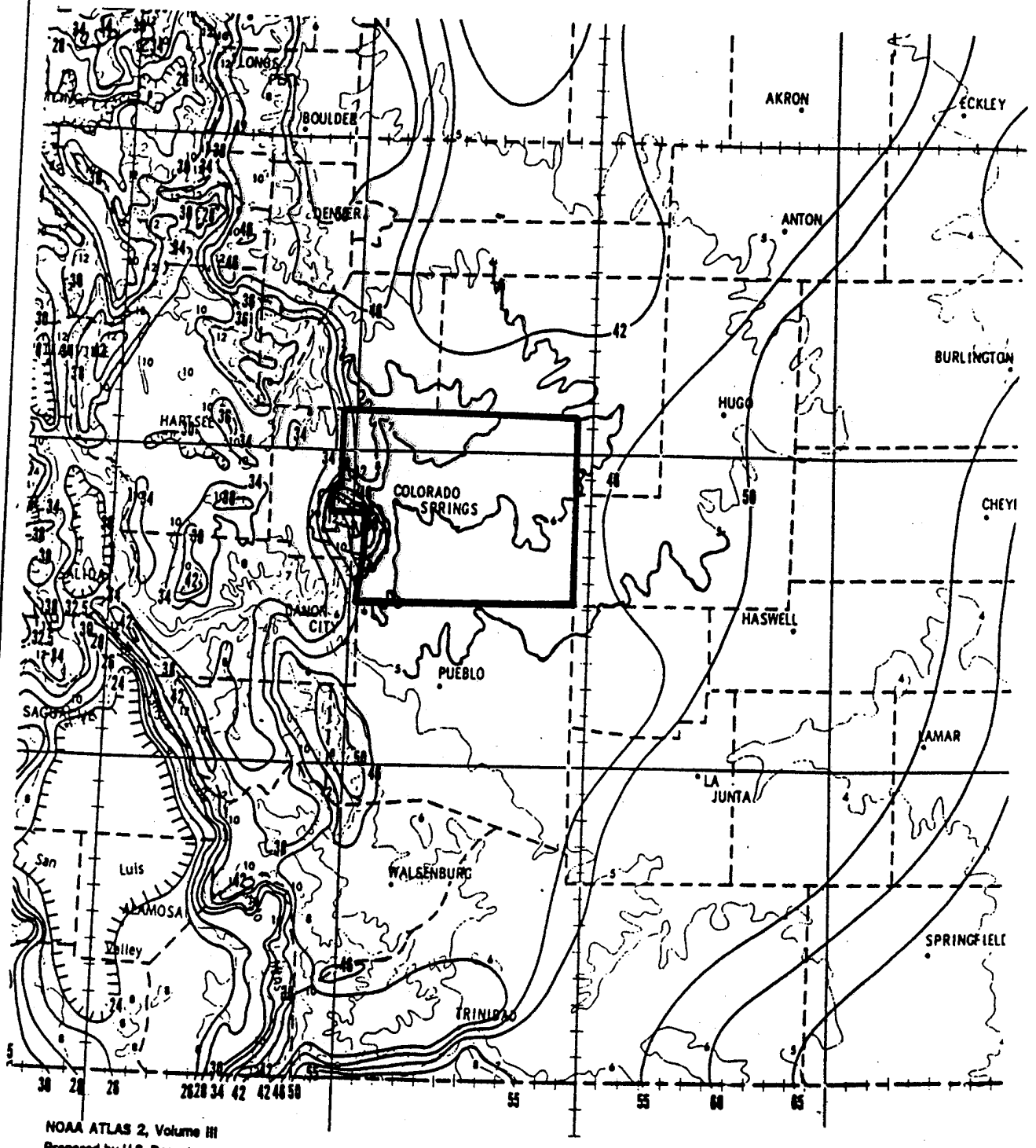
ISOPLUVIALS OF 10-YR 24-HR PRECIPITATION IN TENTHS OF AN INCH

HDR Infrastructure, Inc.
A Centerra Company

The City of Colorado Springs / El Paso County
Drainage Criteria Manual

Date
OCT. 1987

Figure
5-4d



NOAA ATLAS 2, Volume III

Prepared by U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service, Office of Hydrology

Prepared for U.S. Department of Agriculture,
Soil Conservation Service, Engineering Division

ISOPLUVIALS OF 100-YR 24-HR PRECIPITATION IN TENTHS OF AN INCH

HDR Infrastructure, Inc.
A Centerra Company

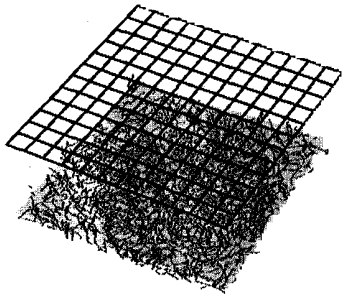
The City of Colorado Springs / El Paso County
Drainage Criteria Manual

Date
OCT. 1987

Figure
5-4e

EXAMPLE OF TEMPORARY CHANNEL LINING

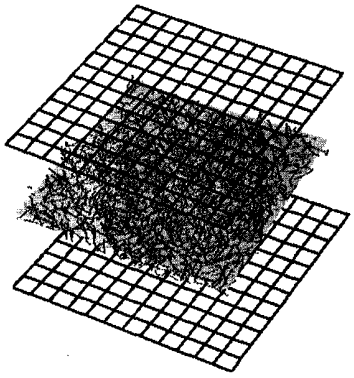
EROSION CONTROL SYSTEMS
EXCELSIOR BLANKETS



Standard Excelsior Mat:

A wood fiber mat produced of wood excelsior of 80% eight-inch or longer fiber lengths. The blanket is of consistent thickness with one side covered with a photodegradable plastic mesh and stitched on 3" centers.

Recommended Use: *Slopes 4:1*
Channels to 5 fps



High Impact Excelsior Mat:

A wood fiber mat produced of wood excelsior of 80% eight-inch or longer fiber lengths. The blanket is of consistent thickness with each side covered with a photo-degradable plastic mesh and stitched on 3" centers.

Recommended Use: *Slopes 3:1*
Channels to 7 fps

Heavy High Impact Excelsior Mat:

The excelsior blanket consists of a heavyweight construction of wood fibers produced in a mat form and stitched on 3" centers. Each side covered with photo-degradable plastic net.

Recommended Use: *Slopes 1-1/2:1 needing long-term protection*

PRODUCT DESCRIPTIONS

[illegible] STANDARD EXCELSIOR MATTING	[illegible] HEAVY HIGH IMPACT EXCELSIOR MATTING	[illegible] HIGH IMPACT EXCELSIOR MATTING
[illegible]	with 3/4" (1.9 cm) photo-degradable netting stitched on 3" (7.6 cm) centers on both sides	[illegible] (7.6 cm) photo-degradable netting stitched on [illegible] centers on both sides
Width [illegible]	Width 7.5 Ft. (2.3 m)	Width [illegible] (2.3 m)
Length [illegible] (18.3 m)	Length Approx. 60 Ft. (18.3 m)	Length Approx. 96 Ft. [illegible] m)
Weight [illegible]	Weight 80 lbs/Roll ± 10% (36.3 kilograms)	Weight [illegible] lbs/Roll ± 10% [illegible] kilograms)
Area [illegible]	Area 50 Sq Yds (41.8 m²)	Area [illegible] (66.9 m²)
Packaging Vented Plastic Bags White	Packaging Vented Plastic Bags Red	Packaging Vented Plastic Bags Blue

WATER VELOCITIES FOR VARIOUS SOIL CONDITIONS

	Clay, Clay Loam, Silty Clay	Loam, Silty Clay, Sandy Clay Loam	Very Fine Sandy Loam Fine Sandy Loam, Silty Loam
STANDARD EXCELSIOR (Single Net Stitched Blanket with Avg. Shear Stress of 1.80 lbs/ft.)	4.8 fps	4.8 fps	3.9 fps
STANDARD STRAW (Single Net Stitched Blanket with Avg. Shear Stress of 1.60 lbs/ft.)	4.8 fps	4.8 fps	3.9 fps
HIGH IMPACT EXCELSIOR (Double Net Stitched Blanket with Avg. Shear Stress of 2.25 lbs/ft.)	11.0 fps	9.8 fps	8.6 fps
HIGH VELOCITY STRAW (Double Net Stitched Blanket with Avg. Shear Stress of 2.25 lbs/ft.)	11.0 fps	9.8 fps	8.6 fps
EARTH-LOCK (Double Net with Geomatrix Stitched blanket withAvg. Shear Stress of 6.0 lbs/ft.)	13.2 fps	12.5 fps	11.0 fps

NOTES: *These figures are based on ditch lining at over 3% grade and up to 11% - 13%. On slope protection, the determining factor would be the grade of the slope, berms above and sheeting effect of water velocity, etc. Design should be based on the limitation of vegetation under various soil conditions and water velocities.*

EROSION CONTROL SYSTEMS INC.
9015 Energy Lane
Northport, Alabama 35476-6542
800/942-1986 205/333-3080
Fax 205/333-3090

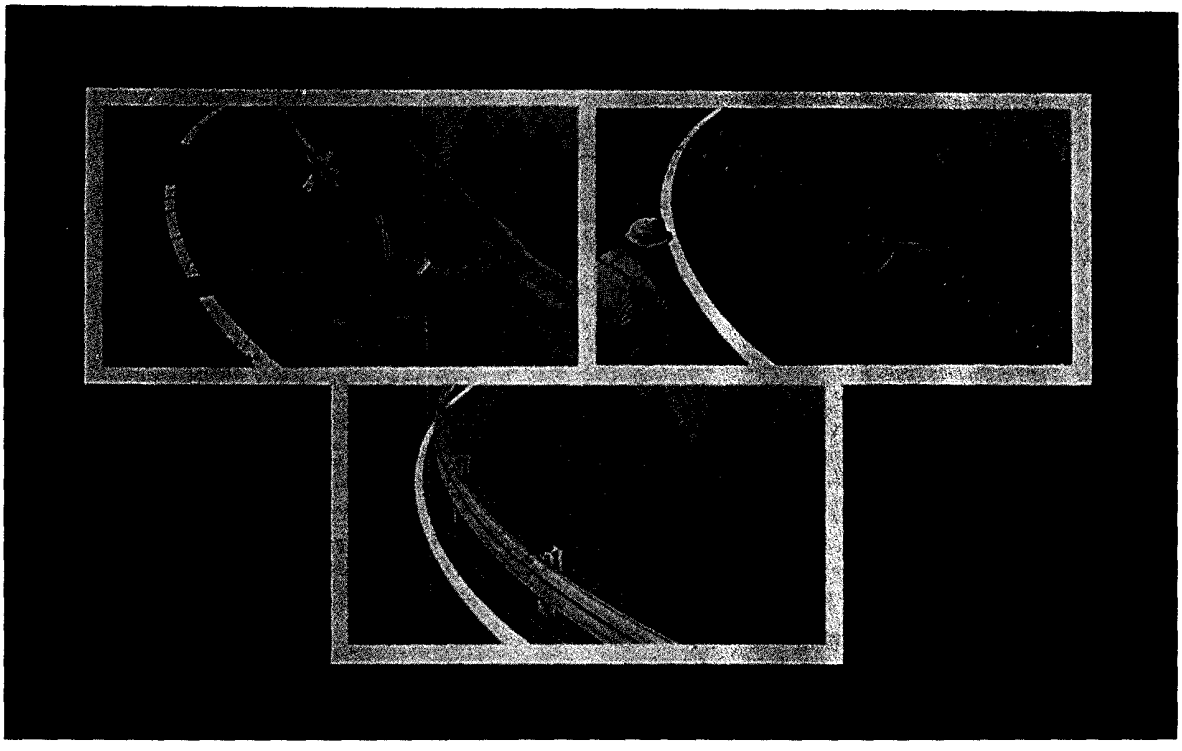
Available in Five Widths Up to 15.5 Feet

02270/AKZ
BuyLine 4170

EXAMPLE OF PERMANENT CHANNEL LINING

Enkamat®

Erosion Control Matting



Multiple solutions for:
- Ditches
- Slopes
- Pipeline Installations
- Ponds
- Slope Aquifer Interceptors
- Acid Slopes
- Earthen Dams
- Storm Channels
- Embankments
- Shoreline Protection
- Landfill Capping
- Landfill Perimeter Ditches
- Spillways
- Zoos

Gaining Ground Through Ingenuity℠

AKZO NOBEL

Enkamat®

Erosion Control Matting

Short Form Specification:

Matting shall be three-dimensional geomatrix of heavy nylon monofilaments fused at their intersections. Ninety five percent of the geomatrix shall be open space available for soil and root interaction with filaments.

Matting will have three-dimensional strength without laminated or stitched layers. Matting must also meet specific dimensions and physical properties listed below.

Properties and Dimensions (All values are typical unless otherwise stated)

ENKAMAT	7010	7020	7210*	7220*
Material Nylon 6.				

Dimensions	7010	7020	7210*	7220*
Weight (oz/yd²)	8.0	12.0	7.7	11.8
Weight (oz/yd²) MARV[1]	7.3	11.1	7.1	10.9
Thickness (inches)	.4	.72	.33	.66
Width (inches)	39	39	39	39
Roll Length (feet)	500	277	394	197
Area (yd²/roll) min.	180	100	142	71
Roll Gross Weight (lbs)	92	77	70	55

[1] MARV = Minimum Avg. Roll Value which represents the industry standard 95% confidence level

Typical Physical Properties**				
Tensile Strength—Length (lbs/ft)	180	245	130	180
Tensile Strength—Width (lbs/ft)	85	120	110	300
Tensile Elongation—Length (%)	65	85	80	75
Tensile Elongation—Width (%)	60	70	35	30

***ENKAMAT FLATBACK**
ENKAMAT 7210 and 7220 have a two-dimensional flat open nylon net thermally bonded to one side of the three dimensional ENKAMAT.

Exposure (for 80% Strength Retention)	
Temperature Range	– 100°F to 250°F
Ph Range	3 to 12

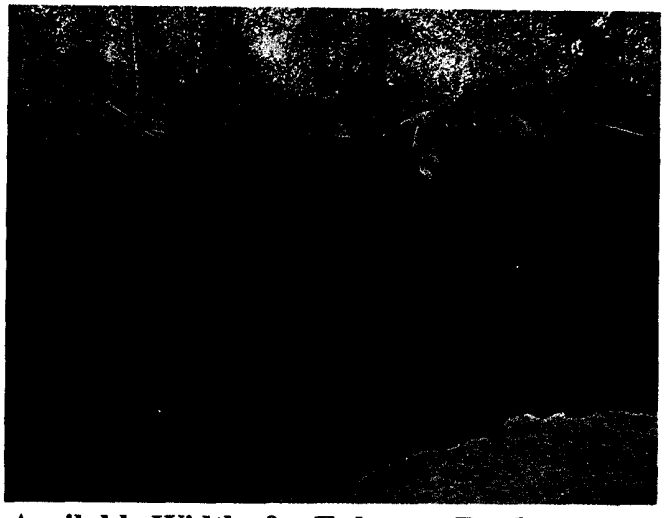
***ASTM 1682 strip test procedure modified to obtain filament bond strength used to indicate tensile properties of Enkamat matting.*

Typical physical properties are representative of the product in a full width application. However, due to the geometry and randomness of the product, some test results may be below the typical values stated.

Minimum average lot values are available upon request.

Enkamat Wide Widths

All Enkamat products are available in multiple/widths up to 15.5 feet. Five different widths are available. Seams are heat bonded to insure uniform strengths.



Available Widths for Enkamat Products

1—Wide*	39 inches	(3.25 ft.)
2—Wide**	76 inches	(6.33 ft.)
3—Wide*	113 inches	(9.42 ft.)
4—Wide**	150 inches	(12.5 ft.)
5—Wide*	187 inches	(15.58 ft.)

*Stock Item ** Special Order

Design and Installation Assistance

This brochure is intended as a general information piece. For technical help, specific information, or the name of our nearest distributor, please call or write: Akzo Nobel Geosynthetics Company, P.O. Box 7249, Asheville, North Carolina 28802, (704) 665-5050

We believe the information contained herein to be reliable and accurate for applications of ENKAMAT®. Since conditions vary with each site, however, Akzo Nobel makes no guarantee of results and assumes no obligation or liability for such results, the suitability of the material or the information contained herein for the use contemplated, unless specifically made in writing by Akzo Nobel, or for safety or other damages occurring in connection with any installation. Furthermore, Akzo Nobel's liability under any claim shall be limited to the cost of the ENKAMAT materials or replacement thereof, at Akzo Nobel's option. This publication is not a license under which to operate and is not intended to suggest infringement upon use of any existing patents or trademarks.

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Akzo Nobel Geosynthetics Company
P.O. Box 7249
Asheville, NC 28802
Telephone (704) 665-5050
Telefax (704) 665-5009

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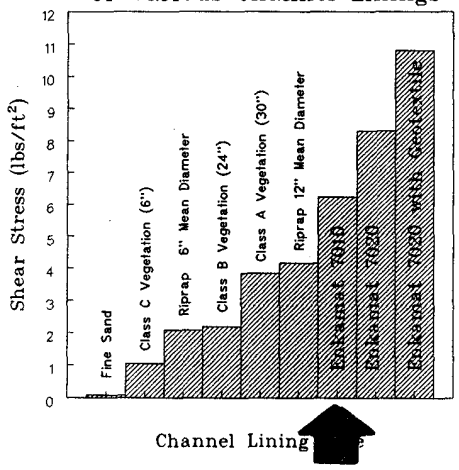
Reinforced Vegetated Channels

All waterways will produce a certain amount of shear stress on the channel lining. A simple calculation of that shear stress can help to design the proper protective measures to guard against the erosion of the channel.

Right: Permissible shear stress of various channel linings.

Below: Performance data from actual projects to determine maximum shear stress for Enkamat products.

Maximum Permissible Shear Stress
Of Various Channel Linings



Note: Enkamat tested with vegetation

Basic Formula to Determine Maximum Shear Stress of a Channel

Unit Weight of Water (62.4 lbs/cu. ft.) × Slope (ft/ft) × Depth (ft.) = Shear Stress (psf)

Performance Data—Enkamat Matting
7010 7020 7220

Shear[a] Stress	V	CASE	Q	A	R	D	S	B	B/D	$\frac{Q}{B}$	N
8.56	10	PENNDOT 7020 MEASURED EVENT W/OUT VEGETATION	17.78	1.778	.426	.610	.225	2.57	6.7	3.84	.040
7.22	15	PENNDOT 7020 MEASURED EVENT W/VEGETATION	9.86	.657	.370	.514	.225	2.41	8.8	4.09	.026
6.90	10	FHWA, SIMONS + LI 7010, FLOOD OVERTOPPING W/OUT SIG. VEG.	7.90	.790	N/A	.790	.14	N/A	N/A	7.90	.048
7.05	18	PENNDOT 7020 CALCULATED W/GRASS OR FULLY SILTED	24.84	1.38	.361	.50	.225	2.76	5.5	9.00	.020
10.43 AVG.	9	CARRIBEAN 7020 CHANNEL W/UNDER-LAY*, 10 YEAR FLOOD	345.8	38.4	2.089	2.965	.08	12.95	4.4	26.70	.030
8.50	17.2	WESTERN CANADA HYDRAULICS LAB PRESSURE CONDUIT, BERMUDA SOD, 7020	56				.054				
8.21	3.5	MCALPINE CREEK 7010 SIDE SLOPE 8/19/86 EVENT	2000	571.4	9.52	14	.03	34.0	2.4	58.82	.020
2.40	5.8	GADOT 7010	36	6.2	.387	1.75	.022	3.55	2.0	10.14	.020
8.24	20.3	CIRIA 7220 FINAL TEST (2 YR. INST)	24.18	1.191	.283	.33	.40	4.04	14.95	5.48	.020

LEGEND

V = velocity in ft. per second
Q = quantity rate of flow, cubic ft. per second
A = cross-sectional area of flow, square ft.
R = hydraulic radius (manning), feet
D = depth of flow, feet
S = slope, feet per feet
B = bottom width of equivalent rectangular channel, feet
B/D = ratio, when + 5 use Q/B for discharge intensity
$\frac{Q}{B}$ = discharge intensity, overland flow, cfs/ft
N = Manning roughness factor

*NonWoven Needlepunched GEOTEXTILE < 4.0 oz/yd²
[a] $\tau_{max.} = \gamma DS$ where $\gamma = 62.4$ lbs/ft³ D = depth, ft. S = slope, (ft/ft)

All Enkamat Products are Available in Widths up to 15.5′

L5: EXISTING CONCRETE CHANNEL DESIGN

UNITED STATES
DEPARTMENT OF
AGRICULURE

NATURAL RESOURCE
CONSERVATION
SERVICE

AREA OFFICE
318 Lacey Avenue
La Junta, CO 81050-2039

Subj: Diversion Construction Around Fort Carson Land Fill #2

Date: 4 Apr 96
(filename= 5RUST.doc)

To: Mark Yaskanin
@
RUST Environment & Infrastructure
Englewood, CO

I was the Design Engineer and Government Project Engineer (COR) for the complete installation of the concrete works of improvement around Land Fill #2. The Notice to Proceed was received on 14 Sept 92 and the job was completed on 29 Oct 92. Over 1,200 cu. yds. of minimum 4 inch thick concrete was placed. I base this information on our on site Job Diary which my Inspector maintained.

On or about 21 Sept 92 building materials were encountered during subgrade excavation. The wood (2X4's, 1X4's, and 1X6's) and shingles were removed and hauled to Fort Carson Land Fill #1 for disposal. Concrete lining was placed over the building materials that were below the design subgrade. I believed the 4 inch thick concrete was structurally sound enough to safely convey the runoff volume from the segments above. I believe very few cracks would develop.

The building materials were only discovered in Segment C from approximate Station 0+40 to 6+20. Native materials were excavated during the remaining installation. All excavated materials (other than the building materials discussed above) were wasted just below the concrete structure or in the nearby gulleys. We designed the diversion to be above the old land fill and to catch all runoff that would enter the site. No other non native (natural) materials were uncovered during the complete installation of the diversion.

I believe it would be reasonable for you, a Corps of Engineers representative, and myself to walk the entire site in the near future. This would allow me to better convey my knowledge of the site to both of you, to more fully answer any and all your questions, and be good for me to see how well the concrete diversion is performing. Please let me know when you would like for me to meet you at the site.

If you have any questions or comments please call me at 719-384-5408 (o) or 719-853-6530 (h).

Nick F. Koch

Nick F. Koch, PE
Agricultural Engineer

pc: John Valentine, RC, Colorado Springs, CO
Brice Boesch, Acting AE, Rocky Ford, CO
John Knapp, AC, La Junta, CO
Dan Meyer, SCE, Lakewood, CO
John Andrews, ASCE, Lakewood, CO

CO Ft. CARSON LAND FILL #2
N.F.K. 3 Apr 91
HYDROLOGY & HYDRAULICS 1 1

Sammie and I redefined sub watersheds and Identified concrete ditch locations and measured lengths of perimeter fence on 14 Mar 91. Previously we planned directing most of the runoff to an existing drainage ditch at the foot of the slope that drains under the entrance to Range 28 (Syncronization Range). The existing ditch below Range 28 makes a fairly sharp left turn and does not have the necessary cross sectional area to safely convey any additional runoff. We then looked for other ways to safely transport the runoff around the land fill. A tenetative method would be the concrete ditches installed on a grade flowing the opposite way previously planned and outletting in a flat area near observation well # FOMW-74 which is NNE of Bldg. 9072.

The following is a summary of our findings to date:

Concrete Ditch	Watershed Length x Width	Watershed Slope	Computed Peak Flows 100 yr.	Accumulated
A - 1,600'	1,600' x 400'	20-40%	64.2 cfs	64.2 cfs
B - 600'	600' x 600'	15-30%	38.4 cfs	102.6 cfs
C - 500'	Transport Section Only			102.6 cfs
D - 700'	700' x 800'	10-15%	55.6 cfs	158.2 cfs
combined E - 800'	800' x 1000'	10-15%	69.6 cfs	227.8 cfs
F - 1,000'	1,000' x 100'	5-10%	9.4 cfs	237.2 cfs
Σ = 5,200 ft.	Σ = 56.6 ac.			

17 Jan 96

→ FAX To: MARK YASKANIN
@
RUST

As you requested.
I found the Drawings
I'll send out Today
If you need anything else please call. Mick Rock

Worksheet 2: Time of concentration and peak discharge

Client: Ft. Carson Land Fill By: N.F.K. Date: 3 Apr 91

County: El Paso State: CO Checked: ____ Date: ____

Practice: Concrete Ditch Lining

Estimating time of concentration

E = 800 X 1000 = 18.4 ac.
F = 1000 X 100 = 2.3 ac.

1. Data:

Rainfall distribution type ..... {700 x 800 = 12.9 ac} = ____ (I, IA, II, III)

Drainage area ..... 1600 X 400 = 14.7 ac. [600 x 600 = 8.3 ac] A = ____ ac

Runoff curve number ..... CN = 86 (Worksheet 1) C Soil Range, Poor Condi

Watershed slope ..... 20-40% [15-30%] {10-15%} Y = ____ %

Flow length ..... 400 + 1,600 = 2,000 [l = 1,200] l = 2,000 ft
{l = 1,500}

2. T_c using l, Y, CN and figure 2-27 ..... = ____ hrs

or using equation 2-5

with Y = 40% → t_c = .12 hrs.
with Y = 20% → t_c = .17 hrs.

$$T_c = \frac{l^{0.8}\left[\left(\frac{1000}{CN}\right) - 9\right]^{0.7}}{1140\, Y^{0.5}} = \frac{(2,000)^{0.8}\left(\frac{1000}{86} - 9\right)^{0.7}}{1140\,(40)^{0.5}} = 0.12 \text{ hrs}$$

(1.97)

$$T_c = \frac{(1,200)^{.8}(1.97)}{1140(30)^{.5}} = 0.09$$

$S = 15\% \rightarrow T_c = 0.13$

with Y = 15% $T_c = \frac{(1,500)^{.8}(1.97)}{1140(15)^{.5}} = 0.16$ with Y = 10% $T_c = .19$

$$E - T_c = \frac{(1,800)^{.8}(1.97)}{1140(15)^{.5}} = 0.18$$

$$F - T_c = \frac{(1,100)^{.8}(1.97)}{1140(10)^{.5}} = 0.15$$

Estimating peak discharge

			A		B		D		E	
			Storm #1		Storm #2		Storm #3			
1. Frequency		yr	50 yr.	100 yr.	50 yr.	100 yr.	50 yr.	100 yr.	100 yr.	100 yr.
2. Rainfall, P (24-hour)		in	4.0	4.4	4.0	4.4	4.0	4.4	4.4	4.
3. Initial abstraction, I_a (Use CN with table 2-4)		in	.326	.326	.326	.326	.326	.326	.326	.3
4. Compute I_a/P ratios			0.08	0.07	.08	.07	.08	.07	.07	.0
			using t_c = .12 hrs.		t_c = .10 hrs.		t_c = .16		t_c = .18	t_c =
5. Unit peak discharge q_u (Use T_c and I_a/P with exhibit 2-11)		cfs/ac/in	1.5	1.5	1.57	1.57	1.48	1.48	1.3	1.
6. Runoff, Q (Use P and CN with figure 2-26 or table 2-2)		in	2.54	2.91	2.54	2.91	2.54	2.91	2.91	2.9
7. Peak discharge, q_p (Where $q_p = q_u AQ$)		cfs	56.0	64.2	33.5	38.4	48.5	55.6	67.6	9.

☆U.S. Government Printing Office : 1990 - 261-454/20812

CO

FT CARSON LAND FILL #2

N.F.K. 1 JULY 91

ENGINEERS Estimate - Quantities 1 2

BID ITEM #2 Concrete Ditch Lining - 5,378 linear ft.

To Include:

Subsidiary Items - Structure Removal; Pollution Control; Removal of Water; Excavation, Slip Ditch, Common; Grading and Shaping; Earthfill; + Loose Rock Riprap

- Concrete Ditch Lining (Z=1.25:1, b=3', t=4" with a radius)
  - 24" for 1,600 L.F. @ 13 cu.yd. per 100 L.F. → 208 yd³
  - 36" for 1,508 L.F. @ 17 " " " " " → 256 "
  - 48" for 2,270 L.F. @ 21 " " " " " → 477 "

  Σ=5,378 L.F. USE

  Σ= 941 yd³

  5% overage

  ∴ use 1000 yd³

- Structure Removal
  - couple old metal structures below D&E Junction (no rocks)
    - 3 hrs. with large front end loader
    - 1 hr. to haul to land fill #1 with dump

- Pollution Control
  - temp. ditches, ground cover, etc.
    - 8 hrs with motor grader to construct
    - 3 hrs. to fill back in when done
    - 30 bales of straw - staked down

- Removal of Water
  - temp. use of 2" trash pump
    - 4 hours depending on weather

- Excavation, Slip Ditch, Common (no rocks)
  - 24" for 1,600 L.F. @ 12.7 ft³/L.F. → 20,320 ft³
  - 36" for 1,508 L.F. @ 20.2 ft³/L.F. → 30,462 ft³
  - 48" for 2,270 L.F. @ 28.8 ft³/L.F. → 65,376 ft³

  Σ=5,378 L.F. ✓ok

  Σ = 116,158 ft³

  OR 4,300 cu. yds. ✓

- Grading and Shaping
  - minor work adjacent both sides of concrete ditch
    - 40 hours with motor grader

CO Ft. Carson Land Fill #2

N.F.K. 1 July 91

Engineers Estimate (cont.) (Quantities) 2 2

- Earthfill, Class C
  - hauling and placing 4,300 yd^3 of material excavated from the ditch lining
- Loose Rock Riprap
  - 1'*12*36' = 14 yd^3 of 12" to 24" riprap

BID ITEM #3 Fence — 11,000 Linear Feet

No Subsidiary Items

- Wire, 4 barb barb wire 11,000'*3 wires = 33,000 L.F. or 25 rolls
- T-posts (heavy weight) 11,000 ÷ 10 = 1,100 each
- Pull Posts
  - 4" Pipe 10' each *30 = 300 L.F
  - 3" Pipe 12' each *30 = 360 L.F.
- Corner Posts
  - 4" Pipe 10' each *20 = 200 L.F.
  - 3" Pipe 2*12' each *20 = 480 L.F.

∴ TOTAL PIPE ⇒ 4" = 300 + 200 = 500 ft.
3" = 360 + 480 = 840 ft.

- Concrete $\frac{4*50 + 8*20}{27} = 30$ cu. yds.

- Reflective Surface
  - O.D. of 4½"
    - $\pi\left(\frac{2.25}{12}\right)^2 = 0.11$ ft²/L.F. on 50 posts 6 ft. long each = 33 ft.²
  - O.D. of 3½"
    - $\pi\left(\frac{3}{12}\right)^2 = 0.09$ ft²/L.F. on 70 posts 8 ft. long each = 51 ft.²

Σ = 84 ft.²

Use 100 ft.²

- Surface Prep. & Painting
  - on 100 ft² for each

AWARD / CONTRACT

1. THIS CONTRACT IS A RATED ORDER UNDER DPAS (15CFR 350) ▶ RATING

PAGE 1 OF PAGES 2

2. CONTRACT (Proc. Inst. Ident.) NO. DAKF06-92-C-0078

3. EFFECTIVE DATE 08/03/92

4. REQUISITION/PURCHASE REQUEST/PROJECT NO. DEHOMA-1284-0015

5. ISSUED BY CODE DOC-C

Directorate of Contracting
Contracting Division
Building 6222
Fort Carson, CO 80913-5022

Elyse Lewis C04
(719)579-2548

6. ADMINISTERED BY (If other than Item 5) CODE DOC-A

Directorate of Contracting
Contract Administration Div.
Building 6222
Fort Carson, CO 80913-5022

7. NAME AND ADDRESS OF CONTRACTOR (No., street, city, county, State and ZIP Code) Vendor ID: 00017241

RICE & RICE, INC.
8150 RICE LANE
FOUNTAIN, CO 80817-

8. DELIVERY
☐ FOB ORIGIN ☒ OTHER (See below)

9. DISCOUNT FOR PROMPT PAYMENT
00.000% 00 Net 000

10. SUBMIT INVOICES (4 copies unless otherwise specified) TO THE ADDRESS SHOWN IN: ▶ ITEM

CODE 0T820 FACILITY CODE

11. SHIP TO/MARK FOR CODE
See Schedule

12. PAYMENT WILL BE MADE BY CODE 505010
FAO Attn: Commercial Accounts
Building 6280
Fort Carson, CO 80913-5024

13. AUTHORITY FOR USING OTHER THAN FULL AND OPEN COMPETITION:
☐ 10 U.S.C. 2304(c)( ) ☐ 41 U.S.C. 253(c)( )

14. ACCOUNTING AND APPROPRIATION DATA
212202000000762022202566000025720000000EHOMA92010015H402005050 10

15A. ITEM NO.	15B. SUPPLIES/SERVICES	15C. QUANTITY	15D. UNIT	15E. UNIT PRICE	15F. AMOUNT
	See attached Schedule(s)				Includes Fencing set

15G. TOTAL AMOUNT OF CONTRACT ▶ $ 183,300.66

16. TABLE OF CONTENTS

(X)	SEC.	DESCRIPTION	PAGE (S)	(X)	SEC.	DESCRIPTION	PAGE (S)
		PART I – THE SCHEDULE				PART II – CONTRACT CLAUSES	
X	A	SOLICITATION/CONTRACT FORM	1		I	CONTRACT CLAUSES	
X	B	SUPPLIES OR SERVICES AND PRICES/COSTS	1			PART III – LIST OF DOCUMENTS, EXHIBITS AND OTHER ATTACH.	
	C	DESCRIPTION/SPECS./WORK STATEMENT			J	LIST OF ATTACHMENTS	
	D	PACKAGING AND MARKING				PART IV – REPRESENTATIONS AND INSTRUCTIONS	
	E	INSPECTION AND ACCEPTANCE			K	REPRESENTATIONS, CERTIFICATIONS AND	
	F	DELIVERIES OR PERFORMANCE				OTHER STATEMENTS OF OFFERORS	
	G	CONTRACT ADMINISTRATION DATA			L	INSTRS., CONDS., AND NOTICES TO OFFERORS	
	H	SPECIAL CONTRACT REQUIREMENTS			M	EVALUATION FACTORS FOR AWARD	

CONTRACTING OFFICER WILL COMPLETE ITEM 17 OR 18 AS APPLICABLE

17. ☐ CONTRACTOR'S NEGOTIATED AGREEMENT (Contractor is required to sign this document and return _____ copies to issuing office.) Contractor agrees to furnish and deliver all items or perform all the services set forth or otherwise identified above and on any continuation sheets for the consideration stated herein. The rights and obligations of the parties to this contract shall be subject to and governed by the following documents: (a) this award / contract, (b) the solicitation, if any, and (c) such provisions, representations, certifications, and specifications, as are attached or incorporated by reference herein. (Attachments are listed herein.)

18. ☐ AWARD (Contractor is not required to sign this document.) Your offer on Solicitation Number _____ including the additions or changes made by you which additions or changes are set forth in full above, is hereby accepted as to the items listed above and on any continuation sheets. This award consummates the contract which consists of the following documents: (a) the Government's solicitation and your offer, and (b) this award / contract. No further contractual document is necessary.

19A. NAME AND TITLE OF SIGNER (Type or print)
Bud W. Rice Pres

20A. NAME OF CONTRACTING OFFICER
Harrison L. Cole K18 (719)579-2213

19B. NAME OF CONTRACTOR
BY Bud W. Rice Pres
(Signature of person authorized to sign)

19C. DATE SIGNED 07 Aug 1992

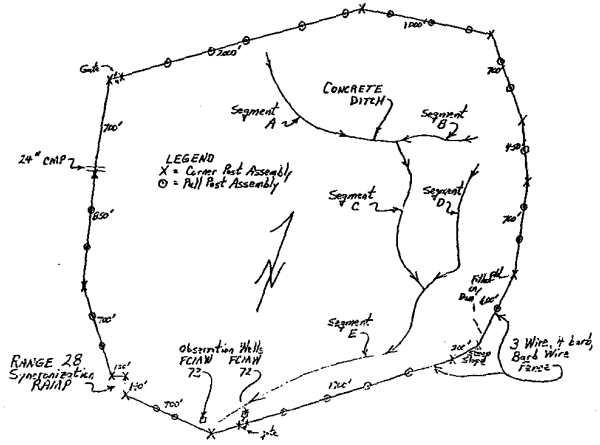
20B. UNITED STATES OF AMERICA
BY Harrison L. Cole
(Signature of Contracting Officer)

20C. DATE SIGNED 7 AUG 92

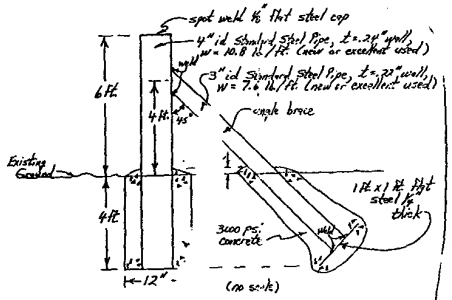
FT. CARSON LANDFILL # 2

EL PASO SCD

EL PASO COUNTY
COLORADO



PLAN VIEW SKETCH
(Scale is Same)



TYPICAL DETAIL OF PULL POST ASSEMBLY
CORNER POST ASSEMBLY
Only 1 Angle with Brace Shown

DIRECTIONS FROM I-25 TO PROJECT SITE

From I-25 proceed west at Exit 132 to Ft. Carson Gate 20 (0.1 miles), pass thru the check point and proceed straight ahead on Magrath Ave. 0.3 miles to the flashing light at Minick Ave. Turn right on Minick Ave. and follow road as it turns left for a total of 0.65 miles. Now turn right and proceed 150 ft. Diagonal to the right is Bldg. 5072. Turn left on the one way concrete tank trail and travel 0.7 miles to Range 28 on your right.

CONSTRUCTION NOTES

1. Fill material shall be obtained from the main [illegible] excavation.
2. Unsuitable excavated material shall be hauled and [illegible] in Landfill #1 approximately 30 miles from this site.
3. Clean excavated material not needed for fill operations shall be placed in nearby gullies and other low areas and graded and shaped to blend in with the surrounding ground.

UTILITIES

The contractor is responsible for ensuring the government has obtained all necessary permits prior to start of any excavation. Any damage to utilities will be the contractor's responsibility.

QUANTITIES

Concrete Ditch with 3 ft. bottom, 4 inches thick, 1.25: 1 side slopes, and depth varies as follows:

Segment	Station	Depth	Length
A	0+00 to 16+00	24"	1,600 ft.
A	16+00 to 16+40	36"	40 ft.
B	0+00 to 4+95	36"	495 ft.
C	0+00 to 4+25	36"	425 ft.
C	4+25 to 6+35	48"	210 ft.
D	0+00 to 5+48	36"	548 ft.
E	0+00 to 20+60	48"	2,060 ft.

TOTALS: 24" Ditch = 1,600 Lin. ft.
36" Ditch = 1,508 Lin. ft.
48" Ditch = 2,270 Lin. ft.
GRAND TOTAL = 5,378 Lin. ft.

Fence - Total Installed Length = 11,000 L.F.
using - 3 wire, 12 1/2 ga., 4 barb wire (33,000 L.F.).
- T-posts, 5 1/2 ft. long, minimum weight of 1.33#/L.F. (1,100 each).
- 30 pull post assemblies with 1 angle brace each (approximately).
- 20 corner post assemblies with 2 angle braces each (approximately).
- Barb wire gates as shown on drawings.
- Surface preparation, coating of primer, and painting of pull post and corner post assemblies.
- Special 3-M reflective coating to be placed on all pull post and corner post assemblies. (100 sq. ft.)

Loose Rock Riprap - 12 to 24" in size with 50% by weight greater than 16". 22 tons (14 cubic yards) of material required.

NOTE:

1. A 3-step corrosion prevention process shall be used on all steel pipe as follows:
   - 1st Surface preparation using a [illegible] blasting and rust remover like CORO, INC #12, #510 or equivalent.
   - 2nd A primer coat shall be applied like CORO, INC RAP #621 or equivalent.
   - 3rd A final coat shall be applied like CORO, INC #207 white Super Rubr-Meric or equivalent.
2. Once the steel pipe is properly in the ground and properly cleaned and coated a Reflective Film Adhesive like 3M Silver Scotchlite (High Intensity Grade Series 5870) or equivalent shall be applied to all above ground steel pipe according to manufacturers recommendation once the final coat has dried for a minimum of 3 days prior to stretching and installing the fence. 4 barb, 12 1/2 gauge barb wire. The barbed wire shall be placed at 18, 30, and 42 inch intervals from the ground surface. All T-Posts shall be placed at intervals of 10 ft. or less.

NOTE:

1. All Corner Post Assemblies will have 2 angle braces unless a gate is installed at a corner. Then only 1 angle brace will be installed.
2. Pull Post Assemblies will be identical to Corner Post Assemblies except only 1 angle brace will be installed.

Manufactures addresses of described material:

- CORO, INC: 3030 West 44th St.; Cleveland, Ohio 44113
  Phone 1-800-227-4569
- 3M Traffic Control Methods Division, Bldg. 223-3N-01, 3M Center, St. Paul, MN 55144-1000
  Phone 1-800-553-1380

DIVERSION "96% Job Class IV"

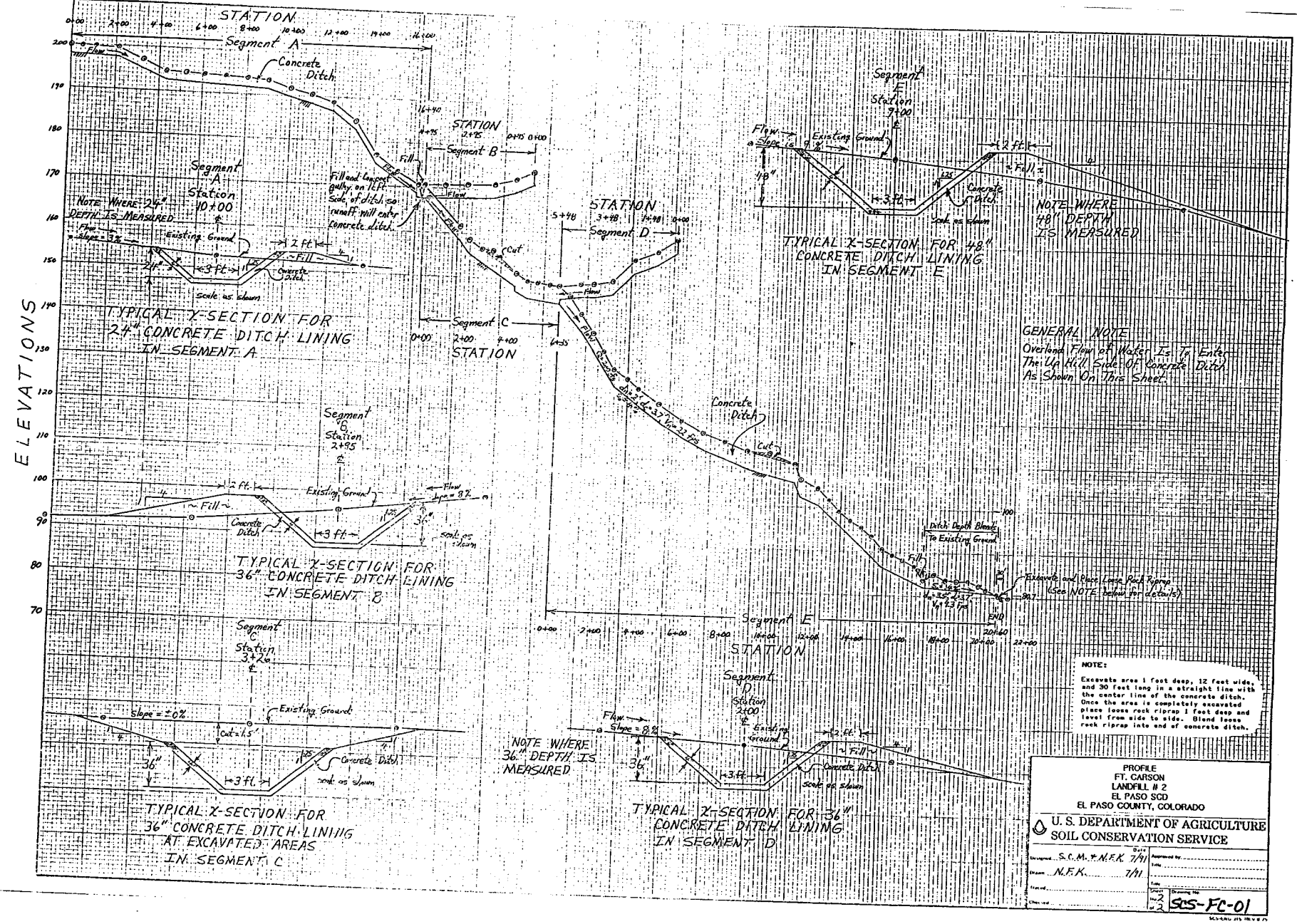
PLAN VIEW
FT. CARSON
LANDFILL # 2
EL PASO SCD
EL PASO COUNTY, COLORADO

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date		
Designed	S.C.M. + N.E.K.	7/91	Approved by	M.F. Boal
Drawn	N.E.K.	7/91	Title	Ag. Engr.
				25 July 91
Traced			Sheet No. 1 of 2	Drawing No. SCS-FC-01
Checked				

SCS-ENG-191C (REV. 6-78)

1 of 2 revised 20 May 91 MFB



ELEVATIONS
STATION
Segment A
Concrete Ditch
Flow
Segment B
Segment C
Segment D
Segment E
Fill
Cut
Fill and Concrete gully on left side of ditch so runoff will enter concrete ditch.
Note Where 24" Depth Is Measured
Existing Ground
Slope = 3%
Scale as shown
TYPICAL X-SECTION FOR 24" CONCRETE DITCH LINING IN SEGMENT A
Segment B Station 2+95
Slope = 8%
TYPICAL X-SECTION FOR 36" CONCRETE DITCH LINING IN SEGMENT B
Segment C Station 3+26
Slope = ±0%
Cut = 1.5'
TYPICAL X-SECTION FOR 36" CONCRETE DITCH LINING AT EXCAVATED AREAS IN SEGMENT C
Segment D Station 2+00
Slope = 8%
NOTE WHERE 36" DEPTH IS MEASURED
TYPICAL X-SECTION FOR 36" CONCRETE DITCH LINING IN SEGMENT D
Segment E Station 9+00
Slope is 9%
TYPICAL X-SECTION FOR 48" CONCRETE DITCH LINING IN SEGMENT E
NOTE WHERE 48" DEPTH IS MEASURED
GENERAL NOTE
Overland Flow of Water Is To Enter The Up Hill Side Of Concrete Ditch As Shown On This Sheet.
Ditch Depth Blends To Existing Ground
Excavate and Place Loose Rock Riprap (See NOTE below for details)
END
NOTE:
Excavate area 1 foot deep, 12 feet wide, and 30 feet long in a straight line with the center line of the concrete ditch. Once the area is completely excavated place loose rock riprap 1 foot deep and level from side to side. Blend loose rock riprap into end of concrete ditch.
PROFILE
FT. CARSON
LANDFILL # 2
EL PASO SCD
EL PASO COUNTY, COLORADO
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Designed S.C.M. + N.F.K. 7/91
Drawn N.F.K. 7/91
Sheet No. 2 of 2
Drawing No. SCS-FC-01