Nevada
Environmental
Restoration
Project

DOE/NV--588

Corrective Action Plan for Corrective Action Unit 417: Central Nevada Test Area Surface, Nevada

UNCONTROLLED

Controlled Copy No.:_____

Revision: 0

April 2000

Environmental Restoration
Division

U.S. Department of Energy
Nevada Operations Office

DISCLAIMER STATEMENT

Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the U.S. Government or any agency thereof or its contractors or subcontractors.

AVAILABILITY STATEMENT

Available for sale to the public from:

U.S. Department of Commerce
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161-0002
Telephone: 800-553-6847 or 703-605-6000
Fax: 703-605-6900
E-mail: orders@ntis.fedworld.gov
Online ordering: http://www.ntis.gov/ordering.htm

Available electronically at http://www.doe.gov/bridge

Available for a processing fee to U.S. Department of Energy and its contractors, in paper, from:

U.S. Department of Energy
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, TN 37831-0062
Telephone: 865-576-8401
Fax: 865-576-5728
E-mail: reports@adonis.osti.gov

DOE/NV--588

CORRECTIVE ACTION PLAN FOR CORRECTIVE ACTION UNIT 417: CENTRAL NEVADA TEST AREA, NEVADA

Prepared for
U. S. Department of Energy
Nevada Operations Office
Work Performed Under Contract No.
DE-AC08-96NV11718

Controlled Copy No.:_____

Revision: 0

February 2000

THIS PAGE INTENTIONALLY LEFT BLANK

DOE/NV--588

CORRECTIVE ACTION PLAN FOR CORRECTIVE ACTION UNIT 417: CENTRAL NEVADA TEST AREA, NEVADA

Approved by: Monica Sanchez Date: 4/13/00

Monica L. Sanchez, Project Manager
Offsites Subproject

Approved by: Runore Wycoff Date: 4/14/00

Runore C. Wycoff, Project Manager
Nevada Environmental Restoration Project

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS vii

EXECUTIVE SUMMARY ES-1

1.0 INTRODUCTION 1
1.1 PURPOSE 6
1.2 SCOPE 6
1.3 CORRECTIVE ACTION PLAN CONTENTS 7

2.0 DETAILED STATEMENT OF WORK 9
2.1 APPROVED ALTERNATIVE IMPLEMENTATION 9
2.1.1 No Action 9
2.1.2 Administrative Controls 10
2.1.2.1 Posting of Signs and Monuments 11
2.1.2.2 Site Posting Closure Activities 12
2.1.3 Clean Closure with Relocation of Impacted Material 13
2.1.3.1 Clean Closure of CAS 58-10-03 (UC-1 Shaker Pad Area S) 14
2.1.3.2 Clean Closure of CAS 58-44-03 (UC-3 Drill Mud/Grout Spill Area Z) .. 14
2.1.3.3 Clean Closure of CAS 58-10-04 (UC-4 Shaker Pad Area W) 14
2.1.3.4 Clean Closure of CAS 58-10-02 (UC-4 Shaker Pad Area S) 15
2.1.4 Engineered Covers 15
2.1.4.1 UC-4 Mud Pit C Cover 16
2.1.4.2 UC-1 CMP Cover 17
2.1.4.2.1 UC-1 CMP Cover Design Criteria 17
2.1.4.2.1.1 Infiltration 17
2.1.4.2.1.2 Precipitation 19
2.1.4.2.1.3 Consolidation 20
2.1.4.2.1.4 Maintenance and Repair 21
2.1.4.3 UC-1 CMP Cover Design 21
2.1.4.4 UC-1 CMP Cover Construction Activities 23
2.1.4.4.1 Relocation Trench Construction 23
2.1.4.4.2 Relocation of Drilling Mud from UC-4 Shaker Pad Area S (CAS 58 -10-02) 23
2.1.4.4.3 UC-1 CMP Cover Construction 24
2.1.4.4.4 Establishment of Vegetative Cover 25
2.1.4.4.5 Excavation of the Diversion Channels 26
2.2 CONSTRUCTION QUALITY ASSURANCE / QUALITY CONTROL 26
2.3 WASTE MANAGEMENT 27
2.4 REMEDIATION VERIFICATION 27
2.5 PERMITS 28

TABLE OF CONTENTS (Continued)

3.0 SCHEDULE 29

4.0 POST-CLOSURE MONITORING PLAN 31
4.1 PROPOSED MONITORING ACTIVITIES 31

5.0 REFERENCES 35

FIGURES

FIGURE 1 - CNTA Location Map 2

FIGURE 2 - CNTA Vicinity Map 3

FIGURE 3 - FY 2000 Closure Activity Schedule 30

FIGURE 4 - UC-1 CMP Cover Monitoring Instrumentation 33

TABLES

TABLE 1 - CAS Location and Approved Corrective Action 4

TABLE 2 - Site Posting Closure Activities 12

APPENDICES

APPENDIX A - Phase I Work Plan for UC-4 Mud Pit C Cover and Other Site Management Activities, Central Nevada Test Area, Corrective Action Unit 417

APPENDIX B - Results of the FY 1999 CNTA Phase I Activities

APPENDIX C - UC-4 Mud Pit C Settlement and Monitoring Plan

APPENDIX D - UC-1 Central Mud Pit Hydrological Modeling Results

APPENDIX E - Sampling, Inspection, Testing, and Acceptance (SITA) Plan

APPENDIX F - Fault Investigations at the Central Nevada Test Area UC-1 Site, Nye County, Nevada

ACRONYMS AND ABBREVIATIONS

ASTM	American Society for Testing and Materials
BLM	U.S. Bureau of Land Management
BN	Bechtel Nevada
CADD	Corrective Action Decision Document
CAIP	Corrective Action Investigation Plan
CAP	Corrective Action Plan
CAS	Corrective Action Site
CAU	Corrective Action Unit
cm	centimeter(s)
cm/sec	centimeter(s) per second
CMP	Central Mud Pit
CNTA	Central Nevada Test Area
COC	Constituent(s) of Concern
CR	Closure Report
DOE/NV	U.S. Department of Energy, Nevada Operations Office
FFACO	Federal Facility Agreement and Consent Order
ft	foot (feet)
FY	fiscal year
GCL	Geosynthetic Clay Liner
in.	inch(es)
kg/hectare	kilogram(s) per hectare
kg/L	kilogram(s) per liter
km	kilometer(s)
km^2	square kilometer(s)
lbs/acre	pound(s) per acre
m	meter(s)
m^3	cubic meter(s)
mi^2	square mile(s)
mg/kg	milligram(s) per kilogram

ACRONYMS AND ABBREVIATIONS

mg/L	milligram(s) per Liter
mi	mile(s)
MDA	minimal detectable activity
NAC	Nevada Administrative Code
NDEP	Nevada Division of Environmental Protection
NTS	Nevada Test Site
PAL	Preliminary Action Level(s)
pCi/L	picocurie(s) per Liter
SITA	Sampling, Inspection, Testing, and Acceptance Plan
TCLP	Toxicity Characteristic Leaching Procedure
TPH	Total Petroleum Hydrocarbons
yd^3	cubic yard(s)

EXECUTIVE SUMMARY

This Corrective Action Plan provides methods for implementing the approved corrective action alternative as provided in the Corrective Action Decision Document for the Central Nevada Test Area (CNTA), Corrective Action Unit (CAU) 417 (DOE/NV, 1999). The CNTA is located in the Hot Creek Valley in Nye County, Nevada, approximately 137 kilometers (85 miles) northeast of Tonopah, Nevada. The CNTA consists of three separate land withdrawal areas commonly referred to as UC-1, UC-3, and UC-4, all of which are accessible to the public. CAU 417 consists of 34 Corrective Action Sites (CASs).

Results of the investigation activities completed in 1998 are presented in Appendix D of the Corrective Action Decision Document (DOE/NV, 1999). According to the results, the only Constituent of Concern at the CNTA is total petroleum hydrocarbons (TPH). Of the 34 CASs, corrective action was proposed for 16 sites in 13 CASs.

In fiscal year 1999, a Phase I Work Plan was prepared for the construction of a cover on the UC-4 Mud Pit C to gather information on cover constructibility and to perform site management activities. With Nevada Division of Environmental Protection concurrence, the Phase I field activities began in August 1999. A multi-layered cover using a Geosynthetic Clay Liner as an infiltration barrier was constructed over the UC-4 Mud Pit. Some TPH impacted material was relocated, concrete monuments were installed at nine sites, signs warning of site conditions were posted at seven sites, and subsidence markers were installed on the UC-4 Mud Pit C cover. Results from the field activities indicated that the UC-4 Mud Pit C cover design was constructable and could be used at the UC-1 Central Mud Pit (CMP). However, because of the size of the UC-1 CMP this design would be extremely costly. An alternative cover design, a vegetated cover, is proposed for the UC-1 CMP.

Closure activities are planned for completion by October 2000, and will consist of:

- Clean closure of four CASs: UC-1 Shaker Pad Area S (58-10-03), UC-3 Drill Mud/Grout Spill Area Z (58-44-03), UC-4 Shaker Pad Area S (58-10-02), and UC-4 Shaker Pad Area W (58-10-04) by the excavation and relocation of TPH impacted material which exceeds the clean-up level of 100 milligrams per kilogram TPH.

- Constructing a vegetated cover over the UC-1 Central Mud Pit (CMP) (58-09-01) and constructing associated diversion channels.

- Complete Use Restriction forms for CASs 58-09-01, 58-09-02, 58-09-05, 58-10-03, 58-44-06, 58-09-06, 58-10-01, 58-25-01, 58-44-03, 58-09-03 (Mud Pits A, B, C, D), 58-10-02, 58-10-04 and 58-10-05.

- Installing concrete monuments at UC-4 Area X (58-10-05), a barbed wire fence with warning signs at the UC-1 CMP (58-09-01) cover, and subsidence markers on the UC-1 CMP cover.

- As-built surveying and stamping of each brass cap of each concrete monument and subsidence marker with coordinates and elevation data.

1.0 INTRODUCTION

This Corrective Action Plan (CAP) has been prepared for the Central Nevada Test Area (CNTA) Corrective Action Unit (CAU) 417 in accordance with the Federal Facility Agreement and Consent Order (FFACO) (Nevada Division of Environmental Protection [NDEP] et al., 1996). This CAP provides the methodology for implementing the approved Corrective Action Alternative as listed in the Corrective Action Decision Document (CADD) (DOE/NV, 1999).

The CNTA is located in Hot Creek Valley, Nye County, Nevada. The CNTA is north of U.S. Highway 6 and consists of three separate land withdrawal areas commonly referred to as UC-1, UC-3, and UC-4 (see Figures 1 and 2). UC-1 is located approximately 55 kilometers (km) (34 miles [mi]) north-northeast of Warm Springs, Nevada, and approximately 135 km (85 mi) northeast of Tonopah, Nevada. The central land withdrawal area, UC-1, spans approximately 2.6 square kilometers (km^2) (1 square mile [mi^2]). UC-3 and UC-4 span approximately 3.9 km^2 (1.5 mi^2) each. UC-3 and UC-4 are located roughly 4 km (2.5 mi) south and north of UC-1, respectively.

All three CNTA land withdrawal areas are accessible to the public. The sites were obtained by the Atomic Energy Commission (presently known as the U.S. Department of Energy) from the U.S. Bureau of Land Management (BLM). A nuclear device for Project Faultless was detonated approximately 975 meters (m) (3,200 feet [ft]) below ground surface on January 19, 1968, in emplacement boring UC-1. Two other emplacement borings (UC-3 and UC-4) were drilled on site but were not used.

Thirty-four Corrective Action Sites (CASs) were identified for investigation at the CNTA (DOE/NV, 1997). Investigation of the CASs was conducted during May and June of 1997 and June of 1998. The investigation included visual observations, geophysical investigations, and collection and analysis of surface and subsurface soil samples. Radioactive contaminants were not detected at the site. Chromium was detected at levels below the Preliminary Action Level (PAL) of 390 milligrams per kilogram (mg/kg) for hexavalent chromium (Appendix D of the CADD, [DOE/NV 1999]). The Constituents of Concern (COCs) detected at CAU 417 are total petroleum hydrocarbons (TPH) which consist of diesel/motor oil concentrations that exceed the 100 mg/kg action level as specified in Nevada Administrative Code (NAC) 445A (NAC, 1996). The CASs and proposed corrective actions are provided in Table 1.

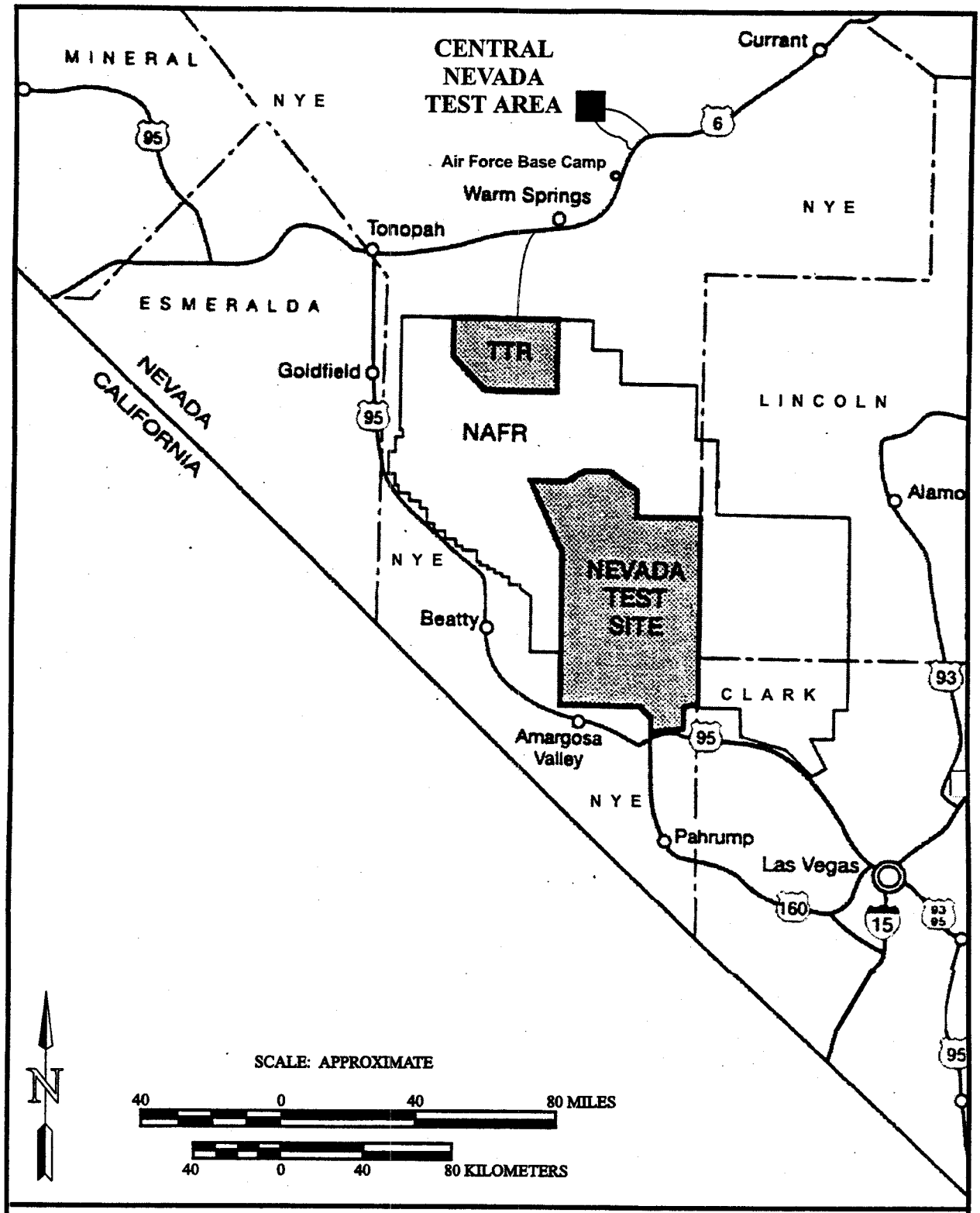


FIGURE 1
CENTRAL NEVADA TEST AREA LOCATION MAP

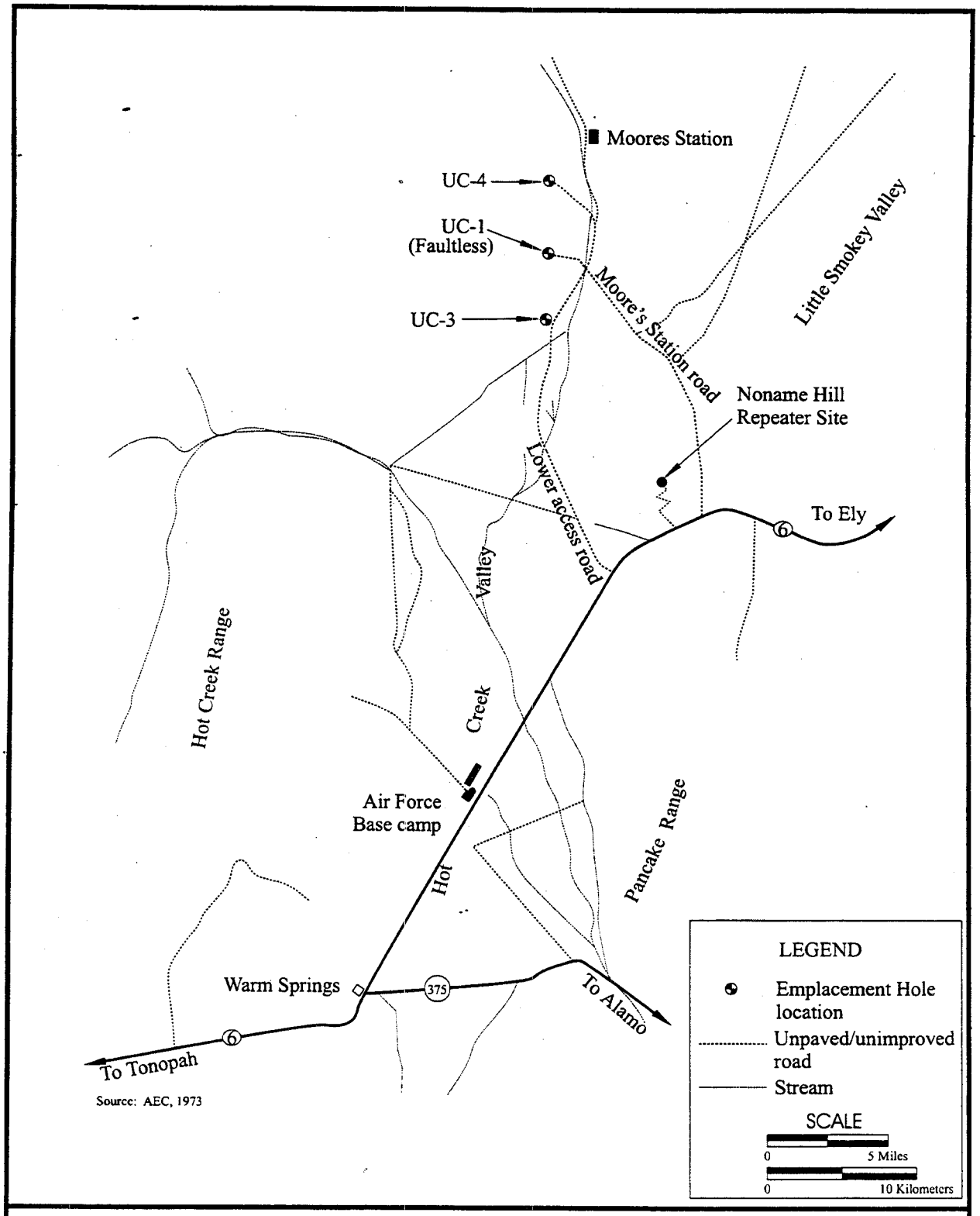


FIGURE 2
CENTRAL NEVADA TEST AREA VICINITY MAP

TABLE 1 - CAS LOCATION AND APPROVED CORRECTIVE ACTION

CAS No.	LAND WITHDRAWAL AREA	SITE DESCRIPTION	PROPOSED CORRECTIVE ACTION
58-05-01	UC-1	Septic system for the support trailer park west of the UC-1 Central Mud Pit (CMP)	NONE
58-07-01	UC-1	Decontamination Facility Pit (U1Z) west of the CMP	NONE
58-09-01	UC-1	Central Mud Pit (CMP)	Engineered Cover
58-09-02	UC-1	Mud Pit A (U1A) west of the CMP	Site Posting
58-09-04	UC-1	Mud Pit/Borrow Pit (U1B) south of UC-1	NONE
58-09-05	UC-1	Mud Pit C (U1C)	NONE
		Mud Pit D (U1D)	NONE
		Mud Pit E (U1E)	Site Posting
58-10-03	UC-1	Shaker Pad Area S (U1S)	Clean Closure with Relocation to CMP
58-35-01	UC-1	Burn Pit (same as 58-07-01) west of the CMP	NONE
58-44-01	UC-1	Drilling Mud/Grout Area X (U1X) west of the CMP	NONE
58-44-02	UC-1	Drilling Mud/Grout Area X (U1X) southeast of UC-1	NONE
58-44-05	UC-1	Grout Piles Area X (U1X) northeast of UC-1	NONE
58-44-06	UC-1	Grout Pile Area Y (U1Y) 1,093 m south of UC-1	Site Posting
58-98-03	UC-1	Waste Pile south of the CMP	NONE
58-05-02	UC-3	Septic System east of UC-3	NONE
58-05-03	UC-3	Underground storage tank at UC-3 recording trailer park	NONE
58-05-05	UC-3	Septic System southeast of UC-3	NONE
58-05-06	UC-3	Septic System at UC-3 recording trailer park	NONE
58-09-06	UC-3	Mud Pit A (U3A)	NONE
		Mud Pit B (U3B)	NONE
		Mud Pit C (U3C)	NONE
		Mud Pit D (U3D)	NONE
		Mud Pit E (U3E)	Site Posting
58-10-01	UC-3	Shaker Pad Area S (U3S) northeast of UC-3	Site Posting

TABLE 1 - CAS LOCATION AND APPROVED CORRECTIVE ACTION

CAS No.	LAND WITHDRAWAL AREA	SITE DESCRIPTION	PROPOSED CORRECTIVE ACTION
58-10-06	UC-3	Drilling Mud/cuttings Area X (U3X) north of UC-3	NONE
58-19-01	UC-3	Scrap and Trash Dump West of UC-3 recording trailer park	NONE
58-25-01	UC-3	Southern Outlier E (U3E) area south of Mud Pit E	Site Posting
58-35-02	UC-3	Burn Area at UC-3 recording trailer park	NONE
58-44-03	UC-3	Drill Mud/Grout Area Z (U3Z) southeast of UC-3	Clean Closure with Relocation to CMP
58-44-04	UC-3	Drilling Mud/Grout Spill Area Y (U3Y) southwest of UC-3	NONE
58-98-01	UC-3	Waste Pile adjacent to UC-3 Mud Pit A	NONE
58-98-02	UC-3	Waste Pile south of UC-3	NONE
58-98-04	UC-3	Waste pile southeast of UC-3	NONE
58-99-01	UC-3	Underground storage tank (U3U) southeast of UC-3	NONE
58-05-04	UC-4	Septic system west of UC-4 Mud Pit A	NONE
58-09-03	UC-4	Mud Pit A (U4A)	Site Posting
		Mud Pit B (U4B)	Site Posting
		Mud Pit C (U4C)	Engineered Cover
		Mud Pit D (U4D)	Site Posting
		Mud Pit E (U4E)	NONE
58-10-02	UC-4	Shaker Pad Area S (U4S) north of UC-4	Clean Closure with Relocation to CMP
58-10-04	UC-4	Shaker Pad Area W (U4W) south of UC-4	Clean Closure with Relocation to CMP
58-10-05	UC-4	Shaker Pad Area X (U4X) northeast of UC-4	Site Posting

In response to a May 12, 1999, meeting between the NDEP and DOE/NV and a May 24, 1999, letter from the NDEP to DOE/NV, a Phase I Work Plan was prepared and transmitted to the NDEP on July 8, 1999. The NDEP approved the work plan on August 6, 1999, and field mobilization activities began on August 4, 1999. The approved Phase I Work Plan is included as Appendix A. The purpose of this work plan was to obtain information on the constructibility of a soil cover, to refine the design and plan the remaining closure activities, and provide increased site management. The field activities consisted of constructing a cover at UC-4 Mud Pit C

(CAS 58-09-03) and performing site management activities at 16 sites in 13 CASs. Results from the fiscal year (FY) 1999 field activities are presented in Appendix B.

1.1 PURPOSE

The purpose of this CAP is to provide the methodology for implementing the closure of CAU 417 as proposed in the CADD (DOE/NV, 1999).

1.2 SCOPE

The scope of this plan is to provide the methods for implementation of the selected corrective action alternative specified in the CADD (DOE/NV, 1999) and document the FY 1999 field activities completed as proposed in the Phase I Work Plan. Detailed information of the site history and results of the investigation activities can be found in the Corrective Action Investigation Plan (CAIP) (DOE/NV, 1997), the CAIP Addendum (DOE/NV, 1998a), and the CADD (DOE/NV, 1999). CASs requiring corrective action and the selected remedial alternative can be found in Table 1. The following closure actions will be implemented under this plan:

- No action will be conducted at CASs 58-05-01, 58-07-01, 58-09-04, 58-09-05 (all but Mud Pit E), 58-35-01, 58-44-01, 58-44-02, 58-44-05, 58-98-03, 58-05-02, 58-05-03, 58-05-05, 58-05-06, 58-09-06 (all but Mud Pit E), 58-10-06, 58-19-01, 58-35-02, 58-44-04, 58-98-01, 58-98-02, 58-98-04, 58-99-01, 58-05-04, and 58-09-03 (Mud Pit E only) since no COCs were detected above regulated action levels.

- Clean closure will be conducted at CASs 58-10-03, 58-44-03, 58-10-04, and 58-10-02 by excavation and relocation of the TPH impacted materials above the 100 mg/kg action level to the UC-1 Central Mud Pit (CMP) or UC-1 CMP mud relocation trench. Petroleum hydrocarbon contaminated material was excavated from CASs 58-10-03, 58-44-03, and 58-10-04 and used in UC-4 Mud Pit C cover construction, and a limited amount of petroleum hydrocarbon contaminated mud from the CAS 58-10-02 was relocated to the UC-4 Mud Pit C relocation trench during Phase I work activities. The remainder of the TPH contaminated material from CASs 58-10-03, 58-44-03, and 58-10-04 will be used in UC-1 CMP cover system construction and the remainder of the TPH contaminated mud from CAS 58-10-02 will be relocated to the UC-1 CMP mud relocation trench during FY 2000 closure activities.

- An engineered cover system will be constructed over CAS 58-09-01 (UC-1 CMP). An engineered cover was constructed over CAS 58-09-03 (UC-4 Mud Pit C) in FY 1999 to determine the constructibility of the cover design for implementation at the UC-1 CMP. A settlement monitoring plan was prepared (Appendix C) to evaluate the consolidation (settlement) of the cover system and to determine if changes to the design were required prior

to implementation at the UC-1 CMP. The closure activities for the UC-4 Mud Pit C will consist of monitoring the cover for settlement and, if required, making design changes to the UC-1 CMP.

- Use restrictions and site postings will be instituted to prohibit intrusive activities, farming, and/or ranching at CASs 58-09-02, 58-09-05 (Mud Pit E only), 58-44-06, 58-09-06 (Mud Pit E only), 58-10-01, 58-25-01, 58-09-03 (Mud Pit A, B, and D) and 58-10-05. Concrete monuments with brass survey markers were installed at each of these sites except CAS 58-10-05 during Phase I work activities. Also, signs warning of site conditions were temporarily posted on T-posts or fences at CAS 58-10-05 and all other CASs requiring corrective action, and a barbed wire fence and warning signs were installed along the perimeter of the CAS 58-09-03 (UC-4 Mud Pit C) cover. Permanent concrete monuments with a brass survey marker will be installed at CASs 58-10-05, 58-09-01, and 58-09-03, and a barbed wire fence with warning signs will be installed along the perimeter of the CAS 58-09-01 (UC-1 CMP) cover system during FY 2000 closure activities. All temporary postings will be removed, and each survey marker will be as-built surveyed and stamped.

1.3 CORRECTIVE ACTION PLAN CONTENTS

This CAP is divided into the following sections:

Section 1.0 - Introduction
Section 2.0 - Detailed Statement of Work
Section 3.0 - Schedule
Section 4.0 - Post-Closure Monitoring Plan
Section 5.0 - References
APPENDIX A - Phase I Work Plan for UC-4 Mud Pit C Cover and Other Site Management Activities, Central Nevada Test Area, Corrective Action Unit 417
APPENDIX B - Results of the 1999 CNTA Phase I Work Activities
APPENDIX C - UC-4 Mud Pit C Settlement and Monitoring Plan
APPENDIX D - UC-1 Central Mud Pit Hydrological Modeling Results
APPENDIX E - Sampling, Inspection, Testing, and Acceptance (SITA) Plan
APPENDIX F - Fault Investigations at the Central Nevada Test Area UC-1 Site, Nye County, Nevada

This plan was developed using information and guidance provided from the following documents:

1997 Annual Book of ASTM Standards (American Society for Testing Materials [ASTM], 1997a and 1997b)

Nevada Administrative Code, 1996

Federal Facility Agreement and Consent Order (FFACO) (NDEP et al., 1996)

Corrective Action Investigation Plan for Central Nevada Test Area CAU No. 417 (DOE/NV, 1997)

Addendum to the Corrective Action Investigation Plan for Central Nevada Test Area CAU No. 417 (DOE/NV, 1998a)

Corrective Action Decision Document for Corrective Action Unit 417: Central Nevada Test Area Surface, Nevada (DOE/NV, 1999)

Test Methods for Evaluation, Solid Waste, Physical Chemical Methods (U.S. Environmental Protection Agency, 1996)

Phase I Work Plan for UC-4 Mud Pit C Cover and Other Site Management Activities, Central Nevada Test Area, Corrective Action Unit 417 (Appendix A)

2.0 DETAILED STATEMENT OF WORK

2.1 APPROVED ALTERNATIVE IMPLEMENTATION

2.1.1 No Action

As indicated in the CADD (DOE/NV, 1999), no corrective action will be taken at the following 24 CASs because no COCs above the PAL were detected: 58-05-01, 58-07-01, 58-09-04, 58-09-05 (all but Mud Pit E), 58-35-01, 58-44-01, 58-44-02, 58-44-05, 58-98-03, 58-05-02, 58-05-03, 58-05-05, 58-05-06, 58-09-06 (all but Mud Pit E), 58-10-06, 58-19-01, 58-35-02, 58-44-04, 58-98-01, 58-98-02, 58-98-04, 58-99-01, 58-05-04, and 58-09-03 (Mud Pit E only).

In 1998, accelerated actions were taken at the following CASs:

CAS No.	Description of Activities
58-98-03	Waste pile (drums, filters, etc.) southwest of UC-1 CMP; metal sent to Nevada Test Site (NTS) Salvage as scrap metal, remainder disposed of at the U10c Landfill at the NTS
58-05-03	Underground storage tank at UC-3 recording trailer park; solidified contents and tank were disposed of at the NTS Area 6 Hydrocarbon Landfill
58-05-05	Septic system southeast of UC-3; backfilled and closed in place
58-05-06	Septic system at the UC-3 recording trailer park; backfilled and closed in place
58-19-01	Scrap and trash dump material west of UC-3 recording trailer park; metal sent to NTS Salvage as scrap metal, remainder disposed of at the NTS U10c Landfill
58-98-01	Waste pile (drums, filters, etc.) west of UC-3; metal sent to NTS Salvage as scrap metal, remainder disposed of at the NTS U10c Landfill
58-98-02	Waste pile (drums, filters, etc.) south of UC-3; metal sent to NTS Salvage as scrap, remainder disposed of at the NTS U10c Landfill
58-98-04	Waste pile (metal, cable, etc.) southeast of UC-3; metal sent to NTS Salvage as scrap metal, remainder disposed of at the NTS U10c Landfill
58-99-01	Protruding pipes (underground storage tank) southeast of UC-3; solidified contents, pipes, and tank disposed of at the NTS Area 6 Hydrocarbon Landfill

Drilling mud/grout piles at the following CASs will be relocated to the CMP as housekeeping activities:

CAS No.	Description of CAS
58-44-01	Drilling mud/grout piles west of UC-1 CMP
58-44-02	Drilling mud/grout piles southeast of UC-1
58-44-05	Grout pile northeast of UC-1
58-44-04	Grout pile Area U3Y at UC-3

These materials will be used as fill/borrow in the CMP cover since:

- COCs were not detected above the PALs
- The materials are granular
- The transportation costs to move the material for use as fill/borrow in the CMP cover are negligible compared to costs to transport the material to the NTS or another facility for disposal.

Results from the 1998 accelerated actions and the proposed housekeeping activities will be documented in the CAU 417 Closure Report (CR). Table 1 lists "NONE" for the proposed corrective action for the "no action" sites.

2.1.2 Administrative Controls

Site management activities were implemented in FY 1999 in accordance with the Phase I Work Plan that complimented the Administrative Controls Alternative. Section 2.1.2.1 summarizes the posting activities conducted in FY 1999. Section 2.1.2.2 provides the activities to complete the closure action at the sites to be closed with site posting.

2.1.2.1 Posting of Signs and Monuments

From August 9 to September 9, 1999, concrete monuments with signs and brass survey markers were placed to mark the boundaries and warn of site conditions at the following nine sites:

CAS Number	Description
58-09-02	UC-1 Mud Pit A
58-09-05	UC-1 Mud Pit E
58-44-06	UC-1 Borrow Pit Area Y
58-09-06	UC-3 Mud Pit E
58-10-01	UC-3 Shaker Pad Area S
58-25-01	UC-3 Spill Southern Outlier Area E
58-09-03	UC-4 Mud Pit A
58-09-03	UC-4 Mud Pit B
58-09-03	UC-4 Mud Pit D

Signs warning of site conditions were posted on T-posts or the fences at:

CAS Number	Description
58-09-01	UC-1 CMP
58-10-03	UC-1 Shaker Pad Area S
58-44-03	UC-3 Drill Mud/Grout Spill Area Z
58-10-02	UC-4 Shaker Pad Area S
58-10-04	UC-4 Shaker Pad Area W
58-10-05	UC-4 Shaker Pad Area X
58-09-03	UC-4 Mud Pit C

Installation of monuments with signs was not implemented at UC-4 Shaker Pad Area X (CAS 58-10-05) and UC-1 CMP (CAS 58-09-01) since closure activities could disturb the postings. The postings at the UC-4 Shaker Pad Area S (CAS 58-10-02), UC-1 Shaker Pad Area S (CAS 58-10-03), UC-4 Shaker Pad Area W (CAS 58-10-04), and UC-3 Drill Mud/Grout Spill Area Z (CAS 58-44-03) are temporary and will be removed during closure activities in FY 2000. A barbed wire fence with signs was erected at the UC-4 Mud Pit C site. The locations of installed monuments will be noted in the CR.

2.1.2.2 Site Posting Closure Activities

Table 2 provides the site posting closure activities to be completed in FY 2000.

TABLE 2 SITE POSTING CLOSURE ACTIVITIES

CAS No.	SITE DESCRIPTION	SITE ACTIVITY TO BE IMPLEMENTED
58-09-02	UC-1 Mud Pit A (U1A)	Complete Use Restriction forms; survey and stamp brass markers
58-09-05	UC-1 Mud Pit E (U1E)	Complete Use Restriction forms; survey and stamp brass markers
58-44-06	UC-1 Borrow Pit Y (U1Y)	Complete Use Restriction forms; survey and stamp brass markers
58-09-06	UC-3 Mud Pit E (U3E)	Complete Use Restriction forms; survey and stamp brass markers
58-10-01	UC-3 Shaker Pad Area S (U3S)	Complete Use Restriction forms; survey and stamp brass markers
58-25-01	UC-3 Spill Southern Outlier E (U3E)	Complete Use Restriction forms; survey and stamp brass markers
58-09-03	UC-4 Mud Pit A, B, and D (U4A, U4B, and U4D)	Complete Use Restriction forms; survey and stamp brass markers
58-10-05	UC-4 Shaker Pad Area X (U4X)	Remove temporary signs; install concrete monuments with brass survey marker; complete Use Restriction forms; survey and stamp brass markers
58-10-02	UC-4 Shaker Pad Area S (U4S)	Remove temporary signs
58-10-04	UC-4 Shaker Pad Area W (U4W)	Remove temporary signs
58-44-03	UC-3 Drill Mud/Grout Spill Area Z (U3Z)	Remove temporary signs
58-10-03	UC-1 Shaker Pad Area S (U1S)	Remove temporary signs
58-09-03	UC-4 Mud Pit C (U4C)	Complete Use Restriction forms; survey and stamp brass subsidence markers
58-09-01	UC-1 CMP	Remove temporary signs; install barbed wire fence with warning signs; install concrete subsidence monuments with brass survey marker; survey and stamp brass subsidence markers, complete Use Restriction forms

The installation of concrete monuments and barbed wire fencing and the stamping of survey markers are to be performed in accordance with the SITA Plan (Appendix E).

2.1.3 Clean Closure with Relocation of Impacted Material

Clean closure by excavation and relocation of the excavated materials to the UC-1 CMP or UC-1 CMP mud relocation trench will be conducted at the following CASs:

- CAS 58-10-03 (UC-1 Shaker Pad Area S)
- CAS 58-44-03 (UC-3 Drill Mud/Grout Spill Area Z)
- CAS 58-10-04 (UC-4 Shaker Pad Area W)
- CAS 58-10-02 (UC-4 Shaker Pad Area S)

As part of the FY 1999 field activities, temporary site postings were installed and petroleum hydrocarbon-impacted soils were excavated from CAS 58-10-03 (UC-1 Shaker Pad Area S), 58-44-03 (UC-3 Drill Mud/Grout Spill Area Z), and 58-10-04 (UC-4 Shaker Pad Area W). Hydrocarbon-impacted soils/drill cutting materials were excavated from each of these CASs and transported to the UC-4 Mud Pit C for inclusion in cover construction. An attempt to excavate granular material from CAS 58-10-02 (UC-4 Shaker Pad Area S) for use in the UC-4 Mud Pit C cover was not possible (see section 2.1.3.4); however, drilling mud material was excavated and placed in the UC-4 Mud Pit C relocation trench. Details of the Phase I work performed at the clean closure sites are provided in Appendix B.

Hydrocarbon-impacted granular material still present in CASs 58-10-03, 58-44-03, and 58-10-04 will be used in the UC-1 CMP cover system design (see section 2.1.4.3). Hydrocarbon-impacted drilling muds from 58-10-02 will be relocated to the UC-1 CMP mud relocation trench. The hydrocarbon-impacted material will be excavated, transported, and placed with standard construction equipment consisting of, but not limited to, front-end loaders, dozers, backhoes, graders, scrapers, and dump trucks. Field screening using a PetroFLAG™ detection kit or equivalent will be conducted during the excavation to evaluate TPH concentrations of the soil at the base of the excavation. When field screening results indicate TPH concentrations are below the clean-up action level of 100 mg/kg, verification samples will be collected and submitted for laboratory analysis. Verification sampling is detailed in Section 2.4. After receipt of results indicating that the TPH concentrations are below the action level, limited backfilling with soil from the UC-1 borrow source and area grading will be conducted. Limited compaction will be conducted with the equipment during area grading. A compaction specification will not be applicable since the surface of the disturbed area will be ripped to approximately 0.3 m (1 ft) to encourage catchment of native seeds and establishment of plants.

2.1.3.1 Clean Closure of CAS 58-10-03 (UC-1 Shaker Pad Area S)

Approximately 92 cubic meters (m^3) (120 cubic yards [yd^3]) of hydrocarbon-impacted granular material was excavated from the UC-1 Shaker Pad Area S and used in the UC-4 Mud Pit C cover construction. Granular material was used in the stabilization layer placed directly over the geogrid to establish a stable base for equipment to construct and compact subsequent layers of the UC-4 Mud Pit C cover. The site was temporarily posted with warning signs. Details of the FY 1999 field activities performed at CAS 58-10-03 are provided in Appendix B.

Approximately 994 m^3 (1,300 yd^3) of hydrocarbon-impacted material will be excavated from the UC-1 Shaker Pad Area S and used in the UC-1 CMP cover system during FY 2000 field activities. Verification samples from the bottom and sides of the excavation will be collected and analyzed to confirm that TPH concentrations are below the clean-up level of 100 mg/kg TPH.

2.1.3.2 Clean Closure of CAS 58-44-03 (UC-3 Drill Mud/Grout Spill Area Z)

Approximately 61 m^3 (80 yd^3) of hydrocarbon-impacted material was excavated from the UC-3 Shaker Pad Area Z and used in the UC-4 Mud Pit C cover construction. Granular material was used in the stabilization layer placed directly over the geogrid to establish a stable base for equipment to construct and compact subsequent layers of the cap. The site was temporarily posted with warning signs. Details of the FY 1999 field activities performed at CAS 58-44-03 are provided in Appendix B.

Approximately 722 m^3 (944 yd^3) of hydrocarbon-impacted material will be excavated from the UC-3 Shaker Pad Area Z and used in the UC-1 CMP cover system during FY 2000 field activities. Verification samples from the bottom and sides of the excavation will be collected and analyzed to confirm that TPH concentrations are below the clean-up level of 100 mg/kg TPH.

2.1.3.3 Clean Closure of CAS 58-10-04 (UC-4 Shaker Pad Area W)

Approximately 375 m^3 (490 yd^3) of hydrocarbon-impacted material was excavated from the UC-4 Shaker Pad Area W and used in the UC-4 Mud Pit C cover construction. Granular material was used in the stabilization layer placed directly over the geogrid to establish a stable base for equipment to construct and compact subsequent layers of the cap. The site was temporarily posted with warning signs. Details of the FY 1999 field activities performed at CAS 58-10-04 are provided in Appendix B.

Approximately 23 m^3 (30 yd^3) of hydrocarbon-impacted material will be excavated from the UC-4 Shaker Pad Area W and used in the UC-1 CMP cover system during FY 2000 field activities. Verification samples from the bottom and sides of the excavation will be collected and analyzed to confirm that TPH concentrations are below the clean-up level of 100 mg/kg TPH.

2.1.3.4 Clean Closure of CAS 58-10-02 (UC-4 Shaker Pad Area S)

During the FY 1999 field activities, an attempt was made to excavate granular material from CAS 58-10-02 for use in the UC-4 Mud Pit C cover. However, it was discovered that the drilling mud content of the granular material was higher than anticipated, and only approximately 92 m^3 (120 yd^3) of hydrocarbon-impacted material out of a planned 382 m^3 (500 yd^3) was excavated from the UC-4 Shaker Pad Area S and used in the UC-4 cover. Approximately 138 m^3 (180 yd^3) of drilling mud was excavated and relocated to the UC-4 Mud Pit C mud relocation trench at the east end of Mud Pit C. The site was temporarily posted with warning signs. Details of the FY 1999 field activities performed at CAS 58-10-02 are provided in Appendix B.

During FY 2000 field work, an estimated 5,200 m^3 (6,800 yd^3) of drilling-mud containing material will be relocated to the UC-1 mud relocation trench. Excavation will continue until analyzed verification samples from the bottom and sides of the excavation confirm that TPH concentrations are below the 100 mg/kg TPH action level.

2.1.4 Engineered Covers

To determine the constructibility and more effectively design and plan the construction of the UC-1 CMP cover system, a soil cover was constructed at UC-4 Mud Pit C (CAS 58-09-03) as part of the FY 1999 Phase I field activities. Results from the FY 1999 Phase I activities indicate that the cover design using multi-layers of soil with a Geosynthetic Clay Liner (GCL) as an infiltration barrier is constructable and could be implemented at the UC-1 CMP. However, this type of design would require significant soil volumes and therefore would be expensive to construct.

An alternative cover design, a vegetated monolayer, has been selected for the UC-1 CMP cover and offers the following benefits:

- protects at least as well as a GCL design based on hydrological modeling results (Appendix D),
- requires less cover material, resulting in shorter duration of field activities,
- appears similar to the existing surroundings when vegetated,
- costs substantially less than a cover using a GCL.

2.1.4.1 UC-4 Mud Pit C Cover

Cover construction activities for the UC-4 Mud Pit C were implemented from August 1, 1999, to September 9, 1999. Construction activities consisted of:

- Construction of a retention berm and modifications to the existing trench at the east end of the mud pit.
- Relocation of drilling mud into the relocation trench.
- Installation of geogrid over the mud pit and relocation trench.
- Placement and compaction of the stabilization layer.
- Placement and compaction of the shaping layer.
- Placement and compaction of the bedding layer.
- Installation of the GCL.
- Placement and compaction of the buffer layer.
- Placement and compaction of the erosion control layer.
- Installation of settlement monuments.
- Installation of a barbed wire fence and warning signs.

Details regarding the construction activities can be found in Appendix B.

The remaining work to be completed at the UC-4 Mud Pit C is the completion of the settlement monitoring prior to implementation of the construction of the UC-1 CMP cover system. The settlement monitoring results will be used to determine if the settlement observed is similar to the settlement calculation used for the design and if modifications in the UC-1 CMP design are necessary. The settlement monitoring plan is included as Appendix C.

2.1.4.2 UC-1 CMP Cover

The UC-1 CMP cover will incorporate some of the features and specifications used for the UC-4 Mud Pit C cover. These include, a mud relocation trench, a geogrid, and a stabilization layer. Unlike the UC-4 Mud Pit C cover, the CMP cover will be vegetated and have less stringent compaction requirements for the cover to encourage the growth of vegetation. The CMP specifications can be found in the SITA Plan (see Appendix E).

2.1.4.2.1 UC-1 CMP Cover Design Criteria

Though landfill closure regulations are not applicable for the mud pits of the CNTA, the cover design for the UC-1 CMP should be protective of the underlying material and environment. The design criteria used in the design of the UC-4 Mud Pit C cover (see Appendix A) are applicable to the UC-1 CMP cover system design. The design criteria are based on: removal of precipitation/infiltration, minimization of precipitation run-on and run-off, consolidation, and cover maintenance and repair.

2.1.4.2.1.1 Infiltration

To protect the underlying material, a cover system must provide a barrier to prevent or limit infiltrating soil moisture, and/or provide a mechanism to remove infiltrating soil moisture. Preventing infiltration can be achieved by creating a barrier to soil moisture by highly compacting cover materials, using a geo-synthetic barrier such as a GCL in the cover system, or using a capillary barrier. Removing infiltration and existing soil moisture from a cover system is effectively achieved by using plants to transpire soil moisture out of the cover system. The proposed cover design for the UC-1 CMP is an engineered vegetated cover that will use plants to remove soil moisture from the cover by transpiration and evaporation. To aid in the establishment of cover vegetation, it is important that the surface soils be relatively loose. For this reason, the cover surface will be disked to a depth of approximately 0.3 m (1 ft) to encourage the successful transplant of mature plants and the germination of native seed.

Hydrological Modeling

The performance of the vegetative cover was determined through hydrological modeling. Results for the modeling are presented in Appendix D. The model used to simulate the UC-1 cover design scenarios, UNSAT-H allows simulation of infiltration, drainage, redistribution, evaporation, and uptake of water by plants (Fayer and Jones, 1990). This model has been used previously to simulate water movement in protective barriers at the Hanford site (Fayer et al., 1992). The accuracy of UNSAT-H has been tested by comparing simulated results for soil water storage to actual field values measured using precision weighing lysimeters for a site in NTS Area 5 (Levitt et al., 1999) Hydrological modeling results for a 1.2 m (4 ft) thick vegetated monolayer soil cover with a permeability of 10^{-4} cm/sec show that the vegetation will effectively remove soil moisture from the cover preventing it from reaching the underlying material. Four

vegetative scenarios differing in the type and mix of plant cover, and the percent area covers were modeled. The scenarios simulated were:

1. A combination of transplanted mature native plant species, seeded native plant species, and a non-native cover crop of wheat or barley (approximately 30 percent of cover is vegetated throughout the simulation);

2. A combination of transplanted and seeded native plant species without a cover crop (Initially 7 percent of the cover is vegetated. Over 6 years the vegetation increases to 25 percent coverage and remains at this level for the duration of the simulation);

3. Seeded native plant species only (Initially 0 percent of the cover is vegetated. Over 6 years the vegetation increases to 15 percent coverage and remains at this level for the duration of the simulation); and

4. A non-native vegetative cover of wheat or barley over 20 percent of the cover (20 percent of the cover is vegetated throughout the simulation).

Scenarios 1 and 2 took approximately 10 years to equilibrate; reach a long-term state where precipitation infiltrating into the cover is equal to that removed by evaporation and transpiration by the vegetation. Scenario 3 reached equilibrium in 25 years, while scenario 4 reached equilibrium in 6 years. In all four scenarios, moisture was removed from the cover and the cover moisture content remained less than saturation (36 percent) over a 30 year simulated time period given an initial condition of a saturated 2-ft soil layer overlying the mud.

The modeling used the following conservative assumptions:

- Used the actual 1998 rainfall record for NTS Area 5 as the model precipitation input because this record was available and detailed. This record included an annual precipitation of 24.4 centimeters (cm) (9.6 inches [in.], which is higher than the reported average of 20 cm (8 in.) for CNTA, and included a 24 hour, 25 year precipitation event.

- The model was run using a permeability value of 10^{-4} cm/sec, whereas the permeability of the native soil in the area of the CMP ranges from approximately 1.0×10^{-7} to 5.0×10^{-4} cm/sec. (permeability results can be found in the Phase I Work Plan, Appendix A).

- One hundred percent of the precipitation was assumed to infiltrate into the cover (no run-off was modeled).

- The hydrological conductivity of the cover was assumed to be uniform. During construction, however, subtle layering will result from the soil placement activities. These layers will slow infiltration.

- The direction of water movement in the cover was assumed to be in the vertical direction only; movement was modeled as one dimensional. There will be horizontal movement as well as vertical and this will reduce infiltration.

- The percentage of area covered by vegetation was assumed to be less than that for the native area. In addition, there are native invader species, such as Russian Thistle, that will vegetated the cover and improve cover performance that were not included in the cover simulation.

Because these assumptions are conservative, it is expected that the constructed cover will perform better than the modeling results indicate; soil moisture in the cover will be removed in a shorter time than the modeling indicated.

2.1.4.2.1.2 Precipitation

Precipitation run-on and run-off can impact the availability of water for infiltration into the cover system and erosion of the cover. Effects from run-on can be mitigated by grading the site to facilitate drainage and/or the design and installation of diversion structures such as berms and/or channels to direct run-on away from the cover. Effects from precipitation run-off can be mitigated with slope, permeability, vegetation, gradation, and diversion channels.

A flood study was conducted in 1998 and 1999 to evaluate the flood hazard at the CNTA for closure design purposes. Results from the study indicate that the UC-1 Central Mud Pit is not within a Federal Emergency Management Agency 100-year, 6-hour flood hazard zone (see Flood Study report in Appendix A). To divert precipitation run-on away from the CMP cover, diversion channels and area grading will be implemented (see Engineering Drawings in Appendix E).

The cover has been designed so that precipitation run-on will not occur, only precipitation falling directly on to the cover will potentially cause erosion of the cover. The transplanted mature plants and the seeded native plants will minimize the potential for erosion. Established plants in arid environments are among the most efficient means of removing moisture from soils. And established plants effectively reduce soil erosion by diminishing the effects of wind and slowing the velocity of any run-off. In addition, the cover will be graded to direct precipitation to the center of the cover with a slope ranging from 0.14 to 2.0 percent. (see Section 2.1.4.3). This shallow slope will also minimize any potential for erosion.

Based on the site conditions discussed above, the design criteria for minimizing precipitation run-on and run-off are:

- Establish vegetation on the cover to minimize erosion.
- Grade the cover to provide drainage off of the cover with a slope ranging from 0.14 to 2.0 percent.
- Construct diversion channels and grade area to divert run-on and run-off away from the cover.

2.1.4.2.1.3 Consolidation

Consolidation (settlement) results from the application of external loads over existing materials and the subsequent expulsion of pore moisture. Based on the results of geotechnical testing, the expected settlement of the cover and contents of the mud pit has been calculated. These calculations indicate that there will be less than 15 cm (6 in.) of consolidation (settlement) of the material contained in the UC-1 CMP. Ninety percent of this settlement is expected to occur between 3 and 13.5 years after cover construction is completed. Because the mud was placed into the pit as a slurry, it is relatively homogeneous and differential settlement due to material differences will be minimal. Settlement over the relocation trench is calculated to be approximately 23 cm (9 in.). Ninety percent of this settlement is expected to occur between 16 and 65 years after construction is completed (see SITA Plan in Appendix E). Material in the relocation trench will be relatively homogeneous and differential settlement is expected to be minimal. Thus, settlement over the area of the cover system will be directly proportional to mud thickness and will vary gradually across the length. Settlement will be minimal at the edges and will increase near the middle of the cover system. Localized settlement, which can result in tension areas within the cover, is not expected. Therefore, the integrity of the cover will not be compromised by the predicted settlement. The cover is designed to provide drainage during and after settlement has occurred.

As the cover settles, water will be squeezed from the drilling mud. The volume of water released will equal the volume change of the mud. Therefore, if 2.5 cm (1 in.) of settlement is predicted, 2.5 cm (1 in.) of free water will be released from the same area. The water will be released as the settlement occurs, which for the mud pit is expected to be over a period of 3 to 13.5 years, with settlement of less than 20 cm (8 in.). Therefore, the settlement will produce, at most, the same amount of water as 20 cm (8 in.) of rainfall over the area of the mud pit. Assuming that half the water is emitted upwards and half downwards, the net emission to the ground below the drilling mud will be the equivalent of a maximum of 10 cm (4 in.) of free water over the span of 3 to 13.5 years. This is not a significant amount of water compared to the natural rainfall at the CNTA

(approximately 20 cm [8 in.] per year). No run-off will be produced by the loading of the mud due to the construction of the cover.

2.1.4.2.1.4 Maintenance and Repair

Maintenance and repair were considered in the cover design because a cover should be designed to minimize maintenance and repair activities. Erosion and intrusive activities can greatly impact the cover performance and influence the need for maintenance or repairs. Erosion is controlled by the presence of established vegetation, the slope, and gradation, of the cover material. Intrusive activities from burrowing and grazing animals can be discouraged by installation of fencing. Intrusion into the cover from human activities will be discouraged by the installation of a fence and warning signs. Therefore, the design criteria will require the following:

- The perimeter of the cover area will be fenced to minimize damage to the cover by humans and large animals.

- The perimeter of the cover area will have signs posted indicating the site conditions and prohibited activities.

- Periodic inspection of cover will be conducted and repair/maintenance performed as required (see Section 4.0). The details of the cover inspection plan will be provided in the CAU 417 CR.

For details concerning the design criteria for the cover system, see the SITA Plan (Appendix E).

2.1.4.3 UC-1 CMP Cover Design

The cover system design using a geogrid and a vegetated monolayer cover was chosen because it will remove infiltrating precipitation and existing soil moisture from the cover; will control precipitation run-on and run off; and will meet settlement, maintenance, and repair considerations. The cover system design, drawings, calculation, and specifications can be found in the SITA Plan located in Appendix E. The cover system will be constructed over the CMP and mud relocation trench.

The cover system design consists of the following layers (layers are listed in ascending order from the drilling mud to the top of the cover):

- **Geogrid.** The geogrid will distribute the load of the cover material and the construction equipment over the drilling mud and increase stability against localized bearing capacity and slope failures. The geogrid will serve only to assist construction. A bench will be cut

around the perimeter of the CMP and within the relocation trench at the level of the mud. The geogrid will be lapped onto this bench and anchored in place by placing a minimum of 0.6 m (2 ft) of clean soil on the edge of the geogrid.

- **Vegetated Stabilization layer.** The stabilization soil layer *overlying* the geogrid forms the single vegetated layer of the cover. The top of the cover will approximate the existing mud pit topography. It will be comprised of two 0.6-m (2-ft) thick lifts, for a total thickness of approximately 1.2 m (4 ft), and will be graded to achieve the designed slope. The stabilization layer will be vegetated as described in Section 2.1.4.4.4.

The initial 0.6-m (2-ft) lift will consist of borrow soil and hydrocarbon-impacted materials from CASs 58-10-03 (UC-1 Shaker Pad Area S), 58-44-03 (UC-3 Drill Mud/Grout Area Z), and UC-4 Shaker Pad Area W (58-10-04). The hydrocarbon-impacted materials will be placed directly over the geogrid and covered with a minimum of 0.6 m (2 ft) of clean borrow material. The CMP contains approximately 40,182 m^3 (52,556 yd^3) of drilling mud with an average TPH concentration of roughly 1,160 mg/kg. The 1,747 m^3 (2,284 yd^3) of hydrocarbon-impacted material to be used in this layer has an average TPH concentration of approximately 570 mg/kg. Therefore, the average TPH concentration under the cover will not increase with the addition of the TPH-impacted materials in the stabilization layer.

The cover will be sloped to direct run-off inward to the cover center and then eastward and off into an existing drainage channel. The slopes to the cover center line will be less than or equal to 2 percent, and the slope of the cover center line will be approximately 0.14 percent to the east. The portion of the cover over the relocation trench will slope between 2 and 4 percent to the east. These shallow slopes will minimize the possibility that run-off will gain enough velocity to cause erosion as it is directed off the cover. Shallow slopes will encourage infiltration into the surface of the cover where the moisture will be removed by the vegetation as indicated by the hydrological modeling discussion and summary of results presented in Section 2.1.4.2.1.1 and in Appendix D. Minimal erosion is anticipated on the cover based upon the shallow slopes, vegetation, and prevention of run-on. Engineering calculations predict that precipitation and wind will erode the surface cover a maximum of 0.7 cm (0.28 in.) over 30 years. Engineering calculations also predict that erosion at the eastern toe of the cover due to precipitation run-off will be a maximum of 8.7 cm (3.4 in.) over 30 years. The calculation for cover surface erosion assumed the cover is not vegetated, while the calculation for erosion at the eastern toe of the cover assumed the cover is vegetated. Revegetation of the cover surface will further reduce erosion due to precipitation and wind. The minimum fill over the drilling mud is 1.2 m (4 ft); therefore erosion of the cover and exposure of drilling mud is not predicted to occur. The cover will be inspected periodically and appropriate corrective measures will be taken if needed (see Section 4.1). See the SITA Plan, Appendix E, for calculations on cover erosion.

2.1.4.4 UC-1 CMP Cover Construction Activities

2.1.4.4.1 Relocation Trench Construction

As part of the FY 1999 field activities, a mud relocation trench, measuring approximately 11 m (36 ft) by 50.3 m (165 ft) at the bottom and 5.8 to 6.4 m (19 to 21 ft) deep, was excavated west of the CMP. This trench was the source of most of the material used to construct the UC-4 Mud Pit C cover and was designed to hold approximately 1,145 m^3 (1,500 yd^3) of drilling mud that was planned to be removed from the CMP in the area of a fault scarp. The drilling mud from the southeast corner of the CMP was proposed to be excavated and moved to the CMP relocation trench to prevent the GCL from being placed over this fault scarp (see Phase I Work Plan, Appendix A). (Use of a GCL was a previous design concept that has been abandoned.) The discovery that approximately 5,202 m^3 (6,800 yd^3) of hydrocarbon-impacted material at the UC-4 Shaker Pad Area S (CAS 58-10-02) was predominantly drilling mud rather than granular material resulted in delaying the relocation of any mud into the trench until FY 2000.

A fault study was conducted in FY 1999 (see Appendix F). The study evaluated the fault and recommended injection of mud/grout into the piping features along the fault scarp and no relocation of drilling mud. The drilling mud in the southeast corner of the CMP is located in close proximity to the fault scarp, approximately 3 m (10 ft), but does not come into contact or overlap the fault scarp. At the time of the study, the design and potential overlap of the cover on the fault was not completed. Engineering concerns for performance, repair, and maintenance were considered if the cover was to extend over the fault area. A cover using a GCL that extends over the fault scarp may be affected by subsurface settlement. Settlement may cause elongation of the GCL, and in turn, failure of the barrier and cover. Because the current cover design does not utilize a GCL, but instead relies on vegetation to transpire moisture from the cover, it will not be affected by settlement along the fault trace. Hence, the current cover design does not require that drilling muds located near the fault scarp be excavated and relocated.

To accommodate the extra mud that must be relocated, the existing UC-1 CMP relocation trench will be widened approximately 12 m (40 ft) and deepened approximately 2 m (6.5 ft) along the entire length of the trench. The trench will be excavated using on-site equipment consisting of, but not limited to dozers, scrapers, front-end loaders, and graders. The excavated materials will be used in the construction of the CMP cover. The engineering design and specifications for the relocation trench expansion are provided in the SITA Plan (see Appendix E).

2.1.4.4.2 Relocation of Drilling Mud from UC-4 Shaker Pad Area S (CAS 58 -10-02)

Approximately 5,202 m^3 (6,800 yd^3) of drilling mud will be excavated from the UC-4 Shaker Pad Area S (CAS 58-10-02) and moved to the UC-1 CMP relocation trench. Relocation of the drilling mud from the southeast corner of the UC-1 CMP was also planned for but not accomplished during the 1999 Phase I activities. The relocation activities were not conducted

because of the observation of drilling muds at the UC-4 Shaker Pad Area S (CAS 58-10-02) as discussed in Section 2.1.4.4.1 of this CAP and Section 2.5 of Appendix B. Because the vegetative cover design does not use a GCL and relies on vegetation to transpire moisture out of the cover, differential settlement will not affect the performance of the cover. Therefore, the vegetated cover design does not require that drilling mud near the CMP fault scarp be relocated to the CMP mud relocation trench.

The drilling mud will be excavated from the UC-4 Shaker Pad Area S (CAS 58-10-02), transported to the trench, and placed in the trench using on-site equipment consisting of, but not limited to, front-end loaders, end and belly dump trucks, dozers, and graders. Excavation will continue until on-site field screening of the excavated area reveals concentrations of TPH below the PAL of 100 mg/kg. The UC-1 cover system design will integrate the trench containing the relocated materials.

2.1.4.4.3 UC-1 CMP Cover Construction

Construction of the UC-1 CMP cover system will be conducted according to the SITA Plan (see Appendix E). Soils for the vegetated stabilization layer will be excavated and transported to the site from the UC-1 borrow sources. Hydrocarbon-impacted materials from CASs 58-10-03, 58-44-03, and 58-10-04 will be used in the first 0.6-m (2-ft) lift of the vegetated stabilization layer. Drilling mud will be relocated from UC-4 Shaker Pad Area S (CAS 58-10-02) to the UC-1 CMP relocation trench.

Standard construction equipment will be used for excavation, compaction, and grading activities. Equipment will consist of, but will not be limited to, dozers, scrapers, graders, front-end loaders, rubber-tired rollers, end and belly dump trucks, water trucks, and light farming equipment. Water for dust suppression and construction activities will be obtained from the HTH-2 Well located within the UC-1 Land Withdrawal. Water was obtained from HTH-2 during the Phase I activities (see Appendix B). Approximately 2,725,500 liters (750,000 gallons) were pumped from the well and used for dust suppression and soil conditioning from August 12 to September 7, 1999. Tritium monitoring was conducted during the Phase I activities. A maximum tritium concentration of 11,599 picocuries/Liter (pCi/L) was detected with typical concentrations being approximately 6,000 pCi/L range. The average minimum detectable activity (MDA) for tritium monitoring was 7,393 pCi/L. Of 54 samples analyzed, only 7 exceeded the average MDA. All tritium concentrations were significantly below the NDEP-approved Underground Testing Area action level of 100,000 pCi/L for surface discharge (see Appendix B).

Water monitoring will not be conducted since no radiological constituents were found which exceeded action levels during the 1999 Phase I field activities.

The geogrid will be placed directly over the existing mud pit surface and the surface of the relocated materials in the adjacent trench. A lift of approximately 0.6 m (2 ft) of

hydrocarbon-impacted materials from CASs 58-10-03, 58-44-03, and 58-10-04 and borrow soil will be pushed ahead of a low ground pressure dozer onto the geogrid. Prior to placing this material, the geogrid will be anchored at the perimeter using native soil.

2.1.4.4.4 Establishment of Vegetative Cover

The objective of revegetation is to insure the long-term stabilization of the mud pit cover and other areas disturbed during the construction of the cover at the UC-1 CMP. Vegetation on the cover is necessary to minimize surface erosion and infiltration of water into the underlying materials.

Vegetation will be established on the cover using a combination of direct seeding and transplants. This combination should increase the amount of vegetative cover during the first growing season.

Prior to transplanting or seeding, the cover surface will be ripped, plowed, and/or disked to a depth of approximately 0.4 m (1.3 ft). Amendments to the soil may include polyacrylamide gel to assist in the retention of soil moisture for seed germination and plant growth. Straw will be applied to the area as a mulch after broadcast-seeding at a rate of approximately 4483 kilograms per hectare (kg/hectare) (2 tons per acre). A seed mixture of native plant species will be applied at a rate of 16.8 kg/hectare (15 pounds per acre [lbs/acre]) of pure live seed. A seed mixture using seed from native, shallow-rooted plant species will be applied between early October and late November 2000. The seed planting time insures that dormancy breaking requirements will be met, and that the seed will be in the ground prior to the winter precipitation. Species to be included in the seed mixture are:

- Big Sagebrush (Artemisia tridentata)
- Fourwing Saltbush (Atriplex canescens)
- Rubber Rabbitbrush (Ericameria nauseosa)
- Low Rabbitbrush (Chrysothamnus viscidiflorus)
- Indian Ricegrass (Achnatherum hymenoides)
- Bottlebrush Squirreltail (Elymus elymoides)
- Threeawn (Aristida purpurea)

Transplants will be planted at a rate of approximately 1,000 plants per 0.4 hectares (1 acre). The window for transplanting is from March to April 2001. Three species will be transplanted: Big Sagebrush, Fourwing Saltbush, and Rubber Rabbitbrush.

The goal for revegetation of the cover will be to establish a vegetative cover similar to native undisturbed areas as quickly as possible. The percent vegetation for a native undisturbed area at the CNTA is approximately 35 percent. The goal for revegetation of the cover is to establish a population of plant species equal to 25-50 percent of the native undisturbed areas during the first two to three years, and then approximately 75-80 percent of native undisturbed areas by the fifth year after revegetation.

Disturbances, other than the cover, e.g., the clean-closed areas, will be revegetated using direct seeding. Polyacrylamide gel may also be used on these areas, and straw will be applied as a mulch after broadcast-seeding at a rate of approximately two tons/acre. These areas will be seeded at a rate of 33.6 kg/hectare (30 lbs/acre) of pure live seed during the same window for seeding as the cover with the same native plant species.

2.1.4.4.5 Excavation of the Diversion Channels

To divert precipitation run-on away from the UC-1 CMP cover, a diversion channel was partially excavated to the west of the UC-1 CMP during FY 1999 field activities. Soils removed were used in the construction of the UC-4 Mud Pit C cover. Additional borrow material from this location will be used in the construction of the UC-1 CMP cover. This diversion channel will be completed and a similar channel to the northeast of the UC-1 CMP will be constructed during FY 2000 field activities. The diversion channels will be excavated using on-site equipment consisting of, but not limited to, front-end loaders, dozers, scraper, and graders.

The west diversion channel will be approximately 445 m (1,460 ft) long and 6.1 m (20 ft) wide. The north diversion channel will be approximately 60 m (200 ft) long and 6.1 m (20 ft) wide. The maximum depth of the two channels will be approximately 1.8 m (6 ft). All material excavated to develop these channels will be used as borrow material in the UC-1 CMP cover construction. The channel areas may be reseeded to encourage the establishment of vegetation.

2.2 CONSTRUCTION QUALITY ASSURANCE / QUALITY CONTROL

For the UC-1 CMP cover system, and diversion channels, a SITA Plan has been prepared to identify responsibilities, acceptance and approval, and documentation and records to assure the result of the construction activities are according to the design. The SITA Plan can be found in Appendix E.

2.3 WASTE MANAGEMENT

Activities at the CNTA will generate sanitary waste. No hazardous wastes are anticipated to be generated since the investigation activities documented in the CAIP (DOE/NV, 1997) and CADD (DOE/NV, 1999) indicate that the only COC was TPH. The TPH impacted materials at the CNTA are not a Resource Conservation and Recovery Act hazardous waste.

Sanitary waste will include construction debris (e.g., plastic sheeting, wood, metal, cardboard, and sump liner materials) and personal protective equipment. These wastes will be transported to an approved sanitary landfill at the Tonopah Test Range or NTS. These wastes may be containerized in drums if the size/quantity of materials permit. Drums used at the site for waste storage/disposal will be labeled as sanitary waste.

Petroleum hydrocarbon impacted material will include drilling muds and soils removed from the clean closure CASs and rinsate generated during equipment cleaning activities. Material from CASs 58-10-03, 58-44-03, and 58-10-04 will be used as stabilization materials in the UC-1 CMP cover system, and drilling mud from CAS 58-10-02 will be transferred to the UC-1 CMP relocation trench. All rinsates will be used for soil conditioning or solidified and placed in the relocation trench and/or stabilization layer in the CMP cover.

Site personnel will adhere to the principles of the Bechtel Nevada (BN) Waste Minimization and Pollution Prevention Program.

2.4 REMEDIATION VERIFICATION

Verification soil samples will be collected at the bottom of the excavations at CASs 58-10-02, 58-10-04, 58-44-03, and 58-10-03. All sample locations will be randomly distributed at the bottom of the excavations. The number of sample locations are: 58-10-02 (13), 58-10-04 (6), 58-44-03 (6), and 58-10-03 (5). The soil samples will be submitted for TPH as diesel and oil analyses (U.S. Environmental Protection Agency Method 8015, Modified) (EPA, 1996) to determine if the soils exceeding the Action Level of 100 mg/kg were removed. If the analytical results indicate concentrations of TPH levels above the Action Level, additional material will be excavated, transported, and used in the UC-1 CMP cover and verification sampling will be conducted.

2.5 PERMITS

A National Environmental Policy Act checklist was prepared and approved by DOE/NV for the site construction activities. Current planned activities do not require an air quality permit. However, dust suppression measures will be used during all construction and site preparation activities. Excavation and Trenching Permits are also not required due to the remote location of the site, and because previous utility surveys did not detect any buried utilities. Permits required for this project may include a BN Hot Work Permit, a Nevada Department of Transportation Oversize Permit, a Surface Disturbance Permit, and a Limited-Use Permit from Nye County, BLM, and/or the United States Forest Service.

3.0 SCHEDULE

The CAU 417 CNTA closure schedule is outlined in Appendix III of the FFACO. The FFACO schedule requires that this plan be submitted for NDEP approval by April 30, 2000, and that the CR be submitted for NDEP approval by January 31, 2001.

The project schedule can be found in Figure 3. Flexibility has been placed in the project schedule to account for minor difficulties (weather, equipment breakdowns, etc.). DOE/NV will keep the NDEP appraised of any condition that may impact the project schedule. In the event that the project schedule requires modification, the DOE/NV will consult with NDEP personnel prior to making any changes.

Activity Description	Cal ID	Orig Dur	Early Start	Early Finish
Central Nevada Test Area (CNTA)				
CAU 417 Closure Activities				
M/S - Submit CAP to NDEP (FFACO Milestone)	5	0	30APR00*	
Mobilize To The Field	2	9	05JUN00*	19JUN00
Construct UC-1 CMP Cover	2	42	19JUN00	30AUG00
Clean Close 4 CAS's	2	15	19JUN00	13JUL00
Construct Drainage Diversion Channels	2	46	19JUN00	06SEP00
Site Postings	2	8	06SEP00	19SEP00
Demobilize	2	8	06SEP00	19SEP00
M/S - Sumbit CR to NDEP (FFACO Milestone)	2	0		31JAN01*
Seed UC-1 CMP Cover	2	28	09OCT00	23NOV00

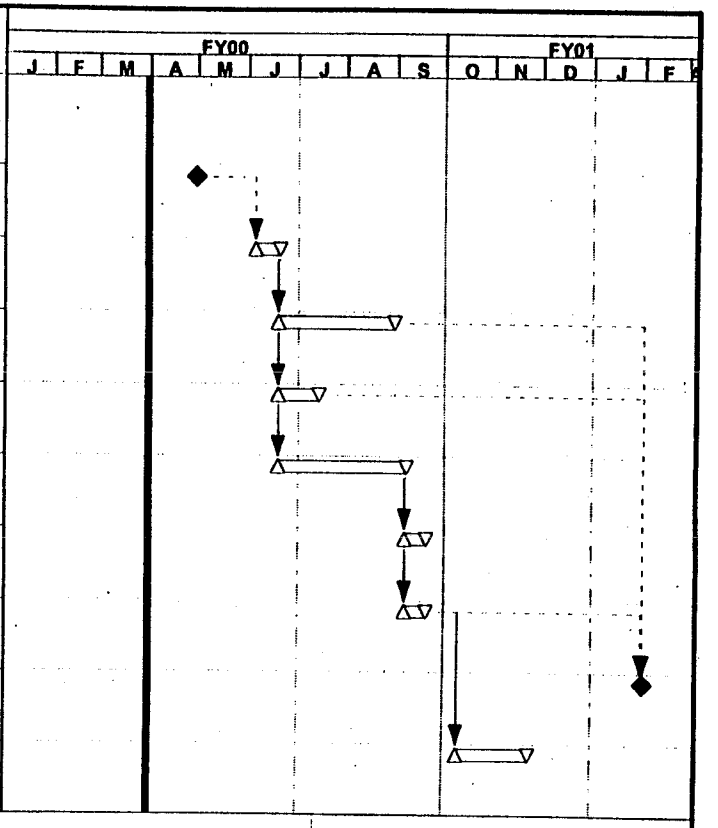


FIGURE 3
FY 2000 CLOSURE ACTIVITY SCHEDULE

4.0 POST-CLOSURE MONITORING PLAN

A Post-Closure Monitoring Plan will be proposed in the CAU 417 CR. The following section provides a brief description of proposed site monitoring activities.

4.1 PROPOSED MONITORING ACTIVITIES

Settlement monitoring activities are being conducted at the UC-4 Mud Pit C. The settlement monitoring plan can be found in Appendix C. Settlement monitoring activities consist of surveying the consolidation markers, visually inspecting the cover system for signs of erosion, animal burrows, cracks, water ponding, and vegetation, and inspecting the fencing, locks, and postings. Inspection and monitoring will be performed once a month for the first six months after construction of the cover has been completed. Results from the UC-4 Mud Pit C settlement monitoring activities will be evaluated prior to constructing the cover at the UC-1 CMP to determine if design changes are required.

The same settlement monitoring plan and monitoring frequency used for the UC-4 Mud Pit C is proposed for the UC-1 CMP to determine if post-closure actions will be required. After completion of the monthly inspections, the cover systems will be inspected and monitored semiannually (twice per year) for the next two years. The frequency after the second year will be determined by the BN Project Engineer, with DOE/NV and NDEP concurrence, based on the results of the previous inspections. Inspection of each posted site within CAU 417 will adhere to the same frequency as the cover inspections and will include verifying that all postings are in place and readable and land-use restrictions are maintained. Additional, unscheduled inspections may be required after severe weather events such as heavy rainfall, flash flooding, and high winds. Any identified maintenance and repair requirements will be remedied within 90 working days of discovery and documented in writing at the time of repair.

Planting of seeds in the revegetation areas will be conducted during October/November 2000. Planting of transplanted native species will be conducted during March/April 2001. Documentation of the seeding activities will be provided in the CAU 417 CR. Documentation of the transplanting activities will be provided in the first annual post-closure monitoring report.

Results of all inspections in a given year will be addressed in a single annual report. The annual report will include the following information:

- Discussion of observations.
- Inspection checklist and maintenance record.
- Conclusions and recommendations.

A copy of each annual report will be submitted to the DOE/NV and NDEP.

In addition to settlement monitoring, the UC-1 CMP cover will be instrumented to allow collection of soil moisture data. Soil moisture data will enable an evaluation of the cover performance in comparison to modeling predictions. Cover performance will be monitored using time-domain reflectometry soil water content sensors buried at various depths within the cover to provide water content profile data. Soil water content profile data will demonstrate whether the cover is performing as expected and efficiently removing water from the cover system.

The sensors will be installed at two locations approximately 0.15 m (0.5 ft), 0.5 m (1.5 ft), 0.76 m (2.5 ft), and 1.1 m (3.5 ft) below the surface (see Figure 4). Two sensors will be installed at each depth. This configuration will provide soil water content profiles at 4 depths at 2 locations, with backup sensors. Installation will be done using shovel, trencher, or a backhoe, depending on available resources. Sensor cables will be placed in shallow trenches, directed to a subsurface vault installed adjacent to the UC-1 CMP cover where data is stored. Soil moisture will be measured once per day with the data being stored in a data logger. Data from the data logger will be collected once per month and will be collected by personnel or by remote access.

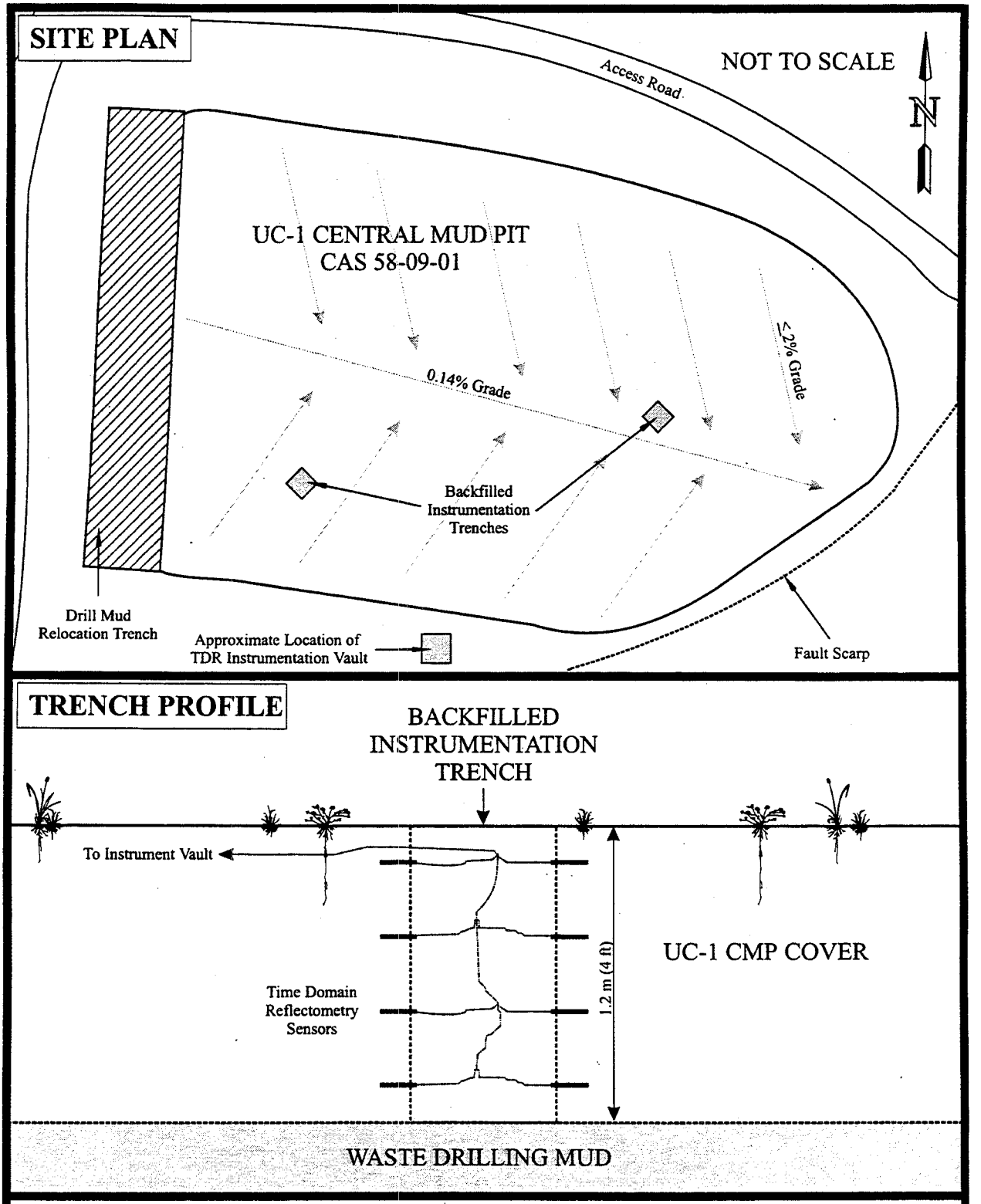


FIGURE 4
UC-1 CMP COVER MONITORING INSTRUMENTATION

THIS PAGE INTENTIONALLY LEFT BLANK

5.0 REFERENCES

ASTM, see American Society for Testing and Materials

American Society for Testing and Materials, 1997a, Method D 1557-91: Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort, 1997 Annual Book of ASTM Standards, Volume 04.08, Soil and Rock (I): D 420 - D 4914.

American Society for Testing and Materials, 1997b, Method D 2922-96: Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth), 1997 Annual Book of ASTM Standards, Volume 04.08, Soil and Rock (I): D 420 - D 4914.

DOE/NV, see U.S. Department of Energy, Nevada Operations Office

EPA, see U.S. Environmental Protection Agency

Fayer, M. J. and T. L. Jones, 1990. UNSAT-H Version 2.0: Unsaturated soil water and heat flow model. Pacific Northwest Laboratory, Richland, WA. PNL-6779 UC-702.

Fayer, M. J., Rockhold, M. L., and Campbell, M. D., 1992. Hydrologic modeling of protective barriers: Comparison of field data and simulation results. Soil Sci. Soc. Am. J. 56:690-700.

Levitt, D. G., Sully, M .J., Dozer, B. L., and Lohrstorfer, C. F., 1999. Determining the Performance of an Arid Zone Radioactive Waste Site Through Site Characterization, Modeling and Monitoring. Proceedings of Waste Management '99 Conference, Tucson, AZ.

Nevada Administrative Code, 1996. NAC 445A, Water Pollution Control.

NDEP, see Nevada Division of Environmental Protection

Nevada Division of Environmental Protection, U.S. Department of Energy, and U.S. Department of Defense. 1996. Federal Facilities Agreement and Consent Order (FFACO) of 1996.

U.S. Department of Energy, Nevada Operations Office. 1997. Corrective Action Investigation Plan for Central Nevada Test Area CAU No. 417, DOE/NV--450 Rev. 0, Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. 1998a. Addendum to the Corrective Action Investigation Plan for Central Nevada Test Area CAU No. 417, DOE/NV--450, Las Vegas, NV.

5.0 REFERENCES (Continued)

U.S. Department of Energy, Nevada Operations Office. 1998b. Closure Plan for Corrective Action Unit 92: Area 6 Decontamination Pond Nevada Test Site, Nevada, DOE/NV--11718-256-Rev. 2., Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. 1999. Corrective Action Decision Document for Corrective Action Unit 417: Central Nevada Test Area Surface, Nevada, DOE/NV--524 Rev. 1, Las Vegas, NV.

U.S. Environmental Protection Agency. 1996. Test Methods for Evaluation, Solid Waste, Physical Chemical Methods, SW 846, Third Edition. Washington, D.C.

APPENDIX A

PHASE I WORK PLAN for UC-4 MUD PIT C COVER and OTHER SITE MANAGEMENT ACTIVITIES, CENTRAL NEVADA TEST AREA, CORRECTIVE ACTION UNIT 417

DISTRIBUTION LIST

	Copies
Bureau of Federal Facilities Division of Environmental Protection 333 W. Nye Lane, Room 13B Carson City, NV 89706-0866	
P. J. Liebendorfer	2
S. Jaunarajs	1
U.S. Department of Energy, Nevada Operations Office P. O. Box 98518, M/S 505 Las Vegas, NV 89193-8518	
Runore C. Wycoff	1
M. O. Giblin	1
P. A. Sanders	1
Bechtel Nevada P. O. Box 98521, M/S NLV008 Las Vegas, NV 89193-8521	
Correspondence Control	1
EM Correspondence, NLV022	1
D. K. Cowser	1
M. D. Shotton	1
D. D. Madsen	1
K. B. Campbell	1
IT Corporation P. O. Box 93838 Las Vegas, NV 89193-3838	
P. Gretsky	1
A. Welcher	1

Phase I Work Plan for UC-4 Mud Pit C Cover and Other Site Management Activities, Central Nevada Test Area, Corrective Action Unit 417

Prepared for
U. S. Department of Energy
Nevada Operations Office
Work Performed Under Contract No.
DE-AC08-96NV11718

Revision: 0

July 1999

5.0 REFERENCES

DOE, see U.S. Department of Energy.

DOE/NV, see U.S. Department of Energy / Nevada Operations.

NDEP, see Nevada Division of Environmental Protection.

Nevada Division of Environmental Protection, U.S. Department of Energy, and U.S. Department of Defense, 1996, *Federal Facilities Agreement and Consent Order (FFACO) of 1996.*

Nevada Division of Environmental Protection, 1999, Letter from Paul J. Liebendorfer to Runore C. Wycoff, *Approval of Corrective Action Decision Document Corrective Action Unit 417, Central Nevada Test Area Surface Federal Facilities Agreement and Consent Order.*

U.S. Department of Energy, March 1994, *Nevada Environmental Restoration Project, Project Management Plan*, Rev. 0, Las Vegas, NV.

U.S. Department of Energy, August 1996, *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada*, DOE/EIS-0243, Las Vegas, NV.

U.S. Department of Energy, May 1998, *Nevada Environmental Restoration Project, Health and Safety Plan*, Rev. 3, Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. 1997. *Corrective Action Investigation Plan for Central Nevada Test Area CAU No. 417*, DOE/NV--450 Rev. 0, Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. 1999a. *Corrective Action Decision Document for Corrective Action Unit 417: Central Nevada Test Area Surface, Nevada*, DOE/NV--524 Rev. 1, Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. June 1999b. *Site Specific Health and Safety Plan for Closure Activities at Corrective Action Unit 417: Central Nevada Test Area, Nevada*, Las Vegas, NV.

ASTM, 1997a, Method D 1557-91: Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort, 1997 Annual Book of ASTM Standards, Volume 04.08, Soil and Rock (I): D 420 - D 4914.

Phase 1 Work Plan for UC-4 Mud Pit C Cover and Other Site Management Activities, Central Nevada Test Area, Corrective Action Unit 417

Approved by: _____ Date: 7-9-99

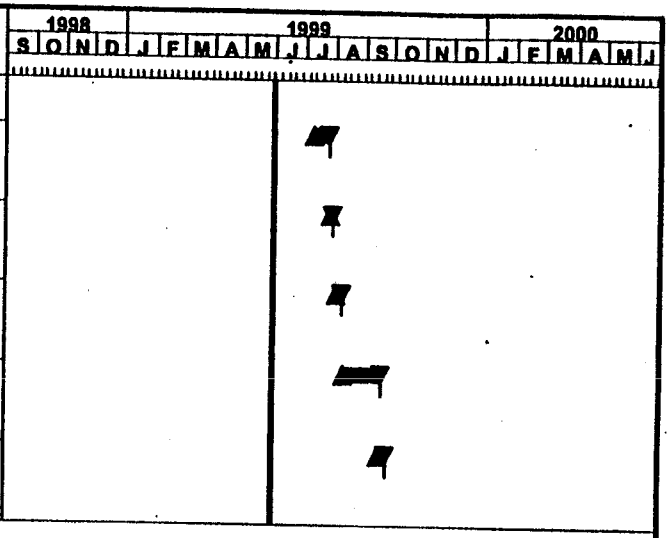
Michael O. Giblin, Project Manager
Off-Sites Subproject

Approved by: _____ Date: 7-9-99

Runore C. Wycoff, Director
Nevada Environmental Restoration Project

CENTRAL NEVADA TEST SITE (CNTA) SCHEDULE

Activity ID	Activity Description	Cal ID	Orig Dur	Rem Dur	%	Early Start	Early Finish
CNTA01	NDEP Review/Approval	1	11	11	0	09JUL99*	23JUL99
CNTA05	Complete Title III Engineering Drawings	1	3	3	0	26JUL99	28JUL99
CNTA10	Field Mobilization	1	5	5	0	02AUG99	06AUG99
CNTA15	Perform Field Activities	1	27	27	0	09AUG99	15SEP99
CNTA20	Filed Demobilization	1	6	6	0	15SEP99	22SEP99



Project Start 01OCT98
Project Finish 23DEC99
Data Date 31MAY99
Run Date 21JUN99

CURRENT
TARGET
Progress Bar
Critical Activity

© Primavera Systems, Inc

CNTA

sheet 1 of 1

FIGURE 5 1999 Field Activity Schedule

TABLE OF CONTENTS

LIST OF ACRONYMS AND ABBREVIATIONS viii

EXECUTIVE SUMMARY ES-1

1.0 INTRODUCTION 1
1.1 Purpose 7
1.2 Scope 7
1.3 Work Plan Contents 7

2.0 DETAILED STATEMENT OF WORK 9
2.1 UC-4 Mud Pit C Cover 9
2.1.1 Design Criteria 9
2.1.1.1 Permeability 9
2.1.1.2 Precipitation Run-on and Run-off 11
2.1.1.3 Consolidation 12
2.1.1.4 Maintenance and Repair 13
2.1.2 Cover Design 13
2.1.3 Cover Construction 16
2.2 Site Management Activities 17
2.2.1 Sign Posting 17
2.2.2 Relocate UC-1 CMP Drilling Mud 18
2.2.2.1 Trench Excavation and Drilling Mud Relocation 18
2.2.2.2 Collection of Verification Samples 19
2.2.3 Construct UC-1 CMP Retention Berm 21
2.3 Construction Quality Assurance/Quality Control 21
2.4 Waste Management 21
2.5 Site Control 23
2.6 Permits 23

3.0 SCHEDULE 24

4.0 POST-CLOSURE MONITORING PLAN 26

5.0 REFERENCES 27

Site personnel will adhere to the principles of the Bechtel Nevada Waste Minimization and Pollution Prevention Program. Care will be taken to segregate waste from non-waste materials. As part of this approach, clean soil from impacted areas will be stockpiled in a location separate from waste soil.

2.5 SITE CONTROL

Public access to the CNTA is not controlled. Site control during construction activities will be accomplished with warning signs and rope fences. Road closures are not anticipated since access is required to be provided to public lands adjacent to the CNTA land withdrawals. During non-construction hours, personnel will be present to discourage unauthorized access to areas and/or equipment.

2.6 PERMITS

A National Environmental Policy Act checklist was prepared and approved by DOE/NV for the site construction activities. Current planned activities do not require an air quality permit. However, dust suppression measures will be used during all construction and site preparation activities. Excavation and Trenching Permits are also not required due to the remote location of the site, and because pervious utility surveys did not detect any buried utilities. The CMP mud relocation trench is expected to be approximately 6.1 m (20 ft) in depth and will require an engineering design and stability analysis as specified by Occupational Safety and Health Administration regulations. Finally, the anticipated amount of surface area disturbed during Phase 1 will be less than the minimum requiring a surface disturbance permit.

TABLE OF CONTENTS (continued)

APPENDICES

APPENDIX A - PERMEABILITY RESULTS

APPENDIX B - HYDROLOGIC MODELING SUMMARY AND RESULTS

APPENDIX C - FLOOD STUDY

APPENDIX D - SAMPLING, INSPECTION, TESTING, and ACCEPTANCE (SITA) PLAN

verification of complete excavation of impacted muds and soils in excess of the 100 mg/kg TPH action level from the southeastern corner of the UC-1 CMP.

In addition to the verification samples, one duplicate, matrix spike, and matrix spike duplicate will be sent to the analyzing laboratory for quality control purposes.

TABLE 5 -- VERIFICATION SAMPLE ANALYSES

PARAMETER	ANALYTICAL METHOD	SAMPLE CONTAINER
TPH (oil and diesel)	SW 846, EPA 8015 Modified	**Soil** 1 - 250 mL glass jar

2.2.3 Construct Retention Berm at UC-1 CMP

A retention berm will be constructed to prevent drilling muds from migrating into the excavated area in the southeast corner of the UC-1 CMP. Borrow materials used to construct the berm will be from a borrow source in the UC-1 Land Withdrawal area. Engineering drawings, specification, and testing requirements are provided in the SITA Plan (Appendix D). The soils used to construct the berm will be compacted to 90% of maximum density.

The cover design for the UC-1 CMP will be proposed in the CAP and will integrate the cover system with the retention berm.

2.3 CONSTRUCTION QUALITY ASSURANCE/QUALITY CONTROL

The SITA Plan has been prepared to identify responsibilities, sampling and testing frequency, acceptance and approval, and documentation and records to assure the result of the construction activities are according to the design. The SITA Plan can be found in Appendix D.

2.4 WASTE MANAGEMENT

Activities at the CNTA will generate sanitary waste and petroleum hydrocarbon waste. No hazardous wastes are anticipated to be generated since the investigation activities documented in the CAIP (DOE, 1997) and CADD (DOE, 1999a) indicate the only constituents of concern were TPH and chromium. The TPH impacted materials at the CNTA are not considered a Resource Conservation and Recovery Act (RCRA) hazardous waste. Based upon the results of the investigation activities, the chromium-containing materials at the CNTA are not a RCRA hazardous waste under the exclusion provision of Title 40 Code of Federal Regulations 261.4

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

km	kilometer
km^2	square kilometer
m	meter
m^3	cubic meters
mi	mile
mi^2	square mile
mg/kg	milligrams per kilogram
NDEP	Nevada Division of Environmental Protection
NTS	Nevada Test Site
NV	Nevada
PAL	Preliminary Action Level
ppm	parts per million
QA	Quality Assurance
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
SITA	Sampling, Inspection, Testing and Acceptance (Plan)
TCLP	Toxicity Leaching Characterization Procedure
TPH	Total Petroleum Hydrocarbons
yd^3	cubic yard

(Section 2.2.2.2).

The UC-1 CMP cover design to be proposed in the CAP will integrate the trench containing the relocated materials with the cover system.

2.2.2.2 Collection of Verification Samples

Prior to construction of the retention berm (discussed in Section 2.2.3), verification sampling and laboratory analysis will be conducted. The verification samples will be collected when field screening results indicate that the impacted materials above the 100 mg/kg TPH PAL have been removed. Laboratory analysis will be conducted on a minimum of three soil samples randomly collected from the bottom of the excavated area in the southeast corner of the UC-1 CMP. These samples will be analyzed for TPH in the diesel and waste oil range (Table 5), and serve as

EXECUTIVE SUMMARY

The Central Nevada Test Area (CNTA) is located in the Hot Creek Valley in Nye County approximately 85 miles northeast of Tonopah, Nevada. The CNTA includes three land withdrawal areas commonly referred to as UC-1, UC-3, and UC-4, and has been identified as Corrective Action Unit (CAU) 417 in the Federal Facilities Agreement And Consent Order between the Nevada Division of Environmental Protection and U.S. Department of Energy/Nevada Operations Office. CAU 417 consists of 34 Corrective Action Sites (CASs). Results from investigation activities indicate that the only Constituents of Concern are petroleum hydrocarbons which exceed the Preliminary Action Level (PAL) of 100 mg/kg. Sixteen of the 34 CASs contained petroleum hydrocarbons in excess of the PAL.

To better manage the site until closure activities are conducted in Year 2000, the following activities are proposed: site posting at 16 CASs, relocation of drilling muds at the UC-1 Central Mud Pit (CMP), construction of a retention berm at the UC-1 CMP, and construction and testing of a cover design at the UC-4 Mud Pit C. The proposed cover is to be constructed over bentonite drilling muds that have low load bearing capacity. The cover system will consist of a geogrid, petroleum impacted soils excavated from CASs to be clean closed in Year 2000, native site soils, and a geosynthetic clay liner (GCL).

Results from the construction of the UC-4 Mud Pit C cover and CAS management activities will be used to more effectively design and plan the UC-1 CMP cover and will be documented in the Corrective Action Plan (CAP) scheduled for submittal to Nevada Division of Environmental Protection (NDEP) on January 31, 2000. The activities proposed in this work plan compliment the remedial alternatives proposed in the Corrective Action Decision Document (DOE/NV, 1999a); however, the CAP will propose the methodology for implementing the closure activities.

GCL.

The erosion control layer will be placed directly over the buffer layer and will be compacted to a minimum of 90 percent of the maximum dry density.

Density testing (ASTM, D2922 and D3017 [Nuclear Density Tests]) will be conducted on the compacted soil to verify the compaction specification is achieved. Quality assurance test requirements and frequency are provided in the SITA Plan (Appendix D).

2.2 Site Management Activities

2.2.1 Sign Posting

A minimum of two signs will be posted at each of the 16 CASs where TPH concentrations exceed the 100 mg/kg PAL for cleanup. Table 1 identifies the sites where site posting will be conducted. The site locations for posting are shown in Figure 3. Currently, limited or no site posting is present at the sites. The site posting is to warn site visitors of site conditions and minimize inadvertent intrusion into the impacted materials. The postings will provide the following information:

WARNING!
Petroleum Impacted Soil.
No excavation, drilling, and/or removal of materials
is permitted without U.S. Government Permission.
Contact: U.S. Department of Energy, Nevada Operations Office
Environmental Restoration Division
P.O. Box 98518, Las Vegas, Nevada 89193-8518
(702) 295-7063

Signs posted at the UC-4 Mud Pit C cover will be worded as follows:

WARNING!
Petroleum Impacted Soil.
No excavation, drilling, and/or removal of materials is permitted.
Contact: U.S. Department of Energy, Nevada Operations Office
Environmental Restoration Division
P.O. Box 98518, Las Vegas, Nevada 89193-8518
(702) 295-7063

In addition, the UC-4 Mud Pit C will be enclosed by fencing to discourage animals and personnel from entering the capped area. Additional site monumenting/posting activities will be proposed in the CAP and completed during Year 2000 closure activities.

1.0 INTRODUCTION

This Work Plan has been prepared for the Central Nevada Test Area (CNTA) Surface Corrective Action Unit (CAU) 417 in response to a May 12, 1999, meeting between the Nevada Division of Environmental Protection (NDEP) and U.S. Department of Energy, Nevada Operations Office (DOE/NV) and a May 24, 1999, letter from the NDEP to DOE/NV (NDEP, 1999). This plan details field activities that are required for the preparation of the Corrective Action Plan (CAP). The proposed field activities consist of constructing a cover at the UC-4 Mud Pit C (Corrective Action Site [CAS 58-09-03] and performing site management activities at 16 CASs. A summary of the proposed field activities is provided in Table 1. Results from the construction of the UC-4 Mud Pit C cover and CAS management activities will be used to more effectively design and plan the UC-1 Central Mud Pit (CMP) cover and will be documented in the CAP.

The CNTA is located in Hot Creek Valley, Nye County, Nevada (Figure 1 and Figure 2). The CNTA is north of U.S. Highway 6 and consists of three separate land withdrawals commonly referred to as UC-1, UC-3, and UC-4 (Figure 3). Using public access roads, UC-1 is located approximately 55 kilometers (km) (34 miles [mi]) north of Warm Springs, Nevada and approximately 135 km (85 mi) northeast of Tonopah, Nevada. The UC-1 area spans approximately 2.59 square kilometers (km^2) (1 square mile [mi^2]). UC-3 and UC-4 span approximately 2.89 km^2 (1.4 mi^2) each . UC-3 and UC-4 areas are located roughly 4 km (2.5 mi) south and north of UC-1, respectively. All three CNTA land withdrawal areas are accessible to the public (Figure 3). The sites were obtained by the Atomic Energy Commission (now known as the Department of Energy [DOE]) from the U.S. Bureau of Land Management.

On January 19, 1968, a nuclear device denoted as Faultless was detonated approximately 975 meters (m) (3,200 feet [ft]) below ground surface in emplacement hole UC-1. Two other emplacement holes, UC-3 and UC-4, were drilled but were not used for testing. To support the drilling activities, unlined sumps were constructed at UC-1, UC-3, and UC-4, to contain drilling fluids for reuse and management purposes. The CNTA was demobilized in the fall of 1973. Detailed information of the site history can found in the Corrective Action Investigation Plan (CAIP) (DOE/NV, 1997).

Investigation activities were conducted in 1997 and 1998 to determine site conditions. The investigation included visual observations, geophysical investigations, and the collection of surface and subsurface soil samples. Detailed information of the investigation results can be found in Appendix D of the Corrective Action Decision Document (CADD) (DOE/NV, 1999a). Radioactive contaminants were not detected at the site. Chromium was detected at concentrations below the Preliminary Action Level (PAL) of 390 milligrams per kilogram (mg/kg) for hexavalent chromium, and 72,000 mg/kg for trivalent chromium (DOE/NV, 1999a). Only petroleum hydrocarbons in the diesel/motor oil range were detected at 16 CASs that

TABLE 4 -- SUMMARY OF HYDROCARBON IMPACTED MATERIAL VOLUMES AND TPH CONCENTRATIONS

CAS No.	Location	Site Description	Volume (yd^3)	TPH Range (mg/kg)	Average TPH Concentration[1] (mg/kg)	Weighted Average TPH Concentration[2] (mg/kg)	Volume Change of TPH material in 1999 (yd^3)	Volume Change of TPH material in 2000 (yd^3)
58-09-01	UC-1	Central Mud Pit	52,566	6 - 2,560	1,159	NA[4]	0 (1,500 yd^3 is relocated at the CMP)	+9,331 granular
58-09-03	UC-4	Mud Pit C	1,778	18 - 985	456	NA	+700granular +200 mud	0
58-10-02	UC-4	Shaker Pad Area S (U4S)	7,111	13 - 862	309	220	-200 mud -500 granular (relocated to UC-4 Mud Pit C)	-6,611 granular (relocated to CMP)
58-10-03	UC-1	Shaker Pad Area S (U1S)	1,422	13 - 4,500	2,122	303	-100 granular (relocated to UC-4 Mud Pit C)	-1,322 granular (relocated to CMP)
58-10-04	UC-4	Shaker Pad Area W (U4W)	474	14 - 301	196[3]	8	-30 granular (relocated to UC-4 Mud Pit C)	-444 granular (relocated to CMP)
58-44-03	UC-3	Drill Mud/Grout Area Z (U3Z)	1,024	13 - 676	396	40	-70 granular (relocated to UC-4 Mud Pit C)	-954 granular (relocated to CMP)

Notes:
1 Average concentration is the result of adding maximum TPH concentration above the 100 mg/kg action level from each borehole and taking the average of the maximum concentrations.
2 The weighted average is the result of dividing the average TPH concentration by the volume percent of impacted material from the CASs to be clean closed (example: a total of 700 cy of granular material will be relocated from 4 CASs to the UC-4 Mud Pit C; the average TPH concentration of the granular material from CAS 58-10-03 is 2,122 mg/kg; 100 cy of the 700 cy will come from CAS 58-10-03 (14.3%); the TPH concentration from CAS 58-10-03 that would be contributed to the 700 cy mixture would be 14.3% of the TPH concentration (2,122) = 303.
3 Represents one borehole with 4 samples that exceed the 100 mg/kg action level
4 Not applicable

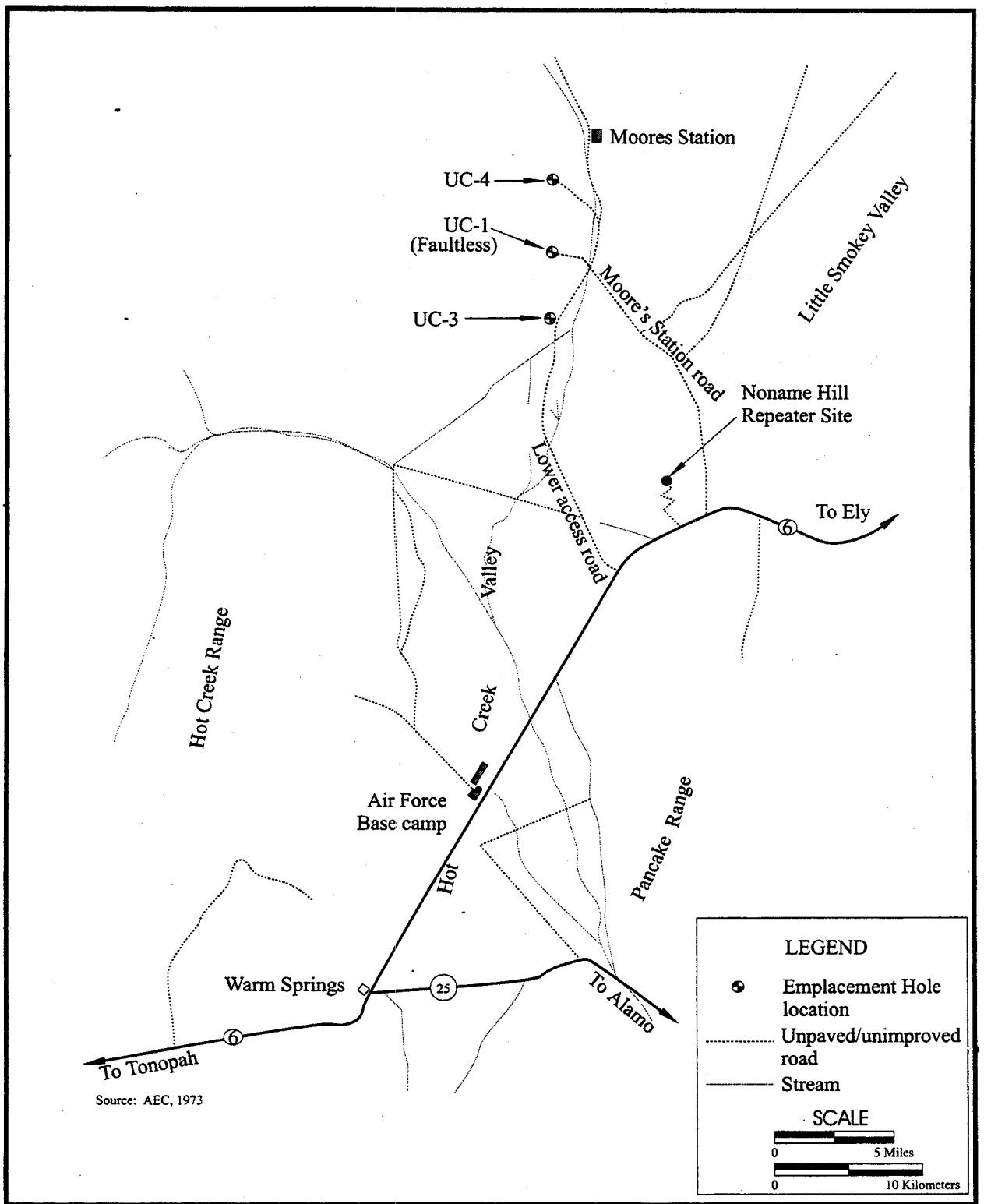


FIGURE 2
CENTRAL NEVADA TEST AREA VICINITY MAP

occurs, which for UC-4 Mud Pit C is expected to be within a year or less, with settlement of about two inches. Therefore, the UC-4 Mud Pit C settlement will produce the same amount of water as two inches of rainfall over the area of the mud pit. Assuming that half the water is emitted upwards and half downwards, the net emission to the ground below the waste package will be the equivalent of one inch of free water. This is a minor amount of water compared to the natural rainfall at UC-4 (approximately 8 in/yr). No run-off will be produced by the loading of the mud due to the construction of the UC-4 Mud Pit C cover.

2.1.1.4 Maintenance and Repair

Maintenance and repair is considered in the design since a cover should be designed to minimize maintenance/repair activities. Erosion and intrusive activities can greatly impact the cover performance and influence the need for maintenance or repairs. Erosion is controlled by the slope, gradation, and compaction of the cover material (discussed in Section 2.1.1.2). Intrusive activities from burrowing animals can be discouraged by the compaction of the cover material and the absence of vegetation. Intrusion into the cover from human activities will be discouraged by the installation of a fence and signs. Deep rooted vegetation can penetrate the GCL and provide pathways for moisture to move through or accumulate in the underlying materials. Therefore, the design criteria will require the following:

- The perimeter of the cover area to be fenced to minimize damage to the cover by humans and large animals.
- The perimeter of the cover area to have signs posted indicating the site conditions and prohibited activities.
- The removal of deep rooted vegetation from the cover to protect the GCL.

2.1.2 Cover Design

The cover design using the GCL was chosen because it met the permeability considerations and reduced constructability risks. Features and specifications incorporated in the UC-4 Mud Pit C cover will be approximately proportionate to those planned for the UC-1 CMP if they are determined to be implementable in the field. The UC-4 Mud Pit C cover design and specifications can be found in the Site Inspection, Testing, and Assurance (SITA) Plan located in Appendix D. The cover design consists of the following layers (layers are listed in order from the drilling mud to the top of the cover):

- **Geo-grid.** The geogrid distributes the load and reduces the ground pressure of the cover material and the construction equipment.
- **Stabilization layers.** Two stabilization layers (each approximately 0.6 m [2 ft] thick) serve as a shaping horizon for the overlying layers. The stabilization layers have been

TABLE 1 - SUMMARY OF PROPOSED 1999 FIELD ACTIVITIES

Location	CAS Number	1999 Field Activity	Selected Remedial Alternative
UC-1 Mud Pit A (U1A)	58-09-02	Install Signs	Site Posting
UC-1 Mud Pit E (U1E)	58-09-05	Install Signs	Site Posting
UC-1 Borrow Pit Y (U1Y)	58-44-06	Install Signs	Site Posting
UC-3 Mud Pit E (U3E)	58-09-06	Install Signs	Site Posting
UC-3 Shaker Pad Area S (U3S)	58-10-01	Install Signs	Site Posting
UC-3 Spill Southern Outlier E (U3E)	58-25-01	Install Signs	Site Posting
UC-4 Mud Pit A (U4A)	58-09-03	Install Signs	Site Posting
UC-4 Mud Pit B (U4B)	58-09-03	Install Signs	Site Posting
UC-4 Mud Pit D (U4D)	58-09-03	Install Signs	Site Posting
UC-4 Shaker Pad Area X (U4X)	58-10-05	Install Signs	Site Posting
UC-1 Central Mud Pit	58-09-01	Excavate Trench, Relocate Muds from SE Corner, Construct Retention Berm, Install Perimeter Fencing and Signs	Engineered Cover
UC-4 Shaker Pad Area S (U4S)	58-10-02	Limited Excavation of Impacted Material with Relocation to UC-4 Mud Pit C, Install Signs	Clean Closure with Relocation to CMP
UC-4 Shaker Pad Area W (U4W)	58-10-04	Limited Excavation of Impacted Material with Relocation to UC-4 Mud Pit C, Install Signs	Clean Closure with Relocation to CMP
UC-3 Drill Mud/Grout Spill Area Z (U3Z)	58-44-03	Limited Excavation of Impacted Material with Relocation to UC-4 Mud Pit C, Install Signs	Clean Closure with Relocation to CMP
UC-1 Shaker Pad Area S (U1S)	58-10-03	Limited Excavation of Impacted Material with Relocation to UC-4 Mud Pit C, Install Signs	Clean Closure with Relocation to CMP
UC-4 Mud Pit C (U4C)	58-09-03	Excavate Trench, Relocate Muds from CASs 58-10-02 and 58-09-01, Construct Engineered Cover, Install Perimeter Fencing and Signs	Engineered Cover

For both cover designs, the modeling results are conservative because the effects of vegetation transpiration and precipitation run-off (due to cover slope in the design) are not accounted for in the model. The design criteria for cover permeability was chosen to be equal to or less than 1×10^{-5} cm/sec for the following reasons:

- Hydrologic modeling results are conservative,
- 1×10^{-5} cm/sec is the specification for a sanitary landfill cover,
- 1×10^{-5} cm/sec is considered achievable in the field by construction engineers and based on materials testing laboratory results.

Results of the hydrologic modeling are presented in Appendix B.

2.1.1.2 Precipitation run-on and run-off

Precipitation run-on and run-off can impact the availability of water for infiltration into the cover system and erosion of the cover. Effects from run-on can be mitigated by grading the site to facilitate drainage and/or the design and installation of diversion structures such as berms and/or channels to direct run-on away from the cover. Effects from precipitation run-off can be mitigated with slope, permeability (see Section 2.1.1.3), compaction, gradation, and diversion structures such as channels.

A flood study was conducted in 1998 and 1999 to evaluate the flood hazard at the CNTA for closure design purposes. Results from the study indicate that the UC-4 Mud Pit C is located on a topographic high between large drainage channels and is not within a Federal Emergency Management Agency 100-year, 6-hour flood hazard zone (BN, 1999). The flood study is provided in Appendix C. Based upon the existing site topography (see engineering drawings in Appendix D), precipitation run-on is anticipated only on the west side of the cover and will be extremely minimal. Any run-on will be diverted by the western toe of the cover, thus eliminating the potential of infiltration and erosion effects from precipitation run-on.

To minimize precipitation infiltrating the cover system, the surface of the cover will be constructed with a slope of 0.6 to 2.5 percent. This will provide positive drainage and minimize erosion.

Samples collected from the borrow area indicate that grain size gradations approximate a Type II base course material. Type II base course material is typically used in paving applications under pavements and on road shoulders. When used on shoulders, Type II base course serves as an armor to reduce impacts from erosion/infiltration. To minimize erosion impacts on the cover (and to reduce maintenance and repair costs), the top one foot will be constructed of borrow soils that approximate a Type II base course and will be compacted to a minimum of 90 percent of the maximum dry density (ASTM, D1557 [Modified Proctor Test]).

1.1 PURPOSE

The purpose of the activities proposed in this plan is to obtain constructability and planning information during the construction of a cover at the UC-4 Mud Pit C which can be used to design and construct a similar cover at the UC-1 Central Mud Pit (CMP). Results from the construction of the UC-4 Mud Pit C cover will be documented in the CAP for CAU 417. Site posting at 16 CASs, relocation of drilling muds at the UC-1 CMP, and construction of a retention berm at the UC-1 CMP are also proposed to better manage the site until closure activities can be completed during Fiscal Year 2000. The activities proposed in this plan compliment the remedial alternatives proposed in the CADD (DOE/NV, 1999a); however, the CAP will propose the methodology for implementing the closure activities.

1.2 SCOPE

The scope of work to be implemented under this plan is to:

- Design and construct a cover for the UC-4 Mud Pit C.
- Post signs at the 16 CASs where TPH action levels were exceeded.
- Relocate drilling muds from the southeast corner to the west side of the UC-1 CMP.
- Construct a retention berm in the area of the removed drilling muds at the UC-1 CMP.
- Partially excavate contaminated soils and muds from four CASs for use in constructing the UC-4 Mud Pit C cover.

1.3 WORK PLAN CONTENTS

This Plan is divided into the following sections:

Section 1.0 - Introduction
Section 2.0 - Detailed Statement of Work
Section 3.0 - Schedule
Section 4.0 - Post-Closure Monitoring Plan
Section 5.0 - References
Appendices

2.0 DETAILED STATEMENT OF WORK

The following sections provide a detailed discussion regarding the cover design and site activities covered under this plan. Results from the construction activities will be provided in the CAP and will be used to propose the methodology for implementing the closure activities.

2.1 UC-4 Mud Pit C Cover

The remedial alternative selected in the CADD for the UC-4 Mud Pit C is an engineered cover (DOE, 1999). Even though landfill closure regulations are not applicable for the mud pits at CNTA, the cover design for the UC-4 Mud Pit C should be protective of the contents and environment. Design criteria were determined for the UC-4 Mud Pit C cover based upon:

- Permeability.
- Precipitation run-on and run-off.
- Consolidation.
- Maintenance and repair.

The following sections provide a discussion regarding the application of the design criteria to the engineering design of the cover.

2.1.1 Design Criteria

2.1.1.1 Permeability

The permeability of a cover system in conjunction with site conditions (soil characteristics, precipitation, temperature, vegetation, etc.) can affect the ability of the cover to protect the underlying materials. For this reason, permeability criteria are required for the design of the UC-4 Mud Pit C cover system.

Permeabilities of the native site and borrow soils were used to determine potential permeability ranges for the cover. Based on laboratory test results the permeabilities of in-situ native materials at the UC-4 Mud Pit C range from 10^{-4} to 10^{-6} centimeters/second (cm/sec), and 10^{-5} to 10^{-8} cm/sec for compacted borrow materials. The permeability test results are summarized in Table 3 and are provided in Appendix A.

APPENDIX A

PERMEABILITY RESULTS

Bechtel Nevada
Materials Testing Laboratory
P.O.BOX 98521, M/S NTS 188, LAS VEGAS, NV 89193
(702) 295-6669

Table 1.

SAMPLE CNTA PERMEABILITY TO DI WATER
ASTM D 2434-68 (Reapproved 1974)
Standard Test Method for Permeability of Granular Soils (Constant Head)

Project: CENTRAL NEVADA TEST AREA
Requestor: JULIE SOROLA
Organization: Bechtel
Address: NLV086
Phone: 5-2142
Tested by: DALE, TOM, DAVE
Test start: 07/31/98

MTL Lab: 2009
Request #: S-179
Charge #: C5R1A0EA
Sample Origin: MODIFIED PROCTOR POINT # 1
Sample Type: NATIVE SOUTH AREA
Water Temperature: 23.2 C
Checked by: V. Thummala

7.430 = Sample Length (cm)
6.033 = Sample Diameter (cm)
28.58 = X-Sec. Area (sq cm)

Reading # Days From Start	Manometers H1 mm	Manometers H2 mm	Head cm	Q cm^3	t sec.	Q/At	h/l	k - 20 C cm/sec	Date Tested	Time Tested
-3	919	32	88.7	0.66	1500.0	0.00001539	11.9389	1.19E-06	08/01/98	AM
-3	919	32	88.7	0.93	2020.0	0.00001611	11.9389	1.25E-06	08/01/98	AM
-3	919	32	88.7	0.90	1920.0	0.00001640	11.9389	1.27E-06	08/01/98	AM

Bechtel Nevada
Materials Testing Laboratory
P.O.BOX 98521, M/S NTS 188, LAS VEGAS, NV 89193
(702) 295-6669

Table 2.

SAMPLE CNTA PERMEABILITY TO DI WATER
ASTM D 2434-68 (Reapproved 1974)
Standard Test Method for Permeability of Granular Soils (Constant Head)

Project: CENTRAL NEVADA TEST AREA
Requestor: JULIE SOROLA
Organization: Bechtel
Address: NLV086
Phone: 5-2142
Tested by: DALE, TOM, DAVE
Test start: 08/04/98

MTL Lab: 2009
Request #: 3-179
Charge #: C5R1A0EA
Sample Origin: MODIFIED PROCTOR POINT # 2
Sample Type: NATIVE SOUTH AREA
Water Temperature: 23.2 C
Checked by: V. Thummala

7.430 = Sample Length (cm)
6.033 = Sample Diameter (cm)
28.58 = X-Sec. Area (sq cm)

Reading # Days From Start	Manometers H1 mm	Manometers H2 mm	Head cm	Q cm^3	t sec.	Q/At	h/l	k - 20 C cm/sec	Date Tested	Time Tested
6	931	34	89.7	0.77	13920.0	0.00000194	12.0735	1.48E-07	08/10/98	AM
7	971	35	93.6	0.46	7320.0	0.00000220	12.5984	1.62E-07	08/11/98	AM
9	885	35	85.0	0.88	240.0	0.00012829	11.4409	1.04E-05	08/13/98	AM
9	885	35	85.0	0.76	245.0	0.00010853	11.4409	8.78E-06	08/13/98	AM
9	885	35	85.0	0.83	255.0	0.00011388	11.4409	9.22E-06	08/13/98	AM
9	885	35	85.0	0.85	246.0	0.00012089	11.4409	9.78E-06	08/13/98	AM

Bechtel Nevada
Materials Testing Laboratory
P.O.BOX 98521, M/S NTS 188, LAS VEGAS, NV 89193
(702) 295-6669

Table 3.

SAMPLE CNTA PERMEABILITY TO DI WATER
ASTM D 2434-68 (Reapproved 1974)
Standard Test Method for Permeability of Granular Soils (Constant Head)

Project: CENTRAL NEVADA TEST AREA
Requestor: JULIE SOROLA
Organization: Bechtel
Address: NLV085
Phone: 5-2142
Tested by: DALE, TOM, DAVE
Test start: 08/04/98

MTL Lab: 2009
Request #: S-179
Charge #: C5R1A0EA
Sample Origin: MODIFIED PROCTOR POINT # 3
Sample Type: NATIVE SOUTH AREA
Water Temperature: 23.2 C
Checked by: V.Thummala

7.430 = Sample Length (cm)
6.033 = Sample Diameter (cm)
28.58 = X-Sec. Area (sq cm)

Reading # Days From Start	Manometers H1 mm	Manometers H2 mm	Head cm	Q cm^3	t sec.	Q/At	h/l	k - 20 C cm/sec	Date Tested	Time Tested
6	934	36	89.8	0.35	2880.0	0.00000419	12.0870	3.21E-07	08/10/98	AM
6	929	36	89.3	0.31	2580.0	0.00000414	12.0197	3.19E-07	08/10/98	AM
6	928	33	89.5	0.74	6180.0	0.00000419	12.0466	3.22E-07	08/10/98	AM
7	971	37	93.4	0.62	420.0	0.00005165	12.5715	3.80E-06	08/11/98	AM
7	971	36	93.5	0.63	540.0	0.00004082	12.5850	3.00E-06	08/11/98	AM

Bechtel Nevada
Materials Testing Laboratory
P.O.BOX 98521, M/S NTS 188, LAS VEGAS, NV 89193
(702) 295-6669

Table 4.

SAMPLE CNTA PERMEABILITY TO DI WATER
ASTM D 2434-68 (Reapproved 1974)
Standard Test Method for Permeability of Granular Soils (Constant Head)

Project: CENTRAL NEVADA TEST AREA
Requestor: JULIE SOROLA
Organization: Bechtel
Address: NLVO86
Phone: 6-2142
Tested by: DALE, TOM, DAVE
Test start: 08/04/98

MTL Lab: 2009
Request #: S-179
Charge #: C5R1A0EA
Sample Origin: MODIFIED PROCTOR POINT #4
Sample Type: NATIVE SOUTH AREA
Water Temperature: 23.2 C
Checked by: V. Thummala

7.430 = Sample Length (cm)
6.033 = Sample Diameter (cm)
28.58 = X-Sec Area (sq cm)

Reading # Days From Start	Manometers H1 mm	Manometers H2 mm	Head cm	Q cm^3	t sec.	Q/At	h/l	k - 20 C cm/sec	Date Tested	Time Tested
7	971	33	93.8	0.20	6600.0	0.00000103	12.6253	7.58E-08	08/11/98	AM
9	885	33	85.2	0.49	19405.0	0.00000088	11.4678	7.13E-08	08/13/98	AM
13	973	35	93.8	0.25	7740.0	0.00000113	12.6253	8.29E-08	08/17/98	AM
14	971	37	93.4	0.69	27660.0	0.00000087	12.5715	6.43E-08	08/18/98	AM
15	972	36	93.6	0.66	19860.0	0.00000116	12.5984	8.55E-08	08/19/98	AM
16	971	36	93.5	0.80	28920.0	0.00000097	12.5850	7.12E-08	08/20/98	AM

Bechtel Nevada
Materials Testing Laboratory
P.O.BOX 98521, M/S NTS 188, LAS VEGAS, NV 89193
(702) 295-6669

Table 5.

SAMPLE CNTA PERMEABILITY TO DI WATER
ASTM D 2434-68 (Reapproved 1974)
Standard Test Method for Permeability of Granular Soils (Constant Head)

Project: CENTRAL NEVADA TEST AREA
Requestor: JULIE SOROLA
Organization: Bechtel
Address: NLV086
Phone: 6-2142
Tested by: DALE, TOM, DAVE
Test start: 08/04/98

MTL Lab 2009
Request #: S-179
Charge #: C8R1A0EA
Sample Origin: MODIFIED PROCTOR POINT # 6
Sample Type: NATIVE SOUTH AREA
Water Temperature: 23.2 C
Checked by: V. Thummala

7.430 = Sample Length (cm)
6.033 = Sample Diameter (cm)
28.58 = X-Sec Area (sq cm)

Reading # Days From Start	Manometers H1 mm	Manometers H2 mm	Head cm	Q cm^3	t sec.	Q/At	h/l	k - 20 C cm/sec	Date Tested	Time Tested
7	971	36	93.5	0.43	840.0	0.00001770	12.5850	1.30E-06	08/11/98	AM
7	971	38	93.3	0.70	1440.0	0.00001701	12.5580	1.25E-06	08/11/98	AM
7	971	33	93.8	0.58	1020.0	0.00001989	12.6253	1.46E-06	08/11/98	AM
9	968	42	92.6	0.78	1140.0	0.00002379	12.4638	1.77E-06	08/13/98	AM

Bechtel Nevada
Materials Testing Laboratory
P.O.BOX 98521, M/S NTS 188, LAS VEGAS, NV 89193
(702) 295-6669

Table 1.

SAMPLE CNTA PERMEABILITY TO DI WATER
ASTM D 2434-68 (Reapproved 1974)
Standard Test Method for Permeability of Granular Soils (Constant Head)

Project: CENTRAL NEVADA TEST AREA	MTL Lab: 2009	15.240 = Sample Length (cm)
Requestor: JULIE SOROLA	Request #: 6-175	6.033 = Sample Diameter (cm)
Organization: Bechtel	Charge #: C6W01H04	28.58 = X-Sec. Area (sq cm)
Address: NLVO98	Sample Origin: 80% OF MODIFIED PROCTOR	
Phone: 6-2142	Sample Type: NATIVE SOUTH AREA	
Tested by: DALE, TOM	Water Temperature: 21.6 C	
Test start: 05/17/99	Checked by: V. Thurmaia	

Reading # Days From Start	Manometers H1 mm	Manometers H2 mm	Head cm	Q cm^3	t sec.	Q/At	h/l	k - 20 C cm/sec	Date Tested	Time Tested
1	954	41	91.3	1.30	173.0	0.00026291	5.9908	4.06E-05	05/18/99	AM
1	954	42	91.2	1.80	235.0	0.00026799	5.9843	4.15E-05	05/18/99	AM
1	954	41	91.3	1.60	212.0	0.00026406	5.9908	4.08E-05	05/18/99	AM
1	954	41	91.3	1.80	240.0	0.00026241	5.9908	4.06E-05	05/18/99	AM
1	954	41	91.3	1.80	180.0	0.00034988	5.9908	5.41E-05	05/18/99	AM
1	954	41	91.3	1.80	180.0	0.00034988	5.9908	5.41E-05	05/18/99	AM

Bechtel Nevada
Materials Testing Laboratory
P.O.BOX 98521, M/S NTS 188, LAS VEGAS, NV 89193
(702) 295-6669

Table 2.

SAMPLE CNTA PERMEABILITY TO DI WATER
ASTM D 2434-68 (Reapproved 1974)
Standard Test Method for Permeability of Granular Soils (Constant Head)

Project: CENTRAL NEVADA TEST AREA	MTL Lab: 2909	15.240 = Sample Length (cm)
Requestor: JULIE SOROLA	Request #: S-179	6.033 = Sample Diameter (cm)
Organization: Bechtel	Charge #: C8W01H04	28.58 = X-Sec. Area (sq cm)
Address: NLV095	Sample Origin: 80% OF MODIFIED PROCTOR	
Phone: 8-2142	Sample Type: NATIVE SOUTH AREA	
Tested by: DALE, TOM	Water Temperature: 21.5 C	
Test start: 05/17/99	Checked by: V. Thummala	

Reading # Days From Start	Manometers H1 mm	Manometers H2 mm	Head cm	Q cm^3	t sec.	Q/At	h/l	k - 20 C cm/sec	Date Tested	Time Tested
1	954	41	91.3	1.60	156.0	0.00035885	5.9908	5.55E-05	05/18/99	AM
1	954	48	90.6	1.90	175.0	0.00037987	5.9449	5.92E-05	05/18/99	AM
1	954	41	91.3	1.40	140.0	0.00034988	5.9908	5.41E-05	05/18/99	AM
1	954	41	91.3	1.70	120.0	0.00049566	5.9908	7.66E-05	05/18/99	AM
1	954	41	91.3	1.80	180.0	0.00034988	5.9908	5.41E-05	05/18/99	AM
1	954	41	91.3	1.80	180.0	0.00034988	5.9908	5.41E-05	05/18/99	AM

Bechtel Nevada
Materials Testing Laboratory
P.O.BOX 98521, M/S NTS 188, LAS VEGAS, NV 89193
(702) 295-6669

Table 3.

SAMPLE CNTA PERMEABILITY TO DI WATER
ASTM D 2434-68 (Reapproved 1974)
Standard Test Method for Permeability of Granular Soils (Constant Head)

Project: CENTRAL NEVADA TEST AREA
Requestor: JULIE SOROLA
Organization: Bechtel
Address: NLV085
Phone: 8-2142
Tested by: DALE, TOM
Test start: 05/17/99

MTL Lab: 2008
Request #: 5-179
Charge #: C8W01H04
Sample Origin: 85% OF MODIFIED PROCTOR
Sample Type: NATIVE SOUTH AREA
Water Temperature: 21.6 C
Checked by: V. Thumanala

15.240 = Sample Length (cm)
6.033 = Sample Diameter (cm)
28.56 = X-Sec. Area (sq cm)

Reading # Days From Start	Manometers H1 mm	Manometers H2 mm	Head cm	Q cm^3	t sec.	Q/At	h/l	k - 20 C cm/sec	Date Tested	Time Tested
1	949	39	91.0	1.80	420.0	0.00014995	5.9711	2.33E-05	05/18/99	AM
1	949	39	91.0	2.30	558.0	0.00014421	5.9711	2.24E-05	05/18/99	AM
1	949	40	90.9	2.00	482.0	0.00014518	5.9646	2.25E-05	05/18/99	AM
1	949	41	90.8	1.50	360.0	0.00014578	5.9580	2.27E-05	05/18/99	AM
1	949	42	90.7	1.60	480.0	0.00011663	5.9514	1.81E-05	05/18/99	AM
1	949	42	90.7	1.40	300.0	0.00016328	5.9514	2.54E-05	05/18/99	AM
							AVERAGE =	2.24E-05		

B[illegible]el Nevada
Materials Testing Laboratory
P.O.BOX 98521, M/S NTS 188, LAS VEGAS, NV 89193
(702) 295-6669

Table 4.

SAMPLE CNTA PERMEABILITY TO DI WATER
ASTM D 2434-68 (Reapproved 1974)
Standard Test Method for Permeability of Granular Soils (Constant Head)

Project: CENTRAL NEVADA TEST AREA
Requestor: JULIE SOROLA
Organization: Bechtel
Address: NLV085
Phone: 8-2142
Tested by: DALE, TOM
Test start: 05/17/99

MTL Lab: 2009
Request #: 5-179
Charge #: C8W01H94
Sample Origin: 85% OF MODIFIED PROCTOR
Sample Type: NATIVE SOUTH AREA
Water Temperature: 21.5 C
Checked by: V. Thummala

15.240 = Sample Length (cm)
6.033 = Sample Diameter (cm)
29.66 = X-Sec. Area (sq cm)

Reading # Days From Start	Manometers H1 mm	Manometers H2 mm	Head cm	Q cm^3	t sec.	Q/At	h/l	k - 20 C cm/sec	Date Tested	Time Tested
1	949	40	90.9	2.00	596.0	0.00011741	5.9646	1.82E-05	05/18/99	AM
1	949	40	90.9	1.70	535.0	0.00011118	5.9646	1.73E-05	05/18/99	AM
1	949	43	90.6	2.00	622.0	0.00011250	5.9449	1.75E-05	05/18/99	AM
1	949	42	90.7	1.50	360.0	0.00014578	5.9514	2.27E-05	05/18/99	AM
1	949	42	90.7	1.90	600.0	0.00011079	5.9514	1.72E-05	05/18/99	AM
1	949	41	90.8	1.60	480.0	0.00011663	5.9580	1.81E-05	05/18/99	AM
							AVERAGE =	1.85E-05		

APR 06 1999

NUCLEAR DENSITY ASTM D2922-96 CAMPBELL MC-2/MC-3	BECHTEL NEVADA MATERIALS TESTING LABORATORY P. O. BOX 98521, M/S NTS188 LAS VEGAS, NV 89193-8521	CHARGE #: C8W01C04 DATE TYPED 04/05/99 PAGE 1 OF 1

Requested by D. MADSEN User/Agency BECHTEL Material NATIVE

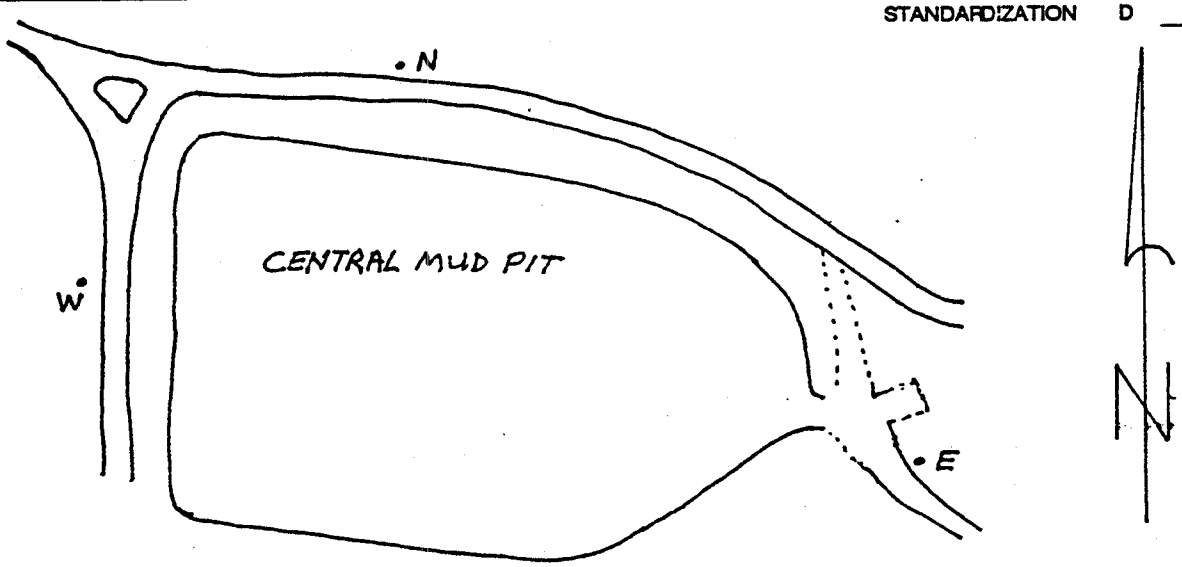
Project CNTA Location of Tests NORTH, WEST, & EAST OF UC1 MUD PIT

Tested by D. HERRINGTON Date Tested 03/22/99 Checked by V. Quinn

LABORATORY NO	1188	1189	1190	N/A	N/A	N/A
TEST LOCATION	WEST	NORTH	EAST			
DEPTH OF PROBE	12"	12"	12"			
DEPTH OF TESTS	GRADE	GRADE	GRADE			
WET DENSITY-PCF	127.1	112.3	117.4			
DRY DENSITY-PCF	111.5	105.3	109.1			
MOISTURE %	14.0	6.6	7.6			

GAUGE NO 23205 DATE OF STANDARDIZATION 03/22/99 VALUE OF STANDARDIZATION M 635 D 2917

PLOT PLAN



REMARKS: APPROXIMATE TEST LOCATIONS WERE DESIGNATED BY J. SOROLA. MATERIAL FROM EACH TEST AREA WAS TAKEN TO BE REMOLDED FOR PERMEABILITY TESTS AT NATIVE MOISTURE & DENSITY.

CC: J. SOROLA BECHTEL
D. MADSEN BECHTEL
MTL BECHTEL FILES

Bechtel Nevada
Materials Testing Laboratory
P.O.BOX 98521, M/S NTS 188, LAS VEGAS, NV 89193
(702) 295-6669

Table 1.

SAMPLE UC1 PERMEABILITY TO DI WATER
ASTM D 2434-68 (Reapproved 1974)
Standard Test Method for Permeability of Granular Soils (Constant Head)

Project: CNTA UC1	MTL Lab: 1188 A	16.24 = Sample Length (cm)
Requestor: JULIE SOROLA	Request #: S-87	6.03 = Sample Diameter (cm)
Organization: Bechtel	Charge #: C8W01H04	28.58 = X-Sec. Area (sq cm)
Address: NLV086	Sample Origin: WEST SIDE	
Phone: 6-2142	Sample Type: NATIVE SOIL	
Tested by: DALE	Water Temperature: 20.3 C	
Test start: 04/17/99	Checked by:	

Reading # Days From Start	Manometers H1 mm	Manometers H2 mm	Head cm	Q cm^3	t sec.	Q/At	h/l	k - 20 C cm/sec	Date Tested	Time Tested
12	960	38	92.2	0.46	7500.0	0.00000216	6.0499	3.31E-07	04/29/99	AM
16	940	37	90.3	0.21	8820.0	0.00000081	5.9252	1.27E-07	05/03/99	AM
18	940	35	90.5	0.53	28740.0	0.00000064	5.9383	1.00E-07	05/05/99	AM
19	939	35	90.4	0.50	19260.0	0.00000090	5.9318	1.40E-07	05/06/99	AM

Bechtel Nevada
Materials Testing Laboratory
P.O.BOX 98521, M/S NTS 188, LAS VEGAS, NV 89193
(702) 295-6669

Table 2.

SAMPLE UC1 PERMEABILITY TO DI WATER
ASTM D 2434-68 (Reapproved 1974)
Standard Test Method for Permeability of Granular Soils (Constant Head)

Project: CNTA UC1	MTL Lab: 1188 B	16.24 = Sample Length (cm)
Requestor: JULIE SOROLA	Request #: S-87	6.03 = Sample Diameter (cm)
Organization: Bechtel	Charge #: C8W01H04	28.58 = X-Sec. Area (sq cm)
Address: NLV086	Sample Origin: WEST SIDE	
Phone: 6-2142	Sample Type: NATIVE SOIL	
Tested by: DALE	Water Temperature: 20.3 C	
Test start: 04/17/99	Checked by: V. [illegible]	

Reading # Days From Start	Manometers H1 mm	Manometers H2 mm	Head cm	Q cm^3	t sec.	Q/At	h/l	k - 20 C cm/sec	Date Tested	Time Tested
12	960	38	92.2	0.53	7620.0	0.00000243	6.0499	3.72E-07	04/29/99	AM
16	940	38	90.2	0.60	10380.0	0.00000202	5.9186	3.16E-07	05/03/99	AM
16	940	38	90.2	0.41	6600.0	0.00000217	5.9186	3.40E-07	05/03/99	AM
18	940	36	90.4	0.73	13560.0	0.00000188	5.9318	2.94E-07	05/05/99	AM
18	940	36	90.4	0.79	14820.0	0.00000185	5.9318	2.89E-07	05/05/99	AM
19	939	35	90.4	0.97	18720.0	0.00000180	5.9318	2.82E-07	05/06/99	AM

Bechtel Nevada
Materials Testing Laboratory
P.O.BOX 98521, M/S NTS 188, LAS VEGAS, NV 89193
(702) 295-6669

Table 3.

SAMPLE UC1 PERMEABILITY TO DI WATER
ASTM D 2434-68 (Reapproved 1974)
Standard Test Method for Permeability of Granular Soils (Constant Head)

Project: CNTA UC1
Requestor: JULIE SOROLA
Organization: Bechtel
Address: NLV086
Phone: 8-2142
Tested by: DALE
Test start: 04/20/99

MTL Lab: 1189 A
Request #: S-97
Charge #: C8W01H04
Sample Origin: NORTH SIDE
Sample Type: NATIVE SOIL
Water Temperature: 20.3 C
Checked by: [illegible]

16.24 = Sample Length (cm)
6.03 = Sample Diameter (cm)
28.58 = X-Sec. Area (sq cm)

Reading # Days From Start	Manometers H1 mm	Manometers H2 mm	Head cm	Q cm^3	t sec.	Q/At	h/l	k - 20 C cm/sec	Date Tested	Time Tested
12	960	35	92.5	1.03	7620.0	0.00000471	6.0696	7.18E-07	04/29/99	AM
16	940	42	89.8	0.61	3480.0	0.00000613	5.8924	9.64E-07	05/03/99	AM
16	940	37	90.3	0.70	4260.0	0.00000571	5.9252	8.92E-07	05/03/99	AM
18	940	35	90.5	0.94	6000.0	0.00000548	5.9383	8.55E-07	05/05/99	AM
18	940	38	90.2	1.14	7260.0	0.00000549	5.9186	8.60E-07	05/05/99	AM
18	940	35	90.5	1.09	6960.0	0.00000548	5.9383	8.54E-07	05/05/99	AM
18	939	35	90.4	0.95	5700.0	0.00000580	5.9318	9.06E-07	05/05/99	AM

Bechtel Nevada
Materials Testing Laboratory
P.O.BOX 98521, M/S NTS 188, LAS VEGAS, NV 89193
(702) 295-6669

Table 4.

SAMPLE UC1 PERMEABILITY TO DI WATER
ASTM D 2434-68 (Reapproved 1974)
Standard Test Method for Permeability of Granular Soils (Constant Head)

Project: CNTA UC1	MTL Lab: 1188 B	16.24 = Sample Length (cm)
Requestor: JULIE SOROLA	Request #: S-87	6.03 = Sample Diameter (cm)
Organization: Bechtel	Charge #: C8Wn1fk04	28.58 = X-Sec. Area (sq cm)
Address: NLV088	Sample Origin: NORTH SIDE	
Phone: 8-2142	Sample Type: NATIVE SOIL	
Tested by: DALE	Water Temperature: 20-3 C	
Test start: 04/20/99	Checked by: [illegible]	

Reading # Days From Start	Manometers H1 mm	Manometers H2 mm	Head cm	Q cm^3	t sec.	Q/At	h/l	k - 20 C cm/sec	Date Tested	Time Tested
12	960	35	92.5	0.45	3120.0	0.00000505	6.0696	7.70E-07	04/29/99	AM
16	940	37	90.3	0.54	4380.0	0.00000431	5.9252	6.74E-07	05/03/99	AM
16	940	36	90.4	0.64	4560.0	0.00000491	5.9318	7.67E-07	05/03/99	AM
18	940	35	90.5	0.75	5940.0	0.00000442	5.9383	6.89E-07	05/05/99	AM
18	940	36	90.4	0.92	7140.0	0.00000451	5.9318	7.04E-07	05/05/99	AM
18	940	36	90.4	0.89	6900.0	0.00000451	5.9318	7.05E-07	05/05/99	AM
18	940	36	90.4	0.73	5760.0	0.00000443	5.9318	6.92E-07	05/05/99	AM

Bechtel Nevada
Materials Testing Laboratory
P.O.BOX 98521, M/S NTS 188, LAS VEGAS, NV 89193
(702) 295-6669

Table 5.

SAMPLE UC1 PERMEABILITY TO DI WATER
ASTM D 2434-68 (Reapproved 1974)
Standard Test Method for Permeability of Granular Soils (Constant Head)

Project: CNTA UC1
Requestor: JULIE SOROLA
Organization: Bechtel
Address: NLV086
Phone: 4-2142
Tested by: DALE
Test start: 04/20/99

MTL Lab: 1199 A
Request #: 5-87
Charge #: C8W01H04
Sample Origin: EAST SIDE
Sample Type: NATIVE SOIL
Water Temperature: 20.3 C
Checked by: [illegible]

16.24 = Sample Length (cm)
6.03 = Sample Diameter (cm)
29.58 = X-Sec. Area (sq cm)

Reading # Days From Start	Manometers H1 mm	Manometers H2 mm	Head cm	Q cm^3	t sec.	Q/At	h/l	k - 20 C cm/sec	Date Tested	Time Tested
12	960	55	90.5	10.00	293.0	0.00119412	5.9383	1.86E-04	04/29/99	AM
12	960	55	90.5	10.00	233.0	0.00150162	5.9383	2.34E-04	04/29/99	AM
12	960	55	90.5	10.00	179.0	0.00195462	5.9383	3.05E-04	04/29/99	AM
12	960	55	90.5	10.00	179.0	0.00195462	5.9383	3.05E-04	04/29/99	AM
12	960	55	90.5	10.00	184.0	0.00190151	5.9383	2.97E-04	04/29/99	AM

Bechtel Nevada
Materials Testing Laboratory
P.O.BOX 98521, M/S NTS 188, LAS VEGAS, NV 89193
(702) 295-6669

Table 6.

SAMPLE UC1 PERMEABILITY TO DI WATER
ASTM D 2434-68 (Reapproved 1974)
Standard Test Method for Permeability of Granular Soils (Constant Head)

Project: CNTA UC1	MTL Lab: 1199 B	16.24 = Sample Length (cm)
Requestor: JULIE SOROLA	Request #: S-87	6.03 = Sample Diameter (cm)
Organization: Bechtel	Charge #: C8W01H04	28.58 = X-Sec. Area (sq cm)
Address: NLV086	Sample Origin: EAST SIDE	
Phone: 6-2142	Sample Type: NATIVE SOIL	
Tested by: DALE	Water Temperature: 20.3 C	
Test start: 04/20/99	Checked by: V. [illegible]	

Reading # Days From Start	Manometers H1 mm	Manometers H2 mm	Head cm	Q cm^3	t sec.	Q/At	h/l	k - 20 C cm/sec	Date Tested	Time Tested
12	949	52	89.7	10.00	120.0	0.00291564	5.8858	4.59E-04	04/29/99	AM
12	949	52	89.7	10.00	125.0	0.00279902	5.8858	4.40E-04	04/29/99	AM
12	949	52	89.7	10.00	110.0	0.00318070	5.8858	5.00E-04	04/29/99	AM
12	949	52	89.7	10.00	128.0	0.00273341	5.8858	4.30E-04	04/29/99	AM

APR 06 1999

NUCLEAR DENSITY ASTM D2922-96 CAMPBELL MC-2/MC-3	BECHTEL NEVADA MATERIALS TESTING LABORATORY P. O. BOX 98521, M/S NTS188 LAS VEGAS, NV 89193-8521	CHARGE #: C8W01C04 DATE TYPED 04/05/99 PAGE 1 OF 1

Requested by D. MADSEN User/Agency BECHTEL Material NATIVE

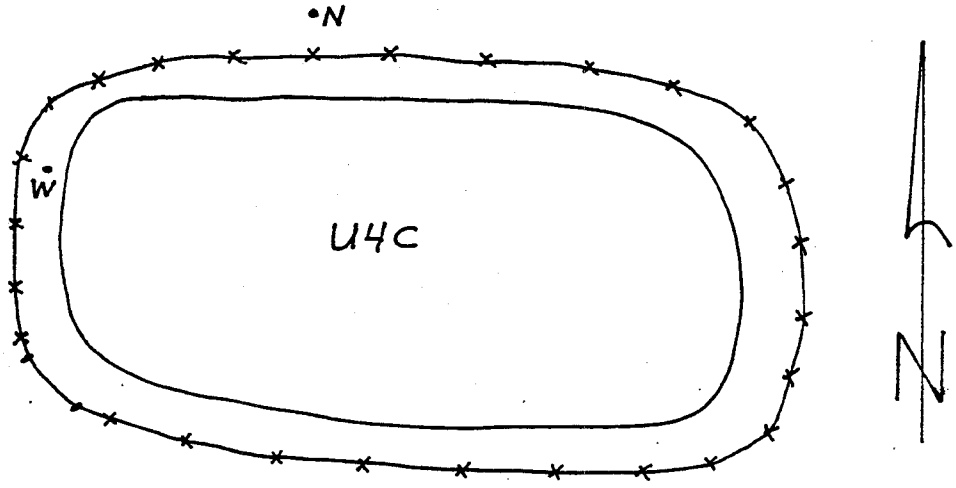
Project CNTA Location of Tests NORTH & WEST OF U4C

Tested by D. HERRINGTON Date Tested 03/22/99 Checked by V. Quinla

LABORATORY NO	1191	1192	N/A	N/A	N/A	N/A
TEST LOCATION	WEST	NORTH				
DEPTH OF PROBE	12"	12"				
DEPTH OF TESTS	GRADE	GRADE				
WET DENSITY-PCF	124.7	120.1				
DRY DENSITY-PCF	115.5	111.2				
MOISTURE %	8.0	8.0				

GAUGE NO 23205 DATE OF STANDARDIZATION 03/22/99 VALUE OF STANDARDIZATION M 635 D 2917

PLOT PLAN



REMARKS: APPROXIMATE TEST LOCATIONS WERE DESIGNATED BY J. SOROLA. MATERIAL FROM EACH TEST AREA WAS TAKEN TO BE REMOLDED FOR PERMEABILITY TESTS AT NATIVE MOISTURE & DENSITY.

CC: J. SOROLA BECHTEL
D. MADSEN BECHTEL
MTL BECHTEL FILES

Bechtel Nevada
Materials Testing Laboratory
P.O.BOX 98521, M/S NTS 188, LAS VEGAS, NV 89193
(702) 295-6669

Table 1.

SAMPLE U4C PERMEABILITY TO DI WATER
ASTM D 2434-68 (Reapproved 1974)
Standard Test Method for Permeability of Granular Soils (Constant Head)

Project: CNTA U4C
Requestor: JULIE SOROLA
Organization: Bechtel
Address: NLV086
Phone: 5-2142
Tested by: DALE
Test start: 04/20/99

MTL Lab: 1191 A
Request #: S-97
Charge #: C8W01H14
Sample Origin: WEST SIDE
Sample Type: NATIVE SOIL
Water Temperature: 20.3 C
Checked by: V. [illegible]

16.240 = Sample Length (cm)
6.033 = Sample Diameter (cm)
28.58 = X-Sec. Area (sq cm)

Reading # Days From Start	Manometers H1 mm	Manometers H2 mm	Head cm	Q cm^3	t sec.	Q/At	h/l	k - 20 C cm/sec	Date Tested	Time Tested
9	960	36	92.4	1.00	840.0	0.00004165	6.0630	6.36E-06	04/29/99	AM
9	960	36	92.4	1.26	1108.0	0.00003979	6.0630	6.08E-06	04/29/99	AM
9	960	36	92.4	0.73	640.0	0.00003991	6.0630	6.10E-06	04/29/99	AM
9	960	36	92.4	1.02	860.0	0.00004150	6.0630	6.34E-06	04/29/99	AM

Bechtel Nevada
Materials Testing Laboratory
P.O.BOX 98521, M/S NTS 188, LAS VEGAS, NV 89193
(702) 295-6669

Table 2.

SAMPLE U4C PERMEABILITY TO DI WATER
ASTM D 2434-68 (Reapproved 1974)
Standard Test Method for Permeability of Granular Soils (Constant Head)

Project: CNTA U4C	MTL Lab: 1191 B	16.240 = Sample Length (cm)
Requestor: JULIE SOROLA	Request #: S-87	6.033 = Sample Diameter (cm)
Organization: Bechtel	Charge #: C8W01H14	28.58 = X-Sec. Area (sq cm)
Address: NLVO85	Sample Origin: WEST SIDE	
Phone: 5-2142	Sample Type: NATIVE SOIL	
Tested by: DALE	Water Temperature: 20.3 C	
Test start: 04/20/99	Checked by:	

Reading # Days From Start	Manometers H1 mm	Manometers H2 mm	Head cm	Q cm^3	t sec.	Q/At	h/l	k - 20 C cm/sec	Date Tested	Time Tested
9	960	38	92.2	0.70	253.0	0.00009680	6.0499	1.48E-05	04/29/99	AM
9	960	37	92.3	0.85	320.0	0.00009294	6.0564	1.42E-05	04/29/99	AM
9	960	35	92.5	0.65	242.0	0.00009398	6.0696	1.43E-05	04/29/99	AM
9	960	48	91.2	2.00	647.0	0.00010815	5.9843	1.67E-05	04/29/99	AM
9	960	48	91.2	3.00	999.0	0.00010507	5.9843	1.63E-05	04/29/99	AM

Bechtel Nevada
Materials Testing Laboratory
P.O.BOX 98521, M/S NTS 188, LAS VEGAS, NV 89193
(702) 295-6669

Table 3.

SAMPLE U4C PERMEABILITY TO DI WATER
ASTM D 2434-68 (Reapproved 1974)
Standard Test Method for Permeability of Granular Soils (Constant Head)

Project: CNTA U4C	MTL Lab: 1192 A	15.240 = Sample Length (cm)
Requestor: JULIE SOROLA	Request #: 5-97	6.033 = Sample Diameter (cm)
Organization: Bechtel	Charge #: C8W01H14	28.58 = X-Sec. Area (sq cm)
Address: NLV065	Sample Origin: NORTH SIDE	
Phone: 5-2142	Sample Type: NATIVE SOIL	
Tested by: DALE	Water Temperature: 20.3 C	
Test start: 04/20/99	Checked by:	

Reading # Days From Start	Manometers H1 mm	Manometers H2 mm	Head cm	Q cm^3	t sec.	Q/At	h/l	k - 20 C cm/sec	Date Tested	Time Tested
9	960	50	91.0	10.00	456.0	0.00076727	5.9711	1.19E-04	04/29/99	AM
9	960	50	91.0	10.00	464.0	0.00075405	5.9711	1.17E-04	04/29/99	AM
9	960	50	91.0	10.00	468.0	0.00074760	5.9711	1.16E-04	04/29/99	AM
9	960	50	91.0	10.00	478.0	0.00073196	5.9711	1.14E-04	04/29/99	AM
9	956	49	90.7	10.00	487.0	0.00071843	5.9514	1.12E-04	04/29/99	AM

Bechtel Nevada
Materials Testing Laboratory
P.O.BOX 98521, M/S NTS 188, LAS VEGAS, NV 89193
(702) 295-6669

Table 4.

SAMPLE U4C PERMEABILITY TO DI WATER
ASTM D 2434-68 (Reapproved 1974)
Standard Test Method for Permeability of Granular Soils (Constant Head)

Project: CNTA U4C	MTL Lab: 1192 B	15.240 = Sample Length (cm)
Requestor: JULIE SOROLA	Request #: S-97	6.033 = Sample Diameter (cm)
Organization: Bechtel	Charge #: CSW01H14	28.58 = X-Sec. Area (sq cm)
Address: NLV085	Sample Origin: NORTH SIDE	
Phone: 5-2142	Sample Type: NATIVE SOIL	
Tested by: DALE	Water Temperature: 20.3 C	
Test start: 04/29/99	Checked by:	

Reading # Days From Start	Manometers H1 mm	Manometers H2 mm	Head cm	Q cm^3	t sec.	Q/At	h/l	k - 20 C cm/sec	Date Tested	Time Tested
9	960	75	88.5	10.00	242.0	0.00144577	5.8071	2.31E-04	04/29/99	AM
9	960	75	88.5	10.00	235.0	0.00148884	5.8071	2.37E-04	04/29/99	AM
9	960	75	88.5	10.00	235.0	0.00148884	5.8071	2.37E-04	04/29/99	AM

APPENDIX B

HYDROLOGIC MODELING SUMMARY AND RESULTS

COVER PERFORMANCE MODELING

The performance of the proposed UC4 Mudpit C cover design has been evaluated using a comprehensive numerical model for solving Richards Equation in one dimension. The ODIRE (One-Dimensional Infiltration - Redistribution - Evaporation) model couples infiltration and redistribution with a complex atmospheric boundary. A unique feature of ODIRE allows it to account for a falling head boundary and simultaneously account for free surface evaporation. ODIRE uses an integrated finite difference technique which couples mass balance and two phase flow.

The first cover design strategy utilized native soils to build a 1.8 meter (6 foot) thick monolayer over the top of Mudpit C. The cover design was subjected to the historic precipitation record from the Western Regional Climate Center meteorological monitoring station (Blue Jay Highway STN #260961), located about 35 kilometers (21 miles) south of Mudpit C, to determine if the mono-layer was an effective barrier to infiltration.

The second design strategy utilized a GCL with a 0.46 meter (1.5 foot) buffer and erosion control layer above and an 0.9 meter (3 foot) shaping layer below. This cover was subjected to the same historical precipitation record to determine if the GCL was an effective barrier to infiltration. The modeling runs, including the results and conclusions are described below.

Mono-layer design

The mono-layer cover design utilizes native soils to develop a uniform homogenous cover. Each lift would be placed and compacted to meet specific criteria. From a hydrologic modeling standpoint the cover would have to uniformly meet a specified saturated hydraulic conductivity. It was determined that field compaction of native material could achieve hydraulic conductivities ranging from 1×10^{-3} cm/s to 1×10^{-5} cm/s. Soil samples were collected and used to determine hydraulic conductivities, porosities, and moisture retention characteristics for the soils in the vicinity of Mudpit C. These parameters were incorporated into the model. A complete list of modeling parameters for each layer are located in Table 1.

Initial water content in the first 1.5 meters (5 feet) of the mono-layer was set to eight percent. The last 0.3 meters (1 foot) was set to saturation. This was done because the weight of the mono-layer on top of the drilling mud will compress the mud causing some of the liquid bound within the drilling mud to be released. Engineering calculations estimate that consolidation will be on the order of several inches. This would produce a saturated condition at the base of the mono-layer of approximately 0.3 meters (1 foot). The drilling mud was assumed to be completely saturated. All modeling runs of the mono-layer cover failed within the 30 year modeling period. Precipitation was able to reach the drilling mud beneath and build a saturated layer on top. The last run using a saturated hydraulic conductivity of 1×10^{-5} cm/s is shown in Figure 1.

GCL cover design

The GCL cover design consists of a GCL sandwiched between native soils placed to serve as both a buffering layer and shaping fill. The native soils would not require compaction to meet any specific saturated hydraulic conductivity criteria because the specifications of the GCL already accomplish this. A complete list of modeling parameters for each layer of the GCL cover design are located in Table 1.

Initial water content in the first 0.5 meters (1.6 feet) of the GCL cover was set to eight percent. The GCL itself was given an initial water content of 18 percent. The 0.6 meters of shaping fill beneath the GCL was set at eight percent. The last 0.3 meters (1 foot) of shaping fill was set to saturation. This was set equivalent to the previous runs for the mono-layer, although amount of liquids released from the GCL cover will be less (the GCL cover is not as thick). The drilling mud was assumed to be completely saturated. Results from the GCL cover modeling runs show an initial redistribution of water as the GCL hydrates. Liquid is pulled up slowly from the saturated zone on top of the drilling mud. Throughout the simulation the GCL proves to be an adequate barrier to infiltration. At the end of the 30 year modeling period the upper portion of the drilling mud has dried out to a small degree. The water content in the shaping fill is fairly uniform with a gradient directed toward the GCL and ultimately the ground surface. Figure 1 shows the results from of the GCL modeling run.

Conclusions

Results from the investigation activities (DOE, 1999) show that concentrations of the COCs are relatively low and that they are not migrating significantly. Modeling results from the GCL cover design show that this cover provides an additional level of protection for the groundwater by limiting infiltration resulting from meteorologic events.

TABLE 1 - MODELING PARAMETERS FOR THE UC4 MUDPIT C COVER DESIGN.

PARAMETER	SOIL DESCRIPTION	VALUE	ESTIMATED OR MEASURED	SOURCE
Vertical hydraulic conductivity	Mono-layer	10^{-5} cm/s (3.28 x 10^{-7} ft/s)	Measured	MTL data sheets
Vertical hydraulic conductivity	GCL	10^{-9} cm/s (3.28 x 10^{-11} ft/s)	Measured	Bentofix Data Sheets
Vertical hydraulic conductivity	Shaping fill & bedding layer	10^{-4} cm/s (3.28 x 10^{-6} ft/s)	Measured	MTL data sheets
Vertical hydraulic conductivity	Drilling Mud	10^{-9} cm/s (3.28 x 10^{-6} ft/s)	Measured	MTL data sheets
α	Mono-layer	0.175 m (0.574 ft)	Measured	Levitt, 1999
α	GCL	2.0 x 10^{-2} m (6.6 x 10^{-2} ft)	Estimated	DOE, 1997
α	Shaping fill & bedding layer	0.175 m (0.574 ft)	Measured	Levitt, 1999
α	Drilling Mud	0.5 m (1.64 ft)	Estimated	DOE, 1997
n	Mono-layer	1.24	Measured	Levitt, 1999
n	GCL	1.14	Estimated	DOE, 1997
n	Shaping fill & bedding layer	1.24	Measured	Levitt, 1999
n	Drilling Mud	1.48	Estimated	DOE, 1997
θ sat	Mono-layer	0.365	Measured	Levitt, 1999
θ sat	GCL	0.50	Estimated	DOE, 1997
θ sat	Shaping fill & bedding layer	0.365	Measured	Levitt, 1999
θ sat	Drilling Mud	0.545	Measured	MTL data sheets
θ res	Mono-layer	0.03	Estimated	DOE, 1997
θ res	GCL	0.03	Estimated	DOE, 1997
θ res	Shaping fill & bedding layer	0.03	Estimated	DOE, 1997
θ res	Drilling Mud	0.03	Estimated	DOE, 1997
τ (Tortuosity)	NA	0.66	Estimated	Jury et.al., 1991
h^{air} (Relative Humidity)	NA	100% while raining 10% otherwise	Measured	National Weather Service
ΔB_L (boundary layer thickness)	NA	2.0 m (6.5 ft)	Estimated	Weaver, 1990
Φ_{rain} (rain intensity)	NA	Monthly historic record	Measured	Western Regional Climate Center
Potential Evaporation	NA	4.3 mm/day (0.16 in/day)	Measured	Letter Report DRI, 1993

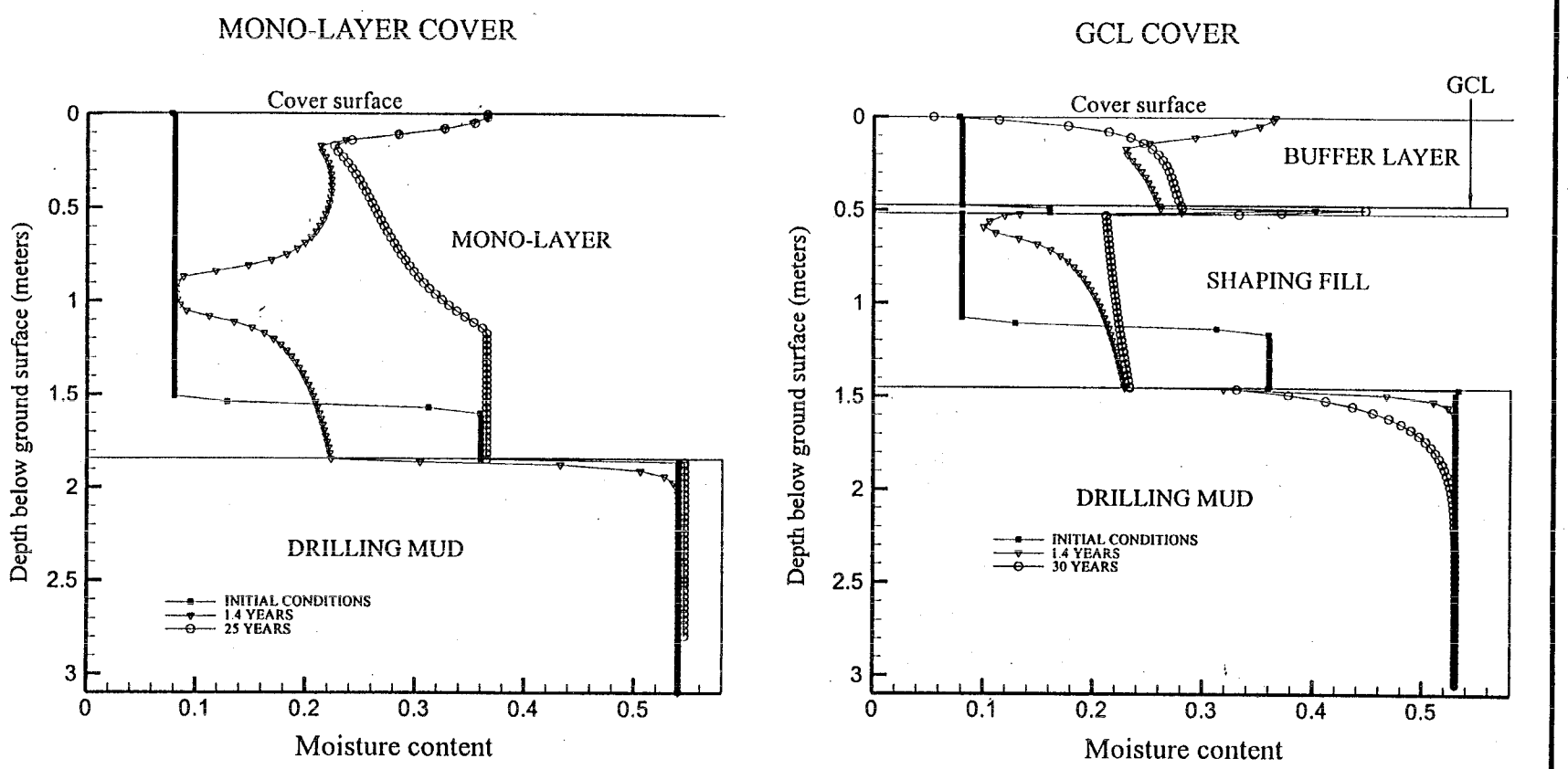


FIGURE 1 - ONE DIMENSIONAL MODELING RESULTS

REFERENCES

DOE, 1997. Report of Activities and Geotechnical/Hydrological Results May and June 1997 Characterization Sampling Area 6 Decon Pond, CAU 92.

DOE, 1999. Corrective Action Decision Document for Corrective Action Unit 417: Central Nevada Test Area Surface, Nevada.

Johnson, N.M., and S.J. Dreiss. 1989. Hydrostratigraphic interpretation using indicator geostatistics. Water Resour. Res. 25:2501-2510.

Jury, W. A., W. R. Gardner, W. H. Gardner, 1991. Soil Physics, fifth edition. John Wiley & Sons, Inc. New York.

Weaver, W. H., 1990. Temperature and Humidity Flux-Variance Relations Determined by One-Dimensional Eddy Correlation: Boundary Layer Meteorology. Kluwer Academic Publishers. Netherlands.

APPENDIX C

FLOOD STUDY

Flood Assessment for the

Central Nevada Test Area UC-1, UC-3, and UC-4 Sites

CONTENTS

ABSTRACT iii

1.0 INTRODUCTION 1
- 1.1 Location 1
- 1.2 Purpose 1
- 1.3 Objective 1

2.0 WATERSHED DESCRIPTIONS 3
- 2.1 Introduction 3
- 2.2 Apex Definitions 3
- 2.3 UC-1 Alluvial Fans and Subbasins 3
- 2.4 UC-3 Subbasins 8
- 2.5 UC-4 Subbasins 8

3.0 HYDROLOGY 9
- 3.1 Methods 9
  - 3.1.1 Precipitation 10
  - 3.1.2 Drainage Areas 13
  - 3.1.3 Precipitation Losses 13
  - 3.1.4 Lag Time 16
  - 3.1.5 Channel Routing 19
- 3.2 Hydrologic Models 21
- 3.3 Hydrology Results 23
- 3.4 Hydrology Discussion 23
  - 3.4.1 UC-1 Hydrology 24
  - 3.4.2 UC-3 Hydrology 27
  - 3.4.3 UC-4 Hydrology 27

4.0 HYDRAULICS AND FLOOD HAZARD DETERMINATION 27
- 4.1 Hydraulics and Flood Hazard Determination: Methods 28
  - 4.1.1 Alluvial Fan Flooding 28
  - 4.1.2 Shallow Channelized Flow 31
  - 4.1.3 Sheetflow 31
- 4.2 Results and Discussion of Flood Hazard Determination 32
  - 4.2.1 Alluvial Fan Flooding 32
  - 4.2.2 Shallow Concentrated Flow 32
  - 4.2.3 Sheetflow 36

5.0 REFERENCES 36

APPENDIX A HEC-1 MODEL OUTPUT A-1
APPENDIX B FEMA FAN MODEL OUTPUT B-1
APPENDIX C HEC-RAS MODEL OUTPUT C-1
APPENDIX D SHEETFLOW CALCULATIONS D-1

FIGURES

Figure 1. Location map and physiographic features of the Central Nevada Test Area. 2
Figure 2. Watershed map of the UC-1 site 4
Figure 3. Watershed map of the UC-3 site 5
Figure 4. Watershed map of the UC-4 site 6
Figure 5. Idealized alluvial fan profile. 7
Figure 6. Hypothesized zones of precipitation in Southern Nevada 11
Figure 7. Storm distribution curves 12
Figure 8. Travel time velocities 20
Figure 9. Generalized U.S. skew coefficients 25
Figure 10. Alluvial fan plan view 29
Figure 11. Flood hazard map for the UC-1 site 33
Figure 12. Flood hazard map for the UC-3 site 34
Figure 13. Flood hazard map for the UC-4 site 35

TABLES

Table 1. Subbasins used in the CNTA flood assessment 3
Table 2. Six-hour precipitation depth-area reduction factors 14
Table 3. Runoff curve numbers 14-15
Table 4. Subbasin curve numbers 17
Table 5. Lag equation roughness factors 17
Table 6. Lag time parameters. 19
Table 7. Routing parameters used in the Muskingum routing method 21
Table 8. Hydrologic model descriptions 22-23
Table 9. Skew coefficients from different model sets for UC-1 26
Table 10. HEC-1 model-generated discharges at key locations 27

ABSTRACT

A flood assessment at the Central Nevada Test Area (CNTA) in Nye County, Nevada, was conducted to determine the 100-year flood hazard at three Environmental Restoration (ER) sites. Specifically, this study was conducted to determine whether the UC-1, UC-3, or UC-4 sites were located within a 100-year flood hazard, as defined by the Federal Emergency Management Agency (FEMA); and to provide 100-year discharges for design of flood protection.

The watershed areas of the UC-1, UC-3, and UC-4 sites encompass approximately 12.0-, 6.2-, 1.6-square-kilometer (km^2) (4.6-, 2.4-, 0.6-square-mile [mi^2]), respectively, and are located within Hot Creek Valley, encompassing portions of the Hot Creek Range, including Morey Peak. The UC-1 and UC-3 sites are located on the distal ends of coalescing alluvial fans. The UC-4 site is located in the lower elevations of the foothills of the Hot Creek Range.

Potential flooding of the CNTA sites can occur as alluvial fan flooding, channelized flow, and sheetflow. FEMA has developed methods to determine the 100-year flood hazards from these types of flooding. This flood assessment was conducted following criteria for flood hazard determination required by FEMA to provide hydrologic and hydraulic information for design of flood protection structures for the sites.

In the arid Southwest, rainfall-runoff models are often used to estimate flood discharges. Rainfall-runoff models were developed for the CNTA flood assessment using the HEC-1, *Flood Hydrograph Package*, model developed by the U.S. Army Corps of Engineers (COE, 1990). The HEC-1 model-generated peak discharges are incorporated into the FEMA FAN model (1990) to define flood hazards on identified alluvial fans within the study area. The HEC-1 model-generated discharges are also used to calculate channelized flow and sheetflow depths where appropriate. Methods to determine alluvial fan, channelized flow, and sheetflow flood hazards are described in the document.

The CNTA UC-1 site is not located within the FEMA designated 100-year, 6-hour flood hazard zone of either the UC-1 North or UC-1 South alluvial fan. The UC-3 and UC-4 sites are not impacted by alluvial fan flows. Channelized flow occurs in the UC-4B subbasin in a channel that flows along the southern edge of the UC-4 site. Drilling mud was dumped into this channel and is being transported downstream by flows, as evidenced by the channel bed material type and discoloration. Standard hydraulic calculations indicate that flow through several reaches of this channel occurs at depths greater than 0.3 meter (m) (1 foot [ft]); therefore, this channel is designated as a 100-year flood hazard zone. Calculated 100-year sheetflow depths just above the UC-1 mudpit, the UC-3 drillhole, and the UC-4 site are less than 0.3 m (1 ft); therefore, these sites are not located within a 100-year, 6-hour flood hazard zone from sheetflow.

1.0 INTRODUCTION

1.1 Location

A flood assessment was conducted at the UC-1, UC-3, and UC-4 sites in Central Nevada Test Area (CNTA) in Nye County, Nevada (Figure 1) to determine potential flood hazards to these Environmental Restoration (ER) sites. The watershed areas of the UC-1, UC-3, and UC-4 sites encompass approximately 12.0-, 6.2-, 1.6-square-kilometer (km^2) (4.6-, 2.4-, 0.6-square-mile [mi^2]), respectively, and are located within Hot Creek Valley, encompassing portions of the Hot Creek Range, including Morey Peak. The UC-1 and UC-3 sites are located on the distal ends of coalescing alluvial fans. The UC-4 site is located in the lower elevations of the foothills of the Hot Creek Range. Watersheds were delineated by review of topographic maps and aerial photographs of Hot Creek Valley, in addition to field investigations.

1.2 Purpose

Flood assessment is one of several subtasks related to studies at and near the CNTA sites. The principal federal and state regulations and criteria pertaining to flooding to which the CNTA sites must comply are:

- Executive Order 11988, *Floodplain Management*;
- 10 Code of Federal Regulations (CFR) 1022, *Compliance with Floodplain/Wetlands Environmental Review Requirements*;
- 44 CFR 1.9, *Floodplain Management and Protection of Wetlands*;
- Department of Energy (DOE) Order 6430.1A, *General Design Criteria*.

This study focuses on the potential 100-year flood hazard at the CNTA sites, and also provides 100-year discharges for design purposes. This flood assessment does not evaluate any erosion hazards.

1.3 Objective

The flood assessment was conducted to meet requirements of DOE Orders by determining the 100-year, 6-hour flood hazard at and near the CNTA sites, and to provide 100-year discharges for flood protection design, using site-specific approaches for the hydrologic and hydraulic analyses. This flood assessment was conducted following criteria for flood hazard determination required by the Federal Emergency Management Agency (FEMA).

Figure 1. Location map and physiographic features of the Central Nevada Test Area.

2.0 WATERSHED DESCRIPTIONS

2.1 Introduction

The watershed areas of the UC-1, UC-3, and UC-4 sites encompass approximately 12.0-, 6.2-, 1.6-square-kilometer (km^2) (4.6-, 2.4-, 0.6-square-mile [mi^2]), respectively. The watershed areas were divided into subbasins (Table 1; Figures 2, 3, and 4).

Table 1. Subbasins used in the CNTA flood assessment.

Subbasin Name	Subbasin Area km^2 (mi^2)	Subbasin Name	Subbasin Area km^2 (mi^2)
UC-1A	2.1 (0.8)	UC-1F	2.5 (1.0)
UC-1B	3.2 (1.3)	UC-3A	3.6 (1.4)
UC-1C	2.1 (0.8)	UC-3B	2.6 (1.0)
UC-1D	1.8 (0.7)	UC-4A	1.0 (0.4)
UC-1E	0.5 (0.2)	UC-4B	0.5 (0.2)

2.2 Apex Definitions

There are two distinct definitions of alluvial fan apexes: geologic and FEMA (regulatory). The geologic apex of an alluvial fan is the intersection of the mountain front and the piedmont plain (Figure 5). On many alluvial fans, a channel is entrenched into the proximal, and possibly the middle part of the fan (Bull, 1964). Fans with entrenched channels have the active apex farther down the fan. FEMA defines the apex as the point below which the flowpath of the major stream that formed the fan becomes unpredictable and flooding of the fan can occur (FEMA, 1991). The FEMA definition was used in this study to determine the active apexes of the alluvial fans within the study area.

2.3 UC-1 Alluvial Fans and Subbasins

The UC-1 watershed covers 12.0 km^2 (4.6 mi^2) and is located west of the UC-1 site (*Figure 3*). The watershed drains towards the UC-1 site from an area of the Hot Creek Range, near Morey Peak. The watershed was divided into six separate subbasins (*Table 1*), including subbasins located within the Hot Creek Range, the foothills of the range, on alluvial fans, and on coalescing alluvial fan surfaces.

The apexes of two alluvial fans were located where the flowpaths of their respective channels becomes unpredictable. The channels located above the apex of the UC-1 North and UC-1 South alluvial fans are both incised approximately 1.0 to 2.0 meters (m) (3.0 to 6.0 feet [ft]). Debris flow deposits are common in the proximal areas of both alluvial fans. Vegetation types vary with elevation, ranging from pine and pinyon-juniper at higher elevations, to sagebrush and grass at lower elevations, but generally ground cover is 30 percent.

Figure 2. Watershed map of the UC-1 site. (11" x 17" foldout)

Figure 3. Watershed map of the UC-3 site. (11" x 17" foldout)

Figure 4. Watershed map of the UC-4 site. (11" x 17" foldout)

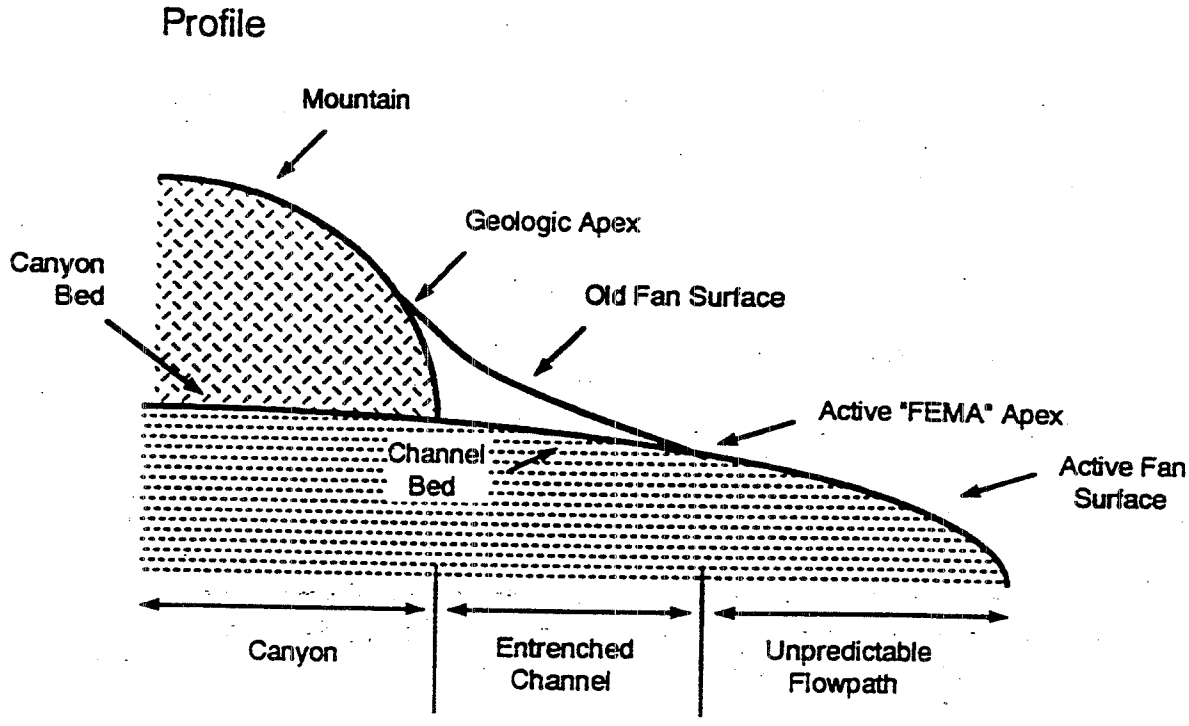


Figure 5. Idealized alluvial fan profile.

The lower subbasin (UC-1F) extends into the bottom of Hot Creek Valley as the UC-1A and UC-1B alluvial fans coalesce. From a hydraulic engineering viewpoint, the flow system on this landform is a distributary-flow system. Hjalmarson and Kemna (1991) stated that the ". . . major physiographic characteristics used to identify and categorize distributary-flow areas . . . include (1) vegetation density and soil color, (2) drainage texture, and (3) the random nature of channel links.". The proximal parts of these coalescing alluvial fans are characterized by channels incised 0.3 to 2.0 m (1.0 to 6.0 ft) deep. Channel depths decrease downgradient until sheetflow, typical of areas of low relief and poorly established drainage systems, occurs on the distal parts of the coalescing alluvial fans.

At the UC-1 ER site, located in the lower subbasin (UC-1F), sheetflow is dominant from the west-northwest, although shallow channels (less than 0.3 m [1 ft]) are present west-northwest of the site. However, a fault scarp at the site focuses water that originally flowed passed the site, directly at the UC-1 ER site. This scarp intercepts shallow channels, and redirects flow along the face of the scarp. At several locations along the scarp, flow is partially blocked, and small ponds occur. Evidence suggests that when the ponds become large enough, water moves around the obstacle, and flow continues along the scarp face towards the UC-1 ER site.

2.4 UC-3 Subbasins

The UC-3 watershed covers 6.2 km^2 (2.4 mi^2) and is located north-northwest of the UC-3 site (*Figure 3*). The watershed drains toward the UC-3 from an area of the Hot Creek Range, near Morey Peak. The watershed was divided into two separate subbasins (*Table 1*), including a subbasin located within the Hot Creek Range and the foothills of the range, and a subbasin on the coalescing alluvial fan surfaces.

The lower subbasin extends into the bottom of Hot Creek Valley as coalescing alluvial fans along the mountain front, and again these coalescing alluvial fans form distributary-flow systems. The proximal parts of these coalescing alluvial fans are characterized by channels incised 0.3 to 1.0 m (1 to 3 ft) deep. Channel depths decrease downgradient until sheetflow occurs on the distal parts of the coalescing alluvial fans. At the UC-3 ER site, sheetflow is dominant, although shallow channels (less than 0.3 m [1.0 ft]) are present near the site.

2.5 UC-4 Subbasins

The UC-4 watershed covers 1.6-km^2 (0.6-mi^2) and is located west of the UC-4 site (*Figure 4*). The watershed drains toward the UC-4 site from an area of the Hot Creek Range. The watershed was divided into two separate subbasins (*Table 1*). One subbasin (UC-4A) drains directly onto the site from the west. The second subbasin (UC-4B) is a channel (and associated drainage area) that flows along the southern edge of the site. Drilling mud was dumped into this channel and is being transported downstream by flows, as evidenced by the channel bed material type and discoloration. Discharge calculations are needed to provide mitigation for this channel.

3.0 HYDROLOGY

3.1 Methods

Standard statistical methods to determine flood discharges for a specific return period are not applicable to most watersheds in the arid Southwest because most of the watersheds in this region generally are ungaged and do not have stream discharge information. Furthermore, arid watersheds that do have discharge data usually have a short period of record with many years of no flow. Typically, in the arid Southwest, rainfall-runoff models are often used to estimate flood discharges.

In this flood assessment, rainfall-runoff models were developed using the HEC-1 computer program developed by the U.S. Army Corps of Engineers (COE) (1990). The *Clark County Hydrologic Criteria and Drainage Design Manual* (CCRFCD Manual) (Clark County Regional Flood Control District [CCRFCD], 1990) lists the HEC-1 computer program as an acceptable tool to estimate discharges and to generate hydrographs for watersheds within Clark County, Nevada. Methods in the CCRFCD Manual (1990) were used to produce the input parameters required for the HEC-1 computer program (COE, 1990).

The hydrologic approach described in the CCRFCD Manual (1990) was developed for Clark County from studies conducted by WRC Engineering and the COE. The methods described in the CCRFCD Manual (1990) were considered the best approach for estimating discharges for the flood assessment of the CNTA sites because:

- the physical setting and flood-producing storms for the CNTA sites are similar to those of Clark County;
- the study area is located in an adjacent county to Clark County;
- local and federal agencies (e.g., FEMA) accept the methods in the CCRFCD Manual (1990); and,
- Clark County is the nearest local jurisdiction with a hydrologic method based on region-specific information.

The Soil Conservation Service (SCS) unit hydrograph option in the HEC-1 computer program (COE, 1990) was used in the hydrologic models. The SCS unit hydrograph is widely used in rainfall-runoff models and is recommended as an option in the CCRFCD Manual (1990). Input parameters required to run the HEC-1 computer program (COE, 1990) using the SCS unit hydrograph option are:

- precipitation parameters (depth of precipitation, storm duration and time distribution, and depth-area ratios);
- drainage area (subbasin areas);
- precipitation losses (curve numbers);
- lag time (each subbasin); and,
- channel routing parameters.

The procedure used to obtain these parameters generally followed methods described in the CCRFCD Manual (1990). The following sections provide an overview of how these parameters were determined and substantiate any deviations from the methods provided in the CCRFCD Manual (1990). A detailed description of how these parameters are determined is in the CCRFCD Manual (1990).

3.1.1 Precipitation

Rainfall events that cause flooding in southern Nevada are usually convectional storms. According to Christenson and Spahr (1980), the probable flood-generating storm in the southern Nevada area would be from summer convectional storms. These flood-producing storms are normally characterized as short-duration (6 hours or less), high-intensity storms over a localized area. Methods regarding precipitation parameters in the CCRFCD Manual (1990) assume that summer convectional storms are the likely precipitation event to produce flooding in Nye County. In an analysis of precipitation records for southern Nevada, WRC Engineering and the COE determined that a 6-hour rainfall should be the design storm (CCRFCD Manual, 1990). A 6-hour mass curve (intensity of rainfall per 15-minute intervals over the 6-hour design storm) was developed and a relationship between precipitation depth and storm size (depth-area ratios) was determined. These parameters are discussed in the following sections in more detail.

a. Point Precipitation Values: As specified in the CCRFCD Manual (1990), the design depths of precipitation for the 6-hour storms were taken from the National Oceanic and Atmospheric Administration (NOAA) Atlas 2, Volume VII (U.S. Department of Commerce [DOC], 1973).

The CCRFCD Manual (1990) requires that point precipitation values listed in NOAA Atlas 2, Volume VII (DOC, 1973) be used to determine point precipitation; however, the CCRFCD Manual (1990) specifies that rainfall events above the 2-year storm be adjusted. Correction factors were identified from studies conducted by WRC Engineering and the COE for Clark County (CCRFCD Manual, 1990) based on available rainfall data, primarily from the Las Vegas Valley and may not be applicable for the CNTA study area.

French (1983) hypothesized that the southern part of Nevada can be divided into three precipitation zones: an excess zone, a transition zone, and a deficit zone (Figure 6). Based on this division, the CNTA site is located in the transition zone. French further hypothesized that the excess zone is a result of storms tracking up the Colorado River Valley, and the influence of the river on precipitation values lessens with distance away from the Colorado River Valley. The precipitation analyses by French (1983) supports this hypothesis and suggests that noncorrected precipitation values at the CNTA site are more applicable than using the precipitation correction factors specified in the CCRFCD Manual (1990). Hydrologic models in this flood assessment used the nonadjusted values in NOAA Atlas 2, Volume VII (DOC, 1973).

b. Storm Duration and Time Distribution: Clark County has adopted two 6-hour storm distribution tables to be used to generate discharges (CCRFCD Manual, 1990). The two storm distributions defined are for areas less than or greater than 26 km^2 (10 mi^2). These storm distributions were used for the subbasins in the hydrologic models for the CNTA site. A mass curve of the two storm distributions is shown in Figure 7.

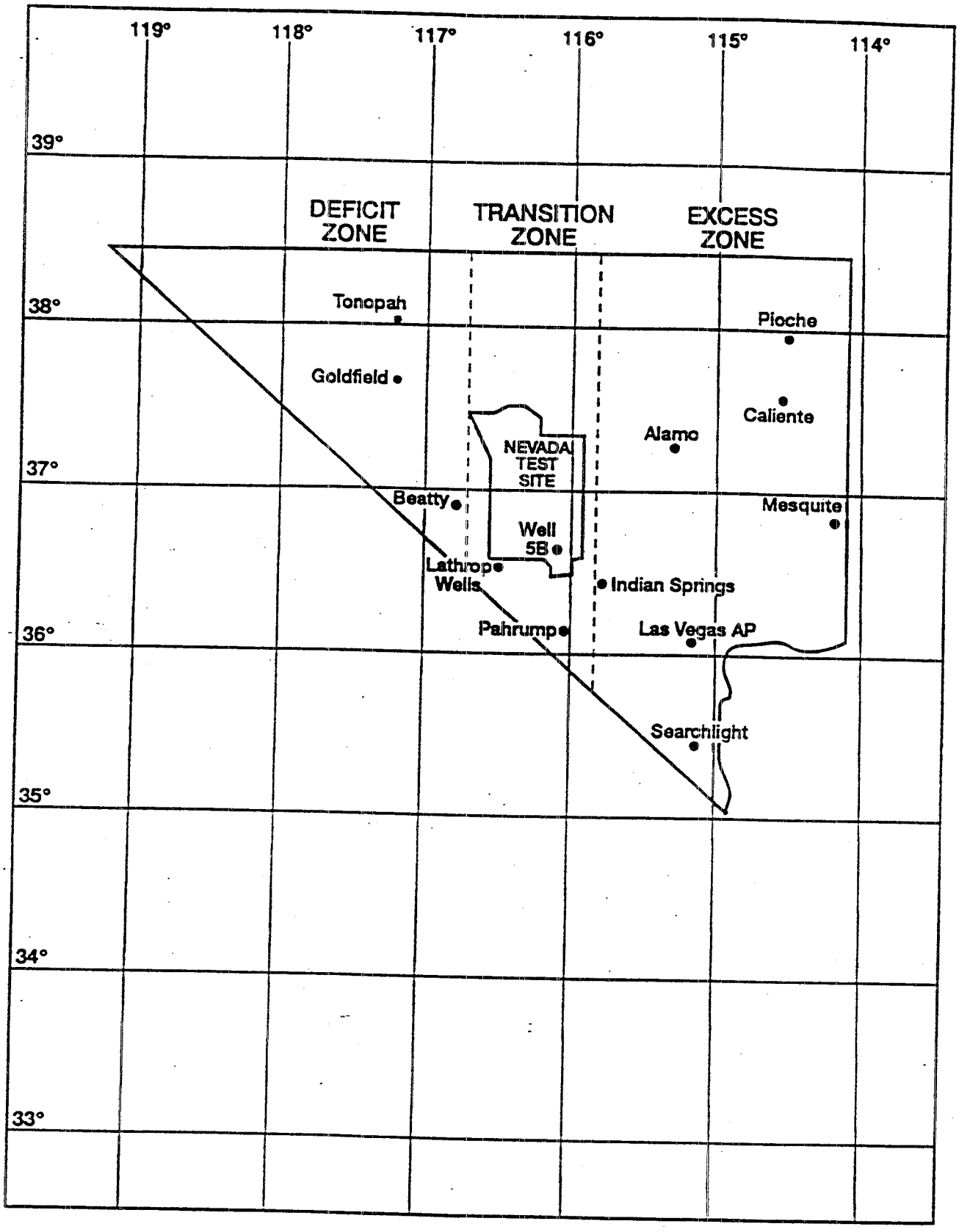
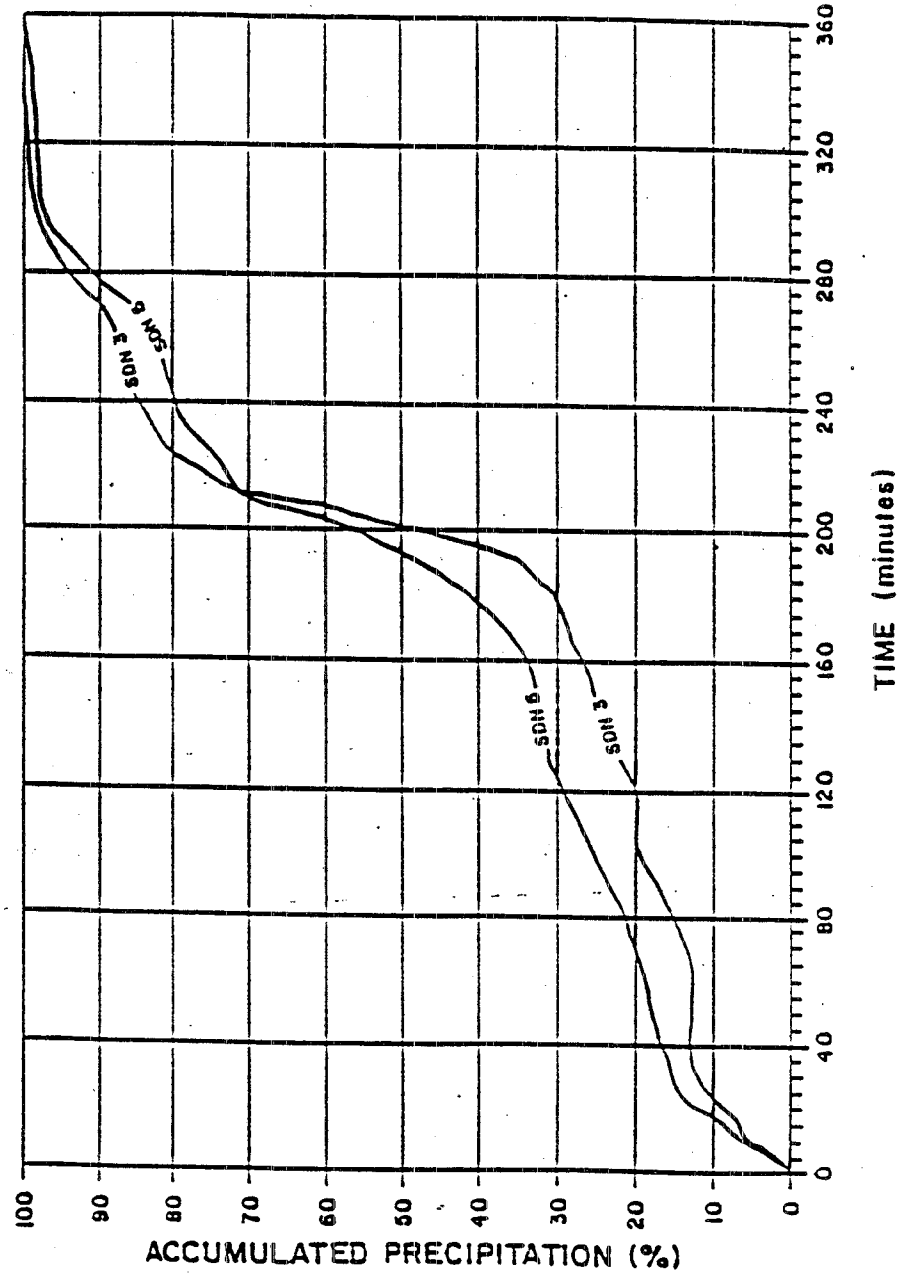


Figure 6. Hypothesized zones of precipitation in Southern Nevada.

SIX-HOUR DESIGN STORM DISTRIBUTIONS



Notes:

1. For drainage areas less than 10 square miles in size, use SDN 3.
2. For drainage areas equal to or greater than 10 square miles in size, use SDN 5.

Figure 7. Storm distribution curves.

c. **DEPTH-AREA RATIOS:** During a flood-producing storm, point precipitation values probably would not apply to an entire drainage basin. Depth-area ratios that reduce the point precipitation value for a watershed as a function of area have been developed for arid regions. Clark County uses the depth-area ratios for 6-hour storms that were developed by the COE for Clark County and vicinity (CCRFCD Manual, 1990) (Table 2). These depth-area ratios are a modification of ratios developed by Zehr and Myers (1984) on arid watersheds in Arizona and New Mexico. Ratios in the CCRFCD Manual (1990) were used in the 6-hour storm hydrologic models for the CNTA sites.

3.1.2 Drainage Areas

The CNTA site watersheds were delineated using 7.5-minute United States Geological Survey (USGS) topographic quadrangle maps. Drainage basin delineations were verified by study of color aerial photos and field investigations. The areas of the CNTA site watersheds and subbasins were determined using a planimeter.

7.5-minute Topographic Quadrangles (USGS):

-Hobble Canyon (1968)
-Moores Station (1982)
-Moores Station SW (1982)
-Morey Peak (1967)

3.1.3 Precipitation Losses

Precipitation losses were determined using the SCS curve number method and the applicable table (Table 3) found in the CCRFCD Manual (1990). The following information is required to determine a curve number for a specific subbasin:

- hydrologic soil group;
- vegetation type; and
- percent vegetation cover.

Table 2. **Six-hour precipitation depth-area reduction factors (CCRFCD Manual, 1990).**

Drainage Area (mi^2)	Reduction Factor	Point Precipitation Values (inches) for Given Return Intervals			
		100-Year	25-Year	10-Year	2-Year
0.01	1.00	1.6	1.3	1.1	0.70
1	0.97	1.55	1.26	1.07	0.68
10	0.86	1.38	1.12	0.95	0.60
20	0.79	1.26	1.02	0.87	0.55
30	0.74	1.18	0.96	0.81	0.52
50	0.68	1.09	0.89	0.75	0.48

Table 3. **Runoff curve numbers (Semiarid Rangelands[1]) [modified from CCRFCD Manual, 1990].**

Cover Description		Curve Numbers for Hydrologic Soil Group			
Cover Type	Hydrologic Condition[2]	A[3]	B	C	D
Herbaceous—mixture of grass, weeds, and low-growing brush, with brush the minor element	Poor	--	80	87	93
	Fair	--	71	81	89
	Good	--	62	74	85
Oak-aspen—mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush	Poor	--	66	74	79
	Fair	--	48	57	63
	Good	--	30	41	48
Pinyon-juniper—pinyon, juniper, or both; grass understory	Poor	--	75	85	89
	Fair	--	58	73	80
	Good	--	41	61	71
Sagebrush with grass understory	Poor	--	67	80	85
	Fair	--	51	63	70
	Good	--	35	47	55

Table 3 (continued)

Cover Description		Curve Numbers for Hydrologic Soil Group			
Cover Type	Hydrologic Condition[2]	A[3]	B	C	D
Desert shrub—major plants include saltbush, greasewood, creosote bush, blackbrush, bursage, palo verde, mesquite, and cactus	Poor	63	77	85	88
	Fair	55	72	81	86
	Good	49	68	79	84

[1] Average runoff condition, and Ia = 0.2S.
[2] Poor: < 30% ground cover (litter, grass, and brush overstory).
Fair: 30 to 70% ground cover.
Good: > 70% ground cover.
[3] Curve numbers for Group A have been developed only for desert shrub.

The following procedures were used to obtain this information.

1. The percent of bedrock and alluvium was determined for the subbasins using aerial photos and geologic and topographic maps. Bedrock areas of the subbasins were assigned as hydrologic soil group D. This soil group has high runoff potential and applies to areas with shallow soils or exposed bedrock. The alluvium is mostly sand and was assigned as hydrologic soil group B based on field investigations.

2. The vegetation cover type for the subbasins was determined to be desert shrub based on descriptions given in *Table 3*, field investigations, and study of aerial color photos.

3. The hydrologic condition was determined to be poor based on field investigations and study of color aerial photos. Vegetation cover was estimated at less than 30 percent (*Table 3*). Because of the steep slopes and minimal or nonexistent soil, bedrock areas have less vegetation than alluvial areas; therefore, the hydrologic condition of the bedrock areas was also classified as poor.

According to the CCRFCD Manual (1990), curve numbers for precipitation losses should be determined assuming an antecedent moisture condition of II (AMC-II). Antecedent moisture condition is dependent on antecedent rainfall. Antecedent rainfall is the amount of rainfall between 5 and 30 days preceding a flood-producing storm. AMC-I assumes the soil is dry; AMC-III assumes the soil is near or at saturation; AMC-II is halfway between AMC-I and AMC-III. The CCRFCD Manual (1990) designates AMC-II because data required to determine the antecedent moisture condition for an entire area are not quantifiable.

Assuming AMC-II, curve numbers for the UC-1 and UC-3 watersheds for alluvium and bedrock were 72 and 89, respectively. The alluvium curve number was an average of curve numbers for cover types of sagebrush and desert shrubs, both in Hydrologic Soil Group B (*Table 3*). The bedrock curve number was selected as a Soil Group D with a cover type of Pinyon-juniper. Curve numbers for the UC-4 watershed for alluvium and bedrock were 75 and 89, respectively. A curve number of 82 (mean) was selected for areas with a thin mantle of alluvium overlying bedrock. The alluvium curve number was selected as Hydrologic Soil Group B with a cover type of Pinyon-juniper. The bedrock curve number was selected as a Hydrologic Soil Group D with a cover type of Pinyon-juniper.

The curve number for each subbasin was subsequently determined by taking the weighted average between the percentage of area covered by alluvium, a thin mantle of alluvium, and bedrock in each subbasin. Curve numbers for the subbasins are listed in Table 4. Hydrologic models in this study developed to estimate the 2-, 10-year, 6-hour discharges assumed antecedent moisture conditions of AMC-II. The 25-year, 6-hour discharges assumed antecedent moisture conditions ranging from AMC-II to AMC-III. The 100-year, 6-hour hydrologic model developed for this study assumed AMC-III conditions. Results from all the models and the justification for varying the curve numbers per antecedent moisture conditions are addressed in *Section 3.4, Hydrology Discussion*.

3.1.4 Lag Time

In the SCS unit hydrograph method, only one input parameter, the lag time, is required. Lag time is calculated using one of two equations depending on subbasin area. The CCRFCD Manual (1990) uses the lag time equation (english units) from the U.S. Bureau of Reclamation (Cudworth, 1989) for subbasins with areas greater than 2.6 km^2 (1 mi^2):

$$T_{lag} = 20K_n\left(\frac{LL_c}{S^{0.5}}\right)^{0.33}$$

T_{lag} = the lag time (hours) between the center of mass of rainfall excess and the peak of the unit hydrograph.

K_n = the Manning roughness factor (dimensionless) for the basin channels.

L = the length of the longest watercourse (miles) within the subbasin.

L_c = the length along the longest watercourse (miles) measured upstream to a point opposite the centroid of the basin.

S = the average slope of the longest watercourse (feet per mile).

Table 4. **Subbasin curve numbers.**

Subbasin Name	Subbasin Area km^2 (mi^2)	100-year, 6-hour	25-year, 6-hour	10-year, 6-hour	2-year, 6-hour
UC-1A	2.1 (0.8)	93	91	88	88
UC-1B	3.2 (1.3)	94	92	89	89
UC-1C	2.1 (0.8)	77	75	72	72
UC-1D	1.8 (0.7)	77	75	72	72
UC-1E	0.5 (0.2)	77	75	72	72
UC-1F	2.5 (1.0)	77	75	72	72
UC-3A	2.1 (0.8)	94	92	89	89
UC-3B	1.8 (0.7)	77	75	72	72
UC-4A	0.5 (0.2)	86	85	82	82
UC-4B	0.5 (0.2)	87	85	82	82

As indicated in the CCRFCD Manual (1990), the K_n factor is subjective. Therefore, criteria listed in the CCRFCD Manual (1990) (Table 5) are recommended and were used for this study. Field investigations found that characteristics of the subbasins fell between the "n" value description for 0.030 and 0.050.

Table 5. **Lag equation roughness factors (modified from CCRFCD Manual, 1990).**

Watershed Characteristics	Roughness Factor, K_n
Urbanized Areas: Water courses in the drainage area consist of street, storm sewer, and improved channels.	0.015
Natural Areas: Water courses in the drainage area are well defined, unimproved channels or washes. Watershed has minimal vegetation.	0.030
Natural Areas: Water courses in the drainage area are not well defined, and consist of many small rills and braided wash areas. Runoff from area combines slowly into channels. Includes mountainous channels with large boulders and flow restrictions.	0.050

The CCRFCD Manual (1990) uses the lag time equation (english units) from the U.S. Bureau of Reclamation (Cudworth, 1989) for subbasins with areas less than 2.6 km^2 (1 mi^2):

$$T_{lag}=0.6(t_c)$$

where

$$t_c=t_i+t_t$$

$$t_i=\frac{1.8(1.1-K_r)(L_o)^{0.5}}{(S)^{0.33}}$$

$$t_t=\frac{(L)}{(V)}$$

T_{lag} = lag time (hours) between the center of mass of rainfall excess and the peak of the unit hydrograph.

t_c = time of concentration (minutes).

t_i = initial time (minutes) to the channel.

t_t = travel time in the channel (minutes).

K_r = flow resistance coefficient, where $K_r=(CN*0.0139)-0.32$

CN = curve number (*Table 4*).

L_o = length of overland flow (feet) (500 feet maximum).

S = average slope of the longest watercourse (feet per mile).

L = length of the longest watercourse (feet) within the subbasin.

V = velocity (feet per second) (CCRFCD, 1990).

Parameters used to determine the lag times for the subbasins are listed in Table 6. The L and S values for each subbasin were determined using a map wheel on the topographic maps. The L_c value was determined using a planimeter to find the centroid of each subbasin. A point on the longest watercourse of each subbasin that was closest to the respective centroid was selected. The L_o value was determined using a map wheel on the

Table 6. Lag time parameters.

Part A: Lag time parameters for subbasins with areas greater than 2.6 km² (1 mi²).

Subbasin	L (mi)	L_c (mi)	K_n	S (ft/mi)	T_{lag} (hrs)
UC-1B	2.20	1.44	0.045	1118.18	0.410
UC-3A	1.36	0.76	0.045	1338.2	0.277
UC-3B	3.54	2.65	0.045	350.3	0.717

Part B: Lag time parameters for subbasins with areas less than 2.6 km² (1 mi²).

Subbasin	L (ft)	L_o (ft)	K_r	S (ft/mi)	V (ft/s)	T_{lag} (hrs)
UC-1A	6600	500	0.903	1160	4.8	0.24
UC-1C	6178	500	0.709	889	4.3	0.26
UC-1D	8818	500	0.680	611	3.0	0.51
UC-1E	4013	500	0.680	526	3.3	0.23
UC-1F	6389	500	0.680	298	2.5	0.45
UC-4A	7392	500	0.820	307	2.4	0.53
UC-4B	6389	500	0.820	289	2.4	0.46

topographic maps. A maximum default value of 152.4 m (500 ft) was used if the measured L_o value was greater than 152.4 m (500 ft). The travel time V value was obtained from the CCRFCD Manual (1990), using the curve labeled "Nearly Bare and Untilled (Overland Flow) & Alluvial Fans, Western Mountain Regions" (Figure 8).

The CCRFCD Manual (1990) suggests that *Figure 8* be used for preliminary travel time calculations; subsequent calculations should be made using the hydraulic properties of the channel. However, field investigations showed that in most of the small subbasins defined in this study, it was difficult to discern when overland flow ceased and channelized flow began as the channels were not well defined. In addition, these subbasins are relatively short in length; therefore, a more detailed assessment of travel time that would be required with longer basin lengths is not necessary.

3.1.5 Channel Routing

The Muskingum routing method was used for routing reaches. This routing method requires three parameters: x, K, and the integer step. The weighting factor (x) expresses the amount of attenuation of the flood wave within the reach (Dunne and Leopold, 1978), and was determined using criteria cited by Cudworth (1989). The Muskingum coefficient (K) accounts for the translation of the peak flow for the entire

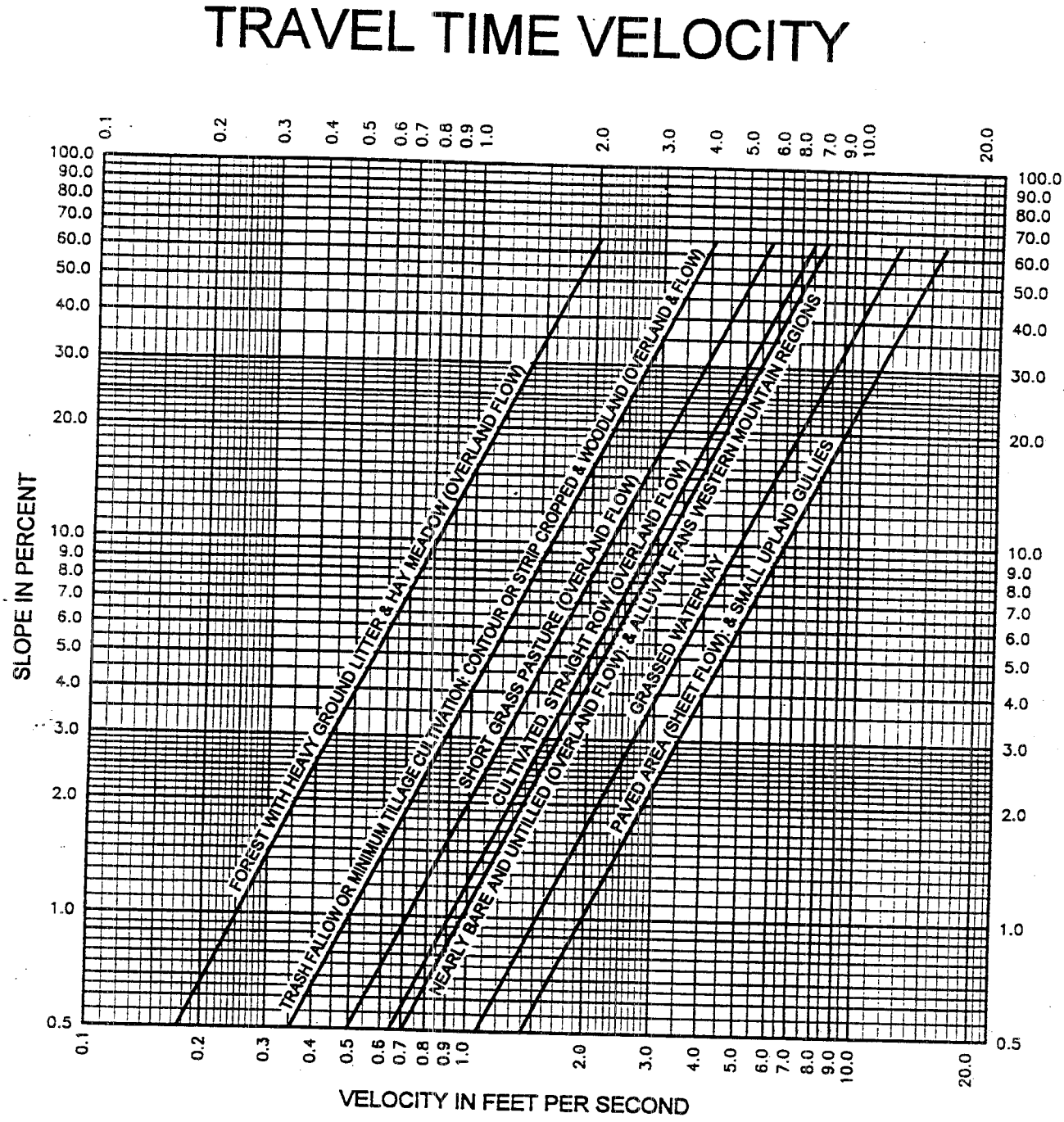


Figure 8. **Travel time velocities (CCRFCD, 1990).**

channel reach. This coefficient is directly related to the length and the average velocity of the reach. The average channel velocity is determined using the Manning Equation. The Manning roughness coefficient was chosen based on field observations. Channel geometry was determined through field measurements. (The integer step and routing reach were determined so that the total travel time through the reach would be equal to K.) Two reaches were routed in the models. Table 7 lists the routing parameters for these reaches.

Table 7. Routing parameters used in the Muskingum routing method.

Reach Name	Integer Step[1]	Storage Constant[2] (K)	Weighting Factor[3] (x)
UC-1A through UC-1D	10	0.82	0.20
UC-1B through UC-1E	4	0.34	0.20
CP1 through UC-1F	9	0.71	0.20

[1] **Integer Step**: The integer step is the number of subreaches used in the Muskingum routing, and is dependent on the time interval specified in the model.

[2] **Storage Constant (K)**: The Muskingum "K" coefficient is the travel time (hours) through the reach.

[3] **Weighting Factor (x)**: The weighting factor expresses the amount of attenuation of the flood wave within the reach.

Transmission losses for the routing reaches are ignored in the models. Variability of infiltration rates along a channel reach can be extensive; thus, these losses over an entire reach are difficult to quantify. Ignoring these losses adds conservatism to the model.

3.2 Hydrologic Models

Twelve final hydrologic models were developed using the HEC-1 computer program (COE, 1990) to determine discharges for this flood assessment. The overall watershed that could impact the UC-1, UC-3, and UC-4 sites was divided into 6, 2, and 2 subbasins, respectively, to provide discharges at concentration points. The HEC-1 output (Appendix A) contains schematics showing how the subbasins were connected in the HEC-1 models. The model layout was the same for all models of the same site, as were the hydrologic parameters, with the exception of subbasin-specific point precipitation values and curve numbers. Differences between models are explained in each model description found in Table 8 and in *Section 3.4, Hydrology Discussion*.

Table 8. Hydrologic model descriptions.

100-Year Hydrologic Models	
1006UC1A	Model used as baseline subbasin delineation/curve number determination for CNTA UC-1 site. Curve numbers were not adjusted. Point precipitation values were taken from NOAA Atlas 2, Volume VII (DOC, 1973).
1006UC1B	Curve numbers were increased by 10. Point precipitation values were taken from NOAA Atlas 2, Volume VII (DOC, 1973) .
1006UC1C	Curve numbers were increased by 7. Point precipitation values were taken from NOAA Atlas 2, Volume VII (DOC, 1973).
1006UC1D	Model used for determining flood hazard at CNTA UC-1 site. Curve numbers were increased by 5. Point precipitation values were taken from NOAA Atlas 2, Volume VII (DOC, 1973).
1006UC3A	Model used as baseline subbasin delineation/curve number determination for CNTA UC-3 site. Curve numbers were not adjusted. Point precipitation values were taken from NOAA Atlas 2, Volume VII (DOC, 1973).
1006UC3B	Model used for determining flood hazard at CNTA UC-3 site. Curve numbers were increased by 5. Point precipitation values were taken from NOAA Atlas 2, Volume VII (DOC, 1973).
1006UC4A	Model used as baseline subbasin delineation/curve number determination for CNTA UC-4 site. Curve numbers were not adjusted. Point precipitation values were taken from NOAA Atlas 2, Volume VII (DOC, 1973).
1006UC4B	Model used for determining flood hazard at CNTA UC-4 site. Curve numbers were increased by 5. Point precipitation values were taken from NOAA Atlas 2, Volume VII (DOC, 1973).
25-Year Hydrologic Models	
256UC1A	Model used as baseline subbasin delineation/curve number determination for CNTA UC-1 site. Curve numbers were not adjusted. Point precipitation values were taken from NOAA Atlas 2, Volume VII (DOC, 1973).
256UC1B	Curve numbers were increased by 5. Point precipitation values were taken from NOAA Atlas 2, Volume VII (DOC, 1973).
256UC1C	Model used for determining flood hazard at CNTA UC-1 site. Curve numbers were increased by 3. Point precipitation values were taken from NOAA Atlas 2, Volume VII (DOC, 1973).
256UC3A	Model used as baseline subbasin delineation/curve number determination for CNTA UC-3 site. Curve numbers were not adjusted. Point precipitation values were taken from NOAA Atlas 2, Volume VII (DOC, 1973).
256UC3B	Model used for determining flood hazard at CNTA UC-3 site. Curve numbers were increased by 3. Point precipitation values were taken from NOAA Atlas 2, Volume VII (DOC, 1973).
256UC4A	Model used as baseline subbasin delineation/curve number determination for CNTA UC-4 site. Curve numbers were not adjusted. Point precipitation values were taken from NOAA Atlas 2, Volume VII (DOC, 1973).
256UC4B	Model used for determining flood hazard at CNTA UC-4 site. Curve numbers were increased by 3. Point precipitation values were taken from NOAA Atlas 2, Volume VII (DOC, 1973).

Table 8 (continued)

10-Year Hydrologic Models	
106UC1A	Model used as baseline subbasin delineation/curve number determination for CNTA UC-1 site. Curve numbers were not adjusted. Point precipitation values were taken from NOAA Atlas 2, Volume VII (DOC, 1973).
106UC3A	Model used as baseline subbasin delineation/curve number determination for CNTA UC-3 site. Curve numbers were not adjusted. Point precipitation values were taken from NOAA Atlas 2, Volume VII (DOC, 1973).
106UC4A	Model used as baseline subbasin delineation/curve number determination for CNTA UC-4 site. Curve numbers were not adjusted. Point precipitation values were taken from NOAA Atlas 2, Volume VII (DOC, 1973).
2-Year Hydrologic Model	
26UC1A	Model used as baseline subbasin delineation/curve number determination for CNTA UC-1 site. Curve numbers were not adjusted. Point precipitation values were taken from NOAA Atlas 2, Volume VII (DOC, 1973).
26UC3A	Model used as baseline subbasin delineation/curve number determination for CNTA UC-3 site. Curve numbers were not adjusted. Point precipitation values were taken from NOAA Atlas 2, Volume VII (DOC, 1973).
26UC4A	Model used as baseline subbasin delineation/curve number determination for CNTA UC-4 site. Curve numbers were not adjusted. Point precipitation values were taken from NOAA Atlas 2, Volume VII (DOC, 1973).

3.3 Hydrology Results

As shown in *Table 8*, discharges from the 1006UC1D, 256UC1C, 106UC1A, and 26UC1A models (100-, 25-, 10-, and 2-year, respectively) were used to analyze the flood hazard at the UC-1 site. Discharges from the 1006UC3B, 256UC3B, 106UC3A, and 26UC3A models (100-, 25-, 10-, and 2-year, respectively) were used to analyze the flood hazard at the UC-3 site. Discharges from the 1006UC4B, 256UC4B, 106UC4A, and 26UC4A models (100-, 25-, 10-, and 2-year, respectively) were used to analyze the flood hazard at the UC-4 site.

These models were generated by the HEC-1 model (COE, 1990) (*Appendix A*) and verified by a comparison of skew coefficients generated by the FEMA FAN model (1990) (Appendix B). Justification for choosing these models is discussed in the *Section 3.4, Hydrology Discussion.*

3.4 Hydrology Discussion

The FEMA FAN model (1990) was used to verify the model-generated discharges for the 2-, 10-, 25-, and 100-year, 6-hour floods. Skew coefficients developed from model-generated discharges were compared with the regional skew coefficient (U.S. Water Resource Council Bulletin-17B [WRC], 1981). If the hydrologic models are producing reasonable discharges, then the skew coefficient from these models should be close to the regional skew coefficient.

A major assumption in using skew coefficients is that the relationship between discharge and return period must follow a Log-Pearson Type III (LP3) probability distribution, as specified by WRC (1981). The FEMA FAN model (1990) contains a subroutine that calculates skew coefficients using a least-square fit and a LP3 probability distribution. This program requires discharges from a minimum of three return periods to calculate the skew coefficient.

Water Resource Council Bulletin 17-B (1981) contains a map that shows the regional skew coefficients for the country (Figure 9). According to information on this map, the skew coefficient for the washes in the CNTA subbasins should be near zero. A zero skew coefficient means that if discharge versus probability was plotted on log-probability paper, then the flood frequency curve would plot as a log-normal distribution (a straight line). Preliminary results from a study by the USGS using stream gage data gathered after 1981 also support a zero skew for this region (Hjalmarson [personal communication], 1992).

A stepwise approach was taken to develop reasonable hydrologic models for the CNTA subbasins. Using the HEC-1 model-generated 2-, 10-, 25-, and 100-year, 6-hour discharges, skew coefficient comparisons were made at the alluvial fan apexes in the UC-1 watershed. If the skew coefficients were not close to zero, modifications were made to the HEC-1 models, and the comparison made again. This iterative process continued until reasonable hydrologic models were developed. Once curve numbers were established for UC-1 subbasins, the same adjustments were made to curve numbers for the UC-3 and UC-4 subbasins.

3.4.1 UC-1 Hydrology

Four model sets were evaluated for the UC-1 watershed using the skew coefficient comparison approach. The first model set, Model Set 1, included the 2-, 10-, 25-, and 100-year, 6-hour models, (26UC1A, 106UC1A, 256UC1A, and 1006UC1A, respectively). This model set was developed as a baseline model set using methods recommended in the CCRFCD Manual (1990). Model-generated discharges from both UC-1 alluvial fan apexes were entered into the FEMA FAN model (1990) to determine the skew coefficients (*Appendix B*). The skew coefficient corresponding to the apexes discharges (Table 9) were not close to zero; therefore, discharges in Model Set 1 needed to be adjusted to move the skew coefficients closer to zero. The 10- and 2-year models were assumed to generate reasonable results; therefore, adjustments were made to the 25- and 100-year, 6-hour models.

The 25- and 100-year, 6-hour hydrologic models can be modified by adjusting curve numbers, depth of precipitation, or lag times. Of these three parameters, curve numbers have the widest variability because they are dependent on antecedent moisture conditions. Curve numbers for the subbasins in this study (*Table 3*) can range in the 50s and 60s under dry soil conditions (AMC-I) to the high 80s and low 90s (AMC-III) for saturated conditions. The CCRFCD Manual (1990) assumes AMC-II because antecedent moisture conditions for a drainage basin are impossible to quantify and a standard approach is required in Clark County to assure consistent analysis and design of drainage facilities and structures. The assumption of AMC-II may be reasonable for the 2- and 10-year flood

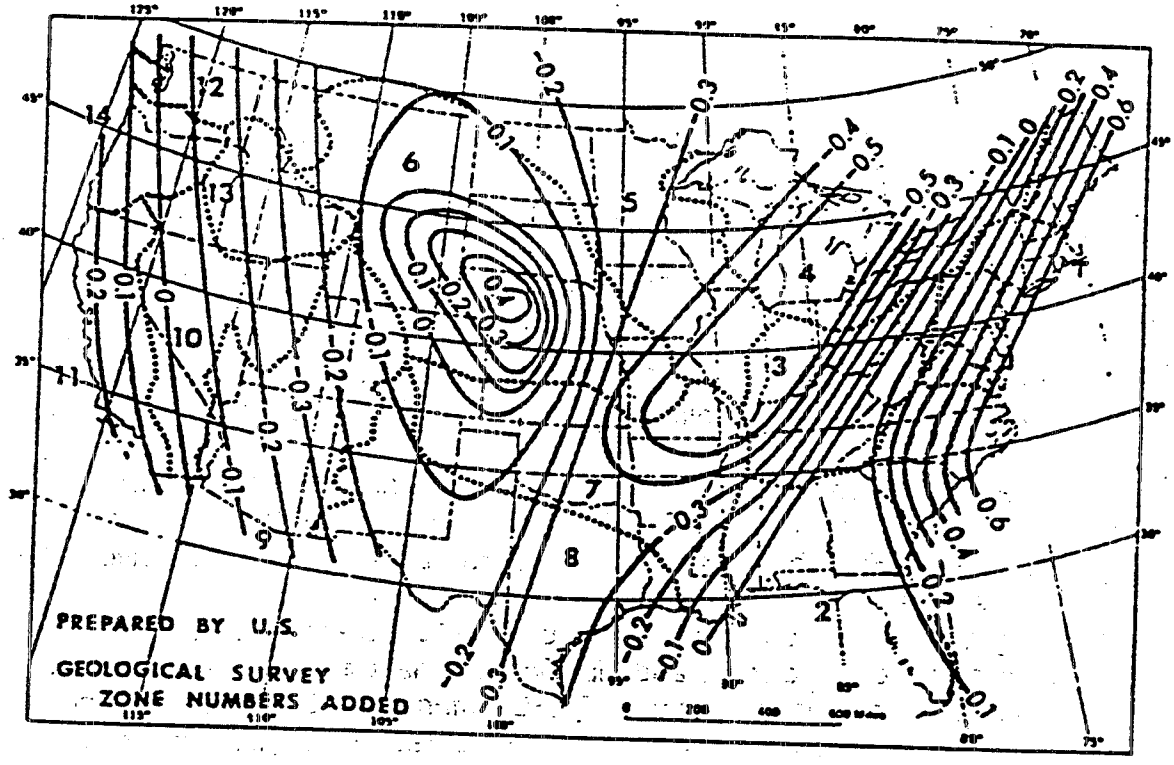


Figure 9. Generalized U.S. skew coefficients.

Table 9. **Skew coefficients from different model sets for UC-1.**

	Skew Coefficients			
	Model Set 1	***Model Set 2***	***Model Set 3***	***Model Set 4***
UC-1 North Alluvial Fan apex	-0.6	0.5	0.4	0.0
UC-1 South Alluvial Fan apex	-0.6	0.6	0.5	0.1
Return Period	***Model Set 1***	***Model Set 2***	***Model Set 3***	***Model Set 4***
2-year Model	26UC1A	26UC1A	26UC1A	26UC1A
10-year Model	106UC1A	106UC1A	106UC1A	106UC1A
25-year Model	256UC1A	256UC1B	256UC1C	256UC1C
100-year Model	1006UC1A	1006UC1B	1006UC1C	1006UC1D

events, but may not be for the 25-, and 100-year flood events. For greater than 10-year floods, the antecedent moisture condition as well as rainfall may contribute to flooding.

Precipitation depth and lag times are not as variable. Variation from the precipitation depths in NOAA Atlas 2, Volume VII (DOC, 1973) is not supportable because precipitation data in the study area (French, 1983; and L. E. Barker [personal communication], 1992) do not vary substantially from the values in NOAA Atlas 2, Volume VII (DOC, 1973). Variability in lag time is limited because three of the four parameters (L, L_c, and S) are measured from a topographic map, and significant variations in the K_n factor are not defendable using methods described in the CCRFCD Manual (1990) (*Table 5*). Therefore, curve numbers in the models were considered the most reasonable parameter to modify.

Modification of curve numbers was evaluated by first making adjustments similar to those used by Schmeltzer and others (1993). Three additional model sets were developed until the discharges of a model set produced a skew coefficient of zero or nearly zero (*Table 9*).

Review of these results indicated that Model Set 4 produced the most reasonable hydrologic models for the entire drainage basin impacting the UC-1 site; therefore, the model-generated discharges from Model Set 4 were used to define the FEMA 100-year, 6-hour flood hazards in this flood assessment (Table 10). The FEMA FAN model (1990) uses skew coefficients to adjust the HEC-1 model-generated discharges to "best fit discharges." Best fit discharges would produce a zero skew coefficient, with the flood frequency curve plotting as a lognormal distribution (a straight line on log-probability paper). From this flood frequency curve, other return period discharges can be interpolated or extrapolated. The FEMA FAN model (1990) automatically interpolates a 50-year discharge and extrapolates a 500-year discharge.

Table 10. **HEC-1 model-generated discharges at key locations.**

Location	Discharges (cfs) for Given Return Intervals			
	2-year	10-year	25-year	100-year
UC-1 North alluvial fan apex	47	164	313	507
UC-1 South alluvial fan apex	69	221	410	654
UC-1 Mudpit	65	237	491	854
UC-3 Drillhole	75	243	449	760
UC-4A Drillhole	4	23	56	108
UC-4B Channel	2	13	32	61

3.4.2 UC-3 Hydrology

Models were developed for UC-3 watershed using the same curve numbers determined in the skew coefficient analyses of the UC-1 site. Review of the model-generated results indicated that the models were reasonable hydrologic models for the entire drainage basin impacting the UC-3 site; therefore, these HEC-1 models were used to define the FEMA 100-year, 6-hour flood hazards in this flood assessment (*Table 9 and 10).*

3.4.3 UC-4 Hydrology

Models were developed for UC-4 watershed using the same curve numbers determined in the skew coefficient analyses of the UC-1 site. Review of the model-generated results indicated that the models were reasonable hydrologic models for the entire drainage basin impacting the UC-4 site; therefore, these HEC-1 models were used to define the FEMA 100-year, 6-hour flood hazards in this flood assessment (*Table 9 and 10*).

4.0 HYDRAULICS AND FLOOD HAZARD DETERMINATION

The CNTA site is located in an arid region where traditional approaches to define flood hazards (e.g., the hydraulic model HEC-RAS [COE, 1996], which assumes a stable and fixed channel geometry) may not be appropriate for all types of flooding. Potential flooding of the CNTA site can occur as alluvial fan flooding, shallow channelized flow, and

sheetflow. FEMA has developed methods to determine the 100-year flood hazards from these types of flooding.

This section provides:

- a brief description of the FEMA methods used to evaluate alluvial fan flooding, shallow channelized flow, and sheetflow;
- the results and discussion of the flood hazard evaluation; and
- flood hazard maps.

4.1 Hydraulics and Flood Hazard Determination: Methods

4.1.1 Alluvial Fan Flooding

Flooding on the UC-1 North and UC-1 South alluvial fans could impact the UC-1 mudpit. Hydraulic processes on alluvial fans are different than in riverine channels. Alluvial fan flooding, as described by FEMA (1991), ". . . is characterized by high-velocity flows; active processes of erosion, sediment transport, and deposition; and unpredictable flowpaths." Channel geometry and direction on alluvial fans can change in direct response to a flood discharge. Field investigations and study of topographic maps and aerial photos of the UC-1 watershed support this description because flowpaths are unpredictable, soil development is weak, and evidence of recent erosion and deposition is present.

FEMA (1991) states that if flowpaths below the active apex cannot be predicted (as is the case for the UC-1 alluvial fans), the FEMA FAN model must be applied to evaluate the 100-year flood hazard. This model, which is a modification of the method proposed by Dawdy (1979), relates probability of discharges at the apex to probability of channel depths and flow velocities that occur on the alluvial fan.

According to Dawdy (1979), flood flow from the apex of a typical alluvial fan does not spread evenly over the fan surface, but is instead confined to a surface of channel that carries flood waters from the apex to the toe of the fan (Figure 10). The active apex is selected at the point where the flowpath becomes unpredictable, and flow is no more likely to follow an existing channel than create a new path. In the upper region of an alluvial fan, flow is confined to a single channel where depth and width of the channel is a function of flow itself. In general, flow occurs at critical depth and velocity as a result of steep slopes associated with this upper region. As slopes decrease towards the mid and distal parts of the fans, channel bifurcation can occur resulting in a multiple-channel region. Dawdy (1979) did not incorporate a multiple-channel region into his method. FEMA (1991) modified the Dawdy method to address multiple-channel regions of alluvial fans.

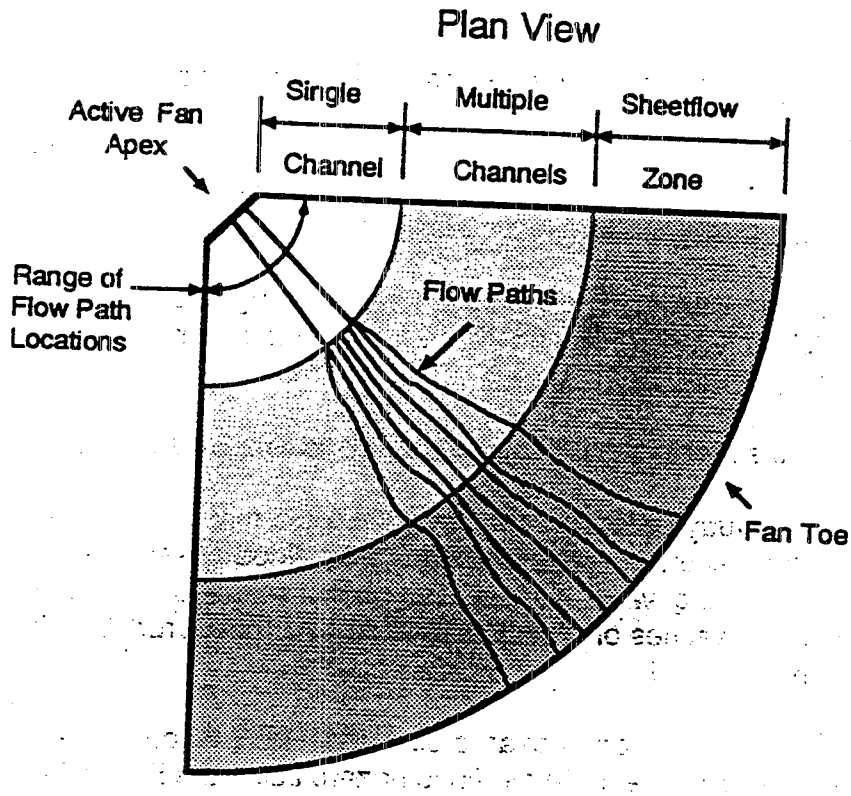


Figure 10. Alluvial fan plan view.

Key assumptions of the FEMA model follow (French, 1987).

- The location of the flood event channel on the alluvial fan surface is random. A uniform probability is assumed, bounded by the edges of the alluvial fan, that a channel passes through any given point on a contour of the alluvial fan.

- Flow occurs in flow-formed channels. Subsequent erosion results in these channels becoming well-defined across the surface.

    - Incised channels do not exist prior to the flow event.

    - Existing channel capacity is not adequate to convey the flow, and overbank flooding occurs.

- The width and depth of the channel are a function of discharge.

- Transmission losses are not considered.

- On-fan precipitation (rainfall directly onto the alluvial fan surface) is not considered.

- The alluvial fan is active (net deposition is occurring in both time and space) and avulsions (channel migrations from one location to another during a single event) are occurring.

- A LP3 flood discharge frequency distribution is available at the alluvial fan apex.

Field observations, a study of topographic and geologic maps, aerial photographs, and examination of historic records were made during the flood assessment of these alluvial fans. Sources of flooding were defined, an apex selected, active fan boundaries delineated, entrenched reaches of channels located and measured, and locations of flow obstructions were determined.

The method used for defining flood hazards on alluvial fans incorporates the FEMA FAN model (1990). Delineation of the 100-year flood hazard using the FEMA FAN model (1990) requires the following parameters and assumptions:

- Discharge information;
- Apex location;
- Fan boundaries and dimensions;
- Potential flow obstructions and/or diversions; and,
- Multiple channel region parameters:
    - Manning roughness coefficient, and slope.

The FEMA FAN model (1990) requires that at least three discharges of different return periods be used to define flood hazard zones on alluvial fans. The 2-, 10-, 25-, and 100-year, 6-hour flood discharges for the UC-1 North and UC-1 South alluvial fans were

taken from the HEC-1 models determined appropriate in *Section 3.4, Hydrology Discussion*. Model-generated discharges for the UC-1 North and UC-1 South alluvial fans were taken from the UC-1A and UC-1B subbasins, respectively.

Apex locations and fan boundaries were determined from aerial photographs; available topographic, geologic, and surficial maps; and field investigations. Apexes were located using the FEMA definition of an active apex. Locations of the apexes for the UC-1 North and UC-1 South alluvial fans are shown on *Figure 2*.

A Manning roughness coefficient of 0.045 was used for the multiple-channel regions of both fans. The Manning roughness coefficient for the multiple-channel regions of the fans was determined from field observations, and confirmed using descriptions and values found in tables developed by Chow (1959). Slope of the fans for the multiple-channel region parameters were determined from the Moores Station (1982) and Morey Peak (1967) 7.5-minute USGS topographic quadrangle maps.

Although the UC-3 site is located on coalescing alluvial fans, it is on such a distal portion of the alluvial fans, that sheetflow conditions exist; thus, no alluvial fan flood hazard needs to be established. The UC-4 site is not impacted by alluvial fans.

4.1.2 Shallow Channelized Flow

The topographic maps of the UC-1 and UC-3 sites indicate channels flow near each site; however, these channels are ill-defined in the field and less than 0.3 m (1 ft). Therefore, these areas are considered to be areas of sheetflow, and are discussed in *Section 4.1.3, Sheetflow*.

The UC-4B subbasin is a channel (and associated drainage area) that flows along the southern edge of the UC-4 site. Drilling mud was dumped into this channel and is being transported downstream by flows, as evidenced by the channel bed material type and discoloration. Standard hydraulic analysis of this channel is appropriate.

4.1.3 Sheetflow

According to FEMA (1991), sheetflow

> . . . is the broad, relatively unconfined downslope movement of water across sloping terrain that results from . . . a channel that crosses a drainage divide, . . . and overflow from a perched channel onto . . . plains of lower elevations . . . . [Sheetflow] is typical in areas of low topographic relief and poorly established drainage systems . . . . Shallow flooding is often characterized by poorly defined channels and highly unpredictable flow direction because of low relief or shifting channels and debris loads. Where such conditions exist, the entire area susceptible to this unpredictable flow should be delineated as an area of equal risk. Small-scale topographic relief that is not evident on existing

topographic mapping and that might lead to "islands" of one flood hazard zone within larger areas of another should be ignored.

This definition of sheetflow describes distal parts of the alluvial fans that drain from the UC-1 and UC-3 upper watersheds towards the bottom of Hot Creek Valley. With current elevation information (6.1-m [20-ft] contour interval) on topographic maps, a detailed assessment of the sheetflow flood hazard was not possible because of the inability to distinguish channels and nonchannel regions; therefore, per FEMA (1991) the 100-year flood hazard of this area was analyzed assuming that the entire area is prone to flooding and is delineated as an area of equal risk. Geomorphologic evidence gathered from analysis of color aerial photos and field observations supports this assumption because these areas have weak soil development and relatively few areas of relic deposits covered by desert pavement with desert varnish.

4.2 Results and Discussion of Flood Hazard Determination

Alluvial fan, shallow channelized flow, and sheetflow areas with 100-year flood depths greater than 0.3 m (1 ft) are designated as Zone AO by FEMA (1991). Zone AO is defined as the area of 100-year shallow flooding where average depths are between 0.3 and 1 m (1 and 3 ft). Zone X represents areas outside the 100-year flood hazard or areas of 100-year shallow flooding (sheetflow) where average depths are less than 0.3 m (1 ft). A Zone X delineation does not mean that floods will not occur within this zone; therefore, flood hazard protection must be addressed.

Using methods described in the previous section, the 100-year flood hazard areas were defined on topographic maps (Figures 11, 12, and 13). Zone AO and Zone X were used to denote the flood hazards in the vicinity of the CNTA ER sites.

4.2.1 Alluvial Fan Flooding

The UC-1 ER site is subject to flooding on the coalesced UC-1 North and UC-1 South alluvial fans. One-hundred-year flood hazard zones for these fans are shown on *Figure 11*. The UC-1 ER site is not within the hazard boundaries of either alluvial fan, or the coalesced alluvial fans, as delineated in this study, and therefore is not within a FEMA-designated 100-year, 6-hour alluvial fan flood hazard zone (Zone AO). However, flow from both fans still must be considered in mitigation design.

The two fans coalesce into a single, broad surface above the UC-1 ER site. Flow from both apexes must be considered independent of flow from the other; therefore, all flow must be combined at the downstream point of interest: the UC-1 ER site. Mitigation design for this flow must be incorporated into the closure of the site.

4.2.2 Shallow Concentrated Flow

The 100-year flood hazard elevation of the drainage through the UC-4B subbasin was estimated using the HEC-RAS computer program (COE, 1996) (*Figure 12*). HEC-RAS is used by FEMA to delineated flood hazards of channelized flow. The input requirements of the HEC-RAS model include channel cross-section information; distances between

Figure 11. Flood hazard map for the UC-1 site. (11" x 17" foldout)

Figure 12. Flood hazard map for the UC-3 site. (11" x 17" foldout)

Figure 13. Flood hazard map for the UC-4 site. (11" x 17" foldout)

cross-sections; and Manning roughness coefficients. Cross-section information and distances were derived from field observations and measurements, in conjunction with information from a 1:24,000 topographic map with 20-foot contour intervals. Manning roughness coefficients were estimated from field observations, and confirmed using the descriptions and values found in tables developed by Chow (1959). The HEC-RAS output is found in Appendix C.

The HEC-RAS model results indicate that flows occur at depths greater than 0.3 m (1 ft) in several reaches throughout the UC-4B subbasin. Thus, this channel is delineated as a 100-year flood hazard zone, as defined by FEMA (*Figure 12*). Velocities within these reaches range from approximately 1.2 to 2.7 meters per second (4 to 9 feet per second).

4.2.3 Sheetflow

Sheetflow areas with 100-year flood depths less than 0.3 m (1 ft) are designated as Zone X by FEMA (1991). Calculated 100-year flow depths near the UC-1, UC-3, and UC-4 ER sites were all less than 0.3 m (1 ft); therefore, these sites are not located within a FEMA-designated 100-year, 6-hour flood hazard zone from sheetflow (*Figures 11, 12, and 13*). Appendix D contains calculations used to estimate the depth of flow in sheetflow regions.

5.0 REFERENCES

Bull, W. B., 1964. History and causes of channel entrenching western Fresno County, California: American Journal of Science, v. 262., p. 249-258.

Chow, V. T., 1959. Open Channel Hydraulics: New York, New York, McGraw-Hill Book Company, paginated by section.

Christenson, R. C. and N. E. Spahr, 1980. Flood potential of Topopah Wash and tributaries, eastern part of Jackass Flats, Nevada Test Site, Southern Nevada: U.S. Geological Survey Open-File Report 80-963, 22 p.

Clark County Regional Flood Control District (CCRFCD), 1990. Hydrologic Criteria and Drainage Design Manual: Las Vegas, Nevada, WRC Engineering, Inc., paginated by section.

Cudworth, A. G., Jr., 1989. Flood Hydrology Manual (first edition): U.S. Bureau of Reclamation, 243 p.

Dawdy, D. R., 1979. Flood-frequency estimates on alluvial fans: American Society of Civil Engineers, Journal of the Hydraulics Division, v. 105, no. HY-11, p. 1407-1413.

Dunne, T., and L. B. Leopold, 1978. Water in Environmental Planning: San Francisco, California, W.H. Freeman and Company, 818 p.

Federal Emergency Management Agency (FEMA), 1991. Flood Insurance Study: Guidelines and Specifications for Study Contractors: Washington, D.C., U.S. Government Printing Office, 100 p.

_____, 1990. FAN: An Alluvial Fan Flooding Computer Program–User's Manual: Washington, D.C., U.S. Government Printing Office, paginated by section.

French, R. H., 1987. Hydraulic Processes on Alluvial Fans: Amsterdam, Elsevier, 243 pages.

French, R. H., 1983. Precipitation in Southern Nevada: American Society of Civil Engineers, Journal of Hydraulic Engineering, v. 109, no. 7, p. 1023-1036.

Hjalmarson, H.W., and S.P. Kemna, 1991. Flood Hazards of Distributary-Flow Area in Southwestern Arizona. U.S. Geological Survey Water-Resources Investigations Report 91-4171. 58 pp.

Hjalmarson, H.W., and B.E. Thomas, 1992. New Look at Regional Flood-Freqency Relations for Arid Lands. American Society of Civil Engineers, Journal of Hydraulic Engineering, Vol. 118, No. 6; June 1992. pp. 868-886.

Schmeltzer, J. S., J. J. Miller, and D. L. Gustafson, 1993. Flood Assessment at the Area 5 Radioactive Waste Management Site and the Proposed Hazardous Waste Storage Unit DOE/Nevada Test Site, Nye County, Nevada: Las Vegas, Nevada, Raytheon Services Nevada, paginated by section.

U.S. Army Corps of Engineers (COE), September 1990. Flood Hydrograph Package (HEC-1 Computer Program, Version 4.0): Davis, California, paginated by section.

_____, 1996. River Analysis System (HEC-RAS Computer Program): Davis, California, paginated by section.

U.S. Department of Commerce (DOC), National Oceanic and Atmospheric Administration (NOAA), 1973. NOAA Atlas 2 Precipitation-Frequency Atlas of the Western United States, Volume VII: Silver Spring, Maryland, paginated by section.

U.S. Water Resources Council (WRC), 1981. Guidelines for determining flood flow frequency: Washington, D.C., Bulletin 17-B of the Hydrology Committee, paginated by section.

Zehr, R. M. and V. A. Myers, 1984. Depth-area ratios in the Semiarid Southwest United States: Silver Spring, Maryland; U.S. Department of Commerce; 45 p.

APPENDIX A

HEC-1 MODEL OUTPUT

UC-1

HEC-1 MODEL OUTPUT

FILENAME: 1006UC1A

(100-YEAR MODEL)

```
1*****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*             MAY   1991                *
*           VERSION 4.0.1E              *
*                                       *
*  RUN DATE  03/03/99  TIME  13:02:16   *
*                                       *
*****************************************
```

```
*************************************
*                                   *
*   U.S. ARMY CORPS OF ENGINEERS    *
*   HYDROLOGIC ENGINEERING CENTER   *
*         609 SECOND STREET         *
*      DAVIS, CALIFORNIA 95616      *
*          (916) 551-1748           *
*                                   *
*************************************
```

```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X              X
XXXXXXX  XXXX     X        XXXXX X
X     X  X        X              X
X     X  X        X     X        X
X     X  XXXXXXX   XXXXX         XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1

HEC-1 INPUT

PAGE 1

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID   FLOOD ASSESSMENT FOR CNTA UC-1 SITE
  2           ID   5 MINUTE INTERVAL IN ITCARD
  3           ID   100-YEAR 6-HOUR STORM 1.6 INCHES
  4           ID   POINT RAINFALL VALUES FROM NOAA ATLAS 2 VOL VII
  5           ID   DEPTH-AREA REDUCTION FACTORS FROM TABLE 502 IN
  6           ID   CLARK COUNTY HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL (CCRFCD, 1990)
  7           ID   CURVE NUMBERS NOT ADJUSTED
              *DIAGRAM
  8           IT       5       0       0     300
  9           IO       5
 10           IN       5
 11           JD     1.6     .01
              * RAINFALL DISTRIBUTION FROM CLARK COUNTY MANUAL LESS THAN 10 SQ. MILES
 12           PC       0       2     5.7     7.0     8.7    10.8    12.4    13.0    13.0    13.0
 13           PC    13.0    13.0    13.0    13.3    14.0    14.2    14.8    15.8    17.2    18.1
 14           PC    19.0    19.7    19.9    20.0    20.1    20.4    21.4    22.9    24.1    24.9
 15           PC    25.1    25.6    27.0    27.8    28.1    28.3    29.5    32.2    35.2    40.9
 16           PC    49.9    59.0    71.0    74.4    78.1    81.2    81.9    83.5    85.1    85.6
 17           PC    86.0    86.8    87.6    88.8    91.0    92.6    93.7    95.0    97.0    97.6
 18           PC    98.2    98.5    98.7    98.9    99.0    99.3    99.3    99.4    99.5    99.8
 19           PC    99.8    99.9   100.0
 20           JD    1.55       1
 21           JD    1.38    9.99
              * CHANGED RAINFALL DISTRIBUTION ABOVE 10 SQ. MILES PER CLARK COUNTY MANUAL
 22           JD    1.38   10.01
 23           PC       0     2.0     5.9     8.0    11.0    14.4    15.0    16.0    16.8    17.1
 24           PC    18.0    18.2    18.7    19.0    19.7    20.2    21.0    22.0    23.0    24.1
 25           PC    25.0    25.9    26.5    28.0    29.0    30.0    30.5    30.9    31.0    31.7
 26           PC    32.1    32.7    33.3    34.6    36.1    38.1    40.8    43.0    47.7    51.4
 27           PC    56.1    63.0    71.0    72.0    73.1    75.2    77.9    79.0    79.5    80.4
 28           PC    81.0    82.0    82.6    84.0    85.9    88.9    91.0    93.8    96.6    97.0
 29           PC    97.4    97.9    98.1    98.3    98.5    98.9    99.0    99.2    99.3    99.6
 30           PC    99.7    99.9   100.0
 31           JD    1.26      20
 32           JD    1.18      30
 33           JD    1.09      50
 34           JD     .96     100
              *
              *  CNTA UC-1 SUBBASINS
              *
```

```
35          KK    UC1A
36          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN A
            * UC1A DISCHARGE IS UC1 NORTH ALLUVIAL FAN APEX DISCHARGE
37          BA    0.79
38          LS              88
39          UD    0.24
            *

40          KK  RTCP1A
41          KM   ROUTE FLOW FROM UC1A THROUGH UC1D TO CP1A (CP1A IS A DUMMY VARIABLE FOR CP1)
42          RM      10    0.82     0.2
            *
```



```
LINE        ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

43          KK    UC1D
44          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN D
45          BA    0.66
46          LS              72
47          UD    0.51
            *
            *

48          KK    UC1B
49          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN B
            * UC1B DISCHARGE IS UC1 SOUTH ALLUVIAL FAN APEX DISCHARGE
50          BA    1.25
51          LS              89
52          UD    0.41
            *

53          KK  RTCP1B
54          KM    ROUTE FLOW FROM UC1B TO CP1B (CP1B IS A DUMMY VARIABLE FOR CP1)
55          RM       4    0.34     0.2
            *
            *

56          KK    UC1E
57          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN E
58          BA    0.22
59          LS              72
60          UD    0.23
            *

61          KK    UC1C
62          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN C
63          BA    0.75
64          LS              72
65          UD    0.26
            *

66          KK     CP1
67          KM     COMBINE FLOWS FROM UC1A, UC1B, UC1C, UC1D, AND UC1E
68          HC       5
            *

69          KK   RTCP2
70          KM   ROUTE FLOW FROM CP1C THROUGH UC1F TO MUDPIT
71          RM      10    0.82     0.2
            *

72          KK    UC1F
73          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN F
74          BA    0.96
75          LS              72
76          UD    0.45
            *
```



```
LINE        ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

77          KK    CP2
78          KM    COMBINE FLOW FROM CP1 AND UC1F AT CP2 (MUDPIT)
79          HC       2
```

```
          80          ZZ
1
                SCHEMATIC DIAGRAM OF STREAM NETWORK
   JT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

  NO.       (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

   35         UC1A
                V
                V
   40       RTCP1A
                .
                .
   43           .        UC1D
                .           .
                .           .
   48           .           .        UC1B
                .           .          V
                .           .          V
   53           .           .      RTCP1B
                .           .          .
                .           .          .
   56           .           .          .        UC1E
                .           .          .          .
                .           .          .          .
   61           .           .          .          .        UC1C
                .           .          .          .          .
                .           .          .          .          .
   66         CP1.............................................
                V
                V
   69       RTCP2
                .
                .
   72           .        UC1F
                .           .
                .           .
   77        CP2 ............
```

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION

```
1*****************************************
*                                        *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)    *
*              MAY   1991                *
*            VERSION 4.0.1E              *
*                                        *
*  RUN DATE  03/03/99  TIME  13:02:16    *
*                                        *
******************************************
```

```
******************************************
*                                        *
*    U.S. ARMY CORPS OF ENGINEERS        *
*    HYDROLOGIC ENGINEERING CENTER       *
*          609 SECOND STREET             *
*       DAVIS, CALIFORNIA 95616          *
*           (916) 551-1748               *
*                                        *
******************************************
```

FLOOD ASSESSMENT FOR CNTA UC-1 SITE
5 MINUTE INTERVAL IN ITCARD
100-YEAR 6-HOUR STORM 1.6 INCHES
POINT RAINFALL VALUES FROM NOAA ATLAS 2 VOL VII
DEPTH-AREA REDUCTION FACTORS FROM TABLE 502 IN
CLARK COUNTY HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL (CCRFCD, 1990)
CURVE NUMBERS NOT ADJUSTED

```
 9 IO        OUTPUT CONTROL VARIABLES
                  IPRNT          5  PRINT CONTROL
                  IPLOT          0  PLOT CONTROL
                  QSCAL         0.  HYDROGRAPH PLOT SCALE

   IT        HYDROGRAPH TIME DATA
                   NMIN          5  MINUTES IN COMPUTATION INTERVAL
                  IDATE      1   0  STARTING DATE
                  ITIME       0000  STARTING TIME
                     NQ        300  NUMBER OF HYDROGRAPH ORDINATES
                 NDDATE      2   0  ENDING DATE
                 NDTIME       0055  ENDING TIME
                  ICENT         19  CENTURY MARK

             COMPUTATION INTERVAL    0.08 HOURS
```

TOTAL TIME BASE 24.92 HOURS

ENGLISH UNITS

DRAINAGE AREA	SQUARE MILES
PRECIPITATION DEPTH	INCHES
LENGTH, ELEVATION	FEET
FLOW	CUBIC FEET PER SECOND
STORAGE VOLUME	ACRE-FEET
SURFACE AREA	ACRES
TEMPERATURE	DEGREES FAHRENHEIT

11 JD INDEX STORM NO. 1

STRM 1.60 PRECIPITATION DEPTH
TRDA 0.01 TRANSPOSITION DRAINAGE AREA

12 PI PRECIPITATION PATTERN

2.00	3.70	1.30	1.70	2.10	1.60	0.60	0.00	0.00	0.00
0.00	0.00	0.30	0.70	0.20	0.60	1.00	1.40	0.90	0.90
0.70	0.20	0.10	0.10	0.30	1.00	1.50	1.20	0.80	0.20
0.50	1.40	0.80	0.30	0.20	1.20	2.70	3.00	5.70	9.00
9.10	12.00	3.40	3.70	3.10	0.70	1.60	1.60	0.50	0.40
0.80	0.80	1.20	2.20	1.60	1.10	1.30	2.00	0.60	0.60
0.30	0.20	0.20	0.10	0.30	0.00	0.10	0.10	0.30	0.00
0.10	0.10								

20 JD INDEX STORM NO. 2

STRM 1.55 PRECIPITATION DEPTH
TRDA 1.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.70	1.30	1.70	2.10	1.60	0.60	0.00	0.00	0.00
0.00	0.00	0.30	0.70	0.20	0.60	1.00	1.40	0.90	0.90
0.70	0.20	0.10	0.10	0.30	1.00	1.50	1.20	0.80	0.20
0.50	1.40	0.80	0.30	0.20	1.20	2.70	3.00	5.70	9.00
9.10	12.00	3.40	3.70	3.10	0.70	1.60	1.60	0.50	0.40
0.80	0.80	1.20	2.20	1.60	1.10	1.30	2.00	0.60	0.60
0.30	0.20	0.20	0.10	0.30	0.00	0.10	0.10	0.30	0.00
0.10	0.10								

21 JD INDEX STORM NO. 3

STRM 1.38 PRECIPITATION DEPTH
TRDA 9.99 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.70	1.30	1.70	2.10	1.60	0.60	0.00	0.00	0.00
0.00	0.00	0.30	0.70	0.20	0.60	1.00	1.40	0.90	0.90
0.70	0.20	0.10	0.10	0.30	1.00	1.50	1.20	0.80	0.20
0.50	1.40	0.80	0.30	0.20	1.20	2.70	3.00	5.70	9.00
9.10	12.00	3.40	3.70	3.10	0.70	1.60	1.60	0.50	0.40
0.80	0.80	1.20	2.20	1.60	1.10	1.30	2.00	0.60	0.60
0.30	0.20	0.20	0.10	0.30	0.00	0.10	0.10	0.30	0.00
0.10	0.10								

22 JD INDEX STORM NO. 4

STRM 1.38 PRECIPITATION DEPTH
TRDA 10.01 TRANSPOSITION DRAINAGE AREA

23 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

31 JD INDEX STORM NO. 5

STRM 1.26 PRECIPITATION DEPTH
TRDA 20.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40

0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

;2 JD INDEX STORM NO. 6

STRM 1.18 PRECIPITATION DEPTH
TRDA 30.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

33 JD INDEX STORM NO. 7

STRM 1.09 PRECIPITATION DEPTH
TRDA 50.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

34 JD INDEX STORM NO. 8

STRM 0.96 PRECIPITATION DEPTH
TRDA 100.00 TRANSPOSITION DRAINAGE AREA

1 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

1

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	UC1A	352.	3.67	53.	13.	13.	0.79		
ROUTED TO	RTCP1A	265.	4.50	53.	13.	13.	0.79		
HYDROGRAPH AT	UC1D	32.	4.17	9.	2.	2.	0.66		
HYDROGRAPH AT	UC1B	454.	3.83	88.	22.	21.	1.25		
ROUTED TO	RTCP1B	417.	4.25	88.	22.	21.	1.25		
HYDROGRAPH AT	UC1E	16.	3.83	3.	1.	1.	0.22		
HYDROGRAPH AT	UC1C	51.	3.83	10.	3.	3.	0.75		
5 COMBINED AT	CP1	598.	4.33	145.	36.	35.	3.67		
ROUTED TO									

+		RTCP2	544.	5.17	145.	36.	35.	3.67
	HYDROGRAPH AT							
+		UC1F	50.	4.08	13.	3.	3.	0.96
	2 COMBINED AT							
+		CP2	562.	5.17	151.	38.	36.	4.63

*** NORMAL END OF HEC-1 ***

UC-1

HEC-1 MODEL OUTPUT

FILENAME: 1006UC1B

(100-YEAR MODEL)

```
1****************************************
*                                      *
    FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
              MAY   1991                *
           VERSION 4.0.1E               *
*                                      *
*  RUN DATE  03/03/99  TIME  13:03:59  *
*                                      *
****************************************
```

```
*************************************
*                                   *
*    U.S. ARMY CORPS OF ENGINEERS   *
*    HYDROLOGIC ENGINEERING CENTER  *
*          609 SECOND STREET        *
*       DAVIS, CALIFORNIA 95616     *
*          (916) 551-1748           *
*                                   *
*************************************
```

```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X              X
XXXXXXX  XXXX     X        XXXXX X
X     X  X        X              X
X     X  X        X     X        X
X     X  XXXXXXX   XXXXX        XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1

HEC-1 INPUT

PAGE 1

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID   FLOOD ASSESSMENT FOR CNTA UC-1 SITE
  2           ID   5 MINUTE INTERVAL IN ITCARD
  3           ID   100-YEAR 6-HOUR STORM 1.6 INCHES
  4           ID   POINT RAINFALL VALUES FROM NOAA ATLAS 2 VOL VII
  5           ID   DEPTH-AREA REDUCTION FACTORS FROM TABLE 502 IN
  6           ID   CLARK COUNTY HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL (CCRFCD, 1990)
  7           ID   CURVE NUMBERS ADJUSTED +10
              *DIAGRAM
  8           IT       5       0       0     300
  9           IO       5
 10           IN       5
 11           JD     1.6     .01
              * RAINFALL DISTRIBUTION FROM CLARK COUNTY MANUAL LESS THAN 10 SQ. MILES
 12           PC       0       2     5.7     7.0     8.7    10.8    12.4    13.0    13.0    13.0
 13           PC    13.0    13.0    13.0    13.3    14.0    14.2    14.8    15.8    17.2    18.1
 14           PC    19.0    19.7    19.9    20.0    20.1    20.4    21.4    22.9    24.1    24.9
 15           PC    25.1    25.6    27.0    27.8    28.1    28.3    29.5    32.2    35.2    40.9
 16           PC    49.9    59.0    71.0    74.4    78.1    81.2    81.9    83.5    85.1    85.6
 17           PC    86.0    86.8    87.6    88.8    91.0    92.6    93.7    95.0    97.0    97.6
 18           PC    98.2    98.5    98.7    98.9    99.0    99.3    99.3    99.4    99.5    99.8
 19           PC    99.8    99.9   100.0
 20           JD    1.55       1
 21           JD    1.38    9.99
              * CHANGED RAINFALL DISTRIBUTION ABOVE 10 SQ. MILES PER CLARK COUNTY MANUAL
 22           JD    1.38   10.01
 23           PC       0     2.0     5.9     8.0    11.0    14.4    15.0    16.0    16.8    17.1
 24           PC    18.0    18.2    18.7    19.0    19.7    20.2    21.0    22.0    23.0    24.1
 25           PC    25.0    25.9    26.5    28.0    29.0    30.0    30.5    30.9    31.0    31.7
 26           PC    32.1    32.7    33.3    34.6    36.1    38.1    40.8    43.0    47.7    51.4
 27           PC    56.1    63.0    71.0    72.0    73.1    75.2    77.9    79.0    79.5    80.4
 28           PC    81.0    82.0    82.6    84.0    85.9    88.9    91.0    93.8    96.6    97.0
 29           PC    97.4    97.9    98.1    98.3    98.5    98.9    99.0    99.2    99.3    99.6
 30           PC    99.7    99.9   100.0
 31           JD    1.26      20
 32           JD    1.18      30
 33           JD    1.09      50
 34           JD     .96     100
              *
              *  CNTA UC-1 SUBBASINS
              *
```

```
 35          KK    UC1A
 36          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN A
             * UC1A DISCHARGE IS UC1 NORTH ALLUVIAL FAN APEX DISCHARGE
 37          BA    0.79
 38          LS              98
 39          UD    0.24
             *

 40          KK  RTCP1A
 41          KM   ROUTE FLOW FROM UC1A THROUGH UC1D TO CP1A (CP1A IS A DUMMY VARIABLE FOR CP1)
 42          RM      10    0.82     0.2
             *
```



```
LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 43          KK    UC1D
 44          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN D
 45          BA    0.66
 46          LS              82
 47          UD    0.51
             *
             *

 48          KK    UC1B
 49          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN B
             * UC1B DISCHARGE IS UC1 SOUTH ALLUVIAL FAN APEX DISCHARGE
 50          BA    1.25
 51          LS              99
 52          UD    0.41
             *

 53          KK  RTCP1B
 54          KM    ROUTE FLOW FROM UC1B TO CP1B (CP1B IS A DUMMY VARIABLE FOR CP1)
 55          RM       4    0.34     0.2
             *
             *

 56          KK    UC1E
 57          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN E
 58          BA    0.22
 59          LS              82
 60          UD    0.23
             *

 61          KK    UC1C
 62          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN C
 63          BA    0.75
 64          LS              82
 65          UD    0.26
             *

 66          KK     CP1
 67          KM     COMBINE FLOWS FROM UC1A, UC1B, UC1C, UC1D, AND UC1E
 68          HC       5
             *

 69          KK   RTCP2
 70          KM   ROUTE FLOW FROM CP1C THROUGH UC1F TO MUDPIT
 71          RM      10    0.82     0.2
             *

 72          KK    UC1F
 73          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN F
 74          BA    0.96
 75          LS              82
 76          UD    0.45
             *
```



```
LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 77          KK    CP2
 78          KM    COMBINE FLOW FROM CP1 AND UC1F AT CP2 (MUDPIT)
 79          HC       2
```

```
          80          ZZ

              SCHEMATIC DIAGRAM OF STREAM NETWORK
  JT
 LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

 NO.       (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

 35          UC1A
               V
               V
 40        RTCP1A
               .
               .
 43            .        UC1D
               .           .
               .           .
 48            .           .        UC1B
               .           .           V
               .           .           V
 53            .           .      RTCP1B
               .           .           .
               .           .           .
 56            .           .           .        UC1E
               .           .           .           .
               .           .           .           .
 61            .           .           .           .        UC1C
               .           .           .           .           .
               .           .           .           .           .
 66          CP1.............................................
               V
               V
 69        RTCP2
               .
               .
 72            .        UC1F
               .           .
               .           .
 77         CP2 ............
```

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION

```
1****************************************
*                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *
*              MAY   1991              *
*           VERSION 4.0.1E             *
*                                      *
*  RUN DATE  03/03/99  TIME  13:03:59  *
*                                      *
****************************************
```

```
****************************************
*                                      *
*    U.S. ARMY CORPS OF ENGINEERS      *
*    HYDROLOGIC ENGINEERING CENTER     *
*          609 SECOND STREET           *
*       DAVIS, CALIFORNIA 95616        *
*           (916) 551-1748             *
*                                      *
****************************************
```

```
                    FLOOD ASSESSMENT FOR CNTA UC-1 SITE
                    5 MINUTE INTERVAL IN ITCARD
                    100-YEAR 6-HOUR STORM 1.6 INCHES
                    POINT RAINFALL VALUES FROM NOAA ATLAS 2 VOL VII
                    DEPTH-AREA REDUCTION FACTORS FROM TABLE 502 IN
                    CLARK COUNTY HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL (CCRFCD, 1990)
                    CURVE NUMBERS ADJUSTED +10

 9 IO        OUTPUT CONTROL VARIABLES
                  IPRNT          5  PRINT CONTROL
                  IPLOT          0  PLOT CONTROL
                  QSCAL         0.  HYDROGRAPH PLOT SCALE

 IT          HYDROGRAPH TIME DATA
                   NMIN          5  MINUTES IN COMPUTATION INTERVAL
                  IDATE     1    0  STARTING DATE
                  ITIME       0000  STARTING TIME
                     NQ        300  NUMBER OF HYDROGRAPH ORDINATES
                 NDDATE     2    0  ENDING DATE
                 NDTIME       0055  ENDING TIME
                  ICENT         19  CENTURY MARK

              COMPUTATION INTERVAL    0.08 HOURS
```

TOTAL TIME BASE 24.92 HOURS

ENGLISH UNITS

DRAINAGE AREA	SQUARE MILES
PRECIPITATION DEPTH	INCHES
LENGTH, ELEVATION	FEET
FLOW	CUBIC FEET PER SECOND
STORAGE VOLUME	ACRE-FEET
SURFACE AREA	ACRES
TEMPERATURE	DEGREES FAHRENHEIT

11 JD INDEX STORM NO. 1

STRM	1.60	PRECIPITATION DEPTH
TRDA	0.01	TRANSPOSITION DRAINAGE AREA

12 PI PRECIPITATION PATTERN

2.00	3.70	1.30	1.70	2.10	1.60	0.60	0.00	0.00	0.00
0.00	0.00	0.30	0.70	0.20	0.60	1.00	1.40	0.90	0.90
0.70	0.20	0.10	0.10	0.30	1.00	1.50	1.20	0.80	0.20
0.50	1.40	0.80	0.30	0.20	1.20	2.70	3.00	5.70	9.00
9.10	12.00	3.40	3.70	3.10	0.70	1.60	1.60	0.50	0.40
0.80	0.80	1.20	2.20	1.60	1.10	1.30	2.00	0.60	0.60
0.30	0.20	0.20	0.10	0.30	0.00	0.10	0.10	0.30	0.00
0.10	0.10								

20 JD INDEX STORM NO. 2

STRM	1.55	PRECIPITATION DEPTH
TRDA	1.00	TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.70	1.30	1.70	2.10	1.60	0.60	0.00	0.00	0.00
0.00	0.00	0.30	0.70	0.20	0.60	1.00	1.40	0.90	0.90
0.70	0.20	0.10	0.10	0.30	1.00	1.50	1.20	0.80	0.20
0.50	1.40	0.80	0.30	0.20	1.20	2.70	3.00	5.70	9.00
9.10	12.00	3.40	3.70	3.10	0.70	1.60	1.60	0.50	0.40
0.80	0.80	1.20	2.20	1.60	1.10	1.30	2.00	0.60	0.60
0.30	0.20	0.20	0.10	0.30	0.00	0.10	0.10	0.30	0.00
0.10	0.10								

21 JD INDEX STORM NO. 3

STRM	1.38	PRECIPITATION DEPTH
TRDA	9.99	TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.70	1.30	1.70	2.10	1.60	0.60	0.00	0.00	0.00
0.00	0.00	0.30	0.70	0.20	0.60	1.00	1.40	0.90	0.90
0.70	0.20	0.10	0.10	0.30	1.00	1.50	1.20	0.80	0.20
0.50	1.40	0.80	0.30	0.20	1.20	2.70	3.00	5.70	9.00
9.10	12.00	3.40	3.70	3.10	0.70	1.60	1.60	0.50	0.40
0.80	0.80	1.20	2.20	1.60	1.10	1.30	2.00	0.60	0.60
0.30	0.20	0.20	0.10	0.30	0.00	0.10	0.10	0.30	0.00
0.10	0.10								

22 JD INDEX STORM NO. 4

STRM	1.38	PRECIPITATION DEPTH
TRDA	10.01	TRANSPOSITION DRAINAGE AREA

23 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

31 JD INDEX STORM NO. 5

STRM	1.26	PRECIPITATION DEPTH
TRDA	20.00	TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40

0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

: JD INDEX STORM NO. 6

STRM 1.18 PRECIPITATION DEPTH
TRDA 30.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

33 JD INDEX STORM NO. 7

STRM 1.09 PRECIPITATION DEPTH
TRDA 50.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

34 JD INDEX STORM NO. 8

STRM 0.96 PRECIPITATION DEPTH
TRDA 100.00 TRANSPOSITION DRAINAGE AREA

` PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

1

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+ HYDROGRAPH AT	UC1A	668.	3.67	113.	28.	27.	0.79		
+ ROUTED TO	RTCP1A	509.	4.50	113.	28.	27.	0.79		
+ HYDROGRAPH AT	UC1D	118.	4.00	27.	7.	6.	0.66		
+ HYDROGRAPH AT	UC1B	846.	3.83	190.	48.	46.	1.25		
+ ROUTED TO	RTCP1B	778.	4.17	189.	48.	46.	1.25		
HYDROGRAPH AT	UC1E	59.	3.67	9.	2.	2.	0.22		
+ HYDROGRAPH AT	UC1C	190.	3.75	30.	8.	7.	0.75		
+ 5 COMBINED AT	CP1	1236.	4.25	339.	85.	82.	3.67		
ROUTED TO									

+	RTCP2	1133.	5.08	338.	85.	82.	3.67
HYDROGRAPH AT							
+	UC1F	182.	3.92	39.	10.	9.	0.96
2 COMBINED AT							
+	CP2	1188.	5.08	365.	92.	89.	4.63

*** NORMAL END OF HEC-1 ***

UC-1

HEC-1 MODEL OUTPUT

FILENAME: 1006UC1C

(100-YEAR MODEL)

```
1*****************************************
*                                       *
    FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
              MAY   1991                *
           VERSION 4.0.1E               *
*                                       *
*  RUN DATE  03/03/99  TIME  13:05:33   *
*                                       *
*****************************************
```

```
*****************************************
*                                       *
*    U.S. ARMY CORPS OF ENGINEERS       *
*    HYDROLOGIC ENGINEERING CENTER      *
*          609 SECOND STREET            *
*       DAVIS, CALIFORNIA 95616         *
*          (916) 551-1748               *
*                                       *
*****************************************
```

```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X               X
XXXXXXX  XXXX     X        XXXXX  X
X     X  X        X               X
X     X  X        X     X         X
X     X  XXXXXXX   XXXXX          XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1

HEC-1 INPUT

PAGE 1

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID   FLOOD ASSESSMENT FOR CNTA UC-1 SITE
  2           ID   5 MINUTE INTERVAL IN ITCARD
  3           ID   100-YEAR 6-HOUR STORM 1.6 INCHES
  4           ID   POINT RAINFALL VALUES FROM NOAA ATLAS 2 VOL VII
  5           ID   DEPTH-AREA REDUCTION FACTORS FROM TABLE 502 IN
  6           ID   CLARK COUNTY HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL (CCRFCD, 1990)
  7           ID   CURVE NUMBERS ADJUSTED +7
              *DIAGRAM
  8           IT       5       0       0     300
  9           IO       5
 10           IN       5
 11           JD     1.6     .01
              * RAINFALL DISTRIBUTION FROM CLARK COUNTY MANUAL LESS THAN 10 SQ. MILES
 12           PC       0       2     5.7     7.0     8.7    10.8    12.4    13.0    13.0    13.0
 13           PC    13.0    13.0    13.0    13.3    14.0    14.2    14.8    15.8    17.2    18.1
 14           PC    19.0    19.7    19.9    20.0    20.1    20.4    21.4    22.9    24.1    24.9
 15           PC    25.1    25.6    27.0    27.8    28.1    28.3    29.5    32.2    35.2    40.9
 16           PC    49.9    59.0    71.0    74.4    78.1    81.2    81.9    83.5    85.1    85.6
 17           PC    86.0    86.8    87.6    88.8    91.0    92.6    93.7    95.0    97.0    97.6
 18           PC    98.2    98.5    98.7    98.9    99.0    99.3    99.3    99.4    99.5    99.8
 19           PC    99.8    99.9   100.0
 20           JD    1.55       1
 21           JD    1.38    9.99
              * CHANGED RAINFALL DISTRIBUTION ABOVE 10 SQ. MILES PER CLARK COUNTY MANUAL
 22           JD    1.38   10.01
 23           PC       0     2.0     5.9     8.0    11.0    14.4    15.0    16.0    16.8    17.1
 24           PC    18.0    18.2    18.7    19.0    19.7    20.2    21.0    22.0    23.0    24.1
 25           PC    25.0    25.9    26.5    28.0    29.0    30.0    30.5    30.9    31.0    31.7
 26           PC    32.1    32.7    33.3    34.6    36.1    38.1    40.8    43.0    47.7    51.4
 27           PC    56.1    63.0    71.0    72.0    73.1    75.2    77.9    79.0    79.5    80.4
 28           PC    81.0    82.0    82.6    84.0    85.9    88.9    91.0    93.8    96.6    97.0
 29           PC    97.4    97.9    98.1    98.3    98.5    98.9    99.0    99.2    99.3    99.6
 30           PC    99.7    99.9   100.0
 31           JD    1.26      20
 32           JD    1.18      30
 33           JD    1.09      50
 34           JD     .96     100
              *
              *  CNTA UC-1 SUBBASINS
              *
```

```
35          KK    UC1A
36          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN A
            * UC1A DISCHARGE IS UC1 NORTH ALLUVIAL FAN APEX DISCHARGE
37          BA    0.79
38          LS              95
39          UD    0.24
            *

40          KK  RTCP1A
41          KM   ROUTE FLOW FROM UC1A THROUGH UC1D TO CP1A (CP1A IS A DUMMY VARIABLE FOR CP1)
42          RM      10    0.82     0.2
            *
```



```
LINE        ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

43          KK    UC1D
44          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN D
45          BA    0.66
46          LS              79
47          UD    0.51
            *
            *

48          KK    UC1B
49          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN B
            * UC1B DISCHARGE IS UC1 SOUTH ALLUVIAL FAN APEX DISCHARGE
50          BA    1.25
51          LS              96
52          UD    0.41
            *

53          KK  RTCP1B
54          KM    ROUTE FLOW FROM UC1B TO CP1B (CP1B IS A DUMMY VARIABLE FOR CP1)
55          RM       4    0.34     0.2
            *
            *

56          KK    UC1E
57          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN E
58          BA    0.22
59          LS              79
60          UD    0.23
            *

61          KK    UC1C
62          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN C
63          BA    0.75
64          LS              79
65          UD    0.26
            *

66          KK     CP1
67          KM     COMBINE FLOWS FROM UC1A, UC1B, UC1C, UC1D, AND UC1E
68          HC       5
            *

69          KK   RTCP2
70          KM   ROUTE FLOW FROM CP1C THROUGH UC1F TO MUDPIT
71          RM      10    0.82     0.2
            *

72          KK    UC1F
73          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN F
74          BA    0.96
75          LS              79
76          UD    0.45
            *
```



```
LINE        ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

77          KK    CP2
78          KM    COMBINE FLOW FROM CP1 AND UC1F AT CP2 (MUDPIT)
79          HC       2
```

```
          80          ZZ
1
                SCHEMATIC DIAGRAM OF STREAM NETWORK
 PUT
 LINE     (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

 NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

 35         UC1A
               V
               V
 40       RTCP1A
               .
               .
 43            .        UC1D
               .           .
               .           .
 48            .           .        UC1B
               .           .           V
               .           .           V
 53            .           .      RTCP1B
               .           .           .
               .           .           .
 56            .           .           .        UC1E
               .           .           .           .
               .           .           .           .
 61            .           .           .           .        UC1C
               .           .           .           .           .
               .           .           .           .           .
 66         CP1.............................................
               V
               V
 69       RTCP2
               .
               .
 72            .        UC1F
               .           .
               .           .
 77       CP2 ............
```

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION

```
1*****************************************
*                                        *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)    *
*              MAY   1991                *
*            VERSION 4.0.1E              *
*                                        *
*  RUN DATE  03/03/99  TIME  13:05:33    *
*                                        *
******************************************
```

```
*****************************************
*                                       *
*    U.S. ARMY CORPS OF ENGINEERS       *
*    HYDROLOGIC ENGINEERING CENTER      *
*          609 SECOND STREET            *
*       DAVIS, CALIFORNIA 95616         *
*           (916) 551-1748              *
*                                       *
*****************************************
```

FLOOD ASSESSMENT FOR CNTA UC-1 SITE
5 MINUTE INTERVAL IN ITCARD
100-YEAR 6-HOUR STORM 1.6 INCHES
POINT RAINFALL VALUES FROM NOAA ATLAS 2 VOL VII
DEPTH-AREA REDUCTION FACTORS FROM TABLE 502 IN
CLARK COUNTY HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL (CCRFCD, 1990)
CURVE NUMBERS ADJUSTED +7

```
9 IO        OUTPUT CONTROL VARIABLES
                 IPRNT          5  PRINT CONTROL
                 IPLOT          0  PLOT CONTROL
                 QSCAL         0.  HYDROGRAPH PLOT SCALE

  IT        HYDROGRAPH TIME DATA
                  NMIN          5  MINUTES IN COMPUTATION INTERVAL
                 IDATE      1   0  STARTING DATE
                 ITIME       0000  STARTING TIME
                    NQ        300  NUMBER OF HYDROGRAPH ORDINATES
                NDDATE      2   0  ENDING DATE
                NDTIME       0055  ENDING TIME
                 ICENT         19  CENTURY MARK

            COMPUTATION INTERVAL    0.08 HOURS
```

TOTAL TIME BASE 24.92 HOURS

ENGLISH UNITS

DRAINAGE AREA	SQUARE MILES
PRECIPITATION DEPTH	INCHES
LENGTH, ELEVATION	FEET
FLOW	CUBIC FEET PER SECOND
STORAGE VOLUME	ACRE-FEET
SURFACE AREA	ACRES
TEMPERATURE	DEGREES FAHRENHEIT

11 JD INDEX STORM NO. 1

STRM	1.60	PRECIPITATION DEPTH
TRDA	0.01	TRANSPOSITION DRAINAGE AREA

12 PI PRECIPITATION PATTERN

2.00	3.70	1.30	1.70	2.10	1.60	0.60	0.00	0.00	0.00
0.00	0.00	0.30	0.70	0.20	0.60	1.00	1.40	0.90	0.90
0.70	0.20	0.10	0.10	0.30	1.00	1.50	1.20	0.80	0.20
0.50	1.40	0.80	0.30	0.20	1.20	2.70	3.00	5.70	9.00
9.10	12.00	3.40	3.70	3.10	0.70	1.60	1.60	0.50	0.40
0.80	0.80	1.20	2.20	1.60	1.10	1.30	2.00	0.60	0.60
0.30	0.20	0.20	0.10	0.30	0.00	0.10	0.10	0.30	0.00
0.10	0.10								

20 JD INDEX STORM NO. 2

STRM	1.55	PRECIPITATION DEPTH
TRDA	1.00	TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.70	1.30	1.70	2.10	1.60	0.60	0.00	0.00	0.00
0.00	0.00	0.30	0.70	0.20	0.60	1.00	1.40	0.90	0.90
0.70	0.20	0.10	0.10	0.30	1.00	1.50	1.20	0.80	0.20
0.50	1.40	0.80	0.30	0.20	1.20	2.70	3.00	5.70	9.00
9.10	12.00	3.40	3.70	3.10	0.70	1.60	1.60	0.50	0.40
0.80	0.80	1.20	2.20	1.60	1.10	1.30	2.00	0.60	0.60
0.30	0.20	0.20	0.10	0.30	0.00	0.10	0.10	0.30	0.00
0.10	0.10								

21 JD INDEX STORM NO. 3

STRM	1.38	PRECIPITATION DEPTH
TRDA	9.99	TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.70	1.30	1.70	2.10	1.60	0.60	0.00	0.00	0.00
0.00	0.00	0.30	0.70	0.20	0.60	1.00	1.40	0.90	0.90
0.70	0.20	0.10	0.10	0.30	1.00	1.50	1.20	0.80	0.20
0.50	1.40	0.80	0.30	0.20	1.20	2.70	3.00	5.70	9.00
9.10	12.00	3.40	3.70	3.10	0.70	1.60	1.60	0.50	0.40
0.80	0.80	1.20	2.20	1.60	1.10	1.30	2.00	0.60	0.60
0.30	0.20	0.20	0.10	0.30	0.00	0.10	0.10	0.30	0.00
0.10	0.10								

22 JD INDEX STORM NO. 4

STRM	1.38	PRECIPITATION DEPTH
TRDA	10.01	TRANSPOSITION DRAINAGE AREA

23 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

31 JD INDEX STORM NO. 5

STRM	1.26	PRECIPITATION DEPTH
TRDA	20.00	TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40

0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

32 JD INDEX STORM NO. 6

STRM 1.18 PRECIPITATION DEPTH

TRDA 30.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

33 JD INDEX STORM NO. 7

STRM 1.09 PRECIPITATION DEPTH

TRDA 50.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

34 JD INDEX STORM NO. 8

STRM 0.96 PRECIPITATION DEPTH

TRDA 100.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

1

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	UC1A	575.	3.67	90.	23.	22.	0.79		
ROUTED TO	RTCP1A	436.	4.50	90.	23.	22.	0.79		
HYDROGRAPH AT	UC1D	85.	4.08	20.	5.	5.	0.66		
HYDROGRAPH AT	UC1B	740.	3.83	151.	38.	36.	1.25		
ROUTED TO	RTCP1B	679.	4.17	151.	38.	36.	1.25		
HYDROGRAPH AT	UC1E	43.	3.75	7.	2.	2.	0.22		
HYDROGRAPH AT	UC1C	138.	3.75	23.	6.	6.	0.75		
5 COMBINED AT	CP1	1036.	4.25	265.	66.	64.	3.67		
ROUTED TO									

+	RTCP2	948.	5.08	264.	66.	64.	3.67
HYDROGRAPH AT							
+	UC1F	133.	4.00	29.	7.	7.	0.96
2 COMBINED AT							
+	CP2	990.	5.08	283.	71.	69.	4.63

*** NORMAL END OF HEC-1 ***

UC-1

HEC-1 MODEL OUTPUT

FILENAME: 1006UC1D

(100-YEAR MODEL)

```
1*****************************************
*                                       *
    FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
              MAY   1991                *
           VERSION 4.0.1E               *
*                                       *
*  RUN DATE  03/03/99  TIME  13:10:11   *
*                                       *
*****************************************
```

```
*************************************
*                                   *
*    U.S. ARMY CORPS OF ENGINEERS   *
*    HYDROLOGIC ENGINEERING CENTER  *
*          609 SECOND STREET        *
*       DAVIS, CALIFORNIA 95616     *
*           (916) 551-1748          *
*                                   *
*************************************
```

```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X              X
XXXXXXX  XXXX     X        XXXXX X
X     X  X        X              X
X     X  X        X     X        X
X     X  XXXXXXX   XXXXX         XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1

HEC-1 INPUT


```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID   FLOOD ASSESSMENT FOR CNTA UC-1 SITE
  2           ID   5 MINUTE INTERVAL IN ITCARD
  3           ID   100-YEAR 6-HOUR STORM 1.6 INCHES
  4           ID   POINT RAINFALL VALUES FROM NOAA ATLAS 2 VOL VII
  5           ID   DEPTH-AREA REDUCTION FACTORS FROM TABLE 502 IN
  6           ID   CLARK COUNTY HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL (CCRFCD, 1990)
  7           ID   CURVE NUMBERS ADJUSTED +5
              *DIAGRAM
  8           IT       5       0       0     300
  9           IO       5
 10           IN       5
 11           JD     1.6     .01
              * RAINFALL DISTRIBUTION FROM CLARK COUNTY MANUAL LESS THAN 10 SQ. MILES
 12           PC       0       2     5.7     7.0     8.7    10.8    12.4    13.0    13.0    13.0
 13           PC    13.0    13.0    13.0    13.3    14.0    14.2    14.8    15.8    17.2    18.1
 14           PC    19.0    19.7    19.9    20.0    20.1    20.4    21.4    22.9    24.1    24.9
 15           PC    25.1    25.6    27.0    27.8    28.1    28.3    29.5    32.2    35.2    40.9
 16           PC    49.9    59.0    71.0    74.4    78.1    81.2    81.9    83.5    85.1    85.6
 17           PC    86.0    86.8    87.6    88.8    91.0    92.6    93.7    95.0    97.0    97.6
 18           PC    98.2    98.5    98.7    98.9    99.0    99.3    99.3    99.4    99.5    99.8
 19           PC    99.8    99.9   100.0
 20           JD    1.55       1
 21           JD    1.38    9.99
              * CHANGED RAINFALL DISTRIBUTION ABOVE 10 SQ. MILES PER CLARK COUNTY MANUAL
 22           JD    1.38   10.01
 23           PC       0     2.0     5.9     8.0    11.0    14.4    15.0    16.0    16.8    17.1
 24           PC    18.0    18.2    18.7    19.0    19.7    20.2    21.0    22.0    23.0    24.1
 25           PC    25.0    25.9    26.5    28.0    29.0    30.0    30.5    30.9    31.0    31.7
 26           PC    32.1    32.7    33.3    34.6    36.1    38.1    40.8    43.0    47.7    51.4
 27           PC    56.1    63.0    71.0    72.0    73.1    75.2    77.9    79.0    79.5    80.4
 28           PC    81.0    82.0    82.6    84.0    85.9    88.9    91.0    93.8    96.6    97.0
 29           PC    97.4    97.9    98.1    98.3    98.5    98.9    99.0    99.2    99.3    99.6
 30           PC    99.7    99.9   100.0
 31           JD    1.26      20
 32           JD    1.18      30
 33           JD    1.09      50
 34           JD     .96     100
              *
              *  CNTA UC-1 SUBBASINS
              *
```

```
 35          KK    UC1A
 36          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN A
             * UC1A DISCHARGE IS UC1 NORTH ALLUVIAL FAN APEX DISCHARGE
 37          BA    0.79
 38          LS              93
 39          UD    0.24
             *

 40          KK  RTCP1A
 41          KM   ROUTE FLOW FROM UC1A THROUGH UC1D TO CP1A (CP1A IS A DUMMY VARIABLE FOR CP1)
 42          RM      10    0.82     0.2
             *
```



```
LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 43          KK    UC1D
 44          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN D
 45          BA    0.66
 46          LS              77
 47          UD    0.51
             *
             *

 48          KK    UC1B
 49          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN B
             * UC1B DISCHARGE IS UC1 SOUTH ALLUVIAL FAN APEX DISCHARGE
 50          BA    1.25
 51          LS              94
 52          UD    0.41
             *

 53          KK  RTCP1B
 54          KM    ROUTE FLOW FROM UC1B TO CP1B (CP1B IS A DUMMY VARIABLE FOR CP1)
 55          RM       4    0.34     0.2
             *
             *

 56          KK    UC1E
 57          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN E
 58          BA    0.22
 59          LS              77
 60          UD    0.23
             *

 61          KK    UC1C
 62          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN C
 63          BA    0.75
 64          LS              77
 65          UD    0.26
             *

 66          KK     CP1
 67          KM     COMBINE FLOWS FROM UC1A, UC1B, UC1C, UC1D, AND UC1E
 68          HC       5
             *

 69          KK   RTCP2
 70          KM   ROUTE FLOW FROM CP1C THROUGH UC1F TO MUDPIT
 71          RM      10    0.82     0.2
             *

 72          KK    UC1F
 73          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN F
 74          BA    0.96
 75          LS              77
 76          UD    0.45
             *
```



```
LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 77          KK    CP2
 78          KM    COMBINE FLOW FROM CP1 AND UC1F AT CP2 (MUDPIT)
 79          HC       2
```

```
          80          ZZ
1
                SCHEMATIC DIAGRAM OF STREAM NETWORK
 'PUT
 -INE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

 NO.       (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

  35        UC1A
               V
               V
  40      RTCP1A
               .
               .
  43           .        UC1D
               .           .
               .           .
  48           .           .        UC1B
               .           .           V
               .           .           V
  53           .           .      RTCP1B
               .           .           .
               .           .           .
  56           .           .           .        UC1E
               .           .           .           .
               .           .           .           .
  61           .           .           .           .        UC1C
               .           .           .           .           .
               .           .           .           .           .
  66        CP1.............................................
               V
               V
  69      RTCP2
               .
               .
  72           .        UC1F
               .           .
               .           .
  77        CP2 ............
```

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION

```
1*****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*              MAY   1991               *
*           VERSION 4.0.1E              *
*                                       *
*  RUN DATE  03/03/99  TIME  13:10:11   *
*                                       *
*****************************************
```

```
*****************************************
*
*    U.S. ARMY CORPS OF ENGINEERS
*    HYDROLOGIC ENGINEERING CENTER
*          609 SECOND STREET
*       DAVIS, CALIFORNIA 95616
*           (916) 551-1748
*
*****************************************
```

```
                    FLOOD ASSESSMENT FOR CNTA UC-1 SITE
                    5 MINUTE INTERVAL IN ITCARD
                    100-YEAR 6-HOUR STORM 1.6 INCHES
                    POINT RAINFALL VALUES FROM NOAA ATLAS 2 VOL-VII
                    DEPTH-AREA REDUCTION FACTORS FROM TABLE 502 IN
                    CLARK COUNTY HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL (CCRFCD, 1990)
                    CURVE NUMBERS ADJUSTED +5

 9 IO          OUTPUT CONTROL VARIABLES
                    IPRNT          5  PRINT CONTROL
                    IPLOT          0  PLOT CONTROL
                    QSCAL         0.  HYDROGRAPH PLOT SCALE

   IT          HYDROGRAPH TIME DATA
                     NMIN          5  MINUTES IN COMPUTATION INTERVAL
                    IDATE     1    0  STARTING DATE
                    ITIME       0000  STARTING TIME
                       NQ        300  NUMBER OF HYDROGRAPH ORDINATES
                   NDDATE     2    0  ENDING DATE
                   NDTIME       0055  ENDING TIME
                   ICENT          19  CENTURY MARK

                COMPUTATION INTERVAL    0.08 HOURS
```

TOTAL TIME BASE 24.92 HOURS

ENGLISH UNITS

DRAINAGE AREA	SQUARE MILES
PRECIPITATION DEPTH	INCHES
LENGTH, ELEVATION	FEET
FLOW	CUBIC FEET PER SECOND
STORAGE VOLUME	ACRE-FEET
SURFACE AREA	ACRES
TEMPERATURE	DEGREES FAHRENHEIT

11 JD INDEX STORM NO. 1

STRM 1.60 PRECIPITATION DEPTH
TRDA 0.01 TRANSPOSITION DRAINAGE AREA

12 PI PRECIPITATION PATTERN

2.00	3.70	1.30	1.70	2.10	1.60	0.60	0.00	0.00	0.00
0.00	0.00	0.30	0.70	0.20	0.60	1.00	1.40	0.90	0.90
0.70	0.20	0.10	0.10	0.30	1.00	1.50	1.20	0.80	0.20
0.50	1.40	0.80	0.30	0.20	1.20	2.70	3.00	5.70	9.00
9.10	12.00	3.40	3.70	3.10	0.70	1.60	1.60	0.50	0.40
0.80	0.80	1.20	2.20	1.60	1.10	1.30	2.00	0.60	0.60
0.30	0.20	0.20	0.10	0.30	0.00	0.10	0.10	0.30	0.00
0.10	0.10								

20 JD INDEX STORM NO. 2

STRM 1.55 PRECIPITATION DEPTH
TRDA 1.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.70	1.30	1.70	2.10	1.60	0.60	0.00	0.00	0.00
0.00	0.00	0.30	0.70	0.20	0.60	1.00	1.40	0.90	0.90
0.70	0.20	0.10	0.10	0.30	1.00	1.50	1.20	0.80	0.20
0.50	1.40	0.80	0.30	0.20	1.20	2.70	3.00	5.70	9.00
9.10	12.00	3.40	3.70	3.10	0.70	1.60	1.60	0.50	0.40
0.80	0.80	1.20	2.20	1.60	1.10	1.30	2.00	0.60	0.60
0.30	0.20	0.20	0.10	0.30	0.00	0.10	0.10	0.30	0.00
0.10	0.10								

21 JD INDEX STORM NO. 3

STRM 1.38 PRECIPITATION DEPTH
TRDA 9.99 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.70	1.30	1.70	2.10	1.60	0.60	0.00	0.00	0.00
0.00	0.00	0.30	0.70	0.20	0.60	1.00	1.40	0.90	0.90
0.70	0.20	0.10	0.10	0.30	1.00	1.50	1.20	0.80	0.20
0.50	1.40	0.80	0.30	0.20	1.20	2.70	3.00	5.70	9.00
9.10	12.00	3.40	3.70	3.10	0.70	1.60	1.60	0.50	0.40
0.80	0.80	1.20	2.20	1.60	1.10	1.30	2.00	0.60	0.60
0.30	0.20	0.20	0.10	0.30	0.00	0.10	0.10	0.30	0.00
0.10	0.10								

22 JD INDEX STORM NO. 4

STRM 1.38 PRECIPITATION DEPTH
TRDA 10.01 TRANSPOSITION DRAINAGE AREA

23 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

31 JD INDEX STORM NO. 5

STRM 1.26 PRECIPITATION DEPTH
TRDA 20.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40

0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

32 JD INDEX STORM NO. 6

STRM 1.18 PRECIPITATION DEPTH
TRDA 30.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

33 JD INDEX STORM NO. 7

STRM 1.09 PRECIPITATION DEPTH
TRDA 50.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

34 JD INDEX STORM NO. 8

STRM 0.96 PRECIPITATION DEPTH
TRDA 100.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

1

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	UC1A	507.	3.67	77.	19.	19.	0.79		
ROUTED TO	RTCP1A	384.	4.50	77.	19.	19.	0.79		
HYDROGRAPH AT	UC1D	67.	4.08	16.	4.	4.	0.66		
HYDROGRAPH AT	UC1B	654.	3.83	130.	33.	31.	1.25		
ROUTED TO	RTCP1B	599.	4.17	130.	33.	31.	1.25		
HYDROGRAPH AT	UC1E	34.	3.75	6.	1.	1.	0.22		
HYDROGRAPH AT	UC1C	108.	3.75	19.	5.	5.	0.75		
5 COMBINED AT	CP1	899.	4.33	224.	56.	54.	3.67		
ROUTED TO									

+		RTCP2	821.	5.17	224.	56.	54.	3.67
	HYDROGRAPH AT							
+		UC1F	104.	4.00	24.	6.	6.	0.96
	2 COMBINED AT							
+		CP2	854.	5.17	238.	60.	58.	4.63

*** NORMAL END OF HEC-1 ***

UC-1

HEC-1 MODEL OUTPUT

FILENAME: 256UC1A

(25-YEAR MODEL)

```
1*****************************************
*                                       *
    FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
              MAY   1991                *
           VERSION 4.0.1E               *
*                                       *
*  RUN DATE  02/08/99  TIME  14:24:08   *
*                                       *
*****************************************
```

```
*************************************
*                                   *
*    U.S. ARMY CORPS OF ENGINEERS   *
*    HYDROLOGIC ENGINEERING CENTER  *
*          609 SECOND STREET        *
*       DAVIS, CALIFORNIA 95616     *
*          (916) 551-1748           *
*                                   *
*************************************
```

```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X              X
XXXXXXX  XXXX     X        XXXXX X
X     X  X        X              X
X     X  X        X     X        X
X     X  XXXXXXX   XXXXX         XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1

HEC-1 INPUT

PAGE 1

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID   FLOOD ASSESSMENT FOR CNTA UC-1 SITE
  2           ID   5 MINUTE INTERVAL IN ITCARD
  3           ID   25-YEAR 6-HOUR STORM 1.3 INCHES
  4           ID   POINT RAINFALL VALUES FROM NOAA ATLAS 2 VOL VII
  5           ID   DEPTH-AREA REDUCTION FACTORS FROM TABLE 502 IN
  6           ID   CLARK COUNTY HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL (CCRFCD, 1990)
  7           ID   CURVE NUMBERS NOT ADJUSTED
              *DIAGRAM
  8           IT       5       0       0     300
  9           IO       5       0
 10           IN       5
 11           JD     1.3     .01
              * RAINFALL DISTRIBUTION FROM CLARK COUNTY MANUAL LESS THAN 10 SQ. MILES
 12           PC       0       2     5.7     7.0     8.7    10.8    12.4    13.0    13.0    13.0
 13           PC    13.0    13.0    13.0    13.3    14.0    14.2    14.8    15.8    17.2    18.1
 14           PC    19.0    19.7    19.9    20.0    20.1    20.4    21.4    22.9    24.1    24.9
 15           PC    25.1    25.6    27.0    27.8    28.1    28.3    29.5    32.2    35.2    40.9
 16           PC    49.9    59.0    71.0    74.4    78.1    81.2    81.9    83.5    85.1    85.6
 17           PC    86.0    86.8    87.6    88.8    91.0    92.6    93.7    95.0    97.0    97.6
 18           PC    98.2    98.5    98.7    98.9    99.0    99.3    99.3    99.4    99.5    99.8
 19           PC    99.8    99.9   100.0
 20           JD    1.26       1
 21           JD    1.12    9.99
              * CHANGED RAINFALL DISTRIBUTION ABOVE 10 SQ. MILES PER CLARK COUNTY MANUAL
 22           JD    1.12   10.01
 23           PC       0     2.0     5.9     8.0    11.0    14.4    15.0    16.0    16.8    17.1
 24           PC    18.0    18.2    18.7    19.0    19.7    20.2    21.0    22.0    23.0    24.1
 25           PC    25.0    25.9    26.5    28.0    29.0    30.0    30.5    30.9    31.0    31.7
 26           PC    32.1    32.7    33.3    34.6    36.1    38.1    40.8    43.0    47.7    51.4
 27           PC    56.1    63.0    71.0    72.0    73.1    75.2    77.9    79.0    79.5    80.4
 28           PC    81.0    82.0    82.6    84.0    85.9    88.9    91.0    93.8    96.6    97.0
 29           PC    97.4    97.9    98.1    98.3    98.5    98.9    99.0    99.2    99.3    99.6
 30           PC    99.7    99.9   100.0
 31           JD    1.03      20
 32           JD     .96      30
 33           JD     .88      50
 34           JD     .78     100
              *
              *  CNTA UC-1 SUBBASINS
              *
```

```
35          KK    UC1A
36          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN A
            * UC1A DISCHARGE IS UC1 NORTH ALLUVIAL FAN APEX DISCHARGE
37          BA    0.79
38          LS              88
39          UD    0.24
            *

40          KK  RTCP1A
41          KM   ROUTE FLOW FROM UC1A THROUGH UC1D TO CP1A (CP1A IS A DUMMY VARIABLE FOR CP1)
42          RM      10    0.82     0.2
            *
```



```
LINE        ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

43          KK    UC1D
44          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN D
45          BA    0.66
46          LS              72
47          UD    0.51
            *
            *

48          KK    UC1B
49          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN B
            * UC1B DISCHARGE IS UC1 SOUTH ALLUVIAL FAN APEX DISCHARGE
50          BA    1.25
51          LS              89
52          UD    0.41
            *

53          KK  RTCP1B
54          KM    ROUTE FLOW FROM UC1B TO CP1B (CP1B IS A DUMMY VARIABLE FOR CP1)
55          RM       4    0.34     0.2
            *
            *

56          KK    UC1E
57          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN E
58          BA    0.22
59          LS              72
60          UD    0.23
            *

61          KK    UC1C
62          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN C
63          BA    0.75
64          LS              72
65          UD    0.26
            *

66          KK     CP1
67          KM     COMBINE FLOWS FROM UC1A, UC1B, UC1C, UC1D, AND UC1E
68          HC       5
            *

69          KK   RTCP2
70          KM   ROUTE FLOW FROM CP1C THROUGH UC1F TO MUDPIT
71          RM      10    0.82     0.2
            *

72          KK    UC1F
73          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN F
74          BA    0.96
75          LS              72
76          UD    0.45
            *
```



```
LINE        ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

77          KK    CP2
78          KM    COMBINE FLOW FROM CP1 AND UC1F AT CP2 (MUDPIT)
79          HC       2
```

```
          80          ZZ
1
                SCHEMATIC DIAGRAM OF STREAM NETWORK
  PUT
 LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

  NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

   35        UC1A
                V
                V
   40      RTCP1A
                .
                .
   43           .        UC1D
                .           .
                .           .
   48           .           .        UC1B
                .           .           V
                .           .           V
   53           .           .      RTCP1B
                .           .           .
                .           .           .
   56           .           .           .        UC1E
                .           .           .           .
                .           .           .           .
   61           .           .           .           .        UC1C
                .           .           .           .           .
                .           .           .           .           .
   66        CP1.............................................
                V
                V
   69      RTCP2
                .
                .
   72           .        UC1F
                .           .
                .           .
   77        CP2 ............

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*              MAY   1991               *
*           VERSION 4.0.1E              *
*                                       *
*  RUN DATE  02/08/99  TIME  14:24:08   *
*                                       *
*****************************************
```

```
*****************************************
*                                       *
*    U.S. ARMY CORPS OF ENGINEERS       *
*    HYDROLOGIC ENGINEERING CENTER      *
*          609 SECOND STREET            *
*       DAVIS, CALIFORNIA 95616         *
*          (916) 551-1748               *
*                                       *
*****************************************
```

```
                    FLOOD ASSESSMENT FOR CNTA UC-1 SITE
                    5 MINUTE INTERVAL IN ITCARD
                    25-YEAR 6-HOUR STORM 1.3 INCHES
                    POINT RAINFALL VALUES FROM NOAA ATLAS 2 VOL VII
                    DEPTH-AREA REDUCTION FACTORS FROM TABLE 502 IN
                    CLARK COUNTY HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL (CCRFCD, 1990)
                    CURVE NUMBERS NOT ADJUSTED

 9 IO          OUTPUT CONTROL VARIABLES
                    IPRNT           5  PRINT CONTROL
                    IPLOT           0  PLOT CONTROL
                    QSCAL          0.  HYDROGRAPH PLOT SCALE

  IT           HYDROGRAPH TIME DATA
                     NMIN           5  MINUTES IN COMPUTATION INTERVAL
                    IDATE      1    0  STARTING DATE
                    ITIME        0000  STARTING TIME
                       NQ         300  NUMBER OF HYDROGRAPH ORDINATES
                   NDDATE      2    0  ENDING DATE
                   NDTIME        0055  ENDING TIME
                   ICENT           19  CENTURY MARK

                COMPUTATION INTERVAL    0.08 HOURS
```

TOTAL TIME BASE 24.92 HOURS

ENGLISH UNITS

DRAINAGE AREA	SQUARE MILES
PRECIPITATION DEPTH	INCHES
LENGTH, ELEVATION	FEET
FLOW	CUBIC FEET PER SECOND
STORAGE VOLUME	ACRE-FEET
SURFACE AREA	ACRES
TEMPERATURE	DEGREES FAHRENHEIT

11 JD INDEX STORM NO. 1

STRM 1.30 PRECIPITATION DEPTH
TRDA 0.01 TRANSPOSITION DRAINAGE AREA

12 PI PRECIPITATION PATTERN

2.00	3.70	1.30	1.70	2.10	1.60	0.60	0.00	0.00	0.00
0.00	0.00	0.30	0.70	0.20	0.60	1.00	1.40	0.90	0.90
0.70	0.20	0.10	0.10	0.30	1.00	1.50	1.20	0.80	0.20
0.50	1.40	0.80	0.30	0.20	1.20	2.70	3.00	5.70	9.00
9.10	12.00	3.40	3.70	3.10	0.70	1.60	1.60	0.50	0.40
0.80	0.80	1.20	2.20	1.60	1.10	1.30	2.00	0.60	0.60
0.30	0.20	0.20	0.10	0.30	0.00	0.10	0.10	0.30	0.00
0.10	0.10								

20 JD INDEX STORM NO. 2

STRM 1.26 PRECIPITATION DEPTH
TRDA 1.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.70	1.30	1.70	2.10	1.60	0.60	0.00	0.00	0.00
0.00	0.00	0.30	0.70	0.20	0.60	1.00	1.40	0.90	0.90
0.70	0.20	0.10	0.10	0.30	1.00	1.50	1.20	0.80	0.20
0.50	1.40	0.80	0.30	0.20	1.20	2.70	3.00	5.70	9.00
9.10	12.00	3.40	3.70	3.10	0.70	1.60	1.60	0.50	0.40
0.80	0.80	1.20	2.20	1.60	1.10	1.30	2.00	0.60	0.60
0.30	0.20	0.20	0.10	0.30	0.00	0.10	0.10	0.30	0.00
0.10	0.10								

21 JD INDEX STORM NO. 3

STRM 1.12 PRECIPITATION DEPTH
TRDA 9.99 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.70	1.30	1.70	2.10	1.60	0.60	0.00	0.00	0.00
0.00	0.00	0.30	0.70	0.20	0.60	1.00	1.40	0.90	0.90
0.70	0.20	0.10	0.10	0.30	1.00	1.50	1.20	0.80	0.20
0.50	1.40	0.80	0.30	0.20	1.20	2.70	3.00	5.70	9.00
9.10	12.00	3.40	3.70	3.10	0.70	1.60	1.60	0.50	0.40
0.80	0.80	1.20	2.20	1.60	1.10	1.30	2.00	0.60	0.60
0.30	0.20	0.20	0.10	0.30	0.00	0.10	0.10	0.30	0.00
0.10	0.10								

22 JD INDEX STORM NO. 4

STRM 1.12 PRECIPITATION DEPTH
TRDA 10.01 TRANSPOSITION DRAINAGE AREA

23 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

31 JD INDEX STORM NO. 5

STRM 1.03 PRECIPITATION DEPTH
TRDA 20.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40

0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

2 JD INDEX STORM NO. 6

STRM 0.96 PRECIPITATION DEPTH
TRDA 30.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

33 JD INDEX STORM NO. 7

STRM 0.88 PRECIPITATION DEPTH
TRDA 50.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

34 JD INDEX STORM NO. 8

STRM 0.78 PRECIPITATION DEPTH
TRDA 100.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

1

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	UC1A	234.	3.67	35.	9.	9.	0.79		
ROUTED TO	RTCP1A	177.	4.58	35.	9.	9.	0.79		
HYDROGRAPH AT	UC1D	14.	5.17	4.	1.	1.	0.66		
HYDROGRAPH AT	UC1B	308.	3.92	60.	15.	14.	1.25		
ROUTED TO	RTCP1B	285.	4.25	60.	15.	14.	1.25		
HYDROGRAPH AT	UC1E	6.	4.92	1.	0.	0.	0.22		
HYDROGRAPH AT	UC1C	18.	4.92	4.	1.	1.	0.75		
5 COMBINED AT	CP1	383.	4.42	92.	23.	22.	3.67		
ROUTED TO									

+		RTCP2	348.	5.25	92.	23.	22.	3.67
	HYDROGRAPH AT							
+		UC1F	20.	5.08	6.	1.	1.	0.96
	2 COMBINED AT							
+		CP2	352.	5.25	93.	23.	22.	4.63

*** NORMAL END OF HEC-1 ***

UC-1

HEC-1 MODEL OUTPUT

FILENAME: 256UC1B

(25-YEAR MODEL)

```
1*****************************************
*                                       *
    FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
              MAY   1991                *
           VERSION 4.0.1E               *
*                                       *
*  RUN DATE  02/08/99  TIME  14:26:41   *
*                                       *
*****************************************
```

```
*****************************************
*                                       *
*    U.S. ARMY CORPS OF ENGINEERS       *
*    HYDROLOGIC ENGINEERING CENTER      *
*          609 SECOND STREET            *
*       DAVIS, CALIFORNIA 95616         *
*           (916) 551-1748              *
*                                       *
*****************************************
```

```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X              X
XXXXXXX  XXXX     X        XXXXX X
X     X  X        X              X
X     X  X        X     X        X
X     X  XXXXXXX   XXXXX         XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1

HEC-1 INPUT

PAGE 1

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID   FLOOD ASSESSMENT FOR CNTA UC-1 SITE
  2           ID   5 MINUTE INTERVAL IN ITCARD
  3           ID   25-YEAR 6-HOUR STORM 1.3 INCHES
  4           ID   POINT RAINFALL VALUES FROM NOAA ATLAS 2 VOL VII
  5           ID   DEPTH-AREA REDUCTION FACTORS FROM TABLE 502 IN
  6           ID   CLARK COUNTY HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL (CCRFCD, 1990)
  7           ID   CURVE NUMBERS ADJUSTED +5
              *DIAGRAM
  8           IT       5       0       0     300
  9           IO       5       0
 10           IN       5
 11           JD     1.3     .01
              * RAINFALL DISTRIBUTION FROM CLARK COUNTY MANUAL LESS THAN 10 SQ. MILES
 12           PC       0       2     5.7     7.0     8.7    10.8    12.4    13.0    13.0    13.0
 13           PC    13.0    13.0    13.0    13.3    14.0    14.2    14.8    15.8    17.2    18.1
 14           PC    19.0    19.7    19.9    20.0    20.1    20.4    21.4    22.9    24.1    24.9
 15           PC    25.1    25.6    27.0    27.8    28.1    28.3    29.5    32.2    35.2    40.9
 16           PC    49.9    59.0    71.0    74.4    78.1    81.2    81.9    83.5    85.1    85.6
 17           PC    86.0    86.8    87.6    88.8    91.0    92.6    93.7    95.0    97.0    97.6
 18           PC    98.2    98.5    98.7    98.9    99.0    99.3    99.3    99.4    99.5    99.8
 19           PC    99.8    99.9   100.0
 20           JD    1.26       1
 21           JD    1.12    9.99
              * CHANGED RAINFALL DISTRIBUTION ABOVE 10 SQ. MILES PER CLARK COUNTY MANUAL
 22           JD    1.12   10.01
 23           PC       0     2.0     5.9     8.0    11.0    14.4    15.0    16.0    16.8    17.1
 24           PC    18.0    18.2    18.7    19.0    19.7    20.2    21.0    22.0    23.0    24.1
 25           PC    25.0    25.9    26.5    28.0    29.0    30.0    30.5    30.9    31.0    31.7
 26           PC    32.1    32.7    33.3    34.6    36.1    38.1    40.8    43.0    47.7    51.4
 27           PC    56.1    63.0    71.0    72.0    73.1    75.2    77.9    79.0    79.5    80.4
 28           PC    81.0    82.0    82.6    84.0    85.9    88.9    91.0    93.8    96.6    97.0
 29           PC    97.4    97.9    98.1    98.3    98.5    98.9    99.0    99.2    99.3    99.6
 30           PC    99.7    99.9   100.0
 31           JD    1.03      20
 32           JD     .96      30
 33           JD     .88      50
 34           JD     .78     100
              *
              *  CNTA UC-1 SUBBASINS
              *
```

```
 35          KK    UC1A
 36          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN A
             * UC1A DISCHARGE IS UC1 NORTH ALLUVIAL FAN APEX DISCHARGE
 37          BA    0.79
 38          LS              93
 39          UD    0.24
             *

 40          KK  RTCP1A
 41          KM   ROUTE FLOW FROM UC1A THROUGH UC1D TO CP1A (CP1A IS A DUMMY VARIABLE FOR CP1)
 42          RM      10    0.82     0.2
             *
```



```
LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 43          KK    UC1D
 44          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN D
 45          BA    0.66
 46          LS              77
 47          UD    0.51
             *
             *

 48          KK    UC1B
 49          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN B
             * UC1B DISCHARGE IS UC1 SOUTH ALLUVIAL FAN APEX DISCHARGE
 50          BA    1.25
 51          LS              94
 52          UD    0.41
             *

 53          KK  RTCP1B
 54          KM    ROUTE FLOW FROM UC1B TO CP1B (CP1B IS A DUMMY VARIABLE FOR CP1)
 55          RM       4    0.34     0.2
             *
             *

 56          KK    UC1E
 57          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN E
 58          BA    0.22
 59          LS              77
 60          UD    0.23
             *

 61          KK    UC1C
 62          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN C
 63          BA    0.75
 64          LS              77
 65          UD    0.26
             *

 66          KK     CP1
 67          KM     COMBINE FLOWS FROM UC1A, UC1B, UC1C, UC1D, AND UC1E
 68          HC       5
             *

 69          KK   RTCP2
 70          KM   ROUTE FLOW FROM CP1C THROUGH UC1F TO MUDPIT
 71          RM      10    0.82     0.2
             *

 72          KK    UC1F
 73          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN F
 74          BA    0.96
 75          LS              77
 76          UD    0.45
             *
```



```
LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 77          KK    CP2
 78          KM    COMBINE FLOW FROM CP1 AND UC1F AT CP2 (MUDPIT)
 79          HC       2
```

```
          80          ZZ

              SCHEMATIC DIAGRAM OF STREAM NETWORK
  UT
 LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

 NO.       (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

 35          UC1A
               V
               V
 40        RTCP1A
               .
               .
 43            .        UC1D
               .           .
               .           .
 48            .           .        UC1B
               .           .           V
               .           .           V
 53            .           .      RTCP1B
               .           .           .
               .           .           .
 56            .           .           .        UC1E
               .           .           .           .
               .           .           .           .
 61            .           .           .           .        UC1C
               .           .           .           .           .
               .           .           .           .           .
 66          CP1.............................................
               V
               V
 69        RTCP2
               .
               .
 72            .        UC1F
               .           .
               .           .
 77          CP2 ............
```

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION

```
1*****************************************
*                                        *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)    *
*              MAY   1991                *
*            VERSION 4.0.1E              *
*                                        *
*  RUN DATE  02/08/99  TIME  14:26:41    *
*                                        *
******************************************
```

```
*****************************************
*
*    U.S. ARMY CORPS OF ENGINEERS
*    HYDROLOGIC ENGINEERING CENTER
*          609 SECOND STREET
*       DAVIS, CALIFORNIA 95616
*           (916) 551-1748
*
*****************************************
```

FLOOD ASSESSMENT FOR CNTA UC-1 SITE
5 MINUTE INTERVAL IN ITCARD
25-YEAR 6-HOUR STORM 1.3 INCHES
POINT RAINFALL VALUES FROM NOAA ATLAS 2 VOL VII
DEPTH-AREA REDUCTION FACTORS FROM TABLE 502 IN
CLARK COUNTY HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL (CCRFCD, 1990)
CURVE NUMBERS ADJUSTED +5

```
 9 IO        OUTPUT CONTROL VARIABLES
                   IPRNT          5  PRINT CONTROL
                   IPLOT          0  PLOT CONTROL
                   QSCAL         0.  HYDROGRAPH PLOT SCALE

   IT        HYDROGRAPH TIME DATA
                    NMIN          5  MINUTES IN COMPUTATION INTERVAL
                   IDATE      1    0  STARTING DATE
                   ITIME       0000  STARTING TIME
                      NQ        300  NUMBER OF HYDROGRAPH ORDINATES
                  NDDATE      2    0  ENDING DATE
                  NDTIME       0055  ENDING TIME
                   ICENT         19  CENTURY MARK

             COMPUTATION INTERVAL    0.08 HOURS
```

TOTAL TIME BASE 24.92 HOURS

ENGLISH UNITS

DRAINAGE AREA	SQUARE MILES
PRECIPITATION DEPTH	INCHES
LENGTH, ELEVATION	FEET
FLOW	CUBIC FEET PER SECOND
STORAGE VOLUME	ACRE-FEET
SURFACE AREA	ACRES
TEMPERATURE	DEGREES FAHRENHEIT

11 JD INDEX STORM NO. 1

STRM 1.30 PRECIPITATION DEPTH
TRDA 0.01 TRANSPOSITION DRAINAGE AREA

12 PI PRECIPITATION PATTERN

2.00	3.70	1.30	1.70	2.10	1.60	0.60	0.00	0.00	0.00
0.00	0.00	0.30	0.70	0.20	0.60	1.00	1.40	0.90	0.90
0.70	0.20	0.10	0.10	0.30	1.00	1.50	1.20	0.80	0.20
0.50	1.40	0.80	0.30	0.20	1.20	2.70	3.00	5.70	9.00
9.10	12.00	3.40	3.70	3.10	0.70	1.60	1.60	0.50	0.40
0.80	0.80	1.20	2.20	1.60	1.10	1.30	2.00	0.60	0.60
0.30	0.20	0.20	0.10	0.30	0.00	0.10	0.10	0.30	0.00
0.10	0.10								

20 JD INDEX STORM NO. 2

STRM 1.26 PRECIPITATION DEPTH
TRDA 1.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.70	1.30	1.70	2.10	1.60	0.60	0.00	0.00	0.00
0.00	0.00	0.30	0.70	0.20	0.60	1.00	1.40	0.90	0.90
0.70	0.20	0.10	0.10	0.30	1.00	1.50	1.20	0.80	0.20
0.50	1.40	0.80	0.30	0.20	1.20	2.70	3.00	5.70	9.00
9.10	12.00	3.40	3.70	3.10	0.70	1.60	1.60	0.50	0.40
0.80	0.80	1.20	2.20	1.60	1.10	1.30	2.00	0.60	0.60
0.30	0.20	0.20	0.10	0.30	0.00	0.10	0.10	0.30	0.00
0.10	0.10								

21 JD INDEX STORM NO. 3

STRM 1.12 PRECIPITATION DEPTH
TRDA 9.99 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.70	1.30	1.70	2.10	1.60	0.60	0.00	0.00	0.00
0.00	0.00	0.30	0.70	0.20	0.60	1.00	1.40	0.90	0.90
0.70	0.20	0.10	0.10	0.30	1.00	1.50	1.20	0.80	0.20
0.50	1.40	0.80	0.30	0.20	1.20	2.70	3.00	5.70	9.00
9.10	12.00	3.40	3.70	3.10	0.70	1.60	1.60	0.50	0.40
0.80	0.80	1.20	2.20	1.60	1.10	1.30	2.00	0.60	0.60
0.30	0.20	0.20	0.10	0.30	0.00	0.10	0.10	0.30	0.00
0.10	0.10								

22 JD INDEX STORM NO. 4

STRM 1.12 PRECIPITATION DEPTH
TRDA 10.01 TRANSPOSITION DRAINAGE AREA

23 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

31 JD INDEX STORM NO. 5

STRM 1.03 PRECIPITATION DEPTH
TRDA 20.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40

0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

: JD INDEX STORM NO. 6

STRM 0.96 PRECIPITATION DEPTH
TRDA 30.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

33 JD INDEX STORM NO. 7

STRM 0.88 PRECIPITATION DEPTH
TRDA 50.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

34 JD INDEX STORM NO. 8

STRM 0.78 PRECIPITATION DEPTH
TRDA 100.00 TRANSPOSITION DRAINAGE AREA

PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

1

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	UC1A	372.	3.67	56.	14.	14.	0.79		
ROUTED TO	RTCP1A	282.	4.50	56.	14.	14.	0.79		
HYDROGRAPH AT	UC1D	31.	4.17	9.	2.	2.	0.66		
HYDROGRAPH AT	UC1B	488.	3.83	96.	24.	23.	1.25		
ROUTED TO	RTCP1B	446.	4.17	96.	24.	23.	1.25		
HYDROGRAPH AT	UC1E	16.	3.75	3.	1.	1.	0.22		
HYDROGRAPH AT	UC1C	50.	3.83	10.	2.	2.	0.75		
5 COMBINED AT	CP1	642.	4.33	156.	39.	38.	3.67		
ROUTED TO									

+	RTCP2	584.	5.17	156.	39.	38.	3.67
HYDROGRAPH AT							
+	UC1F	49.	4.08	12.	3.	3.	0.96
2 COMBINED AT							
+	CP2	600.	5.17	162.	40.	39.	4.63

*** NORMAL END OF HEC-1 ***

UC-1

HEC-1 MODEL OUTPUT

FILENAME: 256UC1C

(25-YEAR MODEL)

```
1****************************************
*                                      *
    FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
              MAY   1991                *
           VERSION 4.0.1E               *
*                                      *
*  RUN DATE  02/08/99-  TIME  14:25:14 *
*                                      *
****************************************
```

```
*************************************
*                                   *
*    U.S. ARMY CORPS OF ENGINEERS   *
*    HYDROLOGIC ENGINEERING CENTER  *
*          609 SECOND STREET        *
*       DAVIS, CALIFORNIA 95616     *
*          (916) 551-1748           *
*                                   *
*************************************
```

```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X               X
XXXXXXX  XXXX     X       XXXXX   X
X     X  X        X               X
X     X  X        X     X         X
X     X  XXXXXXX   XXXXX         XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1

HEC-1 INPUT

PAGE 1

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID   FLOOD ASSESSMENT FOR CNTA UC-1 SITE
  2           ID   5 MINUTE INTERVAL IN ITCARD
  3           ID   25-YEAR 6-HOUR STORM 1.3 INCHES
  4           ID   POINT RAINFALL VALUES FROM NOAA ATLAS 2 VOL VII
  5           ID   DEPTH-AREA REDUCTION FACTORS FROM TABLE 502 IN
  6           ID   CLARK COUNTY HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL (CCRFCD, 1990)
  7           ID   CURVE NUMBERS ADJUSTED (+3)
              *DIAGRAM
  8           IT       5       0       0     300
  9           IO       5       0
 10           IN       5
 11           JD     1.3     .01
              * RAINFALL DISTRIBUTION FROM CLARK COUNTY MANUAL LESS THAN 10 SQ. MILES
 12           PC       0       2     5.7     7.0     8.7    10.8    12.4    13.0    13.0    13.0
 13           PC    13.0    13.0    13.0    13.3    14.0    14.2    14.8    15.8    17.2    18.1
 14           PC    19.0    19.7    19.9    20.0    20.1    20.4    21.4    22.9    24.1    24.9
 15           PC    25.1    25.6    27.0    27.8    28.1    28.3    29.5    32.2    35.2    40.9
 16           PC    49.9    59.0    71.0    74.4    78.1    81.2    81.9    83.5    85.1    85.6
 17           PC    86.0    86.8    87.6    88.8    91.0    92.6    93.7    95.0    97.0    97.6
 18           PC    98.2    98.5    98.7    98.9    99.0    99.3    99.3    99.4    99.5    99.8
 19           PC    99.8    99.9   100.0
 20           JD    1.26       1
 21           JD    1.12    9.99
              * CHANGED RAINFALL DISTRIBUTION ABOVE 10 SQ. MILES PER CLARK COUNTY MANUAL
 22           JD    1.12   10.01
 23           PC       0     2.0     5.9     8.0    11.0    14.4    15.0    16.0    16.8    17.1
 24           PC    18.0    18.2    18.7    19.0    19.7    20.2    21.0    22.0    23.0    24.1
 25           PC    25.0    25.9    26.5    28.0    29.0    30.0    30.5    30.9    31.0    31.7
 26           PC    32.1    32.7    33.3    34.6    36.1    38.1    40.8    43.0    47.7    51.4
 27           PC    56.1    63.0    71.0    72.0    73.1    75.2    77.9    79.0    79.5    80.4
 28           PC    81.0    82.0    82.6    84.0    85.9    88.9    91.0    93.8    96.6    97.0
 29           PC    97.4    97.9    98.1    98.3    98.5    98.9    99.0    99.2    99.3    99.6
 30           PC    99.7    99.9   100.0
 31           JD    1.03      20
 32           JD     .96      30
 33           JD     .88      50
 34           JD     .78     100
              *
              *  CNTA UC-1 SUBBASINS
              *
```

```
 35          KK    UC1A
 36          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN A
             * UC1A DISCHARGE IS UC1 NORTH ALLUVIAL FAN APEX DISCHARGE
 37          BA    0.79
 38          LS              91
 39          UD    0.24
             *

 40          KK  RTCP1A
 41          KM   ROUTE FLOW FROM UC1A THROUGH UC1D TO CP1A (CP1A IS A DUMMY VARIABLE FOR CP1)
 42          RM      10    0.82     0.2
             *
```



```
LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 43          KK    UC1D
 44          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN D
 45          BA    0.66
 46          LS              75
 47          UD    0.51
             *
             *

 48          KK    UC1B
 49          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN B
             * UC1B DISCHARGE IS UC1 SOUTH ALLUVIAL FAN APEX DISCHARGE
 50          BA    1.25
 51          LS              92
 52          UD    0.41
             *

 53          KK  RTCP1B
 54          KM    ROUTE FLOW FROM UC1B TO CP1B (CP1B IS A DUMMY VARIABLE FOR CP1)
 55          RM       4    0.34     0.2
             *
             *

 56          KK    UC1E
 57          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN E
 58          BA    0.22
 59          LS              75
 60          UD    0.23
             *

 61          KK    UC1C
 62          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN C
 63          BA    0.75
 64          LS              75
 65          UD    0.26
             *

 66          KK     CP1
 67          KM     COMBINE FLOWS FROM UC1A, UC1B, UC1C, UC1D, AND UC1E
 68          HC       5
             *

 69          KK   RTCP2
 70          KM   ROUTE FLOW FROM CP1C THROUGH UC1F TO MUDPIT
 71          RM      10    0.82     0.2
             *

 72          KK    UC1F
 73          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN F
 74          BA    0.96
 75          LS              75
 76          UD    0.45
             *
```



```
LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 77          KK    CP2
 78          KM    COMBINE FLOW FROM CP1 AND UC1F AT CP2 (MUDPIT)
 79          HC       2
```

```
          80          ZZ

                SCHEMATIC DIAGRAM OF STREAM NETWORK
 'UT
 LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

 NO.       (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

  35        UC1A
               V
               V
  40      RTCP1A
               .
               .
  43           .        UC1D
               .           .
               .           .
  48           .           .        UC1B
               .           .           V
               .           .           V
  53           .           .      RTCP1B
               .           .           .
               .           .           .
  56           .           .           .        UC1E
               .           .           .           .
               .           .           .           .
  61           .           .           .           .        UC1C
               .           .           .           .           .
               .           .           .           .           .
  66        CP1.............................................
               V
               V
  69      RTCP2
               .
               .
  72           .        UC1F
               .           .
               .           .
  77        CP2 ............
```

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION

```
1*****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*              MAY   1991               *
*           VERSION 4.0.1E              *
*                                       *
*  RUN DATE  02/08/99  TIME  14:25:14   *
*                                       *
*****************************************
```

```
*****************************************
*
*    U.S. ARMY CORPS OF ENGINEERS
*    HYDROLOGIC ENGINEERING CENTER
*          609 SECOND STREET
*       DAVIS, CALIFORNIA 95616
*           (916) 551-1748
*
*****************************************
```

```
                    FLOOD ASSESSMENT FOR CNTA UC-1 SITE
                    5 MINUTE INTERVAL IN ITCARD
                    25-YEAR 6-HOUR STORM 1.3 INCHES
                    POINT RAINFALL VALUES FROM NOAA ATLAS 2 VOL VII
                    DEPTH-AREA REDUCTION FACTORS FROM TABLE 502 IN
                    CLARK COUNTY HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL (CCRFCD, 1990)
                    CURVE NUMBERS ADJUSTED (+3)

 9 IO          OUTPUT CONTROL VARIABLES
                    IPRNT           5  PRINT CONTROL
                    IPLOT           0  PLOT CONTROL
                    QSCAL          0.  HYDROGRAPH PLOT SCALE

  IT           HYDROGRAPH TIME DATA
                     NMIN           5  MINUTES IN COMPUTATION INTERVAL
                    IDATE      1    0  STARTING DATE
                    ITIME        0000  STARTING TIME
                       NQ         300  NUMBER OF HYDROGRAPH ORDINATES
                   NDDATE      2    0  ENDING DATE
                   NDTIME        0055  ENDING TIME
                   ICENT           19  CENTURY MARK

                COMPUTATION INTERVAL    0.08 HOURS
```

TOTAL TIME BASE 24.92 HOURS

ENGLISH UNITS

DRAINAGE AREA	SQUARE MILES
PRECIPITATION DEPTH	INCHES
LENGTH, ELEVATION	FEET
FLOW	CUBIC FEET PER SECOND
STORAGE VOLUME	ACRE-FEET
SURFACE AREA	ACRES
TEMPERATURE	DEGREES FAHRENHEIT

11 JD INDEX STORM NO. 1

STRM 1.30 PRECIPITATION DEPTH
TRDA 0.01 TRANSPOSITION DRAINAGE AREA

12 PI PRECIPITATION PATTERN

2.00	3.70	1.30	1.70	2.10	1.60	0.60	0.00	0.00	0.00
0.00	0.00	0.30	0.70	0.20	0.60	1.00	1.40	0.90	0.90
0.70	0.20	0.10	0.10	0.30	1.00	1.50	1.20	0.80	0.20
0.50	1.40	0.80	0.30	0.20	1.20	2.70	3.00	5.70	9.00
9.10	12.00	3.40	3.70	3.10	0.70	1.60	1.60	0.50	0.40
0.80	0.80	1.20	2.20	1.60	1.10	1.30	2.00	0.60	0.60
0.30	0.20	0.20	0.10	0.30	0.00	0.10	0.10	0.30	0.00
0.10	0.10								

20 JD INDEX STORM NO. 2

STRM 1.26 PRECIPITATION DEPTH
TRDA 1.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.70	1.30	1.70	2.10	1.60	0.60	0.00	0.00	0.00
0.00	0.00	0.30	0.70	0.20	0.60	1.00	1.40	0.90	0.90
0.70	0.20	0.10	0.10	0.30	1.00	1.50	1.20	0.80	0.20
0.50	1.40	0.80	0.30	0.20	1.20	2.70	3.00	5.70	9.00
9.10	12.00	3.40	3.70	3.10	0.70	1.60	1.60	0.50	0.40
0.80	0.80	1.20	2.20	1.60	1.10	1.30	2.00	0.60	0.60
0.30	0.20	0.20	0.10	0.30	0.00	0.10	0.10	0.30	0.00
0.10	0.10								

21 JD INDEX STORM NO. 3

STRM 1.12 PRECIPITATION DEPTH
TRDA 9.99 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.70	1.30	1.70	2.10	1.60	0.60	0.00	0.00	0.00
0.00	0.00	0.30	0.70	0.20	0.60	1.00	1.40	0.90	0.90
0.70	0.20	0.10	0.10	0.30	1.00	1.50	1.20	0.80	0.20
0.50	1.40	0.80	0.30	0.20	1.20	2.70	3.00	5.70	9.00
9.10	12.00	3.40	3.70	3.10	0.70	1.60	1.60	0.50	0.40
0.80	0.80	1.20	2.20	1.60	1.10	1.30	2.00	0.60	0.60
0.30	0.20	0.20	0.10	0.30	0.00	0.10	0.10	0.30	0.00
0.10	0.10								

22 JD INDEX STORM NO. 4

STRM 1.12 PRECIPITATION DEPTH
TRDA 10.01 TRANSPOSITION DRAINAGE AREA

23 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

31 JD INDEX STORM NO. 5

STRM 1.03 PRECIPITATION DEPTH
TRDA 20.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40

0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

2 JD INDEX STORM NO. 6

STRM 0.96 PRECIPITATION DEPTH
TRDA 30.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

33 JD INDEX STORM NO. 7

STRM 0.88 PRECIPITATION DEPTH
TRDA 50.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

34 JD INDEX STORM NO. 8

STRM 0.78 PRECIPITATION DEPTH
TRDA 100.00 TRANSPOSITION DRAINAGE AREA

1 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

1

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	UC1A	313.	3.67	47.	12.	11.	0.79		
ROUTED TO	RTCP1A	236.	4.50	47.	12.	11.	0.79		
HYDROGRAPH AT	UC1D	22.	4.17	6.	2.	2.	0.66		
HYDROGRAPH AT	UC1B	410.	3.83	80.	20.	19.	1.25		
ROUTED TO	RTCP1B	375.	4.25	80.	20.	19.	1.25		
HYDROGRAPH AT	UC1E	11.	3.83	2.	1.	1.	0.22		
HYDROGRAPH AT	UC1C	34.	3.83	7.	2.	2.	0.75		
5 COMBINED AT	CP1	529.	4.33	127.	32.	30.	3.67		
ROUTED TO									

+	RTCP2	480.	5.17	127.	32.	30.	3.67
HYDROGRAPH AT							
+	UC1F	33.	4.08	9.	2.	2.	0.96
2 COMBINED AT							
+	CP2	491.	5.17	130.	33.	31.	4.63

*** NORMAL END OF HEC-1 ***

UC-1

HEC-1 MODEL OUTPUT

FILENAME: 106UC1A

(10-YEAR MODEL)

```
1****************************************
*                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *
*             MAY   1991               *
*           VERSION 4.0.1E             *
*                                      *
* RUN DATE  02/04/99  TIME  15:25:12   *
*                                      *
****************************************
```

```
****************************************
*                                      *
*   U.S. ARMY CORPS OF ENGINEERS       *
*   HYDROLOGIC ENGINEERING CENTER      *
*         609 SECOND STREET            *
*      DAVIS, CALIFORNIA 95616         *
*          (916) 551-1748              *
*                                      *
****************************************
```

```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X              X
XXXXXXX  XXXX     X        XXXXX X
X     X  X        X              X
X     X  X        X     X        X
X     X  XXXXXXX   XXXXX         XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1 HEC-1 INPUT PAGE 1

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID   FLOOD ASSESSMENT FOR CNTA UC-1 SITE        FILENAME: 106UC1A
  2           ID   5 MINUTE INTERVAL IN ITCARD
  3           ID   10-YEAR 6-HOUR STORM 1.1 INCHES
  4           ID   POINT RAINFALL VALUES FROM NOAA ATLAS 2 VOL VII
  5           ID   DEPTH-AREA REDUCTION FACTORS FROM TABLE 502 IN
  6           ID   CLARK COUNTY HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL (CCRFCD, 1990)
  7           ID   CURVE NUMBERS NOT ADJUSTED
              *DIAGRAM
  8           IT       5       0       0     300
  9           IO       5       0
 10           IN       5
 11           JD     1.1     .01
              * RAINFALL DISTRIBUTION FROM CLARK COUNTY MANUAL LESS THAN 10 SQ. MILES
 12           PC       0       2     5.7     7.0     8.7    10.8    12.4    13.0    13.0    13.0
 13           PC    13.0    13.0    13.0    13.3    14.0    14.2    14.8    15.8    17.2    18.1
 14           PC    19.0    19.7    19.9    20.0    20.1    20.4    21.4    22.9    24.1    24.9
 15           PC    25.1    25.6    27.0    27.8    28.1    28.3    29.5    32.2    35.2    40.9
 16           PC    49.9    59.0    71.0    74.4    78.1    81.2    81.9    83.5    85.1    85.6
 17           PC    86.0    86.8    87.6    88.8    91.0    92.6    93.7    95.0    97.0    97.6
 18           PC    98.2    98.5    98.7    98.9    99.0    99.3    99.3    99.4    99.5    99.8
 19           PC    99.8    99.9   100.0
 20           JD    1.07       1
 21           JD     .95    9.99
              * CHANGED RAINFALL DISTRIBUTION ABOVE 10 SQ. MILES PER CLARK COUNTY MANUAL
 22           JD     .95   10.01
 23           PC       0     2.0     5.9     8.0    11.0    14.4    15.0    16.0    16.8    17.1
 24           PC    18.0    18.2    18.7    19.0    19.7    20.2    21.0    22.0    23.0    24.1
 25           PC    25.0    25.9    26.5    28.0    29.0    30.0    30.5    30.9    31.0    31.7
 26           PC    32.1    32.7    33.3    34.6    36.1    38.1    40.8    43.0    47.7    51.4
 27           PC    56.1    63.0    71.0    72.0    73.1    75.2    77.9    79.0    79.5    80.4
 28           PC    81.0    82.0    82.6    84.0    85.9    88.9    91.0    93.8    96.6    97.0
 29           PC    97.4    97.9    98.1    98.3    98.5    98.9    99.0    99.2    99.3    99.6
 30           PC    99.7    99.9   100.0
 31           JD     .87      20
 32           JD     .81      30
 33           JD     .75      50
 34           JD     .66     100
              *
              *  CNTA UC-1 SUBBASINS
              *
```

```
 35          KK    UC1A
 36          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN A
             * UC1A DISCHARGE IS UC1A ALLUVIAL FAN APEX DISCHARGE
 37          BA    0.79
 38          LS              88
 39          UD    0.24
             *

 40          KK  RTCP1A
 41          KM   ROUTE FLOW FROM UC1A THROUGH UC1D TO CP1A (CP1A IS A DUMMY VARIABLE FOR CP1)
 42          RM      10    0.82     0.2
             *
```



```
LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 43          KK    UC1D
 44          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN D
 45          BA    0.66
 46          LS              72
 47          UD    0.51
             *
             *

 48          KK    UC1B
 49          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN B
             * UC1B DISCHARGE IS UC1B ALLUVIAL FAN APEX DISCHARGE
 50          BA    1.25
 51          LS              89
 52          UD    0.41
             *

 53          KK  RTCP1B
 54          KM    ROUTE FLOW FROM UC1B TO CP1B (CP1B IS A DUMMY VARIABLE FOR CP1)
 55          RM       4    0.34     0.2
             *
             *

 56          KK    UC1E
 57          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN E
 58          BA    0.22
 59          LS              72
 60          UD    0.23
             *

 61          KK    UC1C
 62          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN C
 63          BA    0.75
 64          LS              72
 65          UD    0.26
             *

 66          KK     CP1
 67          KM     COMBINE FLOWS FROM UC1A, UC1B, UC1C, UC1D, AND UC1E
 68          HC       5
             *

 69          KK   RTCP2
 70          KM   ROUTE FLOW FROM CP1C THROUGH UC1F TO MUDPIT
 71          RM      10    0.82     0.2
             *

 72          KK    UC1F
 73          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN F
 74          BA    0.96
 75          LS              72
 76          UD    0.45
             *
```



```
LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 77          KK    CP2
 78          KM    COMBINE FLOW FROM CP1 AND UC1F AT CP2 (MUDPIT)
 79          HC       2
```

```
          80          ZZ
1
              SCHEMATIC DIAGRAM OF STREAM NETWORK
   T
  .E      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

 NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

 35         UC1A
              V
              V
 40       RTCP1A
              .
              .
 43           .        UC1D
              .          .
              .          .
 48           .          .        UC1B
              .          .          V
              .          .          V
 53           .          .      RTCP1B
              .          .          .
              .          .          .
 56           .          .          .        UC1E
              .          .          .          .
              .          .          .          .
 61           .          .          .          .        UC1C
              .          .          .          .          .
              .          .          .          .          .
 66         CP1.............................................
              V
              V
 69       RTCP2
              .
              .
 ?            .        UC1F
              .          .
              .          .
 77         CP2 ............
```

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION

```
1****************************************
*                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *
*              MAY   1991              *
*            VERSION 4.0.1E            *
*                                      *
*  RUN DATE  02/04/99  TIME  15:25:12  *
*                                      *
****************************************
```

```
****************************************
*                                      *
*    U.S. ARMY CORPS OF ENGINEERS      *
*    HYDROLOGIC ENGINEERING CENTER     *
*          609 SECOND STREET           *
*       DAVIS, CALIFORNIA 95616        *
*           (916) 551-1748             *
*                                      *
****************************************
```

```
                    FLOOD ASSESSMENT FOR CNTA UC-1 SITE
                    5 MINUTE INTERVAL IN ITCARD
                    10-YEAR 6-HOUR STORM 1.1 INCHES
                    POINT RAINFALL VALUES FROM NOAA ATLAS 2 VOL VII
                    DEPTH-AREA REDUCTION FACTORS FROM TABLE 502 IN
                    CLARK COUNTY HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL (CCRFCD, 1990)
                    CURVE NUMBERS NOT ADJUSTED

  9 IO        OUTPUT CONTROL VARIABLES
                    IPRNT          5  PRINT CONTROL
                    IPLOT          0  PLOT CONTROL
                    QSCAL         0.  HYDROGRAPH PLOT SCALE

   IT         HYDROGRAPH TIME DATA
                     NMIN          5  MINUTES IN COMPUTATION INTERVAL
                    IDATE      1   0  STARTING DATE
                    ITIME       0000  STARTING TIME
                       NQ        300  NUMBER OF HYDROGRAPH ORDINATES
                   NDDATE      2   0  ENDING DATE
                   NDTIME       0055  ENDING TIME
                    ICENT         19  CENTURY MARK

                COMPUTATION INTERVAL    0.08 HOURS
```

```
                TOTAL TIME BASE   24.92 HOURS

ENGLISH UNITS
     DRAINAGE AREA          SQUARE MILES
     PRECIPITATION DEPTH    INCHES
     LENGTH, ELEVATION      FEET
     FLOW                   CUBIC FEET PER SECOND
     STORAGE VOLUME         ACRE-FEET
     SURFACE AREA           ACRES
     TEMPERATURE            DEGREES FAHRENHEIT

11 JD        INDEX STORM NO. 1
                STRM        1.10  PRECIPITATION DEPTH
                TRDA        0.01  TRANSPOSITION DRAINAGE AREA

12 PI          PRECIPITATION PATTERN
                2.00      3.70      1.30      1.70      2.10      1.60      0.60      0.00      0.00      0.00
                0.00      0.00      0.30      0.70      0.20      0.60      1.00      1.40      0.90      0.90
                0.70      0.20      0.10      0.10      0.30      1.00      1.50      1.20      0.80      0.20
                0.50      1.40      0.80      0.30      0.20      1.20      2.70      3.00      5.70      9.00
                9.10     12.00      3.40      3.70      3.10      0.70      1.60      1.60      0.50      0.40
                0.80      0.80      1.20      2.20      1.60      1.10      1.30      2.00      0.60      0.60
                0.30      0.20      0.20      0.10      0.30      0.00      0.10      0.10      0.30      0.00
                0.10      0.10

20 JD        INDEX STORM NO. 2
                STRM        1.07  PRECIPITATION DEPTH
                TRDA        1.00  TRANSPOSITION DRAINAGE AREA

 0 PI          PRECIPITATION PATTERN
                2.00      3.70      1.30      1.70      2.10      1.60      0.60      0.00      0.00      0.00
                0.00      0.00      0.30      0.70      0.20      0.60      1.00      1.40      0.90      0.90
                0.70      0.20      0.10      0.10      0.30      1.00      1.50      1.20      0.80      0.20
                0.50      1.40      0.80      0.30      0.20      1.20      2.70      3.00      5.70      9.00
                9.10     12.00      3.40      3.70      3.10      0.70      1.60      1.60      0.50      0.40
                0.80      0.80      1.20      2.20      1.60      1.10      1.30      2.00      0.60      0.60
                0.30      0.20      0.20      0.10      0.30      0.00      0.10      0.10      0.30      0.00
                0.10      0.10

21 JD        INDEX STORM NO. 3
                STRM        0.95  PRECIPITATION DEPTH
                TRDA        9.99  TRANSPOSITION DRAINAGE AREA

 0 PI          PRECIPITATION PATTERN
                2.00      3.70      1.30      1.70      2.10      1.60      0.60      0.00      0.00      0.00
                0.00      0.00      0.30      0.70      0.20      0.60      1.00      1.40      0.90      0.90
                0.70      0.20      0.10      0.10      0.30      1.00      1.50      1.20      0.80      0.20
                0.50      1.40      0.80      0.30      0.20      1.20      2.70      3.00      5.70      9.00
                9.10     12.00      3.40      3.70      3.10      0.70      1.60      1.60      0.50      0.40
                0.80      0.80      1.20      2.20      1.60      1.10      1.30      2.00      0.60      0.60
                0.30      0.20      0.20      0.10      0.30      0.00      0.10      0.10      0.30      0.00
                0.10      0.10

22 JD        INDEX STORM NO. 4
                STRM        0.95  PRECIPITATION DEPTH
                TRDA       10.01  TRANSPOSITION DRAINAGE AREA

23 PI          PRECIPITATION PATTERN
                2.00      3.90      2.10      3.00      3.40      0.60      1.00      0.80      0.30      0.90
                0.20      0.50      0.30      0.70      0.50      0.80      1.00      1.00      1.10      0.90
                0.90      0.60      1.50      1.00      1.00      0.50      0.40      0.10      0.70      0.40
                0.60      0.60      1.30      1.50      2.00      2.70      2.20      4.70      3.70      4.70
                6.90      8.00      1.00      1.10      2.10      2.70      1.10      0.50      0.90      0.60
                1.00      0.60      1.40      1.90      3.00      2.10      2.80      2.80      0.40      0.40
                0.50      0.20      0.20      0.20      0.40      0.10      0.20      0.10      0.30      0.10
                0.20      0.10

31 JD        INDEX STORM NO. 5
                STRM        0.87  PRECIPITATION DEPTH
                TRDA       20.00  TRANSPOSITION DRAINAGE AREA

 0 PI          PRECIPITATION PATTERN
                2.00      3.90      2.10      3.00      3.40      0.60      1.00      0.80      0.30      0.90
                0.20      0.50      0.30      0.70      0.50      0.80      1.00      1.00      1.10      0.90
                0.90      0.60      1.50      1.00      1.00      0.50      0.40      0.10      0.70      0.40
                0.60      0.60      1.30      1.50      2.00      2.70      2.20      4.70      3.70      4.70
                6.90      8.00      1.00      1.10      2.10      2.70      1.10      0.50      0.90      0.60
                1.00      0.60      1.40      1.90      3.00      2.10      2.80      2.80      0.40      0.40
```

0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

JD INDEX STORM NO. 6

STRM 0.81 PRECIPITATION DEPTH

TRDA 30.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

33 JD INDEX STORM NO. 7

STRM 0.75 PRECIPITATION DEPTH

TRDA 50.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

34 JD INDEX STORM NO. 8

STRM 0.66 PRECIPITATION DEPTH

TRDA 100.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+	HYDROGRAPH AT	UC1A	164.	3.67	25.	6.	6.	0.79		
+	ROUTED TO	RTCP1A	125.	4.58	25.	6.	6.	0.79		
+	HYDROGRAPH AT	UC1D	6.	5.17	1.	0.	0.	0.66		
+	HYDROGRAPH AT	UC1B	221.	3.92	43.	11.	10.	1.25		
+	ROUTED TO	RTCP1B	203.	4.25	43.	11.	10.	1.25		
+	HYDROGRAPH AT	UC1E	3.	4.92	1.	0.	0.	0.22		
+	HYDROGRAPH AT	UC1C	9.	5.00	2.	0.	0.	0.75		
+	5 COMBINED AT	CP1	261.	4.42	63.	16.	15.	3.67		
	ROUTED TO									

+	RTCP2	236.	5.25	63.	16.	15.	3.67
HYDROGRAPH AT							
+	UC1F	10.	5.08	2.	1.	1.	0.96
2 COMBINED AT							
+	CP2	237.	5.25	63.	16.	15.	4.63

*** NORMAL END OF HEC-1 ***

UC-1

HEC-1 MODEL OUTPUT

FILENAME: 26UC1A

(2-YEAR MODEL)

```
1****************************************
*                                      *
    FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
              MAY   1991                *
           VERSION 4.0.1E               *
*                                      *
*  RUN DATE  02/04/99  TIME  15:31:18  *
*                                      *
****************************************
```

```
*************************************
*                                   *
*    U.S. ARMY CORPS OF ENGINEERS   *
*    HYDROLOGIC ENGINEERING CENTER  *
*          609 SECOND STREET        *
*       DAVIS, CALIFORNIA 95616     *
*          (916) 551-1748           *
*                                   *
*************************************
```

```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X              X
XXXXXXX  XXXX     X       XXXXX  X
X     X  X        X              X
X     X  X        X     X        X
X     X  XXXXXXX   XXXXX        XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1 HEC-1 INPUT PAGE 1

```
 LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

   1           ID   FLOOD ASSESSMENT FOR CNTA UC-1 SITE        FILENAME: 26UC1A
   2           ID   5 MINUTE INTERVAL IN ITCARD
   3           ID   2-YEAR 6-HOUR STORM 0.7 INCHES
   4           ID   POINT RAINFALL VALUES FROM NOAA ATLAS 2 VOL VII
   5           ID   DEPTH-AREA REDUCTION FACTORS FROM TABLE 502 IN
   6           ID   CLARK COUNTY HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL (CCRFCD, 1990)
   7           ID   CURVE NUMBERS NOT ADJUSTED
               *DIAGRAM
   8           IT       5       0       0     300
   9           IO       5       0
  10           IN       5
  11           JD     0.7     .01
               * RAINFALL DISTRIBUTION FROM CLARK COUNTY MANUAL LESS THAN 10 SQ. MILES
  12           PC       0       2     5.7     7.0     8.7    10.8    12.4    13.0    13.0    13.0
  13           PC    13.0    13.0    13.0    13.3    14.0    14.2    14.8    15.8    17.2    18.1
  14           PC    19.0    19.7    19.9    20.0    20.1    20.4    21.4    22.9    24.1    24.9
  15           PC    25.1    25.6    27.0    27.8    28.1    28.3    29.5    32.2    35.2    40.9
  16           PC    49.9    59.0    71.0    74.4    78.1    81.2    81.9    83.5    85.1    85.6
  17           PC    86.0    86.8    87.6    88.8    91.0    92.6    93.7    95.0    97.0    97.6
  18           PC    98.2    98.5    98.7    98.9    99.0    99.3    99.3    99.4    99.5    99.8
  19           PC    99.8    99.9   100.0
  20           JD     .68       1
  21           JD     .60    9.99
               * CHANGED RAINFALL DISTRIBUTION ABOVE 10 SQ. MILES PER CLARK COUNTY MANUAL
  22           JD     .60   10.01
  23           PC       0     2.0     5.9     8.0    11.0    14.4    15.0    16.0    16.8    17.1
  24           PC    18.0    18.2    18.7    19.0    19.7    20.2    21.0    22.0    23.0    24.1
  25           PC    25.0    25.9    26.5    28.0    29.0    30.0    30.5    30.9    31.0    31.7
  26           PC    32.1    32.7    33.3    34.6    36.1    38.1    40.8    43.0    47.7    51.4
  27           PC    56.1    63.0    71.0    72.0    73.1    75.2    77.9    79.0    79.5    80.4
  28           PC    81.0    82.0    82.6    84.0    85.9    88.9    91.0    93.8    96.6    97.0
  29           PC    97.4    97.9    98.1    98.3    98.5    98.9    99.0    99.2    99.3    99.6
  30           PC    99.7    99.9   100.0
  31           JD     .55      20
  32           JD     .52      30
  33           JD     .48      50
  34           JD     .42     100
               *
               *  CNTA UC-1 SUBBASINS
               *
```

```
 35          KK    UC1A
 36          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN A
             * UC1A DISCHARGE IS UC1A ALLUVIAL FAN APEX DISCHARGE
 37          BA    0.79
 38          LS              88
 39          UD    0.24
             *

 40          KK  RTCP1A
 41          KM   ROUTE FLOW FROM UC1A THROUGH UC1D TO CP1A (CP1A IS A DUMMY VARIABLE FOR CP1)
 42          RM      10    0.82     0.2
             *
```



```
LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 43          KK    UC1D
 44          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN D
 45          BA    0.66
 46          LS              72
 47          UD    0.51
             *
             *

 48          KK    UC1B
 49          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN B
             * UC1B DISCHARGE IS UC1B ALLUVIAL FAN APEX DISCHARGE
 50          BA    1.25
 51          LS              89
 52          UD    0.41
             *

 53          KK  RTCP1B
 54          KM    ROUTE FLOW FROM UC1B TO CP1B (CP1B IS A DUMMY VARIABLE FOR CP1)
 55          RM       4    0.34     0.2
             *
             *

 56          KK    UC1E
 57          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN E
 58          BA    0.22
 59          LS              72
 60          UD    0.23
             *

 61          KK    UC1C
 62          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN C
 63          BA    0.75
 64          LS              72
 65          UD    0.26
             *

 66          KK     CP1
 67          KM     COMBINE FLOWS FROM UC1A, UC1B, UC1C, UC1D, AND UC1E
 68          HC       5
             *

 69          KK   RTCP2
 70          KM   ROUTE FLOW FROM CP1C THROUGH UC1F TO MUDPIT
 71          RM      10    0.82     0.2
             *

 72          KK    UC1F
 73          KM   BASIN RUNOFF CALCULATION FOR UC-1 SUBBASIN F
 74          BA    0.96
 75          LS              72
 76          UD    0.45
             *
```



```
LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 77          KK    CP2
 78          KM    COMBINE FLOW FROM CP1 AND UC1F AT CP2 (MUDPIT)
 79          HC       2
```

```
          80          ZZ
1
              SCHEMATIC DIAGRAM OF STREAM NETWORK
   T
  .NE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

  NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

   35        UC1A
              V
              V
   40      RTCP1A
              .
              .
   43         .        UC1D
              .           .
              .           .
   48         .           .        UC1B
              .           .          V
              .           .          V
   53         .           .      RTCP1B
              .           .          .
              .           .          .
   56         .           .          .        UC1E
              .           .          .          .
              .           .          .          .
   61         .           .          .          .        UC1C
              .           .          .          .          .
              .           .          .          .          .
   66       CP1.............................................
              V
              V
   69      RTCP2
              .
              .
   72         .        UC1F
              .           .
              .           .
   77       CP2 ............
```

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION

```
1****************************************
*                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *
*              MAY  1991               *
*            VERSION 4.0.1E            *
*                                      *
*  RUN DATE  02/04/99  TIME  15:31:18  *
*                                      *
****************************************
```

```
****************************************
*                                      *
*    U.S. ARMY CORPS OF ENGINEERS      *
*    HYDROLOGIC ENGINEERING CENTER     *
*          609 SECOND STREET           *
*       DAVIS, CALIFORNIA 95616        *
*           (916) 551-1748             *
*                                      *
****************************************
```

```
                    FLOOD ASSESSMENT FOR CNTA UC-1 SITE
                    5 MINUTE INTERVAL IN ITCARD
                    2-YEAR 6-HOUR STORM 0.7 INCHES
                    POINT RAINFALL VALUES FROM NOAA ATLAS 2 VOL VII
                    DEPTH-AREA REDUCTION FACTORS FROM TABLE 502 IN
                    CLARK COUNTY HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL (CCRFCD, 1990)
                    CURVE NUMBERS NOT ADJUSTED

  9 IO        OUTPUT CONTROL VARIABLES
                    IPRNT          5  PRINT CONTROL
                    IPLOT          0  PLOT CONTROL
                    QSCAL         0.  HYDROGRAPH PLOT SCALE

   IT         HYDROGRAPH TIME DATA
                     NMIN          5  MINUTES IN COMPUTATION INTERVAL
                    IDATE     1    0  STARTING DATE
                    ITIME       0000  STARTING TIME
                       NQ        300  NUMBER OF HYDROGRAPH ORDINATES
                   NDDATE     2    0  ENDING DATE
                   NDTIME       0055  ENDING TIME
                    ICENT         19  CENTURY MARK

              COMPUTATION INTERVAL    0.08 HOURS
```

TOTAL TIME BASE 24.92 HOURS

ENGLISH UNITS

DRAINAGE AREA	SQUARE MILES
PRECIPITATION DEPTH	INCHES
LENGTH, ELEVATION	FEET
FLOW	CUBIC FEET PER SECOND
STORAGE VOLUME	ACRE-FEET
SURFACE AREA	ACRES
TEMPERATURE	DEGREES FAHRENHEIT

11 JD INDEX STORM NO. 1

STRM	0.70	PRECIPITATION DEPTH
TRDA	0.01	TRANSPOSITION DRAINAGE AREA

12 PI PRECIPITATION PATTERN

2.00	3.70	1.30	1.70	2.10	1.60	0.60	0.00	0.00	0.00
0.00	0.00	0.30	0.70	0.20	0.60	1.00	1.40	0.90	0.90
0.70	0.20	0.10	0.10	0.30	1.00	1.50	1.20	0.80	0.20
0.50	1.40	0.80	0.30	0.20	1.20	2.70	3.00	5.70	9.00
9.10	12.00	3.40	3.70	3.10	0.70	1.60	1.60	0.50	0.40
0.80	0.80	1.20	2.20	1.60	1.10	1.30	2.00	0.60	0.60
0.30	0.20	0.20	0.10	0.30	0.00	0.10	0.10	0.30	0.00
0.10	0.10								

20 JD INDEX STORM NO. 2

STRM	0.68	PRECIPITATION DEPTH
TRDA	1.00	TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.70	1.30	1.70	2.10	1.60	0.60	0.00	0.00	0.00
0.00	0.00	0.30	0.70	0.20	0.60	1.00	1.40	0.90	0.90
0.70	0.20	0.10	0.10	0.30	1.00	1.50	1.20	0.80	0.20
0.50	1.40	0.80	0.30	0.20	1.20	2.70	3.00	5.70	9.00
9.10	12.00	3.40	3.70	3.10	0.70	1.60	1.60	0.50	0.40
0.80	0.80	1.20	2.20	1.60	1.10	1.30	2.00	0.60	0.60
0.30	0.20	0.20	0.10	0.30	0.00	0.10	0.10	0.30	0.00
0.10	0.10								

21 JD INDEX STORM NO. 3

STRM	0.60	PRECIPITATION DEPTH
TRDA	9.99	TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.70	1.30	1.70	2.10	1.60	0.60	0.00	0.00	0.00
0.00	0.00	0.30	0.70	0.20	0.60	1.00	1.40	0.90	0.90
0.70	0.20	0.10	0.10	0.30	1.00	1.50	1.20	0.80	0.20
0.50	1.40	0.80	0.30	0.20	1.20	2.70	3.00	5.70	9.00
9.10	12.00	3.40	3.70	3.10	0.70	1.60	1.60	0.50	0.40
0.80	0.80	1.20	2.20	1.60	1.10	1.30	2.00	0.60	0.60
0.30	0.20	0.20	0.10	0.30	0.00	0.10	0.10	0.30	0.00
0.10	0.10								

22 JD INDEX STORM NO. 4

STRM	0.60	PRECIPITATION DEPTH
TRDA	10.01	TRANSPOSITION DRAINAGE AREA

23 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

31 JD INDEX STORM NO. 5

STRM	0.55	PRECIPITATION DEPTH
TRDA	20.00	TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40

0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

JD INDEX STORM NO. 6
STRM 0.52 PRECIPITATION DEPTH
TRDA 30.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

33 JD INDEX STORM NO. 7
STRM 0.48 PRECIPITATION DEPTH
TRDA 50.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

34 JD INDEX STORM NO. 8
STRM 0.42 PRECIPITATION DEPTH
TRDA 100.00 TRANSPOSITION DRAINAGE AREA

PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

1

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	UC1A	47.	3.75	8.	2.	2.	0.79		
ROUTED TO	RTCP1A	35.	4.67	8.	2.	2.	0.79		
HYDROGRAPH AT	UC1D	0.	0.08	0.	0.	0.	0.66		
HYDROGRAPH AT	UC1B	69.	3.92	15.	4.	4.	1.25		
ROUTED TO	RTCP1B	63.	4.33	15.	4.	4.	1.25		
HYDROGRAPH AT	UC1E	0.	0.08	0.	0.	0.	0.22		
HYDROGRAPH AT	UC1C	0.	0.08	0.	0.	0.	0.75		
5 COMBINED AT	CP1	72.	4.50	19.	5.	5.	3.67		
ROUTED TO									

+	RTCP2	65.	5.33	19.	5.	5.	3.67
HYDROGRAPH AT							
+	UC1F	0.	0.08	0.	0.	0.	0.96
2 COMBINED AT							
+	CP2	65.	5.33	19.	5.	5.	4.63

*** NORMAL END OF HEC-1 ***

UC-3

HEC-1 MODEL OUTPUT

FILENAME: 1006UC3A

(100-YEAR MODEL)

```
1****************************************
                                        *
    FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
              MAY   1991                *
           VERSION 4.0.1E               *
*                                       *
*  RUN DATE  12/06/98  TIME  20:02:18   *
*                                       *
****************************************
```

```
************************************
*                                  *
*   U.S. ARMY CORPS OF ENGINEERS   *
*   HYDROLOGIC ENGINEERING CENTER  *
*         609 SECOND STREET        *
*      DAVIS, CALIFORNIA 95616     *
*          (916) 551-1748          *
*                                  *
************************************
```

```
X     X  XXXXXXX   XXXXX          X
X     X  X       .X     X        XX
X     X  X        X               X
XXXXXXX  XXXX     X        XXXXX  X
X     X  X        X               X
X     X  X        X     X         X
X     X  XXXXXXX   XXXXX         XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1 HEC-1 INPUT PAGE 1

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID   FLOOD ASSESSMENT FOR CNTA UC-3 SITE    FILENAME:1006UC3A
  2           ID   FILNAME: CNTAUC3A.DAT
  3           ID   5 MINUTE INTERVAL IN ITCARD
  4           ID   100-YEAR 6-HOUR STORM 1.6 INCHES
  5           ID   POINT RAINFALL VALUES FROM NOAA ATLAS 2 VOL VII
  6           ID   DEPTH-AREA REDUCTION FACTORS FROM TABLE 502 IN
  7           ID   CLARK COUNTY HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL (CCRFCD, 1990)
  8           ID   CURVE NUMBERS NOT ADJUSTED
              *DIAGRAM
  9           IT       5       0       0     300
 10           IO       5
 11           IN       5
 12           JD     1.6     .01
              * RAINFALL DISTRIBUTION FROM CLARK COUNTY MANUAL LESS THAN 10 SQ. MILES
 13           PC       0       2     5.7     7.0     8.7    10.8    12.4    13.0    13.0    13.0
 14           PC    13.0    13.0    13.0    13.3    14.0    14.2    14.8    15.8    17.2    18.1
 15           PC    19.0    19.7    19.9    20.0    20.1    20.4    21.4    22.9    24.1    24.9
 16           PC    25.1    25.6    27.0    27.8    28.1    28.3    29.5    32.2    35.2    40.9
 17           PC    49.9    59.0    71.0    74.4    78.1    81.2    81.9    83.5    85.1    85.6
 18           PC    86.0    86.8    87.6    88.8    91.0    92.6    93.7    95.0    97.0    97.6
 19           PC    98.2    98.5    98.7    98.9    99.0    99.3    99.3    99.4    99.5    99.8
 20           PC    99.8    99.9   100.0
 21           JD    1.55       1
 22           JD    1.38    9.99
              * CHANGED RAINFALL DISTRIBUTION ABOVE 10 SQ. MILES PER CLARK COUNTY MANUAL
 23           JD    1.38   10.01
 24           PC       0     2.0     5.9     8.0    11.0    14.4    15.0    16.0    16.8    17.1
 25           PC    18.0    18.2    18.7    19.0    19.7    20.2    21.0    22.0    23.0    24.1
 26           PC    25.0    25.9    26.5    28.0    29.0    30.0    30.5    30.9    31.0    31.7
 27           PC    32.1    32.7    33.3    34.6    36.1    38.1    40.8    43.0    47.7    51.4
 28           PC    56.1    63.0    71.0    72.0    73.1    75.2    77.9    79.0    79.5    80.4
 29           PC    81.0    82.0    82.6    84.0    85.9    88.9    91.0    93.8    96.6    97.0
 30           PC    97.4    97.9    98.1    98.3    98.5    98.9    99.0    99.2    99.3    99.6
 31           PC    99.7    99.9   100.0
 32           JD    1.26      20
 33           JD    1.18      30
 34           JD    1.09      50
 35           JD     .96     100
              *
              *  CNTA UC-3 SUBBASINS
```

```
                    *

 36                 KK    UC3A
 37                 KM   BASIN RUNOFF CALCULATION FOR UC-3 SUBBASIN A
 38                 BA    1.40
 39                 LS              89
 40                 UD    0.28
                    *

 41                 KK   RTCP1
 42                 KM   ROUTE FLOW FROM UC3A THROUGH UC3B TO CP1
 43                 RM       8    .636      .2
                    *
1                                                  HEC-1 INPUT                                                    PAGE  2

LINE                ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 44                 KK    UC3B
 45                 KM   BASIN RUNOFF CALCULATION FOR UC-3 SUBBASIN B
 46                 BA    1.02
 47                 LS              72
 48                 UD    0.72
                    *

 49                 KK     CP1
 50                 KM   CONCENTRATION POINT 1 COMBINES FLOW ROUTED FROM UC3A WITH FLOW FROM UC3B
 51                 HC       2
 52                 ZZ
1
              SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

   36        UC3A
                V
                V
   41       RTCP1
                .
                .
   44           .        UC3B
                .           .
                .           .
   49         CP1............

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************                                                  ***************************************
*                                       *                                                  *                                     *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                  *    U.S. ARMY CORPS OF ENGINEERS     *
*              MAY   1991               *                                                  *    HYDROLOGIC ENGINEERING CENTER    *
*           VERSION 4.0.1E              *                                                  *          609 SECOND STREET          *
*                                       *                                                  *       DAVIS, CALIFORNIA 95616       *
*  RUN DATE  12/06/98  TIME  20:02:18   *                                                  *          (916) 551-1748             *
*                                       *                                                  *                                     *
*****************************************                                                  ***************************************


                        FLOOD ASSESSMENT FOR CNTA UC-3 SITE
                        FILNAME: CNTAUC3A.DAT
                        5 MINUTE INTERVAL IN ITCARD
                        100-YEAR 6-HOUR STORM 1.6 INCHES
                        POINT RAINFALL VALUES FROM NOAA ATLAS 2 VOL VII
                        DEPTH-AREA REDUCTION FACTORS FROM TABLE 502 IN
                        CLARK COUNTY HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL (CCRFCD, 1990)
                        CURVE NUMBERS NOT ADJUSTED

 10 IO          OUTPUT CONTROL VARIABLES
                      IPRNT           5  PRINT CONTROL
                      IPLOT           0  PLOT CONTROL
                      QSCAL          0.  HYDROGRAPH PLOT SCALE

    IT          HYDROGRAPH TIME DATA
                       NMIN           5  MINUTES IN COMPUTATION INTERVAL
```

```
          IDATE      1    0  STARTING DATE
          ITIME         0000  STARTING TIME
             NQ          300  NUMBER OF HYDROGRAPH ORDINATES
         NDDATE      2    0  ENDING DATE
         NDTIME         0055  ENDING TIME
          ICENT           19  CENTURY MARK

     COMPUTATION INTERVAL    0.08 HOURS
          TOTAL TIME BASE   24.92 HOURS

ENGLISH UNITS
    DRAINAGE AREA          SQUARE MILES
    PRECIPITATION DEPTH    INCHES
    LENGTH, ELEVATION      FEET
    FLOW                   CUBIC FEET PER SECOND
    STORAGE VOLUME         ACRE-FEET
    SURFACE AREA           ACRES
    TEMPERATURE            DEGREES FAHRENHEIT

12 JD      INDEX STORM NO. 1
              STRM        1.60  PRECIPITATION DEPTH
              TRDA        0.01  TRANSPOSITION DRAINAGE AREA

13 PI       PRECIPITATION PATTERN
              2.00      3.70      1.30      1.70      2.10      1.60      0.60      0.00      0.00      0.00
              0.00      0.00      0.30      0.70      0.20      0.60      1.00      1.40      0.90      0.90
              0.70      0.20      0.10      0.10      0.30      1.00      1.50      1.20      0.80      0.20
              0.50      1.40      0.80      0.30      0.20      1.20      2.70      3.00      5.70      9.00
              9.10     12.00      3.40      3.70      3.10      0.70      1.60      1.60      0.50      0.40
              0.80      0.80      1.20      2.20      1.60      1.10      1.30      2.00      0.60      0.60
              0.30      0.20      0.20      0.10      0.30      0.00      0.10      0.10      0.30      0.00
              0.10      0.10

21 JD      INDEX STORM NO. 2
              STRM        1.55  PRECIPITATION DEPTH
              TRDA        1.00  TRANSPOSITION DRAINAGE AREA

J PI        PRECIPITATION PATTERN
              2.00      3.70      1.30      1.70      2.10      1.60      0.60      0.00      0.00      0.00
              0.00      0.00      0.30      0.70      0.20      0.60      1.00      1.40      0.90      0.90
              0.70      0.20      0.10      0.10      0.30      1.00      1.50      1.20      0.80      0.20
              0.50      1.40      0.80      0.30      0.20      1.20      2.70      3.00      5.70      9.00
              9.10     12.00      3.40      3.70      3.10      0.70      1.60      1.60      0.50      0.40
              0.80      0.80      1.20      2.20      1.60      1.10      1.30      2.00      0.60      0.60
              0.30      0.20      0.20      0.10      0.30      0.00      0.10      0.10      0.30      0.00
              0.10      0.10

22 JD      INDEX STORM NO. 3
              STRM        1.38  PRECIPITATION DEPTH
              TRDA        9.99  TRANSPOSITION DRAINAGE AREA

0 PI        PRECIPITATION PATTERN
              2.00      3.70      1.30      1.70      2.10      1.60      0.60      0.00      0.00      0.00
              0.00      0.00      0.30      0.70      0.20      0.60      1.00      1.40      0.90      0.90
              0.70      0.20      0.10      0.10      0.30      1.00      1.50      1.20      0.80      0.20
              0.50      1.40      0.80      0.30      0.20      1.20      2.70      3.00      5.70      9.00
              9.10     12.00      3.40      3.70      3.10      0.70      1.60      1.60      0.50      0.40
              0.80      0.80      1.20      2.20      1.60      1.10      1.30      2.00      0.60      0.60
              0.30      0.20      0.20      0.10      0.30      0.00      0.10      0.10      0.30      0.00
              0.10      0.10

23 JD      INDEX STORM NO. 4
              STRM        1.38  PRECIPITATION DEPTH
              TRDA       10.01  TRANSPOSITION DRAINAGE AREA

24 PI       PRECIPITATION PATTERN
              2.00      3.90      2.10      3.00      3.40      0.60      1.00      0.80      0.30      0.90
              0.20      0.50      0.30      0.70      0.50      0.80      1.00      1.00      1.10      0.90
              0.90      0.60      1.50      1.00      1.00      0.50      0.40      0.10      0.70      0.40
              0.60      0.60      1.30      1.50      2.00      2.70      2.20      4.70      3.70      4.70
              6.90      8.00      1.00      1.10      2.10      2.70      1.10      0.50      0.90      0.60
              1.00      0.60      1.40      1.90      3.00      2.10      2.80      2.80      0.40      0.40
              0.50      0.20      0.20      0.20      0.40      0.10      0.20      0.10      0.30      0.10
              0.20      0.10

32 JD      INDEX STORM NO. 5
              STRM        1.26  PRECIPITATION DEPTH
              TRDA       20.00  TRANSPOSITION DRAINAGE AREA
```

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

33 JD INDEX STORM NO. 6

STRM 1.18 PRECIPITATION DEPTH
TRDA 30.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

34 JD INDEX STORM NO. 7

STRM 1.09 PRECIPITATION DEPTH
TRDA 50.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

35 JD INDEX STORM NO. 8

STRM 0.96 PRECIPITATION DEPTH
TRDA 100.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

1

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+	HYDROGRAPH AT	UC3A	607.	3.75	98.	24.	24.	1.40		
+	ROUTED TO	RTCP1	497.	4.42	98.	24.	24.	1.40		
+	HYDROGRAPH AT	UC3B	40.	4.42	14.	3.	3.	1.02		
+	2 COMBINED AT	CP1	508.	4.42	105.	26.	25.	2.42		

*** NORMAL END OF HEC-1 ***

UC-3

HEC-1 MODEL OUTPUT

FILENAME: 1006UC3B

(100-YEAR MODEL)

```
1*****************************************
*                                       *
    FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
              MAY   1991                *
           VERSION 4.0.1E               *
*                                       *
*  RUN DATE  12/07/98  TIME  02:52:03   *
*                                       *
*****************************************
```

```
*************************************
*
*    U.S. ARMY CORPS OF ENGINEERS
*    HYDROLOGIC ENGINEERING CENTER
*          609 SECOND STREET
*       DAVIS, CALIFORNIA 95616
*          (916) 551-1748
*
*************************************
```

```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X              X
XXXXXXX  XXXX     X       XXXXX  X
X     X  X        X              X
X     X  X        X     X        X
X     X  XXXXXXX   XXXXX        XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1

HEC-1 INPUT

PAGE 1

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID   FLOOD ASSESSMENT FOR CNTA UC-3 SITE
  2           ID   FILNAME: 1006UC3B
  3           ID   5 MINUTE INTERVAL IN ITCARD
  4           ID   100-YEAR 6-HOUR STORM 1.6 INCHES
  5           ID   POINT RAINFALL VALUES FROM NOAA ATLAS 2 VOL VII
  6           ID   DEPTH-AREA REDUCTION FACTORS FROM TABLE 502 IN
  7           ID   CLARK COUNTY HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL (CCRFCD, 1990)
  8           ID   CURVE NUMBERS ADJUSTED (+5)
              *DIAGRAM
  9           IT       5       0       0     300
 10           IO       5
 11           IN       5
 12           JD     1.6     .01
              * RAINFALL DISTRIBUTION FROM CLARK COUNTY MANUAL LESS THAN 10 SQ. MILES
 13           PC       0       2     5.7     7.0     8.7    10.8    12.4    13.0    13.0    13.0
 14           PC    13.0    13.0    13.0    13.3    14.0    14.2    14.8    15.8    17.2    18.1
 15           PC    19.0    19.7    19.9    20.0    20.1    20.4    21.4    22.9    24.1    24.9
 16           PC    25.1    25.6    27.0    27.8    28.1    28.3    29.5    32.2    35.2    40.9
 17           PC    49.9    59.0    71.0    74.4    78.1    81.2    81.9    83.5    85.1    85.6
 18           PC    86.0    86.8    87.6    88.8    91.0    92.6    93.7    95.0    97.0    97.6
 19           PC    98.2    98.5    98.7    98.9    99.0    99.3    99.3    99.4    99.5    99.8
 20           PC    99.8    99.9   100.0
 21           JD    1.55       1
 22           JD    1.38    9.99
              * CHANGED RAINFALL DISTRIBUTION ABOVE 10 SQ. MILES PER CLARK COUNTY MANUAL
 23           JD    1.38   10.01
 24           PC       0     2.0     5.9     8.0    11.0    14.4    15.0    16.0    16.8    17.1
 25           PC    18.0    18.2    18.7    19.0    19.7    20.2    21.0    22.0    23.0    24.1
 26           PC    25.0    25.9    26.5    28.0    29.0    30.0    30.5    30.9    31.0    31.7
 27           PC    32.1    32.7    33.3    34.6    36.1    38.1    40.8    43.0    47.7    51.4
 28           PC    56.1    63.0    71.0    72.0    73.1    75.2    77.9    79.0    79.5    80.4
 29           PC    81.0    82.0    82.6    84.0    85.9    88.9    91.0    93.8    96.6    97.0
 30           PC    97.4    97.9    98.1    98.3    98.5    98.9    99.0    99.2    99.3    99.6
 31           PC    99.7    99.9   100.0
 32           JD    1.26      20
 33           JD    1.18      30
 34           JD    1.09      50
 35           JD     .96     100
              *
              *  CNTA UC-3 SUBBASINS
```

```
                    *

 36                 KK    UC3A
 37                 KM    BASIN RUNOFF CALCULATION FOR UC-3 SUBBASIN A
 38                 BA    1.40
 39                 LS              94
 40                 UD    0.28
                    *

 41                 KK    RTCP1
 42                 KM    ROUTE FLOW FROM UC3A THROUGH UC3B TO CP1
 43                 RM       8    .636      .2
                    *
1                                                HEC-1 INPUT                                                    PAGE  2

        LINE        ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 44                 KK    UC3B
 45                 KM    BASIN RUNOFF CALCULATION FOR UC-3 SUBBASIN B
 46                 BA    1.02
 47                 LS              77
 48                 UD    0.72
                    *

 49                 KK     CP1
 50                 KM    CONCENTRATION POINT 1 COMBINES FLOW ROUTED FROM UC3A WITH FLOW FROM UC3B
 51                 HC       2
 52                 ZZ
1
                 SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

   36        UC3A
                V
                V
   41       RTCP1
                .
                .
   44           .        UC3B
                .           .
                .           .
   49         CP1............

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************                                                  ************************************
*                                       *                                                  *                                  *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                  *    U.S. ARMY CORPS OF ENGINEERS
*              MAY   1991               *                                                  *    HYDROLOGIC ENGINEERING CENTER
*           VERSION 4.0.1E              *                                                  *          609 SECOND STREET
*                                       *                                                  *       DAVIS, CALIFORNIA 95616
*  RUN DATE  12/07/98  TIME  02:52:03   *                                                  *          (916) 551-1748
*                                       *                                                  *                                  *
*****************************************                                                  ************************************


                    FLOOD ASSESSMENT FOR CNTA UC-3 SITE
                    FILNAME: CNTAUC3A.DAT
                    5 MINUTE INTERVAL IN ITCARD
                    100-YEAR 6-HOUR STORM 1.6 INCHES
                    POINT RAINFALL VALUES FROM NOAA ATLAS 2 VOL VII
                    DEPTH-AREA REDUCTION FACTORS FROM TABLE 502 IN
                    CLARK COUNTY HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL (CCRFCD, 1990)
                    CURVE NUMBERS ADJUSTED (+5)

 10 IO          OUTPUT CONTROL VARIABLES
                      IPRNT          5  PRINT CONTROL
                      IPLOT          0  PLOT CONTROL
                      QSCAL         0.  HYDROGRAPH PLOT SCALE

    IT          HYDROGRAPH TIME DATA
                       NMIN          5  MINUTES IN COMPUTATION INTERVAL
```

```
          IDATE      1    0  STARTING DATE
          ITIME         0000  STARTING TIME
             NQ          300  NUMBER OF HYDROGRAPH ORDINATES
         NDDATE      2    0  ENDING DATE
         NDTIME         0055  ENDING TIME
          ICENT           19  CENTURY MARK

     COMPUTATION INTERVAL     0.08 HOURS
          TOTAL TIME BASE    24.92 HOURS

ENGLISH UNITS
     DRAINAGE AREA          SQUARE MILES
     PRECIPITATION DEPTH    INCHES
     LENGTH, ELEVATION      FEET
     FLOW                   CUBIC FEET PER SECOND
     STORAGE VOLUME         ACRE-FEET
     SURFACE AREA           ACRES
     TEMPERATURE            DEGREES FAHRENHEIT

12 JD      INDEX STORM NO. 1
              STRM        1.60  PRECIPITATION DEPTH
              TRDA        0.01  TRANSPOSITION DRAINAGE AREA

13 PI      PRECIPITATION PATTERN
              2.00      3.70      1.30      1.70      2.10      1.60      0.60      0.00      0.00      0.00
              0.00      0.00      0.30      0.70      0.20      0.60      1.00      1.40      0.90      0.90
              0.70      0.20      0.10      0.10      0.30      1.00      1.50      1.20      0.80      0.20
              0.50      1.40      0.80      0.30      0.20      1.20      2.70      3.00      5.70      9.00
              9.10     12.00      3.40      3.70      3.10      0.70      1.60      1.60      0.50      0.40
              0.80      0.80      1.20      2.20      1.60      1.10      1.30      2.00      0.60      0.60
              0.30      0.20      0.20      0.10      0.30      0.00      0.10      0.10      0.30      0.00
              0.10      0.10

21 JD      INDEX STORM NO. 2
              STRM        1.55  PRECIPITATION DEPTH
              TRDA        1.00  TRANSPOSITION DRAINAGE AREA

 PI        PRECIPITATION PATTERN
              2.00      3.70      1.30      1.70      2.10      1.60      0.60      0.00      0.00      0.00
              0.00      0.00      0.30      0.70      0.20      0.60      1.00      1.40      0.90      0.90
              0.70      0.20      0.10      0.10      0.30      1.00      1.50      1.20      0.80      0.20
              0.50      1.40      0.80      0.30      0.20      1.20      2.70      3.00      5.70      9.00
              9.10     12.00      3.40      3.70      3.10      0.70      1.60      1.60      0.50      0.40
              0.80      0.80      1.20      2.20      1.60      1.10      1.30      2.00      0.60      0.60
              0.30      0.20      0.20      0.10      0.30      0.00      0.10      0.10      0.30      0.00
              0.10      0.10

22 JD      INDEX STORM NO. 3
              STRM        1.38  PRECIPITATION DEPTH
              TRDA        9.99  TRANSPOSITION DRAINAGE AREA

 0 PI      PRECIPITATION PATTERN
              2.00      3.70      1.30      1.70      2.10      1.60      0.60      0.00      0.00      0.00
              0.00      0.00      0.30      0.70      0.20      0.60      1.00      1.40      0.90      0.90
              0.70      0.20      0.10      0.10      0.30      1.00      1.50      1.20      0.80      0.20
              0.50      1.40      0.80      0.30      0.20      1.20      2.70      3.00      5.70      9.00
              9.10     12.00      3.40      3.70      3.10      0.70      1.60      1.60      0.50      0.40
              0.80      0.80      1.20      2.20      1.60      1.10      1.30      2.00      0.60      0.60
              0.30      0.20      0.20      0.10      0.30      0.00      0.10      0.10      0.30      0.00
              0.10      0.10

23 JD      INDEX STORM NO. 4
              STRM        1.38  PRECIPITATION DEPTH
              TRDA       10.01  TRANSPOSITION DRAINAGE AREA

24 PI      PRECIPITATION PATTERN
              2.00      3.90      2.10      3.00      3.40      0.60      1.00      0.80      0.30      0.90
              0.20      0.50      0.30      0.70      0.50      0.80      1.00      1.00      1.10      0.90
              0.90      0.60      1.50      1.00      1.00      0.50      0.40      0.10      0.70      0.40
              0.60      0.60      1.30      1.50      2.00      2.70      2.20      4.70      3.70      4.70
              6.90      8.00      1.00      1.10      2.10      2.70      1.10      0.50      0.90      0.60
              1.00      0.60      1.40      1.90      3.00      2.10      2.80      2.80      0.40      0.40
              0.50      0.20      0.20      0.20      0.40      0.10      0.20      0.10      0.30      0.10
              0.20      0.10

32 JD      INDEX STORM NO. 5
              STRM        1.26  PRECIPITATION DEPTH
              TRDA       20.00  TRANSPOSITION DRAINAGE AREA
```

```
 0 PI          PRECIPITATION PATTERN
                 2.00      3.90      2.10      3.00      3.40      0.60      1.00      0.80      0.30      0.90
                 0.20      0.50      0.30      0.70      0.50      0.80      1.00      1.00      1.10      0.90
                 0.90      0.60      1.50      1.00      1.00      0.50      0.40      0.10      0.70      0.40
                 0.60      0.60      1.30      1.50      2.00      2.70      2.20      4.70      3.70      4.70
                 6.90      8.00      1.00      1.10      2.10      2.70      1.10      0.50      0.90      0.60
                 1.00      0.60      1.40      1.90      3.00      2.10      2.80      2.80      0.40      0.40
                 0.50      0.20      0.20      0.20      0.40      0.10      0.20      0.10      0.30      0.10
                 0.20      0.10

33 JD         INDEX STORM NO. 6
                    STRM        1.18  PRECIPITATION DEPTH
                    TRDA       30.00  TRANSPOSITION DRAINAGE AREA

 0 PI          PRECIPITATION PATTERN
                 2.00      3.90      2.10      3.00      3.40      0.60      1.00      0.80      0.30      0.90
                 0.20      0.50      0.30      0.70      0.50      0.80      1.00      1.00      1.10      0.90
                 0.90      0.60      1.50      1.00      1.00      0.50      0.40      0.10      0.70      0.40
                 0.60      0.60      1.30      1.50      2.00      2.70      2.20      4.70      3.70      4.70
                 6.90      8.00      1.00      1.10      2.10      2.70      1.10      0.50      0.90      0.60
                 1.00      0.60      1.40      1.90      3.00      2.10      2.80      2.80      0.40      0.40
                 0.50      0.20      0.20      0.20      0.40      0.10      0.20      0.10      0.30      0.10
                 0.20      0.10

34 JD         INDEX STORM NO. 7
                    STRM        1.09  PRECIPITATION DEPTH
                    TRDA       50.00  TRANSPOSITION DRAINAGE AREA

 0 PI          PRECIPITATION PATTERN
                 2.00      3.90      2.10      3.00      3.40      0.60      1.00      0.80      0.30      0.90
                 0.20      0.50      0.30      0.70      0.50      0.80      1.00      1.00      1.10      0.90
                 0.90      0.60      1.50      1.00      1.00      0.50      0.40      0.10      0.70      0.40
                 0.60      0.60      1.30      1.50      2.00      2.70      2.20      4.70      3.70      4.70
                 6.90      8.00      1.00      1.10      2.10      2.70      1.10      0.50      0.90      0.60
                 1.00      0.60      1.40      1.90      3.00      2.10      2.80      2.80      0.40      0.40
                 0.50      0.20      0.20      0.20      0.40      0.10      0.20      0.10      0.30      0.10
                 0.20      0.10

35 JD         INDEX STORM NO. 8
                    STRM        0.96  PRECIPITATION DEPTH
                    TRDA      100.00  TRANSPOSITION DRAINAGE AREA

 0 PI          PRECIPITATION PATTERN
                 2.00      3.90      2.10      3.00      3.40      0.60      1.00      0.80      0.30      0.90
                 0.20      0.50      0.30      0.70      0.50      0.80      1.00      1.00      1.10      0.90
                 0.90      0.60      1.50      1.00      1.00      0.50      0.40      0.10      0.70      0.40
                 0.60      0.60      1.30      1.50      2.00      2.70      2.20      4.70      3.70      4.70
                 6.90      8.00      1.00      1.10      2.10      2.70      1.10      0.50      0.90      0.60
                 1.00      0.60      1.40      1.90      3.00      2.10      2.80      2.80      0.40      0.40
                 0.50      0.20      0.20      0.20      0.40      0.10      0.20      0.10      0.30      0.10
                 0.20      0.10
1
```

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+	HYDROGRAPH AT	UC3A	867.	3.67	144.	36.	35.	1.40		
+	ROUTED TO	RTCP1	714.	4.33	144.	36.	35.	1.40		
+	HYDROGRAPH AT	UC3B	82.	4.33	25.	6.	6.	1.02		
+	2 COMBINED AT	CP1	760.	4.33	161.	40.	39.	2.42		

*** NORMAL END OF HEC-1 ***

UC-3

HEC-1 MODEL OUTPUT

FILENAME: 256UC3A

(25-YEAR MODEL)

```
1*****************************************
*                                       *
    FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
              MAY   1991                *
           VERSION 4.0.1E               *
*                                       *
*  RUN DATE  12/06/98  TIME  19:25:33   *
*                                       *
*****************************************
```

```
*************************************
*                                   *
*    U.S. ARMY CORPS OF ENGINEERS   *
*    HYDROLOGIC ENGINEERING CENTER  *
*          609 SECOND STREET        *
*       DAVIS, CALIFORNIA 95616     *
*          (916) 551-1748           *
*                                   *
*************************************
```

```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X               X
XXXXXXX  XXXX     X        XXXXX  X
X     X  X        X               X
X     X  X        X     X         X
X     X  XXXXXXX   XXXXX         XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1

HEC-1 INPUT

PAGE 1

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID   FLOOD ASSESSMENT FOR CNTA UC-3 SITE
  2           ID   FILENAME: 256UC3A
  3           ID   5 MINUTE INTERVAL IN ITCARD
  4           ID    25-YEAR 6-HOUR STORM 1.3 INCHES
  5           ID   POINT RAINFALL FROM NOAA ATLAS II VOL 7 (NO ADJUSTMENT NECESSARY)
  6           ID   DEPTH-AREA REDUCTION FACTORS FROM TABLE 502 IN
  7           ID   CLARK COUNTY HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL (CCFRCD, 1990)
  8           ID   CURVE NUMBERS NOT ADJUSTED
              *DIAGRAM
  9           IT       5       0       0     300
 10           IO       5
 11           IN       5
 12           JD     1.3     .01
              * RAINFALL DISTRIBUTION FROM CLARK COUNTY MANUAL LESS THAN 10 SQ. MILES
 13           PC       0       2     5.7     7.0     8.7    10.8    12.4    13.0    13.0    13.0
 14           PC    13.0    13.0    13.0    13.3    14.0    14.2    14.8    15.8    17.2    18.1
 15           PC    19.0    19.7    19.9    20.0    20.1    20.4    21.4    22.9    24.1    24.9
 16           PC    25.1    25.6    27.0    27.8    28.1    28.3    29.5    32.2    35.2    40.9
 17           PC    49.9    59.0    71.0    74.4    78.1    81.2    81.9    83.5    85.1    85.6
 18           PC    86.0    86.8    87.6    88.8    91.0    92.6    93.7    95.0    97.0    97.6
 19           PC    98.2    98.5    98.7    98.9    99.0    99.3    99.3    99.4    99.5    99.8
 20           PC    99.8    99.9   100.0
 21           JD    1.26       1
 22           JD    1.12    9.99
              * CHANGED RAINFALL DISTRIBUTION ABOVE 10 SQ. MILES PER CLARK COUNTY MANUAL
 23           JD    1.12   10.01
 24           PC       0     2.0     5.9     8.0    11.0    14.4    15.0    16.0    16.8    17.1
 25           PC    18.0    18.2    18.7    19.0    19.7    20.2    21.0    22.0    23.0    24.1
 26           PC    25.0    25.9    26.5    28.0    29.0    30.0    30.5    30.9    31.0    31.7
 27           PC    32.1    32.7    33.3    34.6    36.1    38.1    40.8    43.0    47.7    51.4
 28           PC    56.1    63.0    71.0    72.0    73.1    75.2    77.9    79.0    79.5    80.4
 29           PC    81.0    82.0    82.6    84.0    85.9    88.9    91.0    93.8    96.6    97.0
 30           PC    97.4    97.9    98.1    98.3    98.5    98.9    99.0    99.2    99.3    99.6
 31           PC    99.7    99.9   100.0
 32           JD    1.03      20
 33           JD     .96      30
 34           JD     .88      50
 35           JD     .78     100
              *
              *  CNTA UC-3 SUBBASINS
```

```
                    *

   36               KK    UC3A
   37               KM   BASIN RUNOFF CALCULATION FOR UC-3 SUBBASIN A
   38               BA    1.40
   39               LS              89
   40               UD     .28
                    *

   41               KK   RTCP1
   42               KM   ROUTE FLOW FROM UC3A THROUGH UC3B TO CP1
   43               RM       8    .636      .2
                    *
1                                                HEC-1 INPUT                                                PAGE  2

 LINE               ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

   44               KK    UC3B
   45               KM   BASIN RUNOFF CALCULATION FOR UC-3 SUBBASIN B
   46               BA    1.02
   47               LS              72
   48               UD     .72
                    *

   49               KK     CP1
   50               KM   CONCENTRATION POINT 1 COMBINES FLOW ROUTED FROM UC3A WITH FLOW FROM UC3B
   51               HC       2
   52               ZZ
1
              SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

   36        UC3A
               V
               V
   41       RTCP1
               .
               .
   44          .        UC3B
               .           .
               .           .
   49        CP1............

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************                                                  ************************************
 *                                       *                                                  *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                  *    U.S. ARMY CORPS OF ENGINEERS
 *              MAY   1991               *                                                  *    HYDROLOGIC ENGINEERING CENTER
 *           VERSION 4.0.1E              *                                                  *          609 SECOND STREET
 *                                       *                                                  *       DAVIS, CALIFORNIA 95616
 *  RUN DATE  12/06/98  TIME  19:25:33   *                                                  *          (916) 551-1748
 *                                       *                                                  *
 *****************************************                                                  ************************************


                        FLOOD ASSESSMENT FOR CNTA UC-3 SITE
                        FILENAME: 256UC3A.DAT
                        5 MINUTE INTERVAL IN ITCARD
                         25-YEAR 6-HOUR STORM 1.3 INCHES
                        POINT RAINFALL FROM NOAA ATLAS II VOL 7 (NO ADJUSTMENT NECESSARY)
                        DEPTH-AREA REDUCTION FACTORS FROM TABLE 502 IN
                        CLARK COUNTY HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL (CCFRCD, 1990)
                        CURVE NUMBERS NOT ADJUSTED

  10 IO          OUTPUT CONTROL VARIABLES
                       IPRNT           5  PRINT CONTROL
                       IPLOT           0  PLOT CONTROL
                       QSCAL          0.  HYDROGRAPH PLOT SCALE

     IT          HYDROGRAPH TIME DATA
                        NMIN           5  MINUTES IN COMPUTATION INTERVAL
```

```
          IDATE      1    0  STARTING DATE
          ITIME         0000  STARTING TIME
             NQ          300  NUMBER OF HYDROGRAPH ORDINATES
         NDDATE      2    0  ENDING DATE
         NDTIME         0055  ENDING TIME
          ICENT           19  CENTURY MARK

     COMPUTATION INTERVAL    0.08 HOURS
          TOTAL TIME BASE   24.92 HOURS

ENGLISH UNITS
     DRAINAGE AREA          SQUARE MILES
     PRECIPITATION DEPTH    INCHES
     LENGTH, ELEVATION      FEET
     FLOW                   CUBIC FEET PER SECOND
     STORAGE VOLUME         ACRE-FEET
     SURFACE AREA           ACRES
     TEMPERATURE            DEGREES FAHRENHEIT

12 JD      INDEX STORM NO. 1
              STRM       1.30  PRECIPITATION DEPTH
              TRDA       0.01  TRANSPOSITION DRAINAGE AREA

13 PI      PRECIPITATION PATTERN
              2.00       3.70       1.30       1.70       2.10       1.60       0.60       0.00       0.00       0.00
              0.00       0.00       0.30       0.70       0.20       0.60       1.00       1.40       0.90       0.90
              0.70       0.20       0.10       0.10       0.30       1.00       1.50       1.20       0.80       0.20
              0.50       1.40       0.80       0.30       0.20       1.20       2.70       3.00       5.70       9.00
              9.10      12.00       3.40       3.70       3.10       0.70       1.60       1.60       0.50       0.40
              0.80       0.80       1.20       2.20       1.60       1.10       1.30       2.00       0.60       0.60
              0.30       0.20       0.20       0.10       0.30       0.00       0.10       0.10       0.30       0.00
              0.10       0.10

21 JD      INDEX STORM NO. 2
              STRM       1.26  PRECIPITATION DEPTH
              TRDA       1.00  TRANSPOSITION DRAINAGE AREA

J PI       PRECIPITATION PATTERN
              2.00       3.70       1.30       1.70       2.10       1.60       0.60       0.00       0.00       0.00
              0.00       0.00       0.30       0.70       0.20       0.60       1.00       1.40       0.90       0.90
              0.70       0.20       0.10       0.10       0.30       1.00       1.50       1.20       0.80       0.20
              0.50       1.40       0.80       0.30       0.20       1.20       2.70       3.00       5.70       9.00
              9.10      12.00       3.40       3.70       3.10       0.70       1.60       1.60       0.50       0.40
              0.80       0.80       1.20       2.20       1.60       1.10       1.30       2.00       0.60       0.60
              0.30       0.20       0.20       0.10       0.30       0.00       0.10       0.10       0.30       0.00
              0.10       0.10

22 JD      INDEX STORM NO. 3
              STRM       1.12  PRECIPITATION DEPTH
              TRDA       9.99  TRANSPOSITION DRAINAGE AREA

0 PI       PRECIPITATION PATTERN
              2.00       3.70       1.30       1.70       2.10       1.60       0.60       0.00       0.00       0.00
              0.00       0.00       0.30       0.70       0.20       0.60       1.00       1.40       0.90       0.90
              0.70       0.20       0.10       0.10       0.30       1.00       1.50       1.20       0.80       0.20
              0.50       1.40       0.80       0.30       0.20       1.20       2.70       3.00       5.70       9.00
              9.10      12.00       3.40       3.70       3.10       0.70       1.60       1.60       0.50       0.40
              0.80       0.80       1.20       2.20       1.60       1.10       1.30       2.00       0.60       0.60
              0.30       0.20       0.20       0.10       0.30       0.00       0.10       0.10       0.30       0.00
              0.10       0.10

23 JD      INDEX STORM NO. 4
              STRM       1.12  PRECIPITATION DEPTH
              TRDA      10.01  TRANSPOSITION DRAINAGE AREA

24 PI      PRECIPITATION PATTERN
              2.00       3.90       2.10       3.00       3.40       0.60       1.00       0.80       0.30       0.90
              0.20       0.50       0.30       0.70       0.50       0.80       1.00       1.00       1.10       0.90
              0.90       0.60       1.50       1.00       1.00       0.50       0.40       0.10       0.70       0.40
              0.60       0.60       1.30       1.50       2.00       2.70       2.20       4.70       3.70       4.70
              6.90       8.00       1.00       1.10       2.10       2.70       1.10       0.50       0.90       0.60
              1.00       0.60       1.40       1.90       3.00       2.10       2.80       2.80       0.40       0.40
              0.50       0.20       0.20       0.20       0.40       0.10       0.20       0.10       0.30       0.10
              0.20       0.10

32 JD      INDEX STORM NO. 5
              STRM       1.03  PRECIPITATION DEPTH
              TRDA      20.00  TRANSPOSITION DRAINAGE AREA
```

0 PI. PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

33 JD INDEX STORM NO. 6

STRM 0.96 PRECIPITATION DEPTH
TRDA 30.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

34 JD INDEX STORM NO. 7

STRM 0.88 PRECIPITATION DEPTH
TRDA 50.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

35 JD INDEX STORM NO. 8

STRM 0.78 PRECIPITATION DEPTH
TRDA 100.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

1

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+	HYDROGRAPH AT	UC3A	414.	3.75	67.	17.	16.	1.40		
+	ROUTED TO	RTCP1	339.	4.42	67.	17.	16.	1.40		
+	HYDROGRAPH AT	UC3B	18.	5.25	6.	1.	1.	1.02		
+	2 COMBINED AT	CP1	339.	4.42	70.	17.	17.	2.42		

*** NORMAL END OF HEC-1 ***

UC-3

HEC-1 MODEL OUTPUT

FILENAME: 256UC3B

(25-YEAR MODEL)

```
1*****************************************
*                                       *
    FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
              MAY   1991                *
           VERSION 4.0.1E               *
                                        *
*  RUN DATE  12/07/98  TIME  03:03:41   *
*                                       *
*****************************************
```

```
*************************************
*                                   *
*    U.S. ARMY CORPS OF ENGINEERS   *
*    HYDROLOGIC ENGINEERING CENTER  *
*          609 SECOND STREET        *
*       DAVIS, CALIFORNIA 95616     *
*          (916) 551-1748           *
*                                   *
*************************************
```

```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X              X
XXXXXXX  XXXX     X        XXXXX X
X     X  X        X              X
X     X  X        X     X        X
X     X  XXXXXXX   XXXXX         XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1

HEC-1 INPUT

PAGE 1

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID   FLOOD ASSESSMENT FOR CNTA UC-3 SITE
  2           ID   FILENAME: 256UC3B
  3           ID   5 MINUTE INTERVAL IN ITCARD
  4           ID    25-YEAR 6-HOUR STORM 1.3 INCHES
  5           ID   POINT RAINFALL FROM NOAA ATLAS II VOL 7 (NO ADJUSTMENT NECESSARY)
  6           ID   DEPTH-AREA REDUCTION FACTORS FROM TABLE 502 IN
  7           ID   CLARK COUNTY HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL (CCFRCD, 1990)
  8           ID   CURVE NUMBERS ADJUSTED (+3)
              *DIAGRAM
  9           IT       5       0       0     300
 10           IO       5
 11           IN       5
 12           JD     1.3     .01
              * RAINFALL DISTRIBUTION FROM CLARK COUNTY MANUAL LESS THAN 10 SQ. MILES
 13           PC       0       2     5.7     7.0     8.7    10.8    12.4    13.0    13.0    13.0
 14           PC    13.0    13.0    13.0    13.3    14.0    14.2    14.8    15.8    17.2    18.1
 15           PC    19.0    19.7    19.9    20.0    20.1    20.4    21.4    22.9    24.1    24.9
 16           PC    25.1    25.6    27.0    27.8    28.1    28.3    29.5    32.2    35.2    40.9
 17           PC    49.9    59.0    71.0    74.4    78.1    81.2    81.9    83.5    85.1    85.6
 18           PC    86.0    86.8    87.6    88.8    91.0    92.6    93.7    95.0    97.0    97.6
 19           PC    98.2    98.5    98.7    98.9    99.0    99.3    99.3    99.4    99.5    99.8
 20           PC    99.8    99.9   100.0
 21           JD    1.26       1
 22           JD    1.12    9.99
              * CHANGED RAINFALL DISTRIBUTION ABOVE 10 SQ. MILES PER CLARK COUNTY MANUAL
 23           JD    1.12   10.01
 24           PC       0     2.0     5.9     8.0    11.0    14.4    15.0    16.0    16.8    17.1
 25           PC    18.0    18.2    18.7    19.0    19.7    20.2    21.0    22.0    23.0    24.1
 26           PC    25.0    25.9    26.5    28.0    29.0    30.0    30.5    30.9    31.0    31.7
 27           PC    32.1    32.7    33.3    34.6    36.1    38.1    40.8    43.0    47.7    51.4
 28           PC    56.1    63.0    71.0    72.0    73.1    75.2    77.9    79.0    79.5    80.4
 29           PC    81.0    82.0    82.6    84.0    85.9    88.9    91.0    93.8    96.6    97.0
 30           PC    97.4    97.9    98.1    98.3    98.5    98.9    99.0    99.2    99.3    99.6
 31           PC    99.7    99.9   100.0
 32           JD    1.03      20
 33           JD     .96      30
 34           JD     .88      50
 35           JD     .78     100
              *
              *  CNTA UC-3 SUBBASINS
```

```
                    *

  36                KK    UC3A
  37                KM   BASIN RUNOFF CALCULATION FOR UC-3 SUBBASIN A
  38                BA    1.40
  39                LS              92
  40                UD     .28
                    *

  41                KK   RTCP1
  42                KM   ROUTE FLOW FROM UC3A THROUGH UC3B TO CP1
  43                RM       8    .636      .2
                    *
1                                                HEC-1 INPUT                                                PAGE  2

        LINE        ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  44                KK    UC3B
  45                KM   BASIN RUNOFF CALCULATION FOR UC-3 SUBBASIN B
  46                BA    1.02
  47                LS              75
  48                UD     .72
                    *

  49                KK     CP1
  50                KM   CONCENTRATION POINT 1 COMBINES FLOW ROUTED FROM UC3A WITH FLOW FROM UC3B
  51                HC       2
  52                ZZ
1
              SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

   36        UC3A
                V
                V
   41       RTCP1
                .
                .
   44           .        UC3B
                .           .
                .           .
   49         CP1............

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************                                                  ****************************************
 *                                       *                                                  *                                      *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                  *    U.S. ARMY CORPS OF ENGINEERS      *
 *              MAY   1991               *                                                  *    HYDROLOGIC ENGINEERING CENTER     *
 *           VERSION 4.0.1E              *                                                  *          609 SECOND STREET           *
 *                                       *                                                  *       DAVIS, CALIFORNIA 95616        *
 *  RUN DATE  12/07/98  TIME  03:03:41   *                                                  *           (916) 551-1748             *
 *                                       *                                                  *                                      *
 *****************************************                                                  ****************************************


                        FLOOD ASSESSMENT FOR CNTA UC-3 SITE
                        FILENAME: 256UC3B.DAT
                        5 MINUTE INTERVAL IN ITCARD
                         25-YEAR 6-HOUR STORM 1.3 INCHES
                        POINT RAINFALL FROM NOAA ATLAS II VOL 7 (NO ADJUSTMENT NECESSARY)
                        DEPTH-AREA REDUCTION FACTORS FROM TABLE 502 IN
                        CLARK COUNTY HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL (CCFRCD, 1990)
                        CURVE NUMBERS ADJUSTED (+3)

  10 IO          OUTPUT CONTROL VARIABLES
                       IPRNT           5  PRINT CONTROL
                       IPLOT           0  PLOT CONTROL
                       QSCAL          0.  HYDROGRAPH PLOT SCALE

     IT          HYDROGRAPH TIME DATA
                        NMIN           5  MINUTES IN COMPUTATION INTERVAL
```

```
          IDATE      1    0  STARTING DATE
          ITIME         0000  STARTING TIME
             NQ          300  NUMBER OF HYDROGRAPH ORDINATES
         NDDATE      2    0  ENDING DATE
         NDTIME         0055  ENDING TIME
          ICENT           19  CENTURY MARK

     COMPUTATION INTERVAL    0.08 HOURS
          TOTAL TIME BASE   24.92 HOURS

ENGLISH UNITS
     DRAINAGE AREA          SQUARE MILES
     PRECIPITATION DEPTH    INCHES
     LENGTH, ELEVATION      FEET
     FLOW                   CUBIC FEET PER SECOND
     STORAGE VOLUME         ACRE-FEET
     SURFACE AREA           ACRES
     TEMPERATURE            DEGREES FAHRENHEIT

12 JD      INDEX STORM NO. 1
              STRM        1.30  PRECIPITATION DEPTH
              TRDA        0.01  TRANSPOSITION DRAINAGE AREA

13 PI        PRECIPITATION PATTERN
              2.00   3.70   1.30   1.70   2.10   1.60   0.60   0.00   0.00   0.00
              0.00   0.00   0.30   0.70   0.20   0.60   1.00   1.40   0.90   0.90
              0.70   0.20   0.10   0.10   0.30   1.00   1.50   1.20   0.80   0.20
              0.50   1.40   0.80   0.30   0.20   1.20   2.70   3.00   5.70   9.00
              9.10  12.00   3.40   3.70   3.10   0.70   1.60   1.60   0.50   0.40
              0.80   0.80   1.20   2.20   1.60   1.10   1.30   2.00   0.60   0.60
              0.30   0.20   0.20   0.10   0.30   0.00   0.10   0.10   0.30   0.00
              0.10   0.10

21 JD      INDEX STORM NO. 2
              STRM        1.26  PRECIPITATION DEPTH
              TRDA        1.00  TRANSPOSITION DRAINAGE AREA

PI           PRECIPITATION PATTERN
              2.00   3.70   1.30   1.70   2.10   1.60   0.60   0.00   0.00   0.00
              0.00   0.00   0.30   0.70   0.20   0.60   1.00   1.40   0.90   0.90
              0.70   0.20   0.10   0.10   0.30   1.00   1.50   1.20   0.80   0.20
              0.50   1.40   0.80   0.30   0.20   1.20   2.70   3.00   5.70   9.00
              9.10  12.00   3.40   3.70   3.10   0.70   1.60   1.60   0.50   0.40
              0.80   0.80   1.20   2.20   1.60   1.10   1.30   2.00   0.60   0.60
              0.30   0.20   0.20   0.10   0.30   0.00   0.10   0.10   0.30   0.00
              0.10   0.10

22 JD      INDEX STORM NO. 3
              STRM        1.12  PRECIPITATION DEPTH
              TRDA        9.99  TRANSPOSITION DRAINAGE AREA

0 PI         PRECIPITATION PATTERN
              2.00   3.70   1.30   1.70   2.10   1.60   0.60   0.00   0.00   0.00
              0.00   0.00   0.30   0.70   0.20   0.60   1.00   1.40   0.90   0.90
              0.70   0.20   0.10   0.10   0.30   1.00   1.50   1.20   0.80   0.20
              0.50   1.40   0.80   0.30   0.20   1.20   2.70   3.00   5.70   9.00
              9.10  12.00   3.40   3.70   3.10   0.70   1.60   1.60   0.50   0.40
              0.80   0.80   1.20   2.20   1.60   1.10   1.30   2.00   0.60   0.60
              0.30   0.20   0.20   0.10   0.30   0.00   0.10   0.10   0.30   0.00
              0.10   0.10

23 JD      INDEX STORM NO. 4
              STRM        1.12  PRECIPITATION DEPTH
              TRDA       10.01  TRANSPOSITION DRAINAGE AREA

24 PI        PRECIPITATION PATTERN
              2.00   3.90   2.10   3.00   3.40   0.60   1.00   0.80   0.30   0.90
              0.20   0.50   0.30   0.70   0.50   0.80   1.00   1.00   1.10   0.90
              0.90   0.60   1.50   1.00   1.00   0.50   0.40   0.10   0.70   0.40
              0.60   0.60   1.30   1.50   2.00   2.70   2.20   4.70   3.70   4.70
              6.90   8.00   1.00   1.10   2.10   2.70   1.10   0.50   0.90   0.60
              1.00   0.60   1.40   1.90   3.00   2.10   2.80   2.80   0.40   0.40
              0.50   0.20   0.20   0.20   0.40   0.10   0.20   0.10   0.30   0.10
              0.20   0.10

32 JD      INDEX STORM NO. 5
              STRM        1.03  PRECIPITATION DEPTH
              TRDA       20.00  TRANSPOSITION DRAINAGE AREA
```

```
0 PI          PRECIPITATION PATTERN
                2.00     3.90     2.10     3.00     3.40     0.60     1.00     0.80     0.30     0.90
                0.20     0.50     0.30     0.70     0.50     0.80     1.00     1.00     1.10     0.90
                0.90     0.60     1.50     1.00     1.00     0.50     0.40     0.10     0.70     0.40
                0.60     0.60     1.30     1.50     2.00     2.70     2.20     4.70     3.70     4.70
                6.90     8.00     1.00     1.10     2.10     2.70     1.10     0.50     0.90     0.60
                1.00     0.60     1.40     1.90     3.00     2.10     2.80     2.80     0.40     0.40
                0.50     0.20     0.20     0.20     0.40     0.10     0.20     0.10     0.30     0.10
                0.20     0.10

33 JD       INDEX STORM NO. 6
                STRM        0.96  PRECIPITATION DEPTH
                TRDA       30.00  TRANSPOSITION DRAINAGE AREA

0 PI          PRECIPITATION PATTERN
                2.00     3.90     2.10     3.00     3.40     0.60     1.00     0.80     0.30     0.90
                0.20     0.50     0.30     0.70     0.50     0.80     1.00     1.00     1.10     0.90
                0.90     0.60     1.50     1.00     1.00     0.50     0.40     0.10     0.70     0.40
                0.60     0.60     1.30     1.50     2.00     2.70     2.20     4.70     3.70     4.70
                6.90     8.00     1.00     1.10     2.10     2.70     1.10     0.50     0.90     0.60
                1.00     0.60     1.40     1.90     3.00     2.10     2.80     2.80     0.40     0.40
                0.50     0.20     0.20     0.20     0.40     0.10     0.20     0.10     0.30     0.10
                0.20     0.10

34 JD       INDEX STORM NO. 7
                STRM        0.88  PRECIPITATION DEPTH
                TRDA       50.00  TRANSPOSITION DRAINAGE AREA

0 PI          PRECIPITATION PATTERN
                2.00     3.90     2.10     3.00     3.40     0.60     1.00     0.80     0.30     0.90
                0.20     0.50     0.30     0.70     0.50     0.80     1.00     1.00     1.10     0.90
                0.90     0.60     1.50     1.00     1.00     0.50     0.40     0.10     0.70     0.40
                0.60     0.60     1.30     1.50     2.00     2.70     2.20     4.70     3.70     4.70
                6.90     8.00     1.00     1.10     2.10     2.70     1.10     0.50     0.90     0.60
                1.00     0.60     1.40     1.90     3.00     2.10     2.80     2.80     0.40     0.40
                0.50     0.20     0.20     0.20     0.40     0.10     0.20     0.10     0.30     0.10
                0.20     0.10

35 JD       INDEX STORM NO. 8
                STRM        0.78  PRECIPITATION DEPTH
                TRDA      100.00  TRANSPOSITION DRAINAGE AREA

0 PI          PRECIPITATION PATTERN
                2.00     3.90     2.10     3.00     3.40     0.60     1.00     0.80     0.30     0.90
                0.20     0.50     0.30     0.70     0.50     0.80     1.00     1.00     1.10     0.90
                0.90     0.60     1.50     1.00     1.00     0.50     0.40     0.10     0.70     0.40
                0.60     0.60     1.30     1.50     2.00     2.70     2.20     4.70     3.70     4.70
                6.90     8.00     1.00     1.10     2.10     2.70     1.10     0.50     0.90     0.60
                1.00     0.60     1.40     1.90     3.00     2.10     2.80     2.80     0.40     0.40
                0.50     0.20     0.20     0.20     0.40     0.10     0.20     0.10     0.30     0.10
                0.20     0.10
1
```

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+	HYDROGRAPH AT	UC3A	544.	3.75	88.	22.	21.	1.40		
+	ROUTED TO	RTCP1	446.	4.42	88.	22.	21.	1.40		
+	HYDROGRAPH AT	UC3B	28.	5.25	10.	2.	2.	1.02		
+	2 COMBINED AT	CP1	449.	4.42	93.	23.	22.	2.42		

*** NORMAL END OF HEC-1 ***

UC-3

HEC-1 MODEL OUTPUT

FILENAME: 106UC3A

(10-YEAR MODEL)

```
1****************************************
*                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *
*            MAY   1991                *
*          VERSION 4.0.1E              *
*                                      *
* RUN DATE  12/06/98  TIME  21:46:57   *
*                                      *
****************************************
```

```
*************************************
*                                   *
*   U.S. ARMY CORPS OF ENGINEERS    *
*   HYDROLOGIC ENGINEERING CENTER   *
*         609 SECOND STREET         *
*      DAVIS, CALIFORNIA 95616      *
*          (916) 551-1748           *
*                                   *
*************************************
```

```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X              X
XXXXXXX  XXXX     X        XXXXX X
X     X  X        X              X
X     X  X        X     X        X
X     X  XXXXXXX   XXXXX         XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1

HEC-1 INPUT

PAGE 1

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID   FLOOD ASSESSMENT FOR CNTA UC-3 SITE
  2           ID   FILENAME: 106UC3A
  3           ID   5 MINUTE INTERVAL IN ITCARD
  4           ID   10-YEAR 6-HOUR STORM 1.1 INCHES
  5           ID   POINT RAINFALL VALUE FROM NOAA ATLASS 2 VOL VII
  6           ID   DEPTH-AREA REDUCTION FACTORS FROM TABLE 502 IN
  7           ID   CLARK COUNTY HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL (CCRFCD, 1990)
  8           ID   CURVE NUMBERS NOT ADJUSTED
              *DIAGRAM
  9           IT       5       0       0     300
 10           IO       5
 11           IN       5
 12           JD     1.1     .01
              * RAINFALL DISTRIBUTION FROM CLARK COUNTY MANUAL LESS THAN 10 SQ. MILES
 13           PC       0       2     5.7     7.0     8.7    10.8    12.4    13.0    13.0    13.0
 14           PC    13.0    13.0    13.0    13.3    14.0    14.2    14.8    15.8    17.2    18.1
 15           PC    19.0    19.7    19.9    20.0    20.1    20.4    21.4    22.9    24.1    24.9
 16           PC    25.1    25.6    27.0    27.8    28.1    28.3    29.5    32.2    35.2    40.9
 17           PC    49.9    59.0    71.0    74.4    78.1    81.2    81.9    83.5    85.1    85.6
 18           PC    86.0    86.8    87.6    88.8    91.0    92.6    93.7    95.0    97.0    97.6
 19           PC    98.2    98.5    98.7    98.9    99.0    99.3    99.3    99.4    99.5    99.8
 20           PC    99.8    99.9   100.0
 21           JD    1.07       1
 22           JD     .95    9.99
              * CHANGED RAINFALL DISTRIBUTION ABOVE 10 SQ. MILES PER CLARK COUNTY MANUAL
 23           JD     .95   10.01
 24           PC       0     2.0     5.9     8.0    11.0    14.4    15.0    16.0    16.8    17.1
 25           PC    18.0    18.2    18.7    19.0    19.7    20.2    21.0    22.0    23.0    24.1
 26           PC    25.0    25.9    26.5    28.0    29.0    30.0    30.5    30.9    31.0    31.7
 27           PC    32.1    32.7    33.3    34.6    36.1    38.1    40.8    43.0    47.7    51.4
 28           PC    56.1    63.0    71.0    72.0    73.1    75.2    77.9    79.0    79.5    80.4
 29           PC    81.0    82.0    82.6    84.0    85.9    88.9    91.0    93.8    96.6    97.0
 30           PC    97.4    97.9    98.1    98.3    98.5    98.9    99.0    99.2    99.3    99.6
 31           PC    99.7    99.9   100.0
 32           JD     .87      20
 33           JD     .81      30
 34           JD     .75      50
 35           JD     .66     100
              *
              *  CNTA UC-3 SUBBASINS
```

```
                    *

 36                 KK    UC3A
 37                 KM   BASIN RUNOFF CALCULATION FOR UC-3 SUBBASIN A
 38                 BA    1.40
 39                 LS              89
 40                 UD     .28
                    *

 41                 KK   RTCP1
 42                 KM   ROUTE FLOW FROM UC3A THROUGH UC3B TO CP1
 43                 RM       8    .636      .2
                    *
1                                                  HEC-1 INPUT                                                  PAGE  2

      LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 44                 KK    UC3B
 45                 KM   BASIN RUNOFF CALCULATION FOR UC-3 SUBBASIN B
 46                 BA    1.02
 47                 LS              72
 48                 UD     .72
                    *

 49                 KK     CP1
 50                 KM   CONCENTRATION POINT 1 COMBINES FLOW ROUTED FROM UC3A WITH FLOW FROM UC3B
 51                 HC       2
 52                 ZZ
1
              SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

   36        UC3A
                V
                V
   41       RTCP1
                .
                .
   44           .        UC3B
                .           .
                .           .
   49         CP1............

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*              MAY   1991               *
*           VERSION 4.0.1E              *
*                                       *
*  RUN DATE  12/06/98  TIME  21:46:57   *
*                                       *
*****************************************
```

```
*****************************************
*                                       *
*    U.S. ARMY CORPS OF ENGINEERS       *
*    HYDROLOGIC ENGINEERING CENTER      *
*          609 SECOND STREET            *
*       DAVIS, CALIFORNIA 95616         *
*           (916) 551-1748              *
*                                       *
*****************************************
```

```
                    FLOOD ASSESSMENT FOR CNTA UC-3 SITE
                    FILENAME: 106UC3A
                    5 MINUTE INTERVAL IN ITCARD
                    10-YEAR 6-HOUR STORM 1.1 INCHES
                    POINT RAINFALL VALUE FROM NOAA ATLASS 2 VOL VII
                    DEPTH-AREA REDUCTION FACTORS FROM TABLE 502 IN
                    CLARK COUNTY HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL (CCRFCD, 1990)
                    CURVE NUMBERS NOT ADJUSTED

 10 IO          OUTPUT CONTROL VARIABLES
                      IPRNT          5  PRINT CONTROL
                      IPLOT          0  PLOT CONTROL
                      QSCAL         0.  HYDROGRAPH PLOT SCALE

    IT          HYDROGRAPH TIME DATA
                       NMIN          5  MINUTES IN COMPUTATION INTERVAL
```

```
          IDATE      1    0  STARTING DATE
          ITIME         0000  STARTING TIME
             NQ          300  NUMBER OF HYDROGRAPH ORDINATES
         NDDATE      2    0  ENDING DATE
         NDTIME         0055  ENDING TIME
          ICENT           19  CENTURY MARK

     COMPUTATION INTERVAL     0.08 HOURS
          TOTAL TIME BASE    24.92 HOURS

ENGLISH UNITS
     DRAINAGE AREA          SQUARE MILES
     PRECIPITATION DEPTH    INCHES
     LENGTH, ELEVATION      FEET
     FLOW                   CUBIC FEET PER SECOND
     STORAGE VOLUME         ACRE-FEET
     SURFACE AREA           ACRES
     TEMPERATURE            DEGREES FAHRENHEIT

12 JD      INDEX STORM NO. 1
              STRM       1.10  PRECIPITATION DEPTH
              TRDA       0.01  TRANSPOSITION DRAINAGE AREA

13 PI      PRECIPITATION PATTERN
              2.00       3.70       1.30       1.70       2.10       1.60       0.60       0.00       0.00       0.00
              0.00       0.00       0.30       0.70       0.20       0.60       1.00       1.40       0.90       0.90
              0.70       0.20       0.10       0.10       0.30       1.00       1.50       1.20       0.80       0.20
              0.50       1.40       0.80       0.30       0.20       1.20       2.70       3.00       5.70       9.00
              9.10      12.00       3.40       3.70       3.10       0.70       1.60       1.60       0.50       0.40
              0.80       0.80       1.20       2.20       1.60       1.10       1.30       2.00       0.60       0.60
              0.30       0.20       0.20       0.10       0.30       0.00       0.10       0.10       0.30       0.00
              0.10       0.10

21 JD      INDEX STORM NO. 2
              STRM       1.07  PRECIPITATION DEPTH
              TRDA       1.00  TRANSPOSITION DRAINAGE AREA

J PI       PRECIPITATION PATTERN
              2.00       3.70       1.30       1.70       2.10       1.60       0.60       0.00       0.00       0.00
              0.00       0.00       0.30       0.70       0.20       0.60       1.00       1.40       0.90       0.90
              0.70       0.20       0.10       0.10       0.30       1.00       1.50       1.20       0.80       0.20
              0.50       1.40       0.80       0.30       0.20       1.20       2.70       3.00       5.70       9.00
              9.10      12.00       3.40       3.70       3.10       0.70       1.60       1.60       0.50       0.40
              0.80       0.80       1.20       2.20       1.60       1.10       1.30       2.00       0.60       0.60
              0.30       0.20       0.20       0.10       0.30       0.00       0.10       0.10       0.30       0.00
              0.10       0.10

22 JD      INDEX STORM NO. 3
              STRM       0.95  PRECIPITATION DEPTH
              TRDA       9.99  TRANSPOSITION DRAINAGE AREA

0 PI       PRECIPITATION PATTERN
              2.00       3.70       1.30       1.70       2.10       1.60       0.60       0.00       0.00       0.00
              0.00       0.00       0.30       0.70       0.20       0.60       1.00       1.40       0.90       0.90
              0.70       0.20       0.10       0.10       0.30       1.00       1.50       1.20       0.80       0.20
              0.50       1.40       0.80       0.30       0.20       1.20       2.70       3.00       5.70       9.00
              9.10      12.00       3.40       3.70       3.10       0.70       1.60       1.60       0.50       0.40
              0.80       0.80       1.20       2.20       1.60       1.10       1.30       2.00       0.60       0.60
              0.30       0.20       0.20       0.10       0.30       0.00       0.10       0.10       0.30       0.00
              0.10       0.10

23 JD      INDEX STORM NO. 4
              STRM       0.95  PRECIPITATION DEPTH
              TRDA      10.01  TRANSPOSITION DRAINAGE AREA

24 PI      PRECIPITATION PATTERN
              2.00       3.90       2.10       3.00       3.40       0.60       1.00       0.80       0.30       0.90
              0.20       0.50       0.30       0.70       0.50       0.80       1.00       1.00       1.10       0.90
              0.90       0.60       1.50       1.00       1.00       0.50       0.40       0.10       0.70       0.40
              0.60       0.60       1.30       1.50       2.00       2.70       2.20       4.70       3.70       4.70
              6.90       8.00       1.00       1.10       2.10       2.70       1.10       0.50       0.90       0.60
              1.00       0.60       1.40       1.90       3.00       2.10       2.80       2.80       0.40       0.40
              0.50       0.20       0.20       0.20       0.40       0.10       0.20       0.10       0.30       0.10
              0.20       0.10

32 JD      INDEX STORM NO. 5
              STRM       0.87  PRECIPITATION DEPTH
              TRDA      20.00  TRANSPOSITION DRAINAGE AREA
```

```
0 PI          PRECIPITATION PATTERN
                2.00    3.90    2.10    3.00    3.40    0.60    1.00    0.80    0.30    0.90
                0.20    0.50    0.30    0.70    0.50    0.80    1.00    1.00    1.10    0.90
                0.90    0.60    1.50    1.00    1.00    0.50    0.40    0.10    0.70    0.40
                0.60    0.60    1.30    1.50    2.00    2.70    2.20    4.70    3.70    4.70
                6.90    8.00    1.00    1.10    2.10    2.70    1.10    0.50    0.90    0.60
                1.00    0.60    1.40    1.90    3.00    2.10    2.80    2.80    0.40    0.40
                0.50    0.20    0.20    0.20    0.40    0.10    0.20    0.10    0.30    0.10
                0.20    0.10

33 JD         INDEX STORM NO. 6
                STRM        0.81  PRECIPITATION DEPTH
                TRDA       30.00  TRANSPOSITION DRAINAGE AREA

0 PI          PRECIPITATION PATTERN
                2.00    3.90    2.10    3.00    3.40    0.60    1.00    0.80    0.30    0.90
                0.20    0.50    0.30    0.70    0.50    0.80    1.00    1.00    1.10    0.90
                0.90    0.60    1.50    1.00    1.00    0.50    0.40    0.10    0.70    0.40
                0.60    0.60    1.30    1.50    2.00    2.70    2.20    4.70    3.70    4.70
                6.90    8.00    1.00    1.10    2.10    2.70    1.10    0.50    0.90    0.60
                1.00    0.60    1.40    1.90    3.00    2.10    2.80    2.80    0.40    0.40
                0.50    0.20    0.20    0.20    0.40    0.10    0.20    0.10    0.30    0.10
                0.20    0.10

34 JD         INDEX STORM NO. 7
                STRM        0.75  PRECIPITATION DEPTH
                TRDA       50.00  TRANSPOSITION DRAINAGE AREA

0 PI          PRECIPITATION PATTERN
                2.00    3.90    2.10    3.00    3.40    0.60    1.00    0.80    0.30    0.90
                0.20    0.50    0.30    0.70    0.50    0.80    1.00    1.00    1.10    0.90
                0.90    0.60    1.50    1.00    1.00    0.50    0.40    0.10    0.70    0.40
                0.60    0.60    1.30    1.50    2.00    2.70    2.20    4.70    3.70    4.70
                6.90    8.00    1.00    1.10    2.10    2.70    1.10    0.50    0.90    0.60
                1.00    0.60    1.40    1.90    3.00    2.10    2.80    2.80    0.40    0.40
                0.50    0.20    0.20    0.20    0.40    0.10    0.20    0.10    0.30    0.10
                0.20    0.10

35 JD         INDEX STORM NO. 8
                STRM        0.66  PRECIPITATION DEPTH
                TRDA      100.00  TRANSPOSITION DRAINAGE AREA

0 PI          PRECIPITATION PATTERN
                2.00    3.90    2.10    3.00    3.40    0.60    1.00    0.80    0.30    0.90
                0.20    0.50    0.30    0.70    0.50    0.80    1.00    1.00    1.10    0.90
                0.90    0.60    1.50    1.00    1.00    0.50    0.40    0.10    0.70    0.40
                0.60    0.60    1.30    1.50    2.00    2.70    2.20    4.70    3.70    4.70
                6.90    8.00    1.00    1.10    2.10    2.70    1.10    0.50    0.90    0.60
                1.00    0.60    1.40    1.90    3.00    2.10    2.80    2.80    0.40    0.40
                0.50    0.20    0.20    0.20    0.40    0.10    0.20    0.10    0.30    0.10
                0.20    0.10
1
```

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+	HYDROGRAPH AT	UC3A	297.	3.75	48.	12.	12.	1.40		
+	ROUTED TO	RTCP1	243.	4.42	48.	12.	12.	1.40		
+	HYDROGRAPH AT	UC3B	8.	5.33	2.	1.	1.	1.02		
+	2 COMBINED AT	CP1	243.	4.42	49.	12.	12.	2.42		

*** NORMAL END OF HEC-1 ***

UC-3

HEC-1 MODEL OUTPUT

FILENAME: 26UC3A

(2-YEAR MODEL)

```
1*****************************************
*                                       *
*    FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *
*              MAY   1991               *
*            VERSION 4.0.1E             *
*                                       *
*  RUN DATE  12/06/98  TIME  22:21:57   *
*                                       *
*****************************************
```

```
*************************************
*                                   *
*   U.S. ARMY CORPS OF ENGINEERS    *
*   HYDROLOGIC ENGINEERING CENTER   *
*         609 SECOND STREET         *
*      DAVIS, CALIFORNIA 95616      *
*          (916) 551-1748           *
*                                   *
*************************************
```

```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X              X
XXXXXXX  XXXX     X        XXXXX X
X     X  X        X              X
X     X  X        X     X        X
X     X  XXXXXXX   XXXXX        XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1

HEC-1 INPUT PAGE 1

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID   FLOOD ASSESSMENT FOR CNTA UC-3 SITE
  2           ID   FILENAME: 26UC3A
  3           ID    2-YEAR 6-HOUR STORM 0.7 INCHES
  4           ID   POINT RAINFALL FROM NOAA ATLAS 2 VOL VII (NO ADJUSTMENT NECESSARY)
  5           ID   DEPTH-AREA REDUCTION FACTORS FROM TABLE 502 IN
  6           ID   CLARK COUNTY HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL (CCFRCD, 1990)
  7           ID   CURVE NUBERS NOT ADJUSTED
              *DIAGRAM
  8           IT       5       0       0     300
  9           IO       5
 10           IN       5
 11           JD     0.7     .01
              * RAINFALL DISTRIBUTION FROM CLARK COUNTY MANUAL LESS THAN 10 SQ. MILES
 12           PC       0       2     5.7     7.0     8.7    10.8    12.4    13.0    13.0    13.0
 13           PC    13.0    13.0    13.0    13.3    14.0    14.2    14.8    15.8    17.2    18.1
 14           PC    19.0    19.7    19.9    20.0    20.1    20.4    21.4    22.9    24.1    24.9
 15           PC    25.1    25.6    27.0    27.8    28.1    28.3    29.5    32.2    35.2    40.9
 16           PC    49.9    59.0    71.0    74.4    78.1    81.2    81.9    83.5    85.1    85.6
 17           PC    86.0    86.8    87.6    88.8    91.0    92.6    93.7    95.0    97.0    97.6
 18           PC    98.2    98.5    98.7    98.9    99.0    99.3    99.3    99.4    99.5    99.8
 19           PC    99.8    99.9   100.0
 20           JD     .68       1
 21           JD     .60    9.99
              * CHANGED RAINFALL DISTRIBUTION ABOVE 10 SQ. MILES PER CLARK COUNTY MANUAL
 22           JD     .60   10.01
 23           PC       0     2.0     5.9     8.0    11.0    14.4    15.0    16.0    16.8    17.1
 24           PC    18.0    18.2    18.7    19.0    19.7    20.2    21.0    22.0    23.0    24.1
 25           PC    25.0    25.9    26.5    28.0    29.0    30.0    30.5    30.9    31.0    31.7
 26           PC    32.1    32.7    33.3    34.6    36.1    38.1    40.8    43.0    47.7    51.4
 27           PC    56.1    63.0    71.0    72.0    73.1    75.2    77.9    79.0    79.5    80.4
 28           PC    81.0    82.0    82.6    84.0    85.9    88.9    91.0    93.8    96.6    97.0
 29           PC    97.4    97.9    98.1    98.3    98.5    98.9    99.0    99.2    99.3    99.6
 30           PC    99.7    99.9   100.0
 31           JD     .55      20
 32           JD     .52      30
 33           JD     .48      50
 34           JD     .42     100
              *
              *  CNTA UC-3 SUBBASINS
              *
```

```
          35          KK    UC3A
          36          KM   BASIN RUNOFF CALCULATION FOR UC-3 SUBBASIN A
          37          BA    1.40
          38          LS              89
          39          UD     .28
                      *

          40          KK   RTCP1
          41          KM   ROUTE FLOW FROM UC3A THROUGH UC3B TO CP1
          42          RM       8    .636      .2
                      *
1                                                  HEC-1 INPUT                                                  PAGE  2

        LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

          43          KK    UC3B
          44          KM   BASIN RUNOFF CALCULATION FOR UC-3 SUBBASIN B
          45          BA    1.02
          46          LS              72
          47          UD     .72
                      *

          48          KK     CP1
          49          KM   CONCENTRATION POINT 1 COMBINES FLOW ROUTED FROM UC3A WITH FLOW FROM UC3B
*** WARNING *** ZZ-CARD MISSING
          50          HC       2
          51          ZZ
1
              SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

   35        UC3A
               V
               V
   40       RTCP1
               .
               .
   43          .        UC3B
               .           .
               .           .
   48         CP1............

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************                                                  ****************************************
*                                       *                                                  *                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                  *    U.S. ARMY CORPS OF ENGINEERS      *
*              MAY   1991               *                                                  *    HYDROLOGIC ENGINEERING CENTER     *
*           VERSION 4.0.1E              *                                                  *          609 SECOND STREET           *
*                                       *                                                  *       DAVIS, CALIFORNIA 95616        *
*  RUN DATE  12/06/98  TIME  22:21:57   *                                                  *           (916) 551-1748             *
*                                       *                                                  *                                      *
*****************************************                                                  ****************************************


                        FLOOD ASSESSMENT FOR CNTA UC-3 SITE
                        FILENAME: 26UC3A.DAT
                         2-YEAR 6-HOUR STORM 0.7 INCHES
                        POINT RAINFALL FROM NOAA ATLAS 2 VOL VII (NO ADJUSTMENT NECESSARY)
                        DEPTH-AREA REDUCTION FACTORS FROM TABLE 502 IN
                        CLARK COUNTY HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL (CCFRCD, 1990)
                        CURVE NUBERS NOT ADJUSTED

  9 IO          OUTPUT CONTROL VARIABLES
                      IPRNT           5  PRINT CONTROL
                      IPLOT           0  PLOT CONTROL
                      QSCAL          0.  HYDROGRAPH PLOT SCALE

   IT           HYDROGRAPH TIME DATA
                       NMIN           5  MINUTES IN COMPUTATION INTERVAL
                      IDATE      1    0  STARTING DATE
```

```
          ITIME        0000  STARTING TIME
             NQ         300  NUMBER OF HYDROGRAPH ORDINATES
         NDDATE       2   0  ENDING DATE
         NDTIME        0055  ENDING TIME
          ICENT          19  CENTURY MARK

     COMPUTATION INTERVAL    0.08 HOURS
          TOTAL TIME BASE   24.92 HOURS

ENGLISH UNITS
     DRAINAGE AREA          SQUARE MILES
     PRECIPITATION DEPTH    INCHES
     LENGTH, ELEVATION      FEET
     FLOW                   CUBIC FEET PER SECOND
     STORAGE VOLUME         ACRE-FEET
     SURFACE AREA           ACRES
     TEMPERATURE            DEGREES FAHRENHEIT

11 JD      INDEX STORM NO. 1
              STRM        0.70  PRECIPITATION DEPTH
              TRDA        0.01  TRANSPOSITION DRAINAGE AREA

12 PI        PRECIPITATION PATTERN
                2.00      3.70      1.30      1.70      2.10      1.60      0.60      0.00      0.00      0.00
                0.00      0.00      0.30      0.70      0.20      0.60      1.00      1.40      0.90      0.90
                0.70      0.20      0.10      0.10      0.30      1.00      1.50      1.20      0.80      0.20
                0.50      1.40      0.80      0.30      0.20      1.20      2.70      3.00      5.70      9.00
                9.10     12.00      3.40      3.70      3.10      0.70      1.60      1.60      0.50      0.40
                0.80      0.80      1.20      2.20      1.60      1.10      1.30      2.00      0.60      0.60
                0.30      0.20      0.20      0.10      0.30      0.00      0.10      0.10      0.30      0.00
                0.10      0.10

20 JD      INDEX STORM NO. 2
              STRM        0.68  PRECIPITATION DEPTH
              TRDA        1.00  TRANSPOSITION DRAINAGE AREA

   PI        PRECIPITATION PATTERN
                2.00      3.70      1.30      1.70      2.10      1.60      0.60      0.00      0.00      0.00
                0.00      0.00      0.30      0.70      0.20      0.60      1.00      1.40      0.90      0.90
                0.70      0.20      0.10      0.10      0.30      1.00      1.50      1.20      0.80      0.20
                0.50      1.40      0.80      0.30      0.20      1.20      2.70      3.00      5.70      9.00
                9.10     12.00      3.40      3.70      3.10      0.70      1.60      1.60      0.50      0.40
                0.80      0.80      1.20      2.20      1.60      1.10      1.30      2.00      0.60      0.60
                0.30      0.20      0.20      0.10      0.30      0.00      0.10      0.10      0.30      0.00
                0.10      0.10

21 JD      INDEX STORM NO. 3
              STRM        0.60  PRECIPITATION DEPTH
              TRDA        9.99  TRANSPOSITION DRAINAGE AREA

0 PI         PRECIPITATION PATTERN
                2.00      3.70      1.30      1.70      2.10      1.60      0.60      0.00      0.00      0.00
                0.00      0.00      0.30      0.70      0.20      0.60      1.00      1.40      0.90      0.90
                0.70      0.20      0.10      0.10      0.30      1.00      1.50      1.20      0.80      0.20
                0.50      1.40      0.80      0.30      0.20      1.20      2.70      3.00      5.70      9.00
                9.10     12.00      3.40      3.70      3.10      0.70      1.60      1.60      0.50      0.40
                0.80      0.80      1.20      2.20      1.60      1.10      1.30      2.00      0.60      0.60
                0.30      0.20      0.20      0.10      0.30      0.00      0.10      0.10      0.30      0.00
                0.10      0.10

22 JD      INDEX STORM NO. 4
              STRM        0.60  PRECIPITATION DEPTH
              TRDA       10.01  TRANSPOSITION DRAINAGE AREA

23 PI        PRECIPITATION PATTERN
                2.00      3.90      2.10      3.00      3.40      0.60      1.00      0.80      0.30      0.90
                0.20      0.50      0.30      0.70      0.50      0.80      1.00      1.00      1.10      0.90
                0.90      0.60      1.50      1.00      1.00      0.50      0.40      0.10      0.70      0.40
                0.60      0.60      1.30      1.50      2.00      2.70      2.20      4.70      3.70      4.70
                6.90      8.00      1.00      1.10      2.10      2.70      1.10      0.50      0.90      0.60
                1.00      0.60      1.40      1.90      3.00      2.10      2.80      2.80      0.40      0.40
                0.50      0.20      0.20      0.20      0.40      0.10      0.20      0.10      0.30      0.10
                0.20      0.10

31 JD      INDEX STORM NO. 5
              STRM        0.55  PRECIPITATION DEPTH
              TRDA       20.00  TRANSPOSITION DRAINAGE AREA
```

```
0 PI          PRECIPITATION PATTERN
                2.00    3.90    2.10    3.00    3.40    0.60    1.00    0.80    0.30    0.90
                0.20    0.50    0.30    0.70    0.50    0.80    1.00    1.00    1.10    0.90
                0.90    0.60    1.50    1.00    1.00    0.50    0.40    0.10    0.70    0.40
                0.60    0.60    1.30    1.50    2.00    2.70    2.20    4.70    3.70    4.70
                6.90    8.00    1.00    1.10    2.10    2.70    1.10    0.50    0.90    0.60
                1.00    0.60    1.40    1.90    3.00    2.10    2.80    2.80    0.40    0.40
                0.50    0.20    0.20    0.20    0.40    0.10    0.20    0.10    0.30    0.10
                0.20    0.10

32 JD         INDEX STORM NO. 6
                STRM        0.52  PRECIPITATION DEPTH
                TRDA       30.00  TRANSPOSITION DRAINAGE AREA

0 PI          PRECIPITATION PATTERN
                2.00    3.90    2.10    3.00    3.40    0.60    1.00    0.80    0.30    0.90
                0.20    0.50    0.30    0.70    0.50    0.80    1.00    1.00    1.10    0.90
                0.90    0.60    1.50    1.00    1.00    0.50    0.40    0.10    0.70    0.40
                0.60    0.60    1.30    1.50    2.00    2.70    2.20    4.70    3.70    4.70
                6.90    8.00    1.00    1.10    2.10    2.70    1.10    0.50    0.90    0.60
                1.00    0.60    1.40    1.90    3.00    2.10    2.80    2.80    0.40    0.40
                0.50    0.20    0.20    0.20    0.40    0.10    0.20    0.10    0.30    0.10
                0.20    0.10

33 JD         INDEX STORM NO. 7
                STRM        0.48  PRECIPITATION DEPTH
                TRDA       50.00  TRANSPOSITION DRAINAGE AREA

0 PI          PRECIPITATION PATTERN
                2.00    3.90    2.10    3.00    3.40    0.60    1.00    0.80    0.30    0.90
                0.20    0.50    0.30    0.70    0.50    0.80    1.00    1.00    1.10    0.90
                0.90    0.60    1.50    1.00    1.00    0.50    0.40    0.10    0.70    0.40
                0.60    0.60    1.30    1.50    2.00    2.70    2.20    4.70    3.70    4.70
                6.90    8.00    1.00    1.10    2.10    2.70    1.10    0.50    0.90    0.60
                1.00    0.60    1.40    1.90    3.00    2.10    2.80    2.80    0.40    0.40
                0.50    0.20    0.20    0.20    0.40    0.10    0.20    0.10    0.30    0.10
                0.20    0.10

34 JD         INDEX STORM NO. 8
                STRM        0.42  PRECIPITATION DEPTH
                TRDA      100.00  TRANSPOSITION DRAINAGE AREA

0 PI          PRECIPITATION PATTERN
                2.00    3.90    2.10    3.00    3.40    0.60    1.00    0.80    0.30    0.90
                0.20    0.50    0.30    0.70    0.50    0.80    1.00    1.00    1.10    0.90
                0.90    0.60    1.50    1.00    1.00    0.50    0.40    0.10    0.70    0.40
                0.60    0.60    1.30    1.50    2.00    2.70    2.20    4.70    3.70    4.70
                6.90    8.00    1.00    1.10    2.10    2.70    1.10    0.50    0.90    0.60
                1.00    0.60    1.40    1.90    3.00    2.10    2.80    2.80    0.40    0.40
                0.50    0.20    0.20    0.20    0.40    0.10    0.20    0.10    0.30    0.10
                0.20    0.10
1
```

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+	HYDROGRAPH AT	UC3A	91.	3.83	16.	4.	4.	1.40		
+	ROUTED TO	RTCP1	75.	4.50	16.	4.	4.	1.40		
+	HYDROGRAPH AT	UC3B	0.	0.08	0.	0.	0.	1.02		
+	2 COMBINED AT	CP1	75.	4.50	16.	4.	4.	2.42		

*** NORMAL END OF HEC-1 ***

UC-4

HEC-1 MODEL OUTPUT

FILENAME: 1006UC4A

(100-YEAR MODEL)

```
1****************************************
 -                                      *
    FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
              MAY   1991                *
           VERSION 4.0.1E               *
*                                       *
*  RUN DATE  12/06/98  TIME  02:01:39   *
*                                       *
****************************************
```

```
*************************************
*                                   *
*    U.S. ARMY CORPS OF ENGINEERS   *
*    HYDROLOGIC ENGINEERING CENTER  *
*          609 SECOND STREET        *
*       DAVIS, CALIFORNIA 95616     *
*          (916) 551-1748           *
*                                   *
*************************************
```

```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X              X
XXXXXXX  XXXX     X       XXXXX  X
X     X  X        X              X
X     X  X        X     X        X
X     X  XXXXXXX   XXXXX         XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1

HEC-1 INPUT

PAGE 1

```
 LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

   1           ID   FLOOD ASSESSMENT FOR CNTA UC-4 SITE   FILENAME:1006UC4A
   2           ID   5 MINUTE INTERVAL IN ITCARD
   3           ID   100-YEAR 6-HOUR STORM 1.6 INCHES
   4           ID   POINT RAINFALL VALUES FROM NOAA ATLAS 2 VOL VII
   5           ID   DEPTH-AREA REDUCTION FACTORS FROM TABLE 502 IN
   6           ID   CLARK COUNTY HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL (CCRFCD, 1990)
   7           ID   CURVE NUMBERS NOT ADJUSTED
               *DIAGRAM
   8           IT     5       0       0     300
   9           IO     5
  10           IN     5
  11           JD   1.6     .01
               * RAINFALL DISTRIBUTION FROM CLARK COUNTY MANUAL LESS THAN 10 SQ. MILES
  12           PC     0       2     5.7     7.0     8.7    10.8    12.4    13.0    13.0    13.0
  13           PC  13.0    13.0    13.0    13.3    14.0    14.2    14.8    15.8    17.2    18.1
  14           PC  19.0    19.7    19.9    20.0    20.1    20.4    21.4    22.9    24.1    24.9
  15           PC  25.1    25.6    27.0    27.8    28.1    28.3    29.5    32.2    35.2    40.9
  16           PC  49.9    59.0    71.0    74.4    78.1    81.2    81.9    83.5    85.1    85.6
  17           PC  86.0    86.8    87.6    88.8    91.0    92.6    93.7    95.0    97.0    97.6
  18           PC  98.2    98.5    98.7    98.9    99.0    99.3    99.3    99.4    99.5    99.8
  19           PC  99.8    99.9   100.0
  20           JD  1.55       1
  21           JD  1.38    9.99
               * CHANGED RAINFALL DISTRIBUTION ABOVE 10 SQ. MILES PER CLARK COUNTY MANUAL
  22           JD  1.38   10.01
  23           PC     0     2.0     5.9     8.0    11.0    14.4    15.0    16.0    16.8    17.1
  24           PC  18.0    18.2    18.7    19.0    19.7    20.2    21.0    22.0    23.0    24.1
  25           PC  25.0    25.9    26.5    28.0    29.0    30.0    30.5    30.9    31.0    31.7
  26           PC  32.1    32.7    33.3    34.6    36.1    38.1    40.8    43.0    47.7    51.4
  27           PC  56.1    63.0    71.0    72.0    73.1    75.2    77.9    79.0    79.5    80.4
  28           PC  81.0    82.0    82.6    84.0    85.9    88.9    91.0    93.8    96.6    97.0
  29           PC  97.4    97.9    98.1    98.3    98.5    98.9    99.0    99.2    99.3    99.6
  30           PC  99.7    99.9   100.0
  31           JD  1.26      20
  32           JD  1.18      30
  33           JD  1.09      50
  34           JD   .96     100
               *
               *  CNTA UC-4 SUBBASINS
               *
```

```
35          KK    UC4A
36          KM   BASIN RUNOFF CALCULATION FOR UC-4 SUBBASIN A
37          BA    0.39
38          LS              82
39          UD    0.53
            *

40          KK    UC4B
41          KM   BASIN RUNOFF CALCULATION FOR UC-4 SUBBASIN B
42          BA    0.20
43          LS              82
44          UD    0.46
45          ZZ
1
              SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

   35        UC4A
                .
                .
   40           .        UC4B

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*              MAY   1991               *
*            VERSION 4.0.1E             *
*                                       *
*  RUN DATE  12/06/98  TIME  02:01:39   *
*                                       *
*****************************************
```

```
*****************************************
*                                       *
*   U.S. ARMY CORPS OF ENGINEERS        *
*   HYDROLOGIC ENGINEERING CENTER       *
*         609 SECOND STREET             *
*       DAVIS, CALIFORNIA 95616         *
*           (916) 551-1748              *
*                                       *
*****************************************
```

```
                    FLOOD ASSESSMENT FOR CNTA UC-4 SITE
                    5 MINUTE INTERVAL IN ITCARD
                    100-YEAR 6-HOUR STORM 1.6 INCHES
                    POINT RAINFALL VALUES FROM NOAA ATLAS 2 VOL VII
                    DEPTH-AREA REDUCTION FACTORS FROM TABLE 502 IN
                    CLARK COUNTY HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL (CCRFCD, 1990)
                    CURVE NUMBERS NOT ADJUSTED

  9 IO        OUTPUT CONTROL VARIABLES
                    IPRNT          5  PRINT CONTROL
                    IPLOT          0  PLOT CONTROL
                    QSCAL         0.  HYDROGRAPH PLOT SCALE

   IT         HYDROGRAPH TIME DATA
                     NMIN          5  MINUTES IN COMPUTATION INTERVAL
                    IDATE     1    0  STARTING DATE
                    ITIME       0000  STARTING TIME
                       NQ        300  NUMBER OF HYDROGRAPH ORDINATES
                   NDDATE     2    0  ENDING DATE
                   NDTIME       0055  ENDING TIME
                    ICENT         19  CENTURY MARK

              COMPUTATION INTERVAL    0.08 HOURS
                   TOTAL TIME BASE   24.92 HOURS

        ENGLISH UNITS
             DRAINAGE AREA          SQUARE MILES
             PRECIPITATION DEPTH    INCHES
             LENGTH, ELEVATION      FEET
             FLOW                   CUBIC FEET PER SECOND
             STORAGE VOLUME         ACRE-FEET
             SURFACE AREA           ACRES
             TEMPERATURE            DEGREES FAHRENHEIT

 11 JD        INDEX STORM NO. 1
                    STRM       1.60  PRECIPITATION DEPTH
                    TRDA       0.01  TRANSPOSITION DRAINAGE AREA
```

12 PI

PRECIPITATION PATTERN

2.00	3.70	1.30	1.70	2.10	1.60	0.60	0.00	0.00	0.00
0.00	0.00	0.30	0.70	0.20	0.60	1.00	1.40	0.90	0.90
0.70	0.20	0.10	0.10	0.30	1.00	1.50	1.20	0.80	0.20
0.50	1.40	0.80	0.30	0.20	1.20	2.70	3.00	5.70	9.00
9.10	12.00	3.40	3.70	3.10	0.70	1.60	1.60	0.50	0.40
0.80	0.80	1.20	2.20	1.60	1.10	1.30	2.00	0.60	0.60
0.30	0.20	0.20	0.10	0.30	0.00	0.10	0.10	0.30	0.00
0.10	0.10								

20 JD

INDEX STORM NO. 2

STRM 1.55 PRECIPITATION DEPTH

TRDA 1.00 TRANSPOSITION DRAINAGE AREA

0 PI

PRECIPITATION PATTERN

2.00	3.70	1.30	1.70	2.10	1.60	0.60	0.00	0.00	0.00
0.00	0.00	0.30	0.70	0.20	0.60	1.00	1.40	0.90	0.90
0.70	0.20	0.10	0.10	0.30	1.00	1.50	1.20	0.80	0.20
0.50	1.40	0.80	0.30	0.20	1.20	2.70	3.00	5.70	9.00
9.10	12.00	3.40	3.70	3.10	0.70	1.60	1.60	0.50	0.40
0.80	0.80	1.20	2.20	1.60	1.10	1.30	2.00	0.60	0.60
0.30	0.20	0.20	0.10	0.30	0.00	0.10	0.10	0.30	0.00
0.10	0.10								

21 JD

INDEX STORM NO. 3

STRM 1.38 PRECIPITATION DEPTH

TRDA 9.99 TRANSPOSITION DRAINAGE AREA

0 PI

PRECIPITATION PATTERN

2.00	3.70	1.30	1.70	2.10	1.60	0.60	0.00	0.00	0.00
0.00	0.00	0.30	0.70	0.20	0.60	1.00	1.40	0.90	0.90
0.70	0.20	0.10	0.10	0.30	1.00	1.50	1.20	0.80	0.20
0.50	1.40	0.80	0.30	0.20	1.20	2.70	3.00	5.70	9.00
9.10	12.00	3.40	3.70	3.10	0.70	1.60	1.60	0.50	0.40
0.80	0.80	1.20	2.20	1.60	1.10	1.30	2.00	0.60	0.60
0.30	0.20	0.20	0.10	0.30	0.00	0.10	0.10	0.30	0.00
0.10	0.10								

22 JD

INDEX STORM NO. 4

STRM 1.38 PRECIPITATION DEPTH

TRDA 10.01 TRANSPOSITION DRAINAGE AREA

23 PI

PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

31 JD

INDEX STORM NO. 5

STRM 1.26 PRECIPITATION DEPTH

TRDA 20.00 TRANSPOSITION DRAINAGE AREA

0 PI

PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

32 JD

INDEX STORM NO. 6

STRM 1.18 PRECIPITATION DEPTH

TRDA 30.00 TRANSPOSITION DRAINAGE AREA

PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10

0.20 0.10

33 JD INDEX STORM NO. 7

STRM 1.09 PRECIPITATION DEPTH
TRDA 50.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

34 JD INDEX STORM NO. 8

STRM 0.96 PRECIPITATION DEPTH
TRDA 100.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

1

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+	HYDROGRAPH AT	UC4A	68.	4.08	16.	4.	4.	0.39		
+	HYDROGRAPH AT	UC4B	39.	4.00	8.	2.	2.	0.20		

*** NORMAL END OF HEC-1 ***

UC-4

HEC-1 MODEL OUTPUT

FILENAME: 1006UC4B

(100-YEAR MODEL)

```
1****************************************
*                                      *
    FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
              MAY   1991                *
           VERSION 4.0.1E               *
*                                      *
*  RUN DATE  12/07/98  TIME  02:27:11  *
*                                      *
****************************************
```

```
*************************************
*                                   *
*    U.S. ARMY CORPS OF ENGINEERS   *
*    HYDROLOGIC ENGINEERING CENTER  *
*          609 SECOND STREET        *
*       DAVIS, CALIFORNIA 95616     *
*          (916) 551-1748           *
*                                   *
*************************************
```

```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X              X
XXXXXXX  XXXX     X       XXXXX  X
X     X  X        X              X
X     X  X        X     X        X
X     X  XXXXXXX   XXXXX        XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1

HEC-1 INPUT

PAGE 1

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID   FLOOD ASSESSMENT FOR CNTA UC-4 SITE   FILENAME:1006UC4B
  2           ID   5 MINUTE INTERVAL IN ITCARD
  3           ID   100-YEAR 6-HOUR STORM 1.6 INCHES
  4           ID   POINT RAINFALL VALUES FROM NOAA ATLAS 2 VOL VII
  5           ID   DEPTH-AREA REDUCTION FACTORS FROM TABLE 502 IN
  6           ID   CLARK COUNTY HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL (CCRFCD, 1990)
  7           ID   CURVE NUMBERS ADJUSTED (+5)
              *DIAGRAM
  8           IT       5       0       0     300
  9           IO       5
 10           IN       5
 11           JD     1.6     .01
              * RAINFALL DISTRIBUTION FROM CLARK COUNTY MANUAL LESS THAN 10 SQ. MILES
 12           PC       0       2     5.7     7.0     8.7    10.8    12.4    13.0    13.0    13.0
 13           PC    13.0    13.0    13.0    13.3    14.0    14.2    14.8    15.8    17.2    18.1
 14           PC    19.0    19.7    19.9    20.0    20.1    20.4    21.4    22.9    24.1    24.9
 15           PC    25.1    25.6    27.0    27.8    28.1    28.3    29.5    32.2    35.2    40.9
 16           PC    49.9    59.0    71.0    74.4    78.1    81.2    81.9    83.5    85.1    85.6
 17           PC    86.0    86.8    87.6    88.8    91.0    92.6    93.7    95.0    97.0    97.6
 18           PC    98.2    98.5    98.7    98.9    99.0    99.3    99.3    99.4    99.5    99.8
 19           PC    99.8    99.9   100.0
 20           JD    1.55       1
 21           JD    1.38    9.99
              * CHANGED RAINFALL DISTRIBUTION ABOVE 10 SQ. MILES PER CLARK COUNTY MANUAL
 22           JD    1.38   10.01
 23           PC       0     2.0     5.9     8.0    11.0    14.4    15.0    16.0    16.8    17.1
 24           PC    18.0    18.2    18.7    19.0    19.7    20.2    21.0    22.0    23.0    24.1
 25           PC    25.0    25.9    26.5    28.0    29.0    30.0    30.5    30.9    31.0    31.7
 26           PC    32.1    32.7    33.3    34.6    36.1    38.1    40.8    43.0    47.7    51.4
 27           PC    56.1    63.0    71.0    72.0    73.1    75.2    77.9    79.0    79.5    80.4
 28           PC    81.0    82.0    82.6    84.0    85.9    88.9    91.0    93.8    96.6    97.0
 29           PC    97.4    97.9    98.1    98.3    98.5    98.9    99.0    99.2    99.3    99.6
 30           PC    99.7    99.9   100.0
 31           JD    1.26      20
 32           JD    1.18      30
 33           JD    1.09      50
 34           JD     .96     100
              *
              *  CNTA UC-4 SUBBASINS
              *
```

```
35          KK    UC4A
36          KM   BASIN RUNOFF CALCULATION FOR UC-4 SUBBASIN A
37          BA    0.39
38          LS              87
39          UD    0.53
            *

40          KK    UC4B
41          KM   BASIN RUNOFF CALCULATION FOR UC-4 SUBBASIN B
42          BA    0.20
43          LS              87
44          UD    0.46
45          ZZ
1
              SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

    35        UC4A
                .
                .
    40          .       UC4B

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************
 *                                       *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
 *              MAY   1991               *
 *            VERSION 4.0.1E             *
 *                                       *
 *  RUN DATE  12/07/98  TIME  02:27:11   *
 *                                       *
 *****************************************

 ****************************************
 *                                      *
 *    U.S. ARMY CORPS OF ENGINEERS      *
 *    HYDROLOGIC ENGINEERING CENTER     *
 *          609 SECOND STREET           *
 *       DAVIS, CALIFORNIA 95616        *
 *           (916) 551-1748             *
 *                                      *
 ****************************************

                    FLOOD ASSESSMENT FOR CNTA UC-4 SITE
                    5 MINUTE INTERVAL IN ITCARD
                    100-YEAR 6-HOUR STORM 1.6 INCHES
                    POINT RAINFALL VALUES FROM NOAA ATLAS 2 VOL VII
                    DEPTH-AREA REDUCTION FACTORS FROM TABLE 502 IN
                    CLARK COUNTY HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL (CCRFCD, 1990)
                    CURVE NUMBERS ADJUSTED (+5)

  9 IO        OUTPUT CONTROL VARIABLES
                IPRNT          5  PRINT CONTROL
                IPLOT          0  PLOT CONTROL
                QSCAL         0.  HYDROGRAPH PLOT SCALE

   IT         HYDROGRAPH TIME DATA
                NMIN           5  MINUTES IN COMPUTATION INTERVAL
               IDATE      1    0  STARTING DATE
               ITIME        0000  STARTING TIME
                  NQ         300  NUMBER OF HYDROGRAPH ORDINATES
              NDDATE      2    0  ENDING DATE
              NDTIME        0055  ENDING TIME
              ICENT          19  CENTURY MARK

          COMPUTATION INTERVAL    0.08 HOURS
               TOTAL TIME BASE   24.92 HOURS

      ENGLISH UNITS
           DRAINAGE AREA          SQUARE MILES
           PRECIPITATION DEPTH    INCHES
           LENGTH, ELEVATION      FEET
           FLOW                   CUBIC FEET PER SECOND
           STORAGE VOLUME         ACRE-FEET
           SURFACE AREA           ACRES
           TEMPERATURE            DEGREES FAHRENHEIT

 11 JD        INDEX STORM NO. 1
               STRM        1.60  PRECIPITATION DEPTH
               TRDA        0.01  TRANSPOSITION DRAINAGE AREA
```

12 PI

PRECIPITATION PATTERN

2.00	3.70	1.30	1.70	2.10	1.60	0.60	0.00	0.00	0.00
0.00	0.00	0.30	0.70	0.20	0.60	1.00	1.40	0.90	0.90
0.70	0.20	0.10	0.10	0.30	1.00	1.50	1.20	0.80	0.20
0.50	1.40	0.80	0.30	0.20	1.20	2.70	3.00	5.70	9.00
9.10	12.00	3.40	3.70	3.10	0.70	1.60	1.60	0.50	0.40
0.80	0.80	1.20	2.20	1.60	1.10	1.30	2.00	0.60	0.60
0.30	0.20	0.20	0.10	0.30	0.00	0.10	0.10	0.30	0.00
0.10	0.10								

20 JD

INDEX STORM NO. 2

STRM 1.55 PRECIPITATION DEPTH

TRDA 1.00 TRANSPOSITION DRAINAGE AREA

0 PI

PRECIPITATION PATTERN

2.00	3.70	1.30	1.70	2.10	1.60	0.60	0.00	0.00	0.00
0.00	0.00	0.30	0.70	0.20	0.60	1.00	1.40	0.90	0.90
0.70	0.20	0.10	0.10	0.30	1.00	1.50	1.20	0.80	0.20
0.50	1.40	0.80	0.30	0.20	1.20	2.70	3.00	5.70	9.00
9.10	12.00	3.40	3.70	3.10	0.70	1.60	1.60	0.50	0.40
0.80	0.80	1.20	2.20	1.60	1.10	1.30	2.00	0.60	0.60
0.30	0.20	0.20	0.10	0.30	0.00	0.10	0.10	0.30	0.00
0.10	0.10								

21 JD

INDEX STORM NO. 3

STRM 1.38 PRECIPITATION DEPTH

TRDA 9.99 TRANSPOSITION DRAINAGE AREA

0 PI

PRECIPITATION PATTERN

2.00	3.70	1.30	1.70	2.10	1.60	0.60	0.00	0.00	0.00
0.00	0.00	0.30	0.70	0.20	0.60	1.00	1.40	0.90	0.90
0.70	0.20	0.10	0.10	0.30	1.00	1.50	1.20	0.80	0.20
0.50	1.40	0.80	0.30	0.20	1.20	2.70	3.00	5.70	9.00
9.10	12.00	3.40	3.70	3.10	0.70	1.60	1.60	0.50	0.40
0.80	0.80	1.20	2.20	1.60	1.10	1.30	2.00	0.60	0.60
0.30	0.20	0.20	0.10	0.30	0.00	0.10	0.10	0.30	0.00
0.10	0.10								

22 JD

INDEX STORM NO. 4

STRM 1.38 PRECIPITATION DEPTH

TRDA 10.01 TRANSPOSITION DRAINAGE AREA

23 PI

PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

31 JD

INDEX STORM NO. 5

STRM 1.26 PRECIPITATION DEPTH

TRDA 20.00 TRANSPOSITION DRAINAGE AREA

0 PI

PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

32 JD

INDEX STORM NO. 6

STRM 1.18 PRECIPITATION DEPTH

TRDA 30.00 TRANSPOSITION DRAINAGE AREA

PI

PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10

0.20 0.10

33 JD INDEX STORM NO. 7

STRM 1.09 PRECIPITATION DEPTH
TRDA 50.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

34 JD INDEX STORM NO. 8

STRM 0.96 PRECIPITATION DEPTH
TRDA 100.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

1

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	UC4A	108.	4.00	24.	6.	6.	0.39		
HYDROGRAPH AT	UC4B	61.	3.92	13.	3.	3.	0.20		

*** NORMAL END OF HEC-1 ***

UC-4

HEC-1 MODEL OUTPUT

FILENAME: 256UC4A

(25-YEAR MODEL)

```
1****************************************
*                                      *
    FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
              MAY   1991                *
           VERSION 4.0.1E               *
*                                      *
*  RUN DATE  12/06/98  TIME  03:51:29  *
*                                      *
****************************************
```

```
*************************************
*                                   *
*    U.S. ARMY CORPS OF ENGINEERS   *
*    HYDROLOGIC ENGINEERING CENTER  *
*          609 SECOND STREET        *
*       DAVIS, CALIFORNIA 95616     *
*          (916) 551-1748           *
*                                   *
*************************************
```

```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X               X
XXXXXXX  XXXX     X       XXXXX   X
X     X  X        X               X
X     X  X        X     X         X
X     X  XXXXXXX   XXXXX         XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1

HEC-1 INPUT

PAGE 1

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID   FLOOD ASSESSMENT FOR CNTA UC-4 SITE     FILENAME:256UC4A
  2           ID   5 MINUTE INTERVAL IN ITCARD
  3           ID    25-YEAR 6-HOUR STORM 1.3 INCHES
  4           ID   POINT RAINFALL FROM NOAA ATLAS II VOL 7 (NO ADJUSTMENT NECESSARY)
  5           ID   DEPTH-AREA REDUCTION FACTORS FROM TABLE 502 IN
  6           ID   CLARK COUNTY HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL (CCFRCD, 1990)
  7           ID   CURVE NUMBERS NOT ADJUSTED
              *DIAGRAM
  8           IT       5       0       0     300
  9           IO       5
 10           IN       5
 11           JD     1.3     .01
              * RAINFALL DISTRIBUTION FROM CLARK COUNTY MANUAL LESS THAN 10 SQ. MILES
 12           PC       0       2     5.7     7.0     8.7    10.8    12.4    13.0    13.0    13.0
 13           PC    13.0    13.0    13.0    13.3    14.0    14.2    14.8    15.8    17.2    18.1
 14           PC    19.0    19.7    19.9    20.0    20.1    20.4    21.4    22.9    24.1    24.9
 15           PC    25.1    25.6    27.0    27.8    28.1    28.3    29.5    32.2    35.2    40.9
 16           PC    49.9    59.0    71.0    74.4    78.1    81.2    81.9    83.5    85.1    85.6
 17           PC    86.0    86.8    87.6    88.8    91.0    92.6    93.7    95.0    97.0    97.6
 18           PC    98.2    98.5    98.7    98.9    99.0    99.3    99.3    99.4    99.5    99.8
 19           PC    99.8    99.9   100.0
 20           JD    1.26       1
 21           JD    1.12    9.99
              * CHANGED RAINFALL DISTRIBUTION ABOVE 10 SQ. MILES PER CLARK COUNTY MANUAL
 22           JD    1.12   10.01
 23           PC       0     2.0     5.9     8.0    11.0    14.4    15.0    16.0    16.8    17.1
 24           PC    18.0    18.2    18.7    19.0    19.7    20.2    21.0    22.0    23.0    24.1
 25           PC    25.0    25.9    26.5    28.0    29.0    30.0    30.5    30.9    31.0    31.7
 26           PC    32.1    32.7    33.3    34.6    36.1    38.1    40.8    43.0    47.7    51.4
 27           PC    56.1    63.0    71.0    72.0    73.1    75.2    77.9    79.0    79.5    80.4
 28           PC    81.0    82.0    82.6    84.0    85.9    88.9    91.0    93.8    96.6    97.0
 29           PC    97.4    97.9    98.1    98.3    98.5    98.9    99.0    99.2    99.3    99.6
 30           PC    99.7    99.9   100.0
 31           JD    1.03      20
 32           JD     .96      30
 33           JD     .88      50
 34           JD     .78     100
              *
              *  CNTA UC-4 SUBBASINS
              *
```

```
35          KK    UC4A
36          KM   BASIN RUNOFF CALCULATION FOR UC-4 SUBBASIN A
37          BA     .39
38          LS              82
39          UD     .53
            *

40          KK    UC4B
41          KM   BASIN RUNOFF CALCULATION FOR UC-4 SUBBASIN B
42          BA     .20
43          LS              82
44          UD     .46
45          ZZ
1
              SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

   35        UC4A
                .
                .
   40           .        UC4B

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*              MAY   1991               *
*            VERSION 4.0.1E             *
*                                       *
*  RUN DATE  12/06/98  TIME  03:51:29   *
*                                       *
*****************************************
```

```
*****************************************
*                                       *
*    U.S. ARMY CORPS OF ENGINEERS       *
*    HYDROLOGIC ENGINEERING CENTER      *
*          609 SECOND STREET            *
*       DAVIS, CALIFORNIA 95616         *
*           (916) 551-1748              *
*                                       *
*****************************************
```

```
                    FLOOD ASSESSMENT FOR CNTA UC-4 SITE
                    5 MINUTE INTERVAL IN ITCARD
                     25-YEAR 6-HOUR STORM 1.3 INCHES
                    POINT RAINFALL FROM NOAA ATLAS II VOL 7 (NO ADJUSTMENT NECESSARY)
                    DEPTH-AREA REDUCTION FACTORS FROM TABLE 502 IN
                    CLARK COUNTY HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL (CCFRCD, 1990)
                    CURVE NUMBERS NOT ADJUSTED

  9 IO        OUTPUT CONTROL VARIABLES
                  IPRNT          5  PRINT CONTROL
                  IPLOT          0  PLOT CONTROL
                  QSCAL         0.  HYDROGRAPH PLOT SCALE

   IT         HYDROGRAPH TIME DATA
                   NMIN          5  MINUTES IN COMPUTATION INTERVAL
                  IDATE    1    0  STARTING DATE
                  ITIME       0000  STARTING TIME
                     NQ        300  NUMBER OF HYDROGRAPH ORDINATES
                 NDDATE      2    0  ENDING DATE
                 NDTIME       0055  ENDING TIME
                  ICENT         19  CENTURY MARK

              COMPUTATION INTERVAL    0.08 HOURS
                   TOTAL TIME BASE   24.92 HOURS

        ENGLISH UNITS
             DRAINAGE AREA          SQUARE MILES
             PRECIPITATION DEPTH    INCHES
             LENGTH, ELEVATION      FEET
             FLOW                   CUBIC FEET PER SECOND
             STORAGE VOLUME         ACRE-FEET
             SURFACE AREA           ACRES
             TEMPERATURE            DEGREES FAHRENHEIT

 11 JD        INDEX STORM NO. 1
                  STRM        1.30  PRECIPITATION DEPTH
                  TRDA        0.01  TRANSPOSITION DRAINAGE AREA
```

12 PI

PRECIPITATION PATTERN

2.00	3.70	1.30	1.70	2.10	1.60	0.60	0.00	0.00	0.00
0.00	0.00	0.30	0.70	0.20	0.60	1.00	1.40	0.90	0.90
0.70	0.20	0.10	0.10	0.30	1.00	1.50	1.20	0.80	0.20
0.50	1.40	0.80	0.30	0.20	1.20	2.70	3.00	5.70	9.00
9.10	12.00	3.40	3.70	3.10	0.70	1.60	1.60	0.50	0.40
0.80	0.80	1.20	2.20	1.60	1.10	1.30	2.00	0.60	0.60
0.30	0.20	0.20	0.10	0.30	0.00	0.10	0.10	0.30	0.00
0.10	0.10								

20 JD

INDEX STORM NO. 2

STRM 1.26 PRECIPITATION DEPTH
TRDA 1.00 TRANSPOSITION DRAINAGE AREA

0 PI

PRECIPITATION PATTERN

2.00	3.70	1.30	1.70	2.10	1.60	0.60	0.00	0.00	0.00
0.00	0.00	0.30	0.70	0.20	0.60	1.00	1.40	0.90	0.90
0.70	0.20	0.10	0.10	0.30	1.00	1.50	1.20	0.80	0.20
0.50	1.40	0.80	0.30	0.20	1.20	2.70	3.00	5.70	9.00
9.10	12.00	3.40	3.70	3.10	0.70	1.60	1.60	0.50	0.40
0.80	0.80	1.20	2.20	1.60	1.10	1.30	2.00	0.60	0.60
0.30	0.20	0.20	0.10	0.30	0.00	0.10	0.10	0.30	0.00
0.10	0.10								

21 JD

INDEX STORM NO. 3

STRM 1.12 PRECIPITATION DEPTH
TRDA 9.99 TRANSPOSITION DRAINAGE AREA

0 PI

PRECIPITATION PATTERN

2.00	3.70	1.30	1.70	2.10	1.60	0.60	0.00	0.00	0.00
0.00	0.00	0.30	0.70	0.20	0.60	1.00	1.40	0.90	0.90
0.70	0.20	0.10	0.10	0.30	1.00	1.50	1.20	0.80	0.20
0.50	1.40	0.80	0.30	0.20	1.20	2.70	3.00	5.70	9.00
9.10	12.00	3.40	3.70	3.10	0.70	1.60	1.60	0.50	0.40
0.80	0.80	1.20	2.20	1.60	1.10	1.30	2.00	0.60	0.60
0.30	0.20	0.20	0.10	0.30	0.00	0.10	0.10	0.30	0.00
0.10	0.10								

_2 JD

INDEX STORM NO. 4

STRM 1.12 PRECIPITATION DEPTH
TRDA 10.01 TRANSPOSITION DRAINAGE AREA

23 PI

PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

31 JD

INDEX STORM NO. 5

STRM 1.03 PRECIPITATION DEPTH
TRDA 20.00 TRANSPOSITION DRAINAGE AREA

0 PI

PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

32 JD

INDEX STORM NO. 6

STRM 0.96 PRECIPITATION DEPTH
TRDA 30.00 TRANSPOSITION DRAINAGE AREA

I

PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10

```
                0.20      0.10

33 JD        INDEX STORM NO. 7
                STRM        0.88  PRECIPITATION DEPTH
                TRDA       50.00  TRANSPOSITION DRAINAGE AREA

 0 PI         PRECIPITATION PATTERN
                2.00      3.90      2.10      3.00      3.40      0.60      1.00      0.80      0.30      0.90
                0.20      0.50      0.30      0.70      0.50      0.80      1.00      1.00      1.10      0.90
                0.90      0.60      1.50      1.00      1.00      0.50      0.40      0.10      0.70      0.40
                0.60      0.60      1.30      1.50      2.00      2.70      2.20      4.70      3.70      4.70
                6.90      8.00      1.00      1.10      2.10      2.70      1.10      0.50      0.90      0.60
                1.00      0.60      1.40      1.90      3.00      2.10      2.80      2.80      0.40      0.40
                0.50      0.20      0.20      0.20      0.40      0.10      0.20      0.10      0.30      0.10
                0.20      0.10

34 JD        INDEX STORM NO. 8
                STRM        0.78  PRECIPITATION DEPTH
                TRDA      100.00  TRANSPOSITION DRAINAGE AREA

 0 PI         PRECIPITATION PATTERN
                2.00      3.90      2.10      3.00      3.40      0.60      1.00      0.80      0.30      0.90
                0.20      0.50      0.30      0.70      0.50      0.80      1.00      1.00      1.10      0.90
                0.90      0.60      1.50      1.00      1.00      0.50      0.40      0.10      0.70      0.40
                0.60      0.60      1.30      1.50      2.00      2.70      2.20      4.70      3.70      4.70
                6.90      8.00      1.00      1.10      2.10      2.70      1.10      0.50      0.90      0.60
                1.00      0.60      1.40      1.90      3.00      2.10      2.80      2.80      0.40      0.40
                0.50      0.20      0.20      0.20      0.40      0.10      0.20      0.10      0.30      0.10
                0.20      0.10
1
```

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+	HYDROGRAPH AT	UC4A	39.	4.08	10.	2.	2.	0.39		
+	HYDROGRAPH AT	UC4B	22.	4.00	5.	1.	1.	0.20		

*** NORMAL END OF HEC-1 ***

UC-4

HEC-1 MODEL OUTPUT

FILENAME: 256UC4B

(25-YEAR MODEL)

```
1*****************************************
*                                       *
    FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
              MAY   1991                *
           VERSION 4.0.1E               *
*                                       *
*  RUN DATE  12/07/98  TIME  02:32:48   *
*                                       *
*****************************************
```

```
*************************************
*                                   *
*    U.S. ARMY CORPS OF ENGINEERS   *
*    HYDROLOGIC ENGINEERING CENTER  *
*          609 SECOND STREET        *
*       DAVIS, CALIFORNIA 95616     *
*          (916) 551-1748           *
*                                   *
*************************************
```

```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X              X
XXXXXXX  XXXX     X        XXXXX X
X     X  X        X              X
X     X  X        X     X        X
X     X  XXXXXXX   XXXXX         XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1

HEC-1 INPUT

PAGE 1

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID   FLOOD ASSESSMENT FOR CNTA UC-4 SITE    FILENAME: 256UC4B
  2           ID   5 MINUTE INTERVAL IN ITCARD
  3           ID    25-YEAR 6-HOUR STORM 1.3 INCHES
  4           ID   POINT RAINFALL FROM NOAA ATLAS II VOL 7 (NO ADJUSTMENT NECESSARY)
  5           ID   DEPTH-AREA REDUCTION FACTORS FROM TABLE 502 IN
  6           ID   CLARK COUNTY HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL (CCFRCD, 1990)
  7           ID   CURVE NUMBERS ADJUSTED (+3)
              *DIAGRAM
  8           IT       5       0       0     300
  9           IO       5
 10           IN       5
 11           JD     1.3     .01
              * RAINFALL DISTRIBUTION FROM CLARK COUNTY MANUAL LESS THAN 10 SQ. MILES
 12           PC       0       2     5.7     7.0     8.7    10.8    12.4    13.0    13.0    13.0
 13           PC    13.0    13.0    13.0    13.3    14.0    14.2    14.8    15.8    17.2    18.1
 14           PC    19.0    19.7    19.9    20.0    20.1    20.4    21.4    22.9    24.1    24.9
 15           PC    25.1    25.6    27.0    27.8    28.1    28.3    29.5    32.2    35.2    40.9
 16           PC    49.9    59.0    71.0    74.4    78.1    81.2    81.9    83.5    85.1    85.6
 17           PC    86.0    86.8    87.6    88.8    91.0    92.6    93.7    95.0    97.0    97.6
 18           PC    98.2    98.5    98.7    98.9    99.0    99.3    99.3    99.4    99.5    99.8
 19           PC    99.8    99.9   100.0
 20           JD    1.26       1
 21           JD    1.12    9.99
              * CHANGED RAINFALL DISTRIBUTION ABOVE 10 SQ. MILES PER CLARK COUNTY MANUAL
 22           JD    1.12   10.01
 23           PC       0     2.0     5.9     8.0    11.0    14.4    15.0    16.0    16.8    17.1
 24           PC    18.0    18.2    18.7    19.0    19.7    20.2    21.0    22.0    23.0    24.1
 25           PC    25.0    25.9    26.5    28.0    29.0    30.0    30.5    30.9    31.0    31.7
 26           PC    32.1    32.7    33.3    34.6    36.1    38.1    40.8    43.0    47.7    51.4
 27           PC    56.1    63.0    71.0    72.0    73.1    75.2    77.9    79.0    79.5    80.4
 28           PC    81.0    82.0    82.6    84.0    85.9    88.9    91.0    93.8    96.6    97.0
 29           PC    97.4    97.9    98.1    98.3    98.5    98.9    99.0    99.2    99.3    99.6
 30           PC    99.7    99.9   100.0
 31           JD    1.03      20
 32           JD     .96      30
 33           JD     .88      50
 34           JD     .78     100
              *
              *  CNTA UC-4 SUBBASINS
              *
```

```
35          KK    UC4A
36          KM   BASIN RUNOFF CALCULATION FOR UC-4 SUBBASIN A
37          BA     .39
38          LS              85
39          UD     .53
            *

40          KK    UC4B
41          KM   BASIN RUNOFF CALCULATION FOR UC-4 SUBBASIN B
42          BA     .20
43          LS              85
44          UD     .46
45          ZZ
1
              SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

   35         UC4A
                .
                .
   40           .        UC4B

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*              MAY   1991               *
*           VERSION 4.0.1E              *
*                                       *
*  RUN DATE  12/07/98  TIME  02:32:48   *
*                                       *
*****************************************
```

```
*************************************
*                                   *
*    U.S. ARMY CORPS OF ENGINEERS   *
*    HYDROLOGIC ENGINEERING CENTER  *
*          609 SECOND STREET        *
*       DAVIS, CALIFORNIA 95616     *
*          (916) 551-1748           *
*                                   *
*************************************
```

```
                    FLOOD ASSESSMENT FOR CNTA UC-4 SITE
                    5 MINUTE INTERVAL IN ITCARD
                     25-YEAR 6-HOUR STORM 1.3 INCHES
                    POINT RAINFALL FROM NOAA ATLAS II VOL 7 (NO ADJUSTMENT NECESSARY)
                    DEPTH-AREA REDUCTION FACTORS FROM TABLE 502 IN
                    CLARK COUNTY HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL (CCFRCD, 1990)
                    CURVE NUMBERS ADJUSTED (+3)

  9 IO        OUTPUT CONTROL VARIABLES
                    IPRNT          5  PRINT CONTROL
                    IPLOT          0  PLOT CONTROL
                    QSCAL         0.  HYDROGRAPH PLOT SCALE

   IT         HYDROGRAPH TIME DATA
                     NMIN          5  MINUTES IN COMPUTATION INTERVAL
                    IDATE     1    0  STARTING DATE
                    ITIME        0000  STARTING TIME
                       NQ         300  NUMBER OF HYDROGRAPH ORDINATES
                   NDDATE     2    0  ENDING DATE
                   NDTIME        0055  ENDING TIME
                    ICENT          19  CENTURY MARK

                COMPUTATION INTERVAL    0.08 HOURS
                     TOTAL TIME BASE   24.92 HOURS

        ENGLISH UNITS
             DRAINAGE AREA          SQUARE MILES
             PRECIPITATION DEPTH    INCHES
             LENGTH, ELEVATION      FEET
             FLOW                   CUBIC FEET PER SECOND
             STORAGE VOLUME         ACRE-FEET
             SURFACE AREA           ACRES
             TEMPERATURE            DEGREES FAHRENHEIT

 11 JD        INDEX STORM NO. 1
                    STRM        1.30  PRECIPITATION DEPTH
                    TRDA        0.01  TRANSPOSITION DRAINAGE AREA
```

12 PI

PRECIPITATION PATTERN

2.00	3.70	1.30	1.70	2.10	1.60	0.60	0.00	0.00	0.00
0.00	0.00	0.30	0.70	0.20	0.60	1.00	1.40	0.90	0.90
0.70	0.20	0.10	0.10	0.30	1.00	1.50	1.20	0.80	0.20
0.50	1.40	0.80	0.30	0.20	1.20	2.70	3.00	5.70	9.00
9.10	12.00	3.40	3.70	3.10	0.70	1.60	1.60	0.50	0.40
0.80	0.80	1.20	2.20	1.60	1.10	1.30	2.00	0.60	0.60
0.30	0.20	0.20	0.10	0.30	0.00	0.10	0.10	0.30	0.00
0.10	0.10								

20 JD

INDEX STORM NO. 2

STRM 1.26 PRECIPITATION DEPTH

TRDA 1.00 TRANSPOSITION DRAINAGE AREA

0 PI

PRECIPITATION PATTERN

2.00	3.70	1.30	1.70	2.10	1.60	0.60	0.00	0.00	0.00
0.00	0.00	0.30	0.70	0.20	0.60	1.00	1.40	0.90	0.90
0.70	0.20	0.10	0.10	0.30	1.00	1.50	1.20	0.80	0.20
0.50	1.40	0.80	0.30	0.20	1.20	2.70	3.00	5.70	9.00
9.10	12.00	3.40	3.70	3.10	0.70	1.60	1.60	0.50	0.40
0.80	0.80	1.20	2.20	1.60	1.10	1.30	2.00	0.60	0.60
0.30	0.20	0.20	0.10	0.30	0.00	0.10	0.10	0.30	0.00
0.10	0.10								

21 JD

INDEX STORM NO. 3

STRM 1.12 PRECIPITATION DEPTH

TRDA 9.99 TRANSPOSITION DRAINAGE AREA

0 PI

PRECIPITATION PATTERN

2.00	3.70	1.30	1.70	2.10	1.60	0.60	0.00	0.00	0.00
0.00	0.00	0.30	0.70	0.20	0.60	1.00	1.40	0.90	0.90
0.70	0.20	0.10	0.10	0.30	1.00	1.50	1.20	0.80	0.20
0.50	1.40	0.80	0.30	0.20	1.20	2.70	3.00	5.70	9.00
9.10	12.00	3.40	3.70	3.10	0.70	1.60	1.60	0.50	0.40
0.80	0.80	1.20	2.20	1.60	1.10	1.30	2.00	0.60	0.60
0.30	0.20	0.20	0.10	0.30	0.00	0.10	0.10	0.30	0.00
0.10	0.10								

22 JD

INDEX STORM NO. 4

STRM 1.12 PRECIPITATION DEPTH

TRDA 10.01 TRANSPOSITION DRAINAGE AREA

23 PI

PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

31 JD

INDEX STORM NO. 5

STRM 1.03 PRECIPITATION DEPTH

TRDA 20.00 TRANSPOSITION DRAINAGE AREA

0 PI

PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

32 JD

INDEX STORM NO. 6

STRM 0.96 PRECIPITATION DEPTH

TRDA 30.00 TRANSPOSITION DRAINAGE AREA

PI

PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10

```
                0.20      0.10

33 JD        INDEX STORM NO. 7
                STRM        0.88  PRECIPITATION DEPTH
                TRDA       50.00  TRANSPOSITION DRAINAGE AREA

 0 PI         PRECIPITATION PATTERN
                2.00      3.90      2.10      3.00      3.40      0.60      1.00      0.80      0.30      0.90
                0.20      0.50      0.30      0.70      0.50      0.80      1.00      1.00      1.10      0.90
                0.90      0.60      1.50      1.00      1.00      0.50      0.40      0.10      0.70      0.40
                0.60      0.60      1.30      1.50      2.00      2.70      2.20      4.70      3.70      4.70
                6.90      8.00      1.00      1.10      2.10      2.70      1.10      0.50      0.90      0.60
                1.00      0.60      1.40      1.90      3.00      2.10      2.80      2.80      0.40      0.40
                0.50      0.20      0.20      0.20      0.40      0.10      0.20      0.10      0.30      0.10
                0.20      0.10

34 JD        INDEX STORM NO. 8
                STRM        0.78  PRECIPITATION DEPTH
                TRDA      100.00  TRANSPOSITION DRAINAGE AREA

 0 PI         PRECIPITATION PATTERN
                2.00      3.90      2.10      3.00      3.40      0.60      1.00      0.80      0.30      0.90
                0.20      0.50      0.30      0.70      0.50      0.80      1.00      1.00      1.10      0.90
                0.90      0.60      1.50      1.00      1.00      0.50      0.40      0.10      0.70      0.40
                0.60      0.60      1.30      1.50      2.00      2.70      2.20      4.70      3.70      4.70
                6.90      8.00      1.00      1.10      2.10      2.70      1.10      0.50      0.90      0.60
                1.00      0.60      1.40      1.90      3.00      2.10      2.80      2.80      0.40      0.40
                0.50      0.20      0.20      0.20      0.40      0.10      0.20      0.10      0.30      0.10
1
```

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+	HYDROGRAPH AT	UC4A	56.	4.08	13.	3.	3.	0.39		
+	HYDROGRAPH AT	UC4B	32.	4.00	7.	2.	2.	0.20		

*** NORMAL END OF HEC-1 ***

UC-4

HEC-1 MODEL OUTPUT

FILENAME: 106UC4A

(10-YEAR MODEL)

```
1*****************************************
*                                       *
    FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
              MAY   1991                *
           VERSION 4.0.1E               *
*                                       *
*  RUN DATE  12/06/98  TIME  21:40:06   *
*                                       *
*****************************************
```

```
*************************************
*                                   *
*    U.S. ARMY CORPS OF ENGINEERS   *
*    HYDROLOGIC ENGINEERING CENTER  *
*          609 SECOND STREET        *
*       DAVIS, CALIFORNIA 95616     *
*          (916) 551-1748           *
*                                   *
*************************************
```

```
X     X  XXXXXXX   XXXXX          X
X     X  X       X     X        XX
X     X  X       X               X
XXXXXXX  XXXX    X       XXXXX   X
X     X  X       X               X
X     X  X       X     X         X
X     X  XXXXXXX   XXXXX        XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1

HEC-1 INPUT

PAGE 1

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID   FLOOD ASSESSMENT FOR CNTA UC-4 SITE
  2           ID   FILENAME: 106UC4A
  3           ID   5 MINUTE INTERVAL IN ITCARD
  4           ID   10-YEAR 6-HOUR STORM 1.1 INCHES
  5           ID   POINT RAINFALL VALUE FROM NOAA ATLASS 2 VOL VII
  6           ID   DEPTH-AREA REDUCTION FACTORS FROM TABLE 502 IN
  7           ID   CLARK COUNTY HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL (CCRFCD, 1990)
  8           ID   CURVE NUMBERS NOT ADJUSTED
              *DIAGRAM
  9           IT       5       0       0     300
 10           IO       5
 11           IN       5
 12           JD     1.1     .01
              * RAINFALL DISTRIBUTION FROM CLARK COUNTY MANUAL LESS THAN 10 SQ. MILES
 13           PC       0       2     5.7     7.0     8.7    10.8    12.4    13.0    13.0    13.0
 14           PC    13.0    13.0    13.0    13.3    14.0    14.2    14.8    15.8    17.2    18.1
 15           PC    19.0    19.7    19.9    20.0    20.1    20.4    21.4    22.9    24.1    24.9
 16           PC    25.1    25.6    27.0    27.8    28.1    28.3    29.5    32.2    35.2    40.9
 17           PC    49.9    59.0    71.0    74.4    78.1    81.2    81.9    83.5    85.1    85.6
 18           PC    86.0    86.8    87.6    88.8    91.0    92.6    93.7    95.0    97.0    97.6
 19           PC    98.2    98.5    98.7    98.9    99.0    99.3    99.3    99.4    99.5    99.8
 20           PC    99.8    99.9   100.0
 21           JD    1.07       1
 22           JD     .95    9.99
              * CHANGED RAINFALL DISTRIBUTION ABOVE 10 SQ. MILES PER CLARK COUNTY MANUAL
 23           JD     .95   10.01
 24           PC       0     2.0     5.9     8.0    11.0    14.4    15.0    16.0    16.8    17.1
 25           PC    18.0    18.2    18.7    19.0    19.7    20.2    21.0    22.0    23.0    24.1
 26           PC    25.0    25.9    26.5    28.0    29.0    30.0    30.5    30.9    31.0    31.7
 27           PC    32.1    32.7    33.3    34.6    36.1    38.1    40.8    43.0    47.7    51.4
 28           PC    56.1    63.0    71.0    72.0    73.1    75.2    77.9    79.0    79.5    80.4
 29           PC    81.0    82.0    82.6    84.0    85.9    88.9    91.0    93.8    96.6    97.0
 30           PC    97.4    97.9    98.1    98.3    98.5    98.9    99.0    99.2    99.3    99.6
 31           PC    99.7    99.9   100.0
 32           JD     .87      20
 33           JD     .81      30
 34           JD     .75      50
 35           JD     .66     100
              *  CNTA UC-4 SUBBASINS
              *
```

```
36          KK    UC4A
37          KM   BASIN RUNOFF CALCULATION FOR UC-4 SUBBASIN A
38          BA     .39
39          LS              82
40          UD     .53
            *

41          KK    UC4B
42          KM   BASIN RUNOFF CALCULATION FOR UC-4 SUBBASIN B
43          BA     .20
44          LS              82
45          UD     .46
46          ZZ
1
            SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

   36        UC4A
                .
                .
   41           .        UC4B

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************                                  ****************************************
 *                                       *                                  *                                      *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                  *    U.S. ARMY CORPS OF ENGINEERS
 *              MAY   1991               *                                  *    HYDROLOGIC ENGINEERING CENTER
 *           VERSION 4.0.1E              *                                  *          609 SECOND STREET
 *                                       *                                  *       DAVIS, CALIFORNIA 95616
 *  RUN DATE  12/06/98  TIME  21:40:06   *                                  *           (916) 551-1748
 *                                       *                                  *                                      *
 *****************************************                                  ****************************************


                        FLOOD ASSESSMENT FOR CNTA UC-4 SITE
                        FILENAME: 106UC4A
                        5 MINUTE INTERVAL IN ITCARD
                        10-YEAR 6-HOUR STORM 1.1 INCHES
                        POINT RAINFALL VALUE FROM NOAA ATLASS 2 VOL VII
                        DEPTH-AREA REDUCTION FACTORS FROM TABLE 502 IN
                        CLARK COUNTY HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL (CCRFCD, 1990)
                        CURVE NUMBERS NOT ADJUSTED

  10 IO        OUTPUT CONTROL VARIABLES
                    IPRNT          5  PRINT CONTROL
                    IPLOT          0  PLOT CONTROL
                    QSCAL         0.  HYDROGRAPH PLOT SCALE

    IT         HYDROGRAPH TIME DATA
                     NMIN          5  MINUTES IN COMPUTATION INTERVAL
                    IDATE      1   0  STARTING DATE
                    ITIME       0000  STARTING TIME
                       NQ        300  NUMBER OF HYDROGRAPH ORDINATES
                   NDDATE      2   0  ENDING DATE
                   NDTIME       0055  ENDING TIME
                   ICENT          19  CENTURY MARK

                COMPUTATION INTERVAL    0.08 HOURS
                     TOTAL TIME BASE   24.92 HOURS

        ENGLISH UNITS
             DRAINAGE AREA          SQUARE MILES
             PRECIPITATION DEPTH    INCHES
             LENGTH, ELEVATION      FEET
             FLOW                   CUBIC FEET PER SECOND
             STORAGE VOLUME         ACRE-FEET
             SURFACE AREA           ACRES
             TEMPERATURE            DEGREES FAHRENHEIT

  12 JD        INDEX STORM NO. 1
                     STRM        1.10  PRECIPITATION DEPTH
```

TRDA 0.01 TRANSPOSITION DRAINAGE AREA

13 PI PRECIPITATION PATTERN

2.00	3.70	1.30	1.70	2.10	1.60	0.60	0.00	0.00	0.00
0.00	0.00	0.30	0.70	0.20	0.60	1.00	1.40	0.90	0.90
0.70	0.20	0.10	0.10	0.30	1.00	1.50	1.20	0.80	0.20
0.50	1.40	0.80	0.30	0.20	1.20	2.70	3.00	5.70	9.00
9.10	12.00	3.40	3.70	3.10	0.70	1.60	1.60	0.50	0.40
0.80	0.80	1.20	2.20	1.60	1.10	1.30	2.00	0.60	0.60
0.30	0.20	0.20	0.10	0.30	0.00	0.10	0.10	0.30	0.00
0.10	0.10								

21 JD INDEX STORM NO. 2

STRM 1.07 PRECIPITATION DEPTH

TRDA 1.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.70	1.30	1.70	2.10	1.60	0.60	0.00	0.00	0.00
0.00	0.00	0.30	0.70	0.20	0.60	1.00	1.40	0.90	0.90
0.70	0.20	0.10	0.10	0.30	1.00	1.50	1.20	0.80	0.20
0.50	1.40	0.80	0.30	0.20	1.20	2.70	3.00	5.70	9.00
9.10	12.00	3.40	3.70	3.10	0.70	1.60	1.60	0.50	0.40
0.80	0.80	1.20	2.20	1.60	1.10	1.30	2.00	0.60	0.60
0.30	0.20	0.20	0.10	0.30	0.00	0.10	0.10	0.30	0.00
0.10	0.10								

22 JD INDEX STORM NO. 3

STRM 0.95 PRECIPITATION DEPTH

TRDA 9.99 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.70	1.30	1.70	2.10	1.60	0.60	0.00	0.00	0.00
0.00	0.00	0.30	0.70	0.20	0.60	1.00	1.40	0.90	0.90
0.70	0.20	0.10	0.10	0.30	1.00	1.50	1.20	0.80	0.20
0.50	1.40	0.80	0.30	0.20	1.20	2.70	3.00	5.70	9.00
9.10	12.00	3.40	3.70	3.10	0.70	1.60	1.60	0.50	0.40
0.80	0.80	1.20	2.20	1.60	1.10	1.30	2.00	0.60	0.60
0.30	0.20	0.20	0.10	0.30	0.00	0.10	0.10	0.30	0.00
0.10	0.10								

23 JD INDEX STORM NO. 4

STRM 0.95 PRECIPITATION DEPTH

TRDA 10.01 TRANSPOSITION DRAINAGE AREA

24 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

32 JD INDEX STORM NO. 5

STRM 0.87 PRECIPITATION DEPTH

TRDA 20.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

33 JD INDEX STORM NO. 6

STRM 0.81 PRECIPITATION DEPTH

TRDA 30.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60

1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

34 JD INDEX STORM NO. 7

STRM 0.75 PRECIPITATION DEPTH
TRDA 50.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

35 JD INDEX STORM NO. 8

STRM 0.66 PRECIPITATION DEPTH
TRDA 100.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

1

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+	HYDROGRAPH AT	UC4A	23.	4.08	6.	2.	1.	0.39		
+	HYDROGRAPH AT	UC4B	13.	4.00	3.	1.	1.	0.20		

*** NORMAL END OF HEC-1 ***

UC-4

HEC-1 MODEL OUTPUT

FILENAME: 26UC4A

(2-YEAR MODEL)

```
1*****************************************
*                                       *
    FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
              MAY   1991                *
           VERSION 4.0.1E               *
                                        *
*  RUN DATE  12/06/98  TIME  22:16:26   *
*                                       *
*****************************************
```

```
*****************************************
*                                       *
*    U.S. ARMY CORPS OF ENGINEERS       *
*    HYDROLOGIC ENGINEERING CENTER      *
*          609 SECOND STREET            *
*       DAVIS, CALIFORNIA 95616         *
*          (916) 551-1748               *
*                                       *
*****************************************
```

```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X              X
XXXXXXX  XXXX     X       XXXXX  X
X     X  X        X              X
X     X  X        X     X        X
X     X  XXXXXXX   XXXXX         XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1

HEC-1 INPUT

PAGE 1

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID   FLOOD ASSESSMENT FOR CNTA UC-4 SITE
  2           ID   FILENAME: 26UC4A
  3           ID    2-YEAR 6-HOUR STORM 0.7 INCHES
  4           ID   POINT RAINFALL FROM NOAA ATLAS 2 VOL VII (NO ADJUSTMENT NECESSARY)
  5           ID   DEPTH-AREA REDUCTION FACTORS FROM TABLE 502 IN
  6           ID   CLARK COUNTY HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL (CCFRCD, 1990)
  7           ID   CURVE NUBERS NOT ADJUSTED
              *DIAGRAM
  8           IT       5       0       0     300
  9           IO       5
 10           IN       5
 11           JD     0.7     .01
              * RAINFALL DISTRIBUTION FROM CLARK COUNTY MANUAL LESS THAN 10 SQ. MILES
 12           PC       0       2     5.7     7.0     8.7    10.8    12.4    13.0    13.0    13.0
 13           PC    13.0    13.0    13.0    13.3    14.0    14.2    14.8    15.8    17.2    18.1
 14           PC    19.0    19.7    19.9    20.0    20.1    20.4    21.4    22.9    24.1    24.9
 15           PC    25.1    25.6    27.0    27.8    28.1    28.3    29.5    32.2    35.2    40.9
 16           PC    49.9    59.0    71.0    74.4    78.1    81.2    81.9    83.5    85.1    85.6
 17           PC    86.0    86.8    87.6    88.8    91.0    92.6    93.7    95.0    97.0    97.6
 18           PC    98.2    98.5    98.7    98.9    99.0    99.3    99.3    99.4    99.5    99.8
 19           PC    99.8    99.9   100.0
 20           JD     .68       1
 21           JD     .60    9.99
              * CHANGED RAINFALL DISTRIBUTION ABOVE 10 SQ. MILES PER CLARK COUNTY MANUAL
 22           JD     .60   10.01
 23           PC       0     2.0     5.9     8.0    11.0    14.4    15.0    16.0    16.8    17.1
 24           PC    18.0    18.2    18.7    19.0    19.7    20.2    21.0    22.0    23.0    24.1
 25           PC    25.0    25.9    26.5    28.0    29.0    30.0    30.5    30.9    31.0    31.7
 26           PC    32.1    32.7    33.3    34.6    36.1    38.1    40.8    43.0    47.7    51.4
 27           PC    56.1    63.0    71.0    72.0    73.1    75.2    77.9    79.0    79.5    80.4
 28           PC    81.0    82.0    82.6    84.0    85.9    88.9    91.0    93.8    96.6    97.0
 29           PC    97.4    97.9    98.1    98.3    98.5    98.9    99.0    99.2    99.3    99.6
 30           PC    99.7    99.9   100.0
 31           JD     .55      20
 32           JD     .52      30
 33           JD     .48      50
 34           JD     .42     100
              *
              *  CNTA UC-4 SUBBASINS
              *
```

```
35          KK    UC4A
36          KM   BASIN RUNOFF CALCULATION FOR UC-4 SUBBASIN A
37          BA     .39
38          LS              82
39          UD     .53
            *

40          KK    UC4B
41          KM   BASIN RUNOFF CALCULATION FOR UC-4 SUBBASIN B
42          BA     .20
43          LS              82
44          UD     .46
45          ZZ
1
              SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

   35         UC4A
                .
                .
   40           .        UC4B

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*              MAY   1991               *
*            VERSION 4.0.1E             *
*                                       *
*  RUN DATE  12/06/98  TIME  22:16:26   *
*                                       *
*****************************************
```

```
*************************************
*                                   *
*    U.S. ARMY CORPS OF ENGINEERS   *
*    HYDROLOGIC ENGINEERING CENTER  *
*          609 SECOND STREET        *
*       DAVIS, CALIFORNIA 95616     *
*           (916) 551-1748          *
*                                   *
*************************************
```

```
                    FLOOD ASSESSMENT FOR CNTA UC-4 SITE
                    FILENAME: 26UC4A.DAT
                     2-YEAR 6-HOUR STORM 0.7 INCHES
                    POINT RAINFALL FROM NOAA ATLAS 2 VOL VII (NO ADJUSTMENT NECESSARY)
                    DEPTH-AREA REDUCTION FACTORS FROM TABLE 502 IN
                    CLARK COUNTY HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL (CCFRCD, 1990)
                    CURVE NUBERS NOT ADJUSTED

  9 IO        OUTPUT CONTROL VARIABLES
                  IPRNT        5  PRINT CONTROL
                  IPLOT        0  PLOT CONTROL
                  QSCAL       0.  HYDROGRAPH PLOT SCALE

   IT         HYDROGRAPH TIME DATA
                   NMIN        5  MINUTES IN COMPUTATION INTERVAL
                  IDATE    1   0  STARTING DATE
                  ITIME     0000  STARTING TIME
                     NQ      300  NUMBER OF HYDROGRAPH ORDINATES
                 NDDATE    2   0  ENDING DATE
                 NDTIME     0055  ENDING TIME
                  ICENT       19  CENTURY MARK

              COMPUTATION INTERVAL    0.08 HOURS
                   TOTAL TIME BASE   24.92 HOURS

        ENGLISH UNITS
             DRAINAGE AREA          SQUARE MILES
             PRECIPITATION DEPTH    INCHES
             LENGTH, ELEVATION      FEET
             FLOW                   CUBIC FEET PER SECOND
             STORAGE VOLUME         ACRE-FEET
             SURFACE AREA           ACRES
             TEMPERATURE            DEGREES FAHRENHEIT

 11 JD        INDEX STORM NO. 1
                  STRM       0.70  PRECIPITATION DEPTH
                  TRDA       0.01  TRANSPOSITION DRAINAGE AREA
```

12 PI

PRECIPITATION PATTERN

2.00	3.70	1.30	1.70	2.10	1.60	0.60	0.00	0.00	0.00
0.00	0.00	0.30	0.70	0.20	0.60	1.00	1.40	0.90	0.90
0.70	0.20	0.10	0.10	0.30	1.00	1.50	1.20	0.80	0.20
0.50	1.40	0.80	0.30	0.20	1.20	2.70	3.00	5.70	9.00
9.10	12.00	3.40	3.70	3.10	0.70	1.60	1.60	0.50	0.40
0.80	0.80	1.20	2.20	1.60	1.10	1.30	2.00	0.60	0.60
0.30	0.20	0.20	0.10	0.30	0.00	0.10	0.10	0.30	0.00
0.10	0.10								

20 JD

INDEX STORM NO. 2

STRM 0.68 PRECIPITATION DEPTH
TRDA 1.00 TRANSPOSITION DRAINAGE AREA

0 PI

PRECIPITATION PATTERN

2.00	3.70	1.30	1.70	2.10	1.60	0.60	0.00	0.00	0.00
0.00	0.00	0.30	0.70	0.20	0.60	1.00	1.40	0.90	0.90
0.70	0.20	0.10	0.10	0.30	1.00	1.50	1.20	0.80	0.20
0.50	1.40	0.80	0.30	0.20	1.20	2.70	3.00	5.70	9.00
9.10	12.00	3.40	3.70	3.10	0.70	1.60	1.60	0.50	0.40
0.80	0.80	1.20	2.20	1.60	1.10	1.30	2.00	0.60	0.60
0.30	0.20	0.20	0.10	0.30	0.00	0.10	0.10	0.30	0.00
0.10	0.10								

21 JD

INDEX STORM NO. 3

STRM 0.60 PRECIPITATION DEPTH
TRDA 9.99 TRANSPOSITION DRAINAGE AREA

0 PI

PRECIPITATION PATTERN

2.00	3.70	1.30	1.70	2.10	1.60	0.60	0.00	0.00	0.00
0.00	0.00	0.30	0.70	0.20	0.60	1.00	1.40	0.90	0.90
0.70	0.20	0.10	0.10	0.30	1.00	1.50	1.20	0.80	0.20
0.50	1.40	0.80	0.30	0.20	1.20	2.70	3.00	5.70	9.00
9.10	12.00	3.40	3.70	3.10	0.70	1.60	1.60	0.50	0.40
0.80	0.80	1.20	2.20	1.60	1.10	1.30	2.00	0.60	0.60
0.30	0.20	0.20	0.10	0.30	0.00	0.10	0.10	0.30	0.00
0.10	0.10								

.2 JD

INDEX STORM NO. 4

STRM 0.60 PRECIPITATION DEPTH
TRDA 10.01 TRANSPOSITION DRAINAGE AREA

23 PI

PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

31 JD

INDEX STORM NO. 5

STRM 0.55 PRECIPITATION DEPTH
TRDA 20.00 TRANSPOSITION DRAINAGE AREA

0 PI

PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

32 JD

INDEX STORM NO. 6

STRM 0.52 PRECIPITATION DEPTH
TRDA 30.00 TRANSPOSITION DRAINAGE AREA

'I

PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10

	0.20	0.10								

33 JD INDEX STORM NO. 7

STRM 0.48 PRECIPITATION DEPTH
TRDA 50.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

34 JD INDEX STORM NO. 8

STRM 0.42 PRECIPITATION DEPTH
TRDA 100.00 TRANSPOSITION DRAINAGE AREA

0 PI PRECIPITATION PATTERN

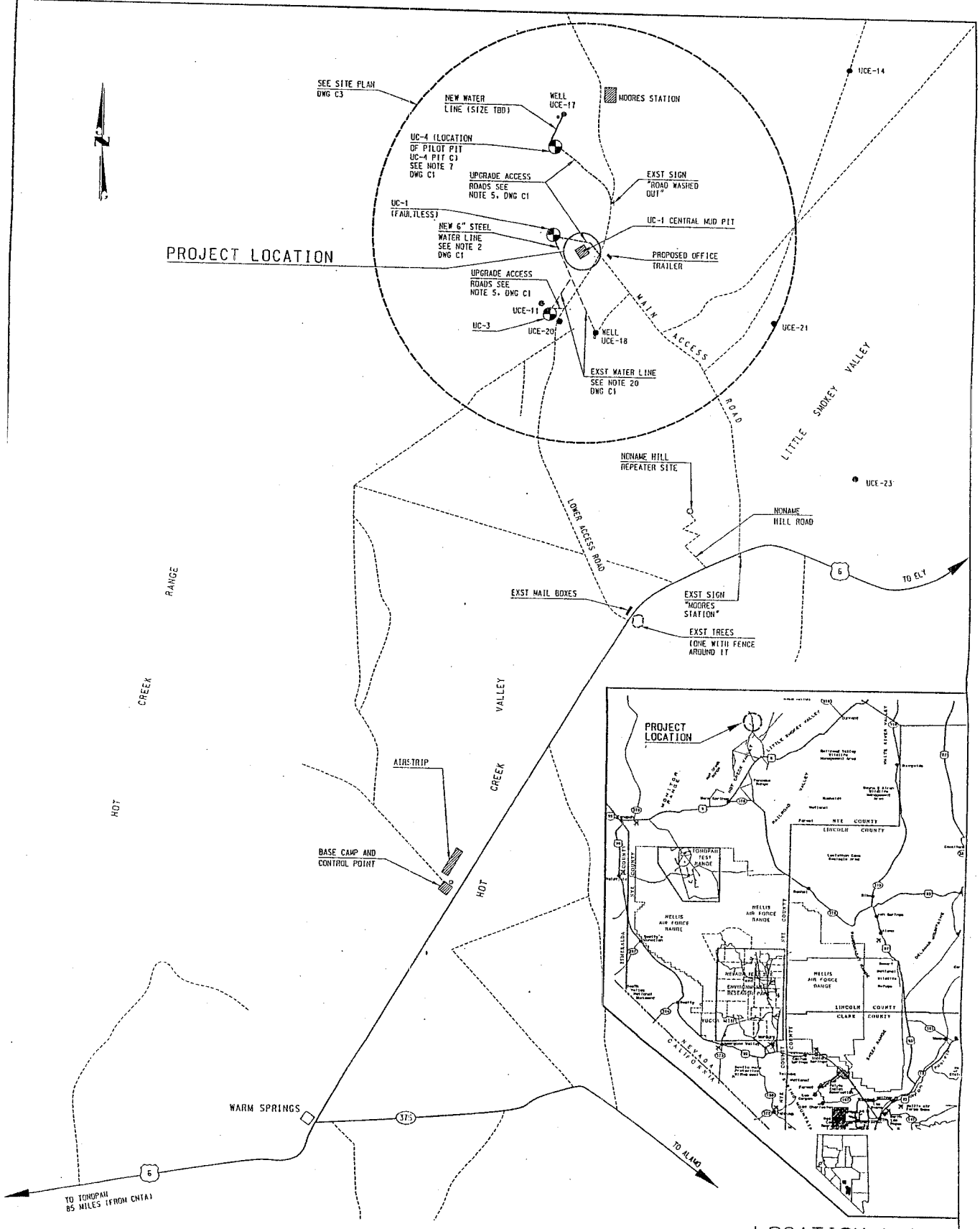
2.00	3.90	2.10	3.00	3.40	0.60	1.00	0.80	0.30	0.90
0.20	0.50	0.30	0.70	0.50	0.80	1.00	1.00	1.10	0.90
0.90	0.60	1.50	1.00	1.00	0.50	0.40	0.10	0.70	0.40
0.60	0.60	1.30	1.50	2.00	2.70	2.20	4.70	3.70	4.70
6.90	8.00	1.00	1.10	2.10	2.70	1.10	0.50	0.90	0.60
1.00	0.60	1.40	1.90	3.00	2.10	2.80	2.80	0.40	0.40
0.50	0.20	0.20	0.20	0.40	0.10	0.20	0.10	0.30	0.10
0.20	0.10								

1

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+	HYDROGRAPH AT	UC4A	4.	5.17	1.	0.	0.	0.39		
+	HYDROGRAPH AT	UC4B	2.	5.08	1.	0.	0.	0.20		

*** NORMAL END OF HEC-1 ***



LOCATION MAP

GRAPHIC SCALE

0 3000 8000 12000

SCALE 1:100,000 METERS

VICINITY MAP

SCALE : 1:100,000

ALL INFORMATION WAS DERIVED FROM BEST AVAILABLE SOURCES AND HAS NOT BEEN VERIFIED TO DATE.

U.S. DEPARTMENT OF ENERGY

NEVADA OPERATIONS OFFICE LAS VEGAS, NEVADA

Bechtel Nevada

CENTRAL NEVADA — AREA 58

CAU 417 REMEDIATION

UC-1 CMP CLOSURE

PRELIMINARY CONCEPTUAL DESIGN

VICINITY MAP

DESIGNED | DRAWN | CHECKED | ENVIR | MAP REF NO.

SUBMITTED BECHTEL NEVADA | DATE

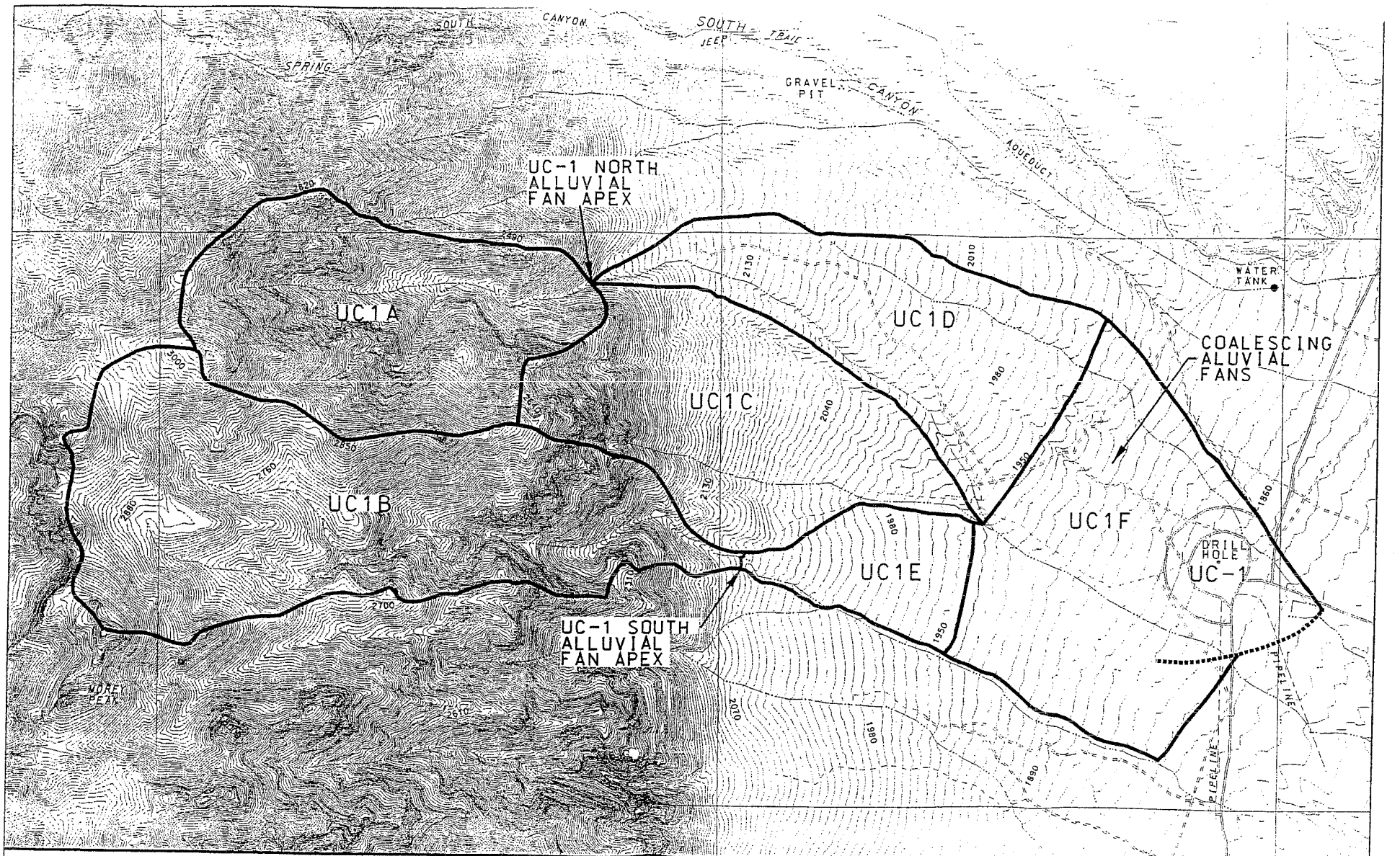
USER | DATE

DEPT OF ENERGY PROJECT ENGINEER | DATE

PROJECT NUMBER 98228A58 | PROJECT AUTH NO | ACTIVITY CODE C5B1A0EA

NO | DATE | REVISION DESCRIPTION

CAU-058-417-C8



LEGEND

WATERSHED BOUNDARY
FAULT SCARP

CONTOURS AND ELEVATIONS IN METERS

BASED FROM USGS HOBBLE CANYON 1968, MOORES STATION 1967, MOREY PEAK 1967, MOORES STATION SW 1967, QUADRANGLES, NEVADA.

GRAPHIC SCALE

0 240 480 720 960 1200 METERS

0 400 800 1600 2400 FEET

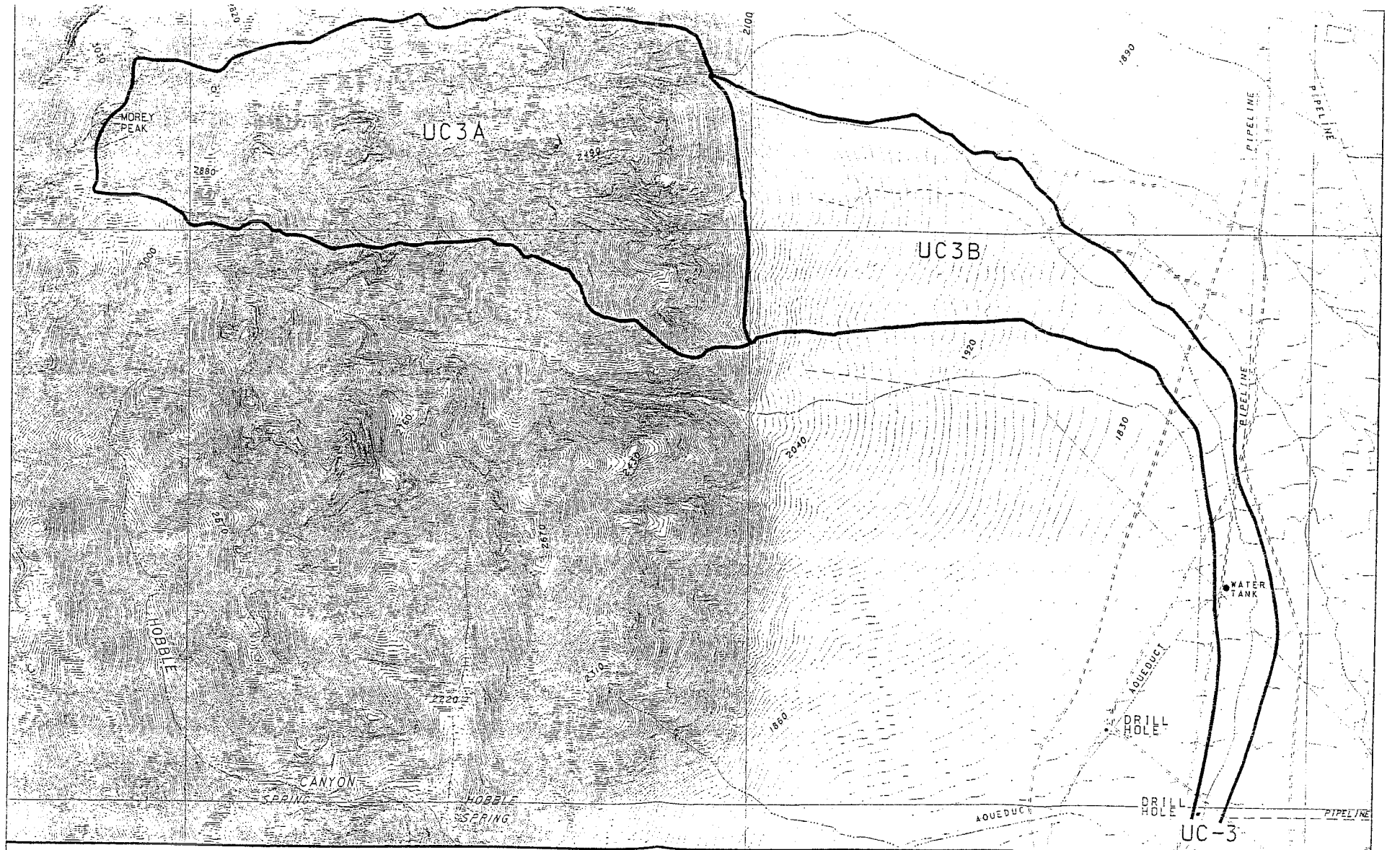
1" = 1600'

CONTOUR INTERVAL 6 METERS

Bechtel Nevada

WATERSHED MAP OF THE AREA 58 CENTRAL NEVADA TEST AREA (CNTA) - UC-1

FIGURE 2



LEGEND

WATERSHED BOUNDARY

CONTOURS AND ELEVATIONS IN METERS

BASED FROM USGS HOBBLE CANYON, NV 1968; MOORES STATION, NV 1967; MOREY PEAK, NV 1967; MOORES STATION SW, NV 1967, QUADRANGLES.

GRAPHIC SCALE

0 240 480 720 960 1200 METERS

0 400 800 1600 2400 FEET

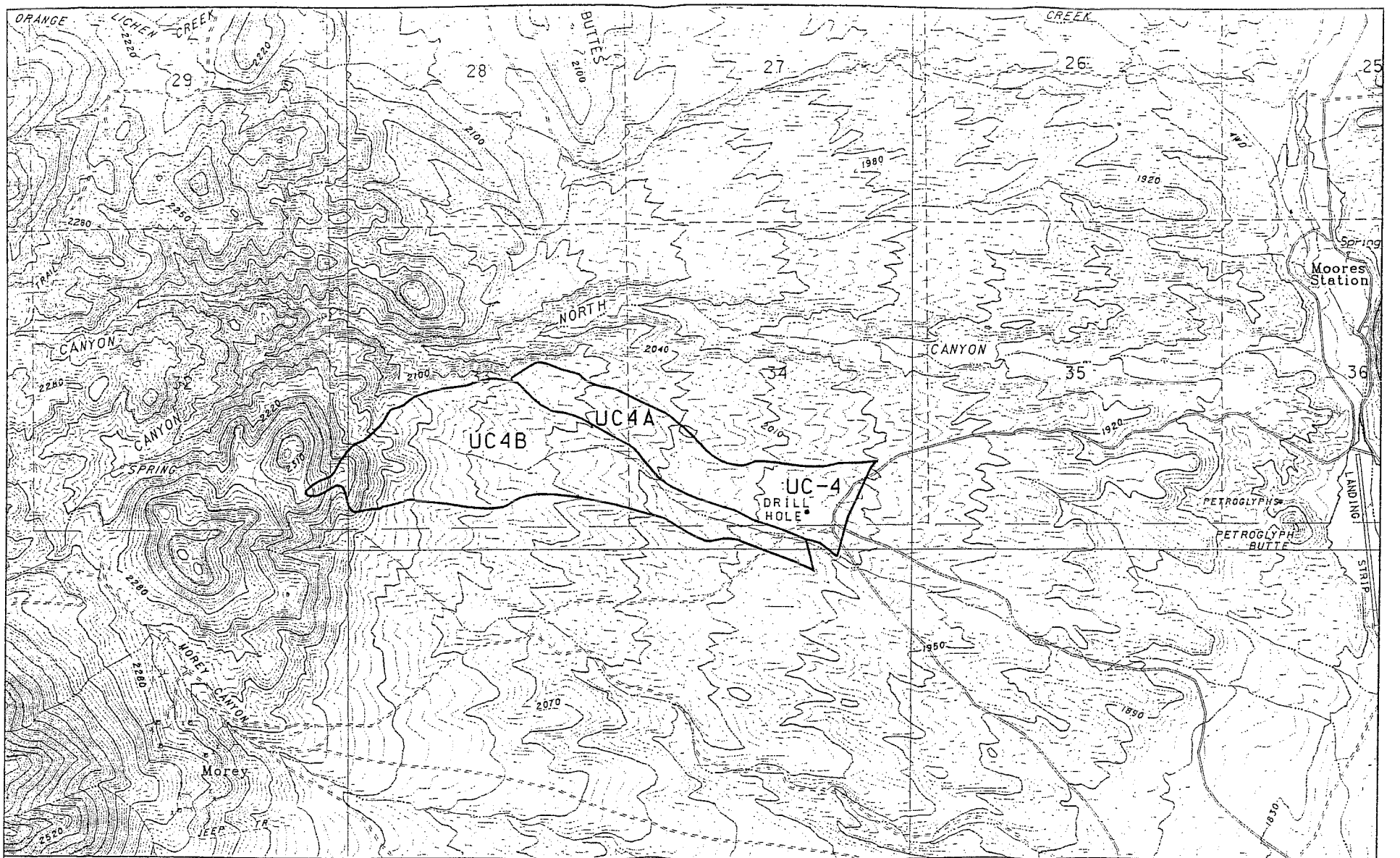
1" = 1600'

CONTOUR INTERVAL 6 METERS

Bechtel Nevada

WATERSHED MAP OF THE AREA 58 CENTRAL NEVADA TEST AREA (CNTA) - UC-3

FIGURE 3



LEGEND

WATERSHED BOUNDARY

CONTOURS AND ELEVATIONS IN METERS

BASED FROM USGS MOORES STATION 1967, MOREY PEAK 1967, QUADRANGLES, NEVADA.

GRAPHIC SCALE

0 240 480 720 960 1200 METERS

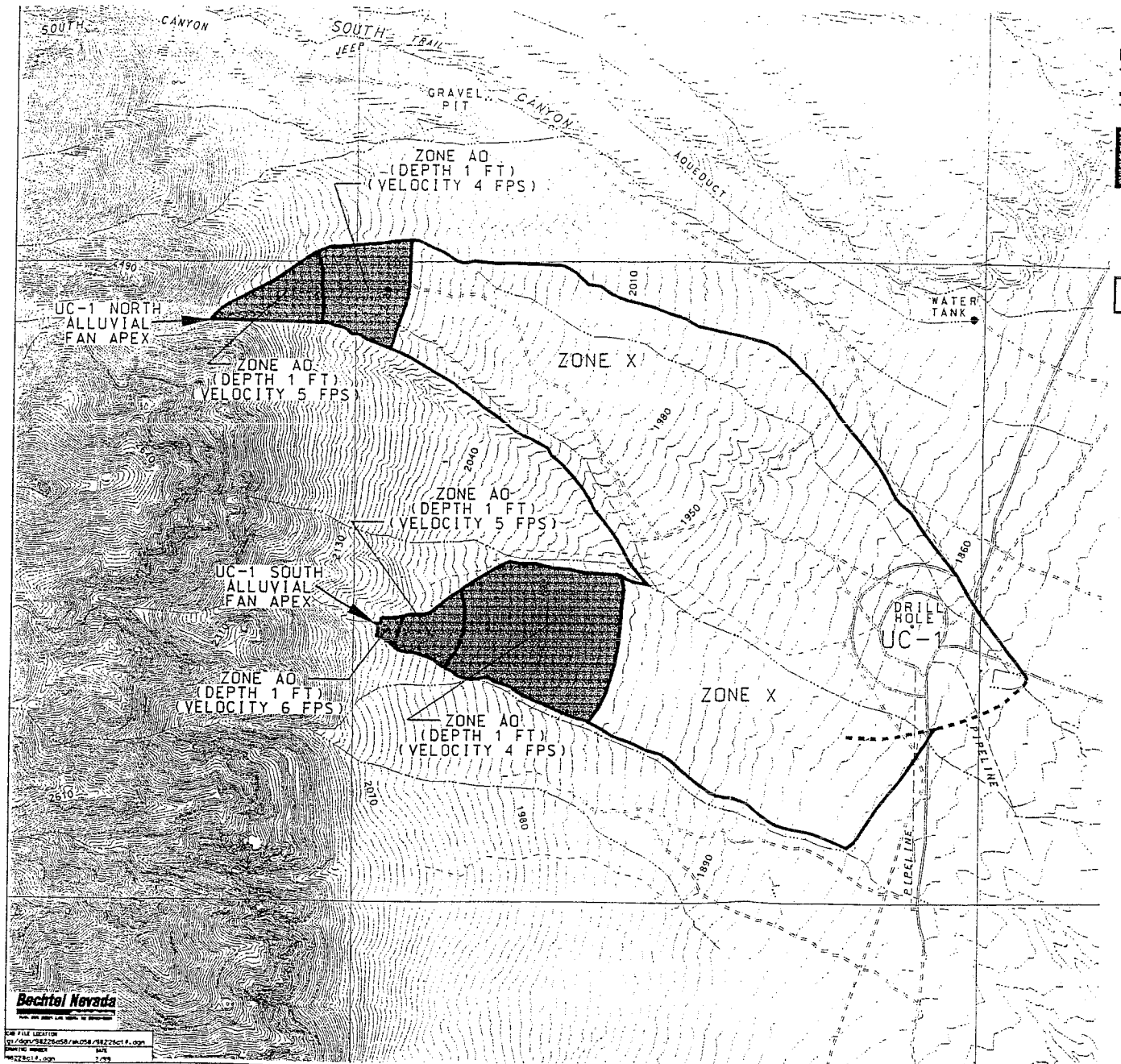
0 400 800 1600 2400 1" = 1600' FEET

CONTOUR INTERVAL 6 METERS

Bechtel Nevada

WATERSHED MAP OF THE AREA 58 CENTRAL NEVADA TEST AREA (CNTA) - UC-4

FIGURE 4



LEGEND

ALLUVIAL FAN BOUNDARY
FAULT SCARP

ZONE AO
(DEPTH 1 FT)
(VELOCITY 5 FPS)

FEMA ALLUVIAL FAN 100-YEAR FLOOD ZONE DESIGNATION THAT CORRESPONDS TO AREAS OF 100-YEAR SHALLOW FLOODING WHERE AVERAGE DEPTHS ARE BETWEEN 1 AND 3 FEET. ANYWHERE THROUGHOUT THE ZONE THERE IS AN EQUALLY LIKELY CHANCE THAT A CHANNEL CAN OCCUR OF THE DESIGNATED DEPTH WITH A FLOW OF THE DESIGNATED VELOCITY

ZONE X

FEMA FLOOD ZONE DESIGNATION THAT CORRESPONDS TO AREAS OUTSIDE THE 100-YEAR ALLUVIAL FAN FLOOD HAZARD AND TO AREAS OF 100-YEAR SHEETFLOW FLOODING WHERE AVERAGE DEPTHS ARE LESS THAN 1 FOOT.

MAP INFORMATION

BASED FROM USGS HOBBLE CANYON 1968. MOORES STATION 1967. MOREY PEAK 1967. MOORES STATION SW 1967. QUADRANGLES. NEVADA.

GRAPHIC SCALE

0 240 480 720 960 1200 METERS

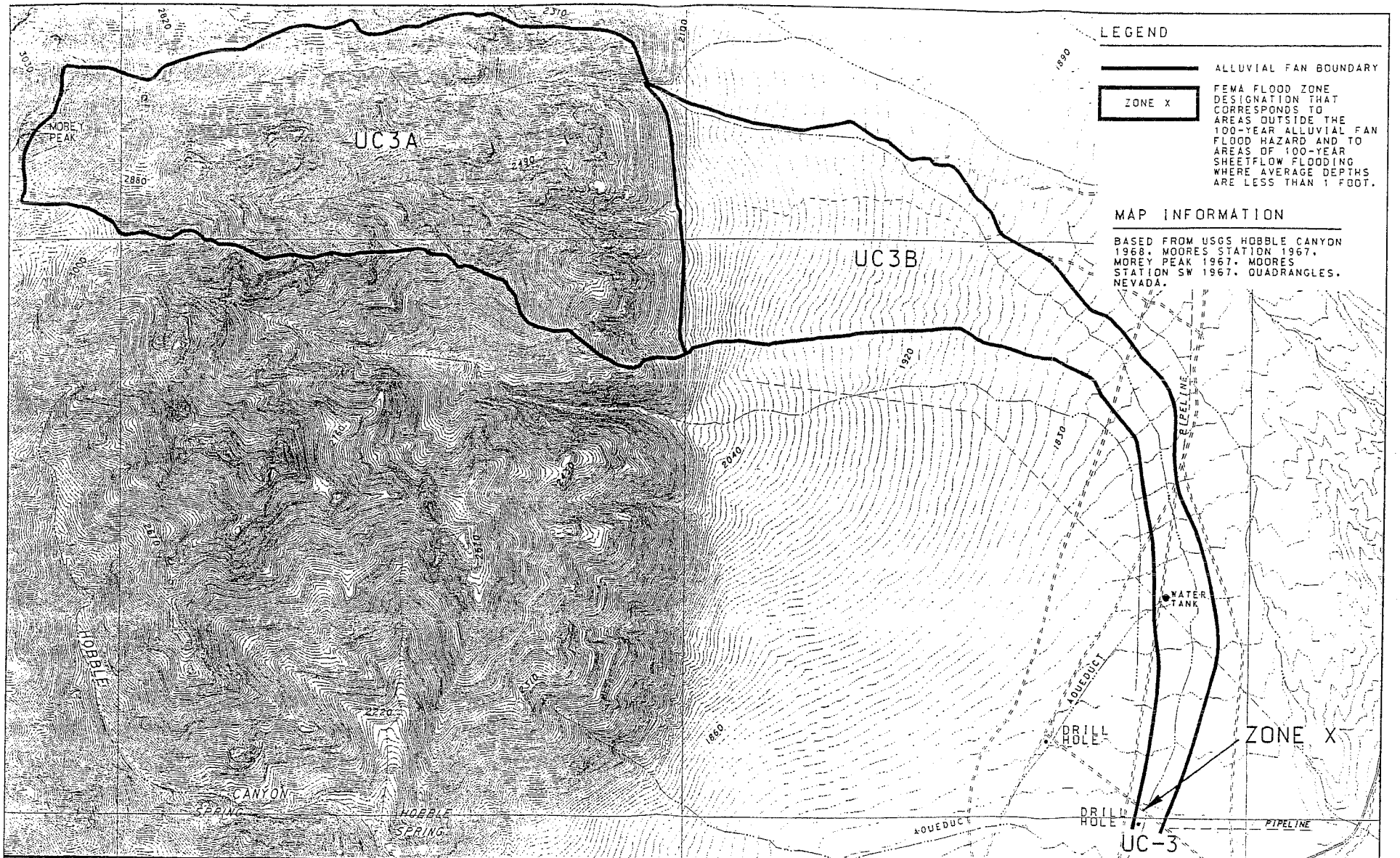
0 400 800 1600 2400 FEET

1" = 1600'

CONTOUR INTERVAL 6 METERS
CONTOURS AND ELEVATIONS IN METERS

100-YEAR FLOOD ZONE DELINEATION MAP OF THE AREA 58 CENTRAL NEVADA TEST AREA (CNTA) - UC1

FIGURE 11



GRAPHIC SCALE

0 240 480 720 960 1200 METERS

0 400 800 1600 2400 FEET

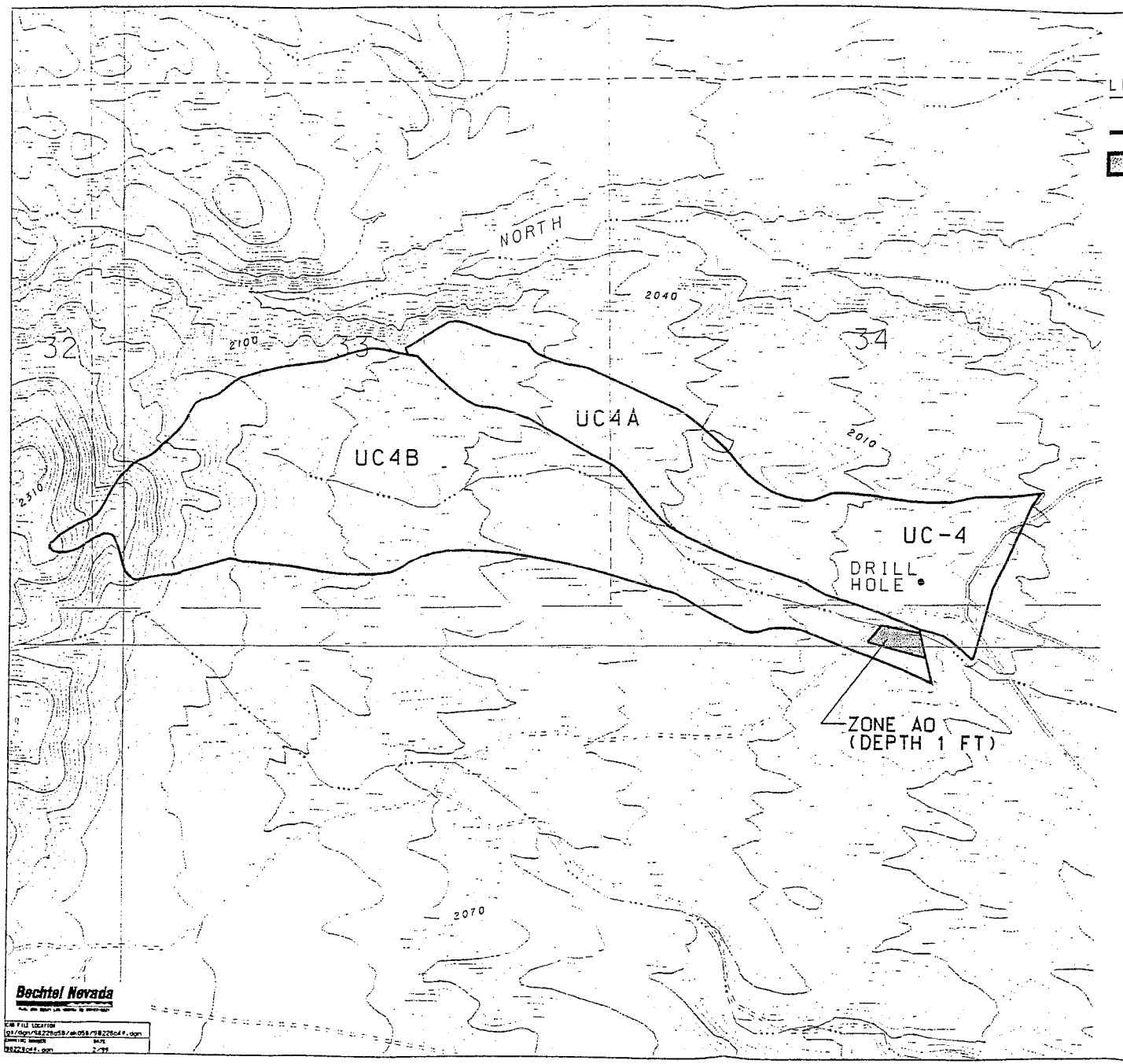
1" = 1600'

CONTOURS AND ELEVATIONS IN METERS
CONTOUR INTERVAL 6 METERS

Bechtel Nevada

100-YEAR FLOOD ZONE DELINEATION MAP OF THE AREA 58 CENTRAL NEVADA TEST AREA (CNTA) - UC3

FIGURE 12



LEGEND

ALLUVIAL FAN BOUNDARY

ZONE AO (DEPTH 1 FT) — 100-YEAR FLOOD ZONE OF SHALLOW CHANNELIZED FLOW.

MAP INFORMATION

BASED FROM USGS HOBBLE CANYON 1968. MOORES STATION 1967. MOREY PEAK 1967. MOORES STATION SW 1967. QUADRANGLES. NEVADA.

GRAPHIC SCALE

0 150 300 450 600 750 METERS

0 250 500 1000 1500 FEET

1" = 1000'

CONTOUR INTERVAL 6 METERS
CONTOURS AND ELEVATIONS IN METERS

100-YEAR FLOOD ZONE DELINEATION MAP OF THE AREA 58 CENTRAL NEVADA TEST AREA (CNTA) - UC4

FIGURE 13

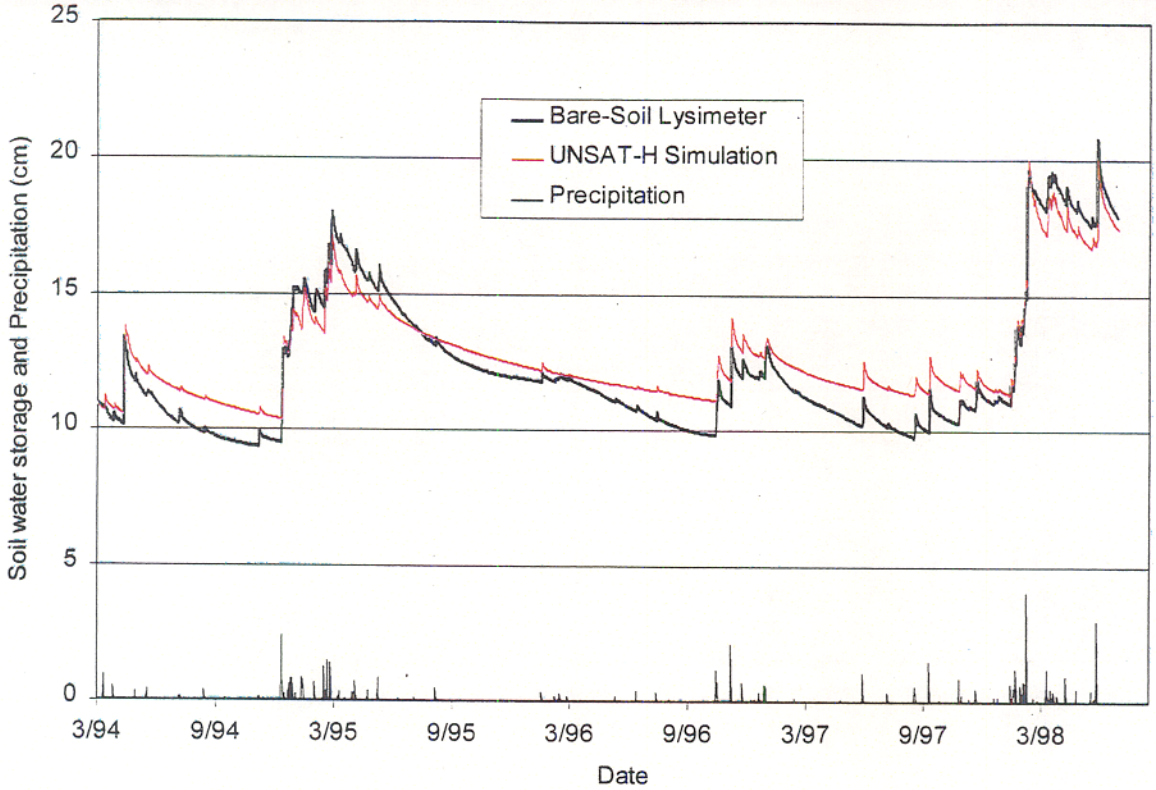


Figure 2. UNSAT-H simulation of bare soil water storage: 1994-1998.

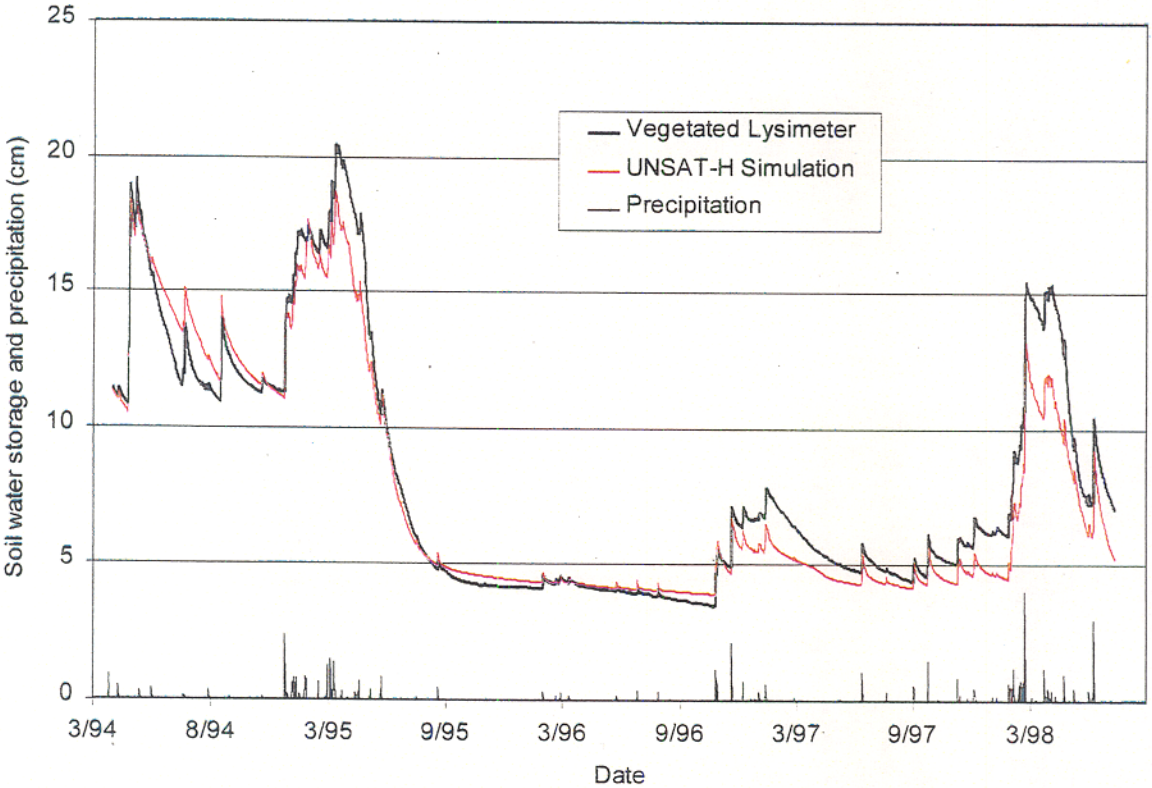


Figure 3. UNSAT-H simulation of vegetated soil water storage: 1994-1998.

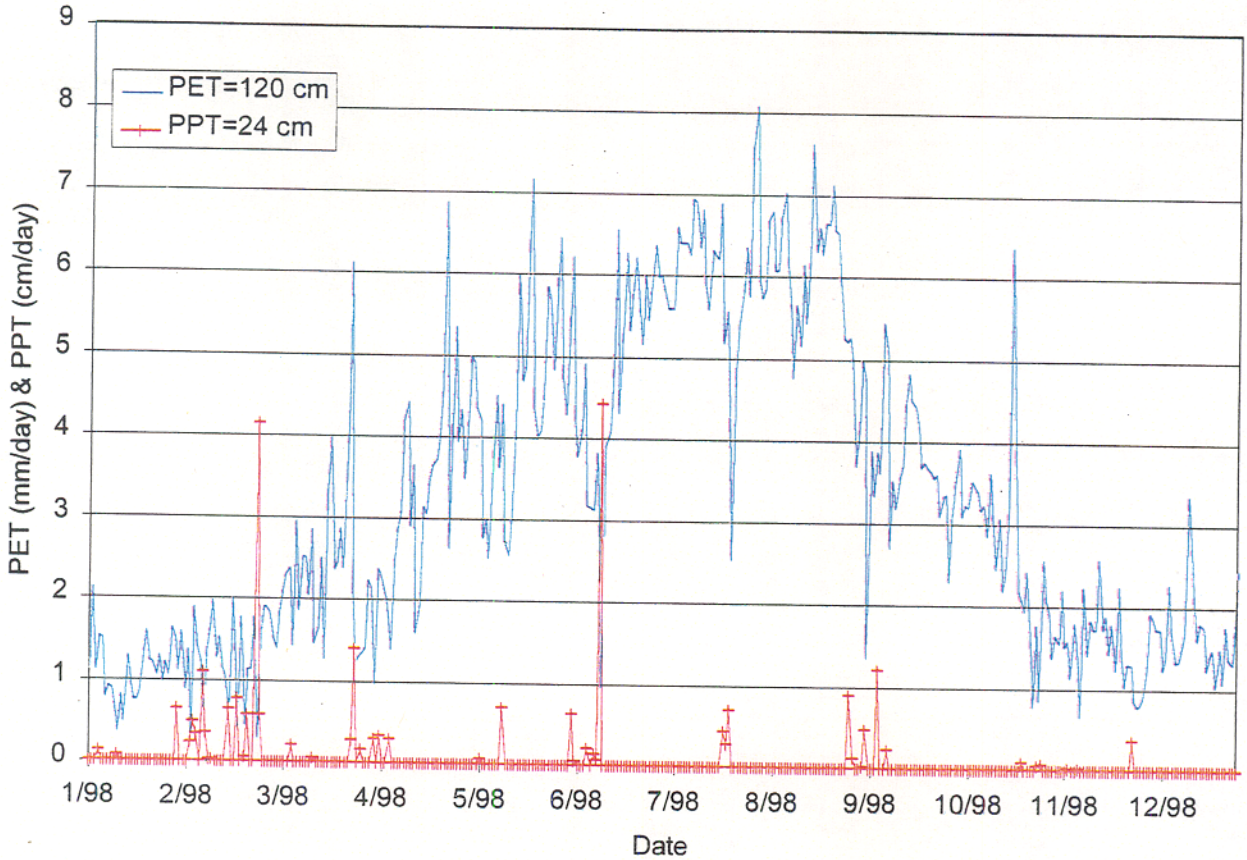


Figure 4. 1998 potential evapotranspiration and precipitation at Area 5, NTS.

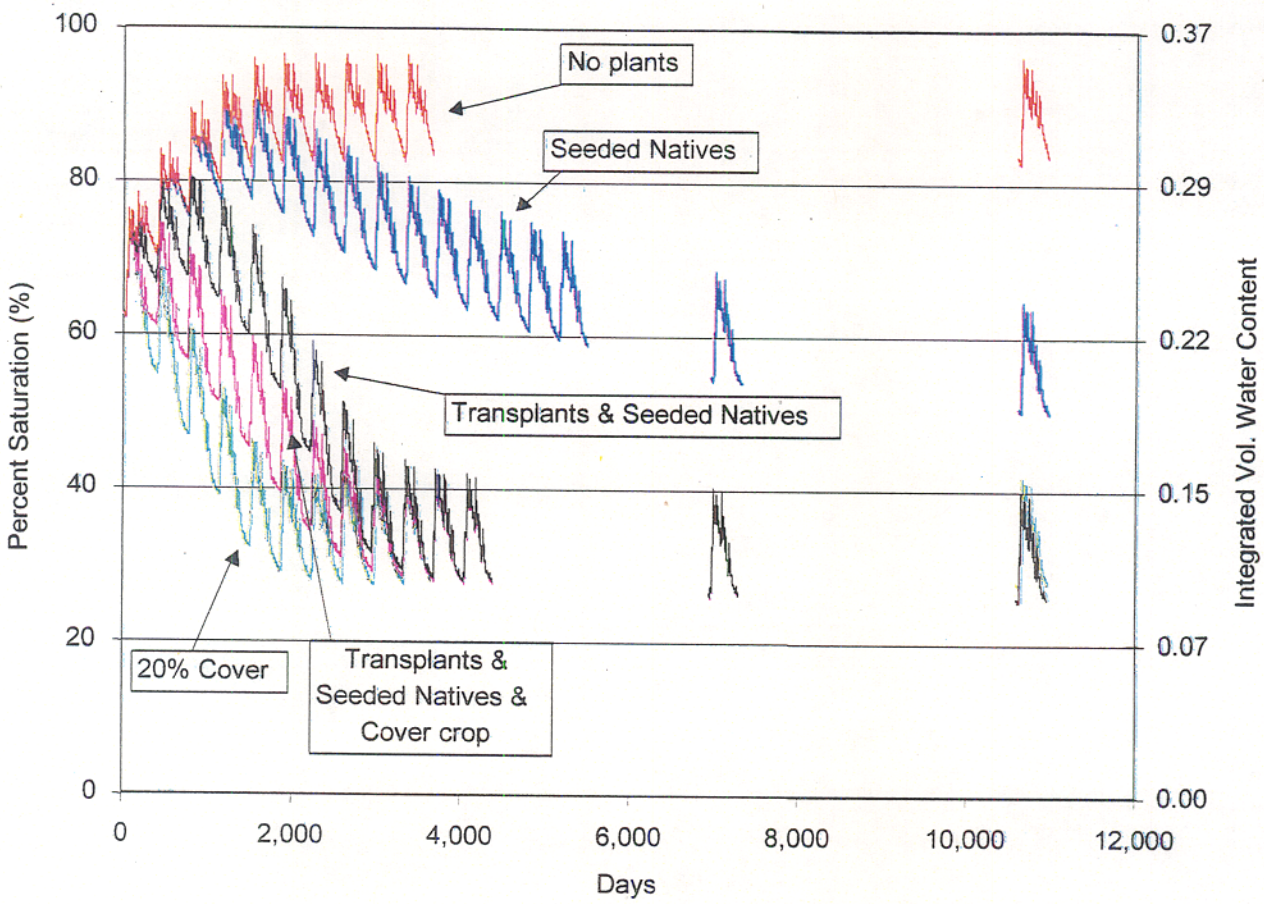


Figure 5. Percent saturation and integrated water content of the cover profile with time.

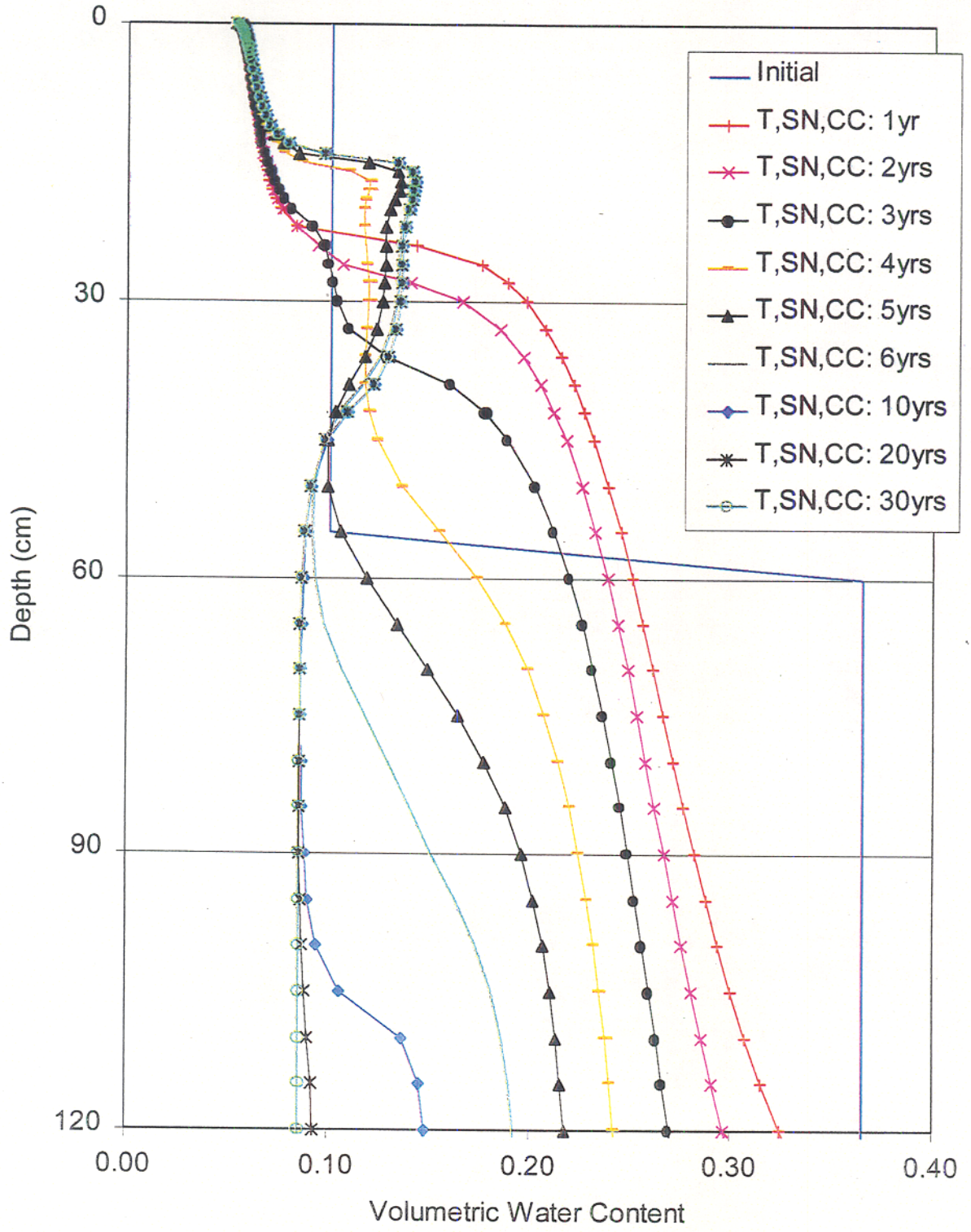


Figure 6. Cover water content profiles with time for Scenario 1: Transplants, Seeded natives, and Cover crop.

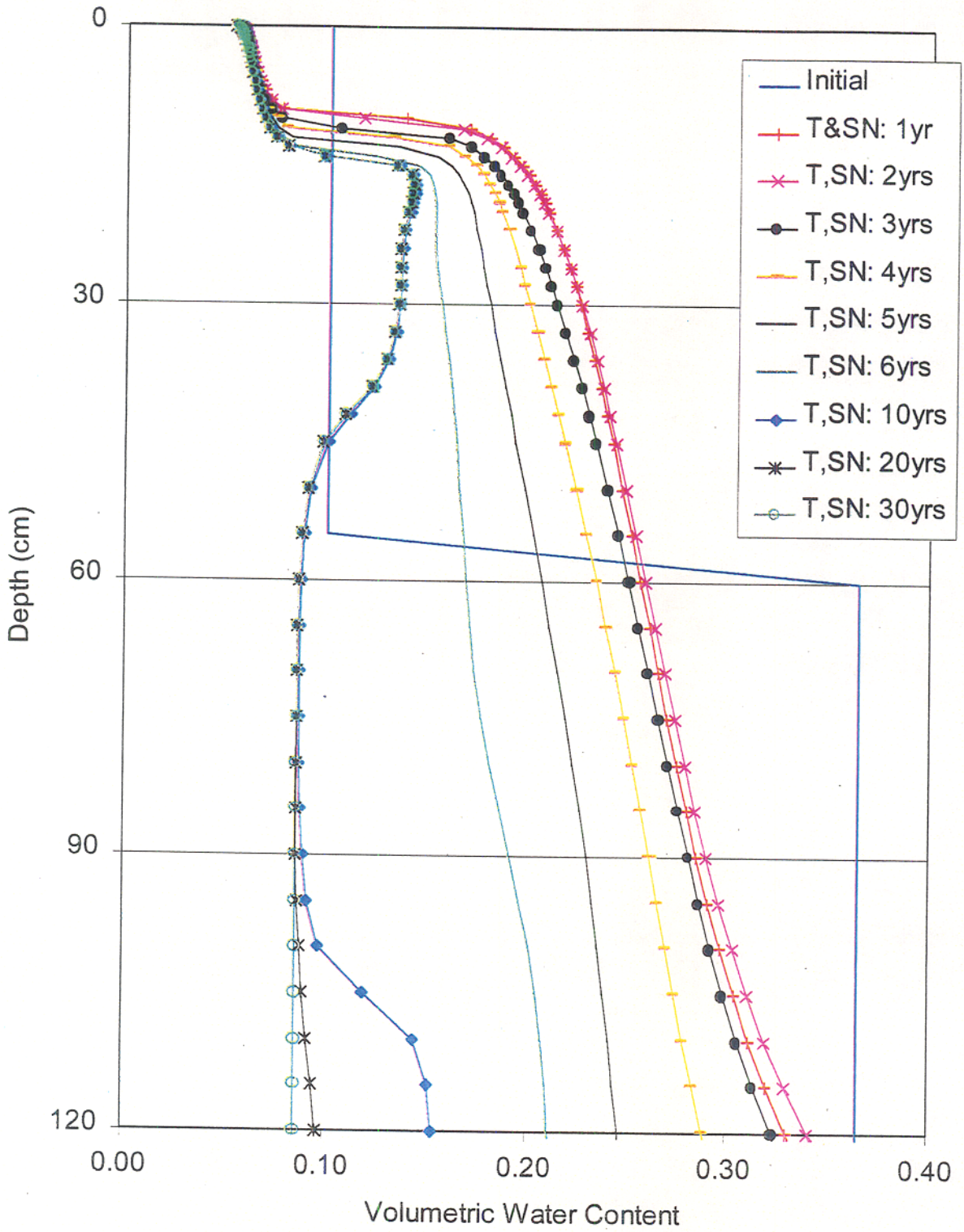


Figure 7. Ccover water content profiles with time for Scenario 2: Transplants, and Seeded natives.

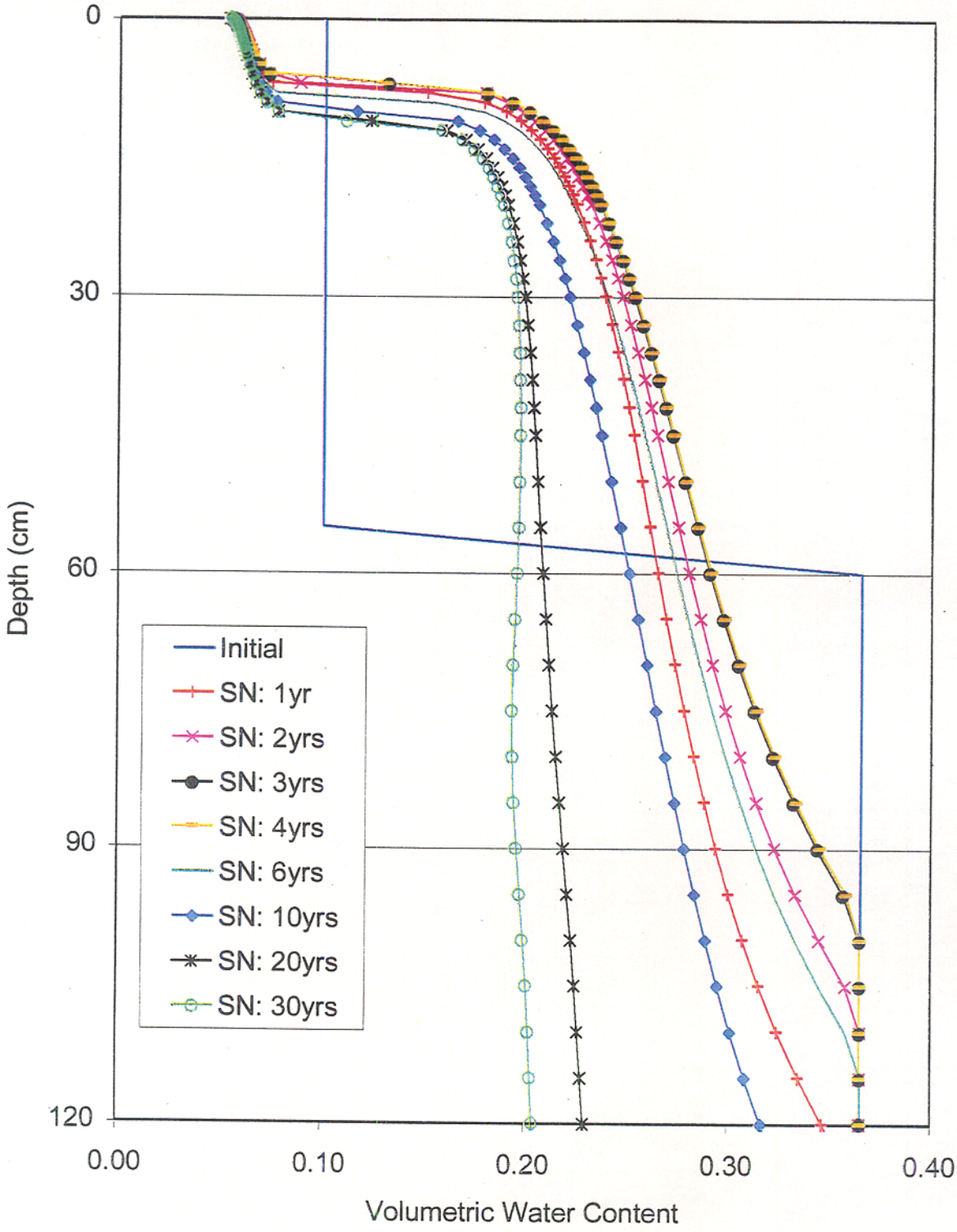


Figure 8. Cover water content profiles with time for Scenario 3: Seeded natives only.

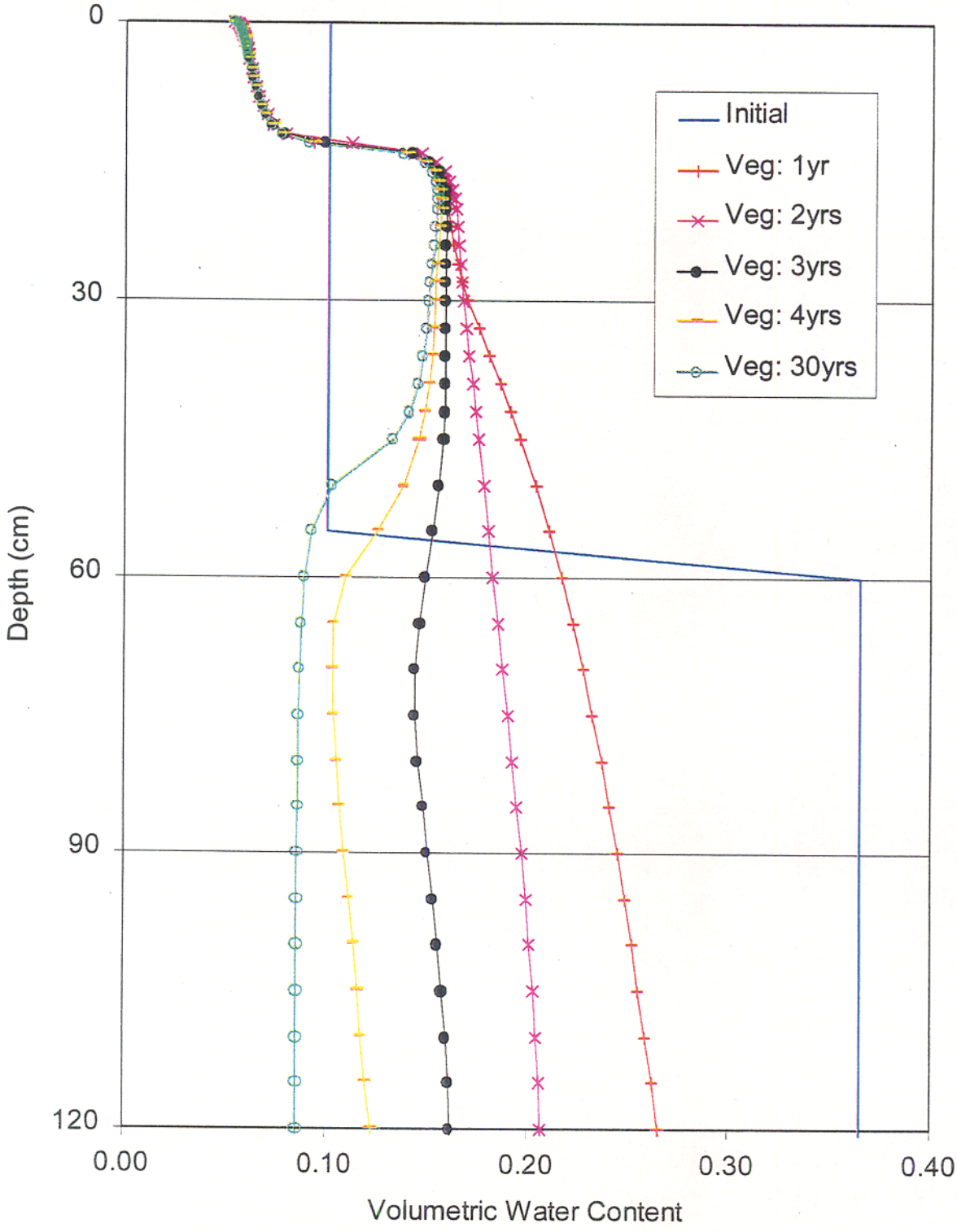


Figure 9. Cover water content profiles with time for Scenario 4: 20 percent vegetated cover with LAI=1.

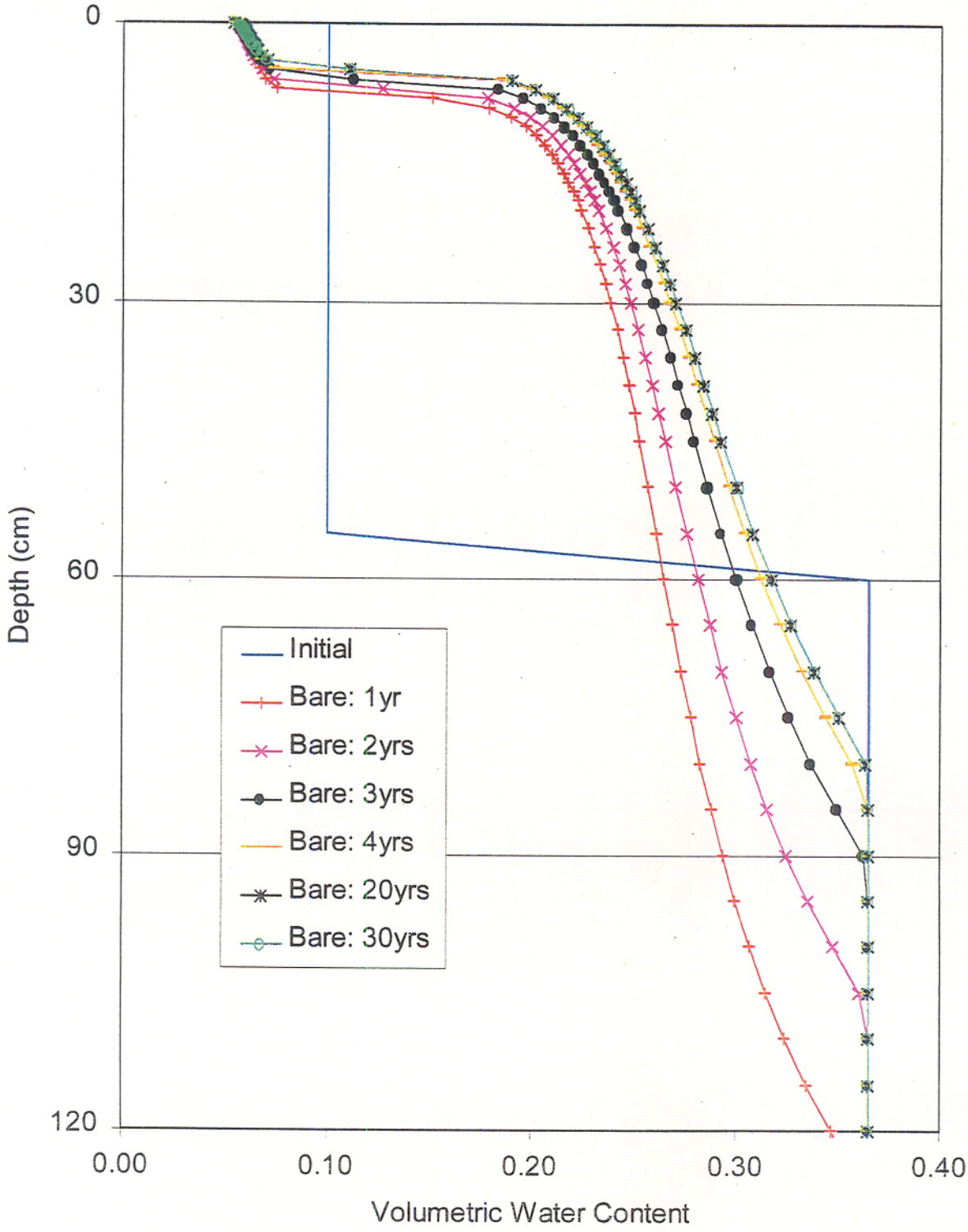


Figure 10. Cover water content profiles with time for Scenario 5: No vegetation.

APPENDIX B

FEMA FAN MODEL OUTPUT

UC-1 NORTH ALLUVIAL FAN

AVULSION FACTOR = 1.5000

FLOOD FREQUENCY CURVE DEFINED BY LEAST-SQUARES FIT OF DATA

RETURN INTERVAL (YEARS)	INPUT DISCHARGE (CFS)	BEST FIT DISCHARGE (CFS)
2	47	47
10	164	176
25	313	287
100	507	521

MEAN = 1.667730
STANDARD DEVIATION = 0.450972
SKEW = 0.0

SUMMARY OF DISCHARGES:

10-YEAR DISCHARGE = 176
50-YEAR DISCHARGE = 393
100-YEAR DISCHARGE = 521
500-YEAR DISCHARGE = 924

STATISTICS AFTER TRANSFORMATION OF Y=LOG(Q) TO Z=0.1871+LOG(Q)

MEAN OF Z = 1.854836
STANDARD DEVIATION = 0.450972
SKEW = 0.000000
TRANSFORMATION CONSTANT = 5.051723

SINGLE-CHANNEL REGION

ENERGY (FT)	DEPTH (FT)	DISCHARGE (CFS)	PROBABILITY OF DISCHARGE BEING EXCEEDED AT THE APEX BY: Q	1.5385 Q	1.0000	WIDTH (FT)
0.5	0.3	49	0.48410	0.64482		4597

VELOCITY (FT/SEC)	DEPTH (FT)	DISCHARGE (CFS)	PROBABILITY OF DISCHARGE BEING EXCEEDED AT THE APEX BY: Q	1.5385 Q	1.0000	WIDTH (FT)
3.5	0.4	68	0.36023	0.52134		3717
4.5	0.6	238	0.06013	0.12846		916

MULTIPLE-CHANNEL REGION

SLOPE = 0.1160000
N-VALUE = 0.0450000

ENERGY (FT)	DEPTH (FT)	DISCHARGE (CFS)	PROBABILITY OF DISCHARGE BEING EXCEEDED AT THE APEX BY: Q	1.5385 Q	1.0000	WIDTH (FT)
0.5	0.2	358	0.02480	0.06321		1712

VELOCITY (FT/SEC)	DEPTH (FT)	DISCHARGE (CFS)	PROBABILITY OF DISCHARGE BEING EXCEEDED AT THE APEX BY: Q	1.5385 Q	1.0000	WIDTH (FT)
4.5	0.3	482	0.01276	0.03387		914

UC-1 SOUTH ALLUVIAL FAN

AVULSION FACTOR = 1.5000

FLOOD FREQUENCY CURVE DEFINED BY LEAST-SQUARES FIT OF DATA

RETURN INTERVAL (YEARS)	INPUT DISCHARGE (CFS)	BEST FIT DISCHARGE (CFS)
2	69	68
10	221	236
25	410	376
100	654	673

MEAN = 1.842139
STANDARD DEVIATION = 0.410860
SKEW = 0.1

SUMMARY OF DISCHARGES:

10-YEAR DISCHARGE = 236
50-YEAR DISCHARGE = 510
100-YEAR DISCHARGE = 673
500-YEAR DISCHARGE = 1187

STATISTICS AFTER TRANSFORMATION OF Y=LOG(Q) TO Z=0.1228+1.0193 LOG(Q)

MEAN OF Z = 2.000433
STANDARD DEVIATION = 0.418775
SKEW = 0.100000
TRANSFORMATION CONSTANT = 5.853971

SINGLE-CHANNEL REGION

ENERGY (FT)	DEPTH (FT)	DISCHARGE (CFS)	PROBABILITY OF DISCHARGE BEING EXCEEDED AT THE APEX BY: Q	1.3268 Q 1.0193	WIDTH (FT)
0.5	0.3	49	0.64177	0.76941	6356

VELOCITY (FT/SEC)	DEPTH (FT)	DISCHARGE (CFS)	PROBABILITY OF DISCHARGE BEING EXCEEDED AT THE APEX BY: Q	1.3268 Q 1.0193	WIDTH (FT)
3.5	0.4	68	0.50457	0.65113	5379
4.5	0.6	238	0.09890	0.18656	1541
5.5	0.9	649	0.01133	0.02964	242

MULTIPLE-CHANNEL REGION

SLOPE = 0.0990000
N-VALUE = 0.0450000

ENERGY (FT)	DEPTH (FT)	DISCHARGE (CFS)	PROBABILITY OF DISCHARGE BEING EXCEEDED AT THE APEX BY: Q	1.3268 Q	1.0193	WIDTH (FT)
0.5	0.2	382	0.03893	0.08730		2741

VELOCITY (FT/SEC)	DEPTH (FT)	DISCHARGE (CFS)	PROBABILITY OF DISCHARGE BEING EXCEEDED AT THE APEX BY: Q	1.3268 Q	1.0193	WIDTH (FT)
4.5	0.3	587	0.01491	0.03659		1149

MODEL SET 1 -- UC1 NORTH STATISTICS

AVULSION FACTOR = 1.5000

FLOOD FREQUENCY CURVE DEFINED BY LEAST-SQUARES FIT OF DATA

RETURN INTERVAL (YEARS)	INPUT DISCHARGE (CFS)	BEST FIT DISCHARGE (CFS)
2	47	47
10	164	163
25	234	236
100	352	351

MEAN = 1.623703
STANDARD DEVIATION = 0.490172
SKEW = -0.6

SUMMARY OF DISCHARGES:

10-YEAR DISCHARGE = 163
50-YEAR DISCHARGE = 293
100-YEAR DISCHARGE = 351
500-YEAR DISCHARGE = 486

STATISTICS AFTER TRANSFORMATION OF Y=LOG(Q) TO Z=0.3882+0.8808 LOG(Q)

MEAN OF Z = 1.818409
STANDARD DEVIATION = 0.431760
SKEW = -0.600000
TRANSFORMATION CONSTANT = 4.889831

SINGLE-CHANNEL REGION

ENERGY (FT)	DEPTH (FT)	DISCHARGE (CFS)	PROBABILITY OF DISCHARGE BEING EXCEEDED AT THE APEX BY: Q	2.4445 Q	0.8808	WIDTH (FT)
0.5	0.3	49	0.48879	0.65259		4503

VELOCITY (FT/SEC)	DEPTH (FT)	DISCHARGE (CFS)	PROBABILITY OF DISCHARGE BEING EXCEEDED AT THE APEX BY: Q	2.4445 Q	0.8808	WIDTH (FT)
3.5	0.4	68	0.36739	0.52827		3645
4.5	0.6	238	0.03921	0.08215		567

MODEL SET 1 -- UC1 SOUTH STATISTICS

AVULSION FACTOR = 1.5000

FLOOD FREQUENCY CURVE DEFINED BY LEAST-SQUARES FIT OF DATA

RETURN INTERVAL (YEARS)	INPUT DISCHARGE (CFS)	BEST FIT DISCHARGE (CFS)
2	69	69
10	221	220
25	308	311
100	454	451

MEAN = 1.792982
STANDARD DEVIATION = 0.458108
SKEW = -0.6

SUMMARY OF DISCHARGES:

10-YEAR DISCHARGE = 220
50-YEAR DISCHARGE = 381
100-YEAR DISCHARGE = 451
500-YEAR DISCHARGE = 612

STATISTICS AFTER TRANSFORMATION OF Y=LOG(Q) TO Z=0.3727+0.8878 LOG(Q)

MEAN OF Z = 1.964384
STANDARD DEVIATION = 0.406687
SKEW = -0.600000
TRANSFORMATION CONSTANT = 5.649212

SINGLE-CHANNEL REGION

ENERGY (FT)	DEPTH (FT)	DISCHARGE (CFS)	PROBABILITY OF DISCHARGE BEING EXCEEDED AT THE APEX BY: Q	2.3586 Q	0.8878	WIDTH (FT)
0.5	0.3	49	0.62715	0.76784		6121

VELOCITY (FT/SEC)	DEPTH (FT)	DISCHARGE (CFS)	PROBABILITY OF DISCHARGE BEING EXCEEDED AT THE APEX BY: Q	2.3586 Q	0.8878	WIDTH (FT)
3.5	0.4	68	0.50689	0.66018		5263
4.5	0.6	238	0.08580	0.15462		1233

MODEL SET 2 -- UC1 NORTH STATISTICS

AVULSION FACTOR = 1.5000

FLOOD FREQUENCY CURVE DEFINED BY LEAST-SQUARES FIT OF DATA

RETURN INTERVAL (YEARS)	INPUT DISCHARGE (CFS)	BEST FIT DISCHARGE (CFS)
2	47	46
10	164	183
25	372	325
100	668	695

MEAN = 1.700089
STANDARD DEVIATION = 0.425274
SKEW = 0.5

SUMMARY OF DISCHARGES:

10-YEAR DISCHARGE = 183
50-YEAR DISCHARGE = 482
100-YEAR DISCHARGE = 695
500-YEAR DISCHARGE = 1525

STATISTICS AFTER TRANSFORMATION OF Y=LOG(Q) TO Z=0.0001+1.1084 LOG(Q)

MEAN OF Z = 1.884518
STANDARD DEVIATION = 0.471381
SKEW = 0.500000
TRANSFORMATION CONSTANT = 5.186242

SINGLE-CHANNEL REGION

ENERGY (FT)	DEPTH (FT)	DISCHARGE (CFS)	PROBABILITY OF DISCHARGE BEING EXCEEDED AT THE APEX BY: Q	1.0003 Q	1.1084	WIDTH (FT)
0.5	0.3	49	0.48044	0.63738		4665

VELOCITY (FT/SEC)	DEPTH (FT)	DISCHARGE (CFS)	PROBABILITY OF DISCHARGE BEING EXCEEDED AT THE APEX BY: Q	1.0003 Q	1.1084	WIDTH (FT)
3.5	0.4	68	0.35298	0.51280		3753
4.5	0.6	238	0.07041	0.15435		1130
5.5	0.9	649	0.01189	0.03686		267

MODEL SET 2 -- UC1 SOUTH STATISTICS

AVULSION FACTOR = 1.5000

FLOOD FREQUENCY CURVE DEFINED BY LEAST-SQUARES FIT OF DATA

RETURN INTERVAL (YEARS)	INPUT DISCHARGE (CFS)	BEST FIT DISCHARGE (CFS)
2	69	68
10	221	246
25	488	425
100	846	885

MEAN = 1.871819
STANDARD DEVIATION = 0.390292
SKEW = 0.6

SUMMARY OF DISCHARGES:

10-YEAR DISCHARGE = 246
50-YEAR DISCHARGE = 620
100-YEAR DISCHARGE = 885
500-YEAR DISCHARGE = 1907

STATISTICS AFTER TRANSFORMATION OF Y=LOG(Q) TO Z=0.0689-1.1207 LOG(Q)

MEAN OF Z = 2.028879
STANDARD DEVIATION = 0.437409
SKEW = 0.600000
TRANSFORMATION CONSTANT = 5.998908

SINGLE-CHANNEL REGION

ENERGY (FT)	DEPTH (FT)	DISCHARGE (CFS)	PROBABILITY OF DISCHARGE BEING EXCEEDED AT THE APEX BY: Q	0.8533 Q	1.1207	WIDTH (FT)
0.5	0.3	49	0.65483	0.77299		6544
1.5	1.0	756	0.01444	0.03981		332

VELOCITY (FT/SEC)	DEPTH (FT)	DISCHARGE (CFS)	PROBABILITY OF DISCHARGE BEING EXCEEDED AT THE APEX BY: Q	0.8533 Q	1.1207	WIDTH (FT)
3.5	0.4	68	0.50254	0.64534		5463
4.5	0.6	238	0.10678	0.20146		1705
5.5	0.9	649	0.01874	0.05069		427

MODEL SET 3 -- UC1 NORTH STATISTICS

AVULSION FACTOR = 1.5000

FLOOD FREQUENCY CURVE DEFINED BY LEAST-SQUARES FIT OF DATA

RETURN INTERVAL (YEARS)	INPUT DISCHARGE (CFS)	BEST FIT DISCHARGE (CFS)
2	47	47
10	164	172
25	313	293
100	575	587

MEAN = 1.696592
STANDARD DEVIATION = 0.409989
SKEW = 0.4

SUMMARY OF DISCHARGES:

10-YEAR DISCHARGE = 172
50-YEAR DISCHARGE = 420
100-YEAR DISCHARGE = 587
500-YEAR DISCHARGE = 1193

STATISTICS AFTER TRANSFORMATION OF Y=LOG(Q) TO Z=0.0288+1.0816 LOG(Q)

MEAN OF Z = 1.863853
STANDARD DEVIATION = 0.443441
SKEW = 0.400000
TRANSFORMATION CONSTANT = 5.133531

SINGLE-CHANNEL REGION

ENERGY (FT)	DEPTH (FT)	DISCHARGE (CFS)	PROBABILITY OF DISCHARGE BEING EXCEEDED AT THE APEX BY: Q	1.0686 Q	1.0816	WIDTH (FT)
0.5	0.3	49	0.48412	0.63447		4596

VELOCITY (FT/SEC)	DEPTH (FT)	DISCHARGE (CFS)	PROBABILITY OF DISCHARGE BEING EXCEEDED AT THE APEX BY: Q	1.0686 Q	1.0816	WIDTH (FT)
3.5	0.4	68	0.35137	0.50344		3647
4.5	0.6	238	0.06067	0.13219		958

MODEL SET 3 -- UC1 SOUTH STATISTICS

AVULSION FACTOR = 1.5000

FLOOD FREQUENCY CURVE DEFINED BY LEAST-SQUARES FIT OF DATA

RETURN INTERVAL (YEARS)	INPUT DISCHARGE (CFS)	BEST FIT DISCHARGE (CFS)
2	69	69
10	221	232
25	410	386
100	740	755

MEAN = 1.867335
STANDARD DEVIATION = 0.376270
SKEW = 0.5

SUMMARY OF DISCHARGES:

10-YEAR DISCHARGE = 232
50-YEAR DISCHARGE = 546
100-YEAR DISCHARGE = 755
500-YEAR DISCHARGE = 1512

STATISTICS AFTER TRANSFORMATION OF Y=LOG(Q) TO Z=0.0343-1.0947 LOG(Q)

MEAN OF Z = 2.009928
STANDARD DEVIATION = 0.411919
SKEW = 0.500000
TRANSFORMATION CONSTANT = 5.939130

SINGLE-CHANNEL REGION

ENERGY (FT)	DEPTH (FT)	DISCHARGE (CFS)	PROBABILITY OF DISCHARGE BEING EXCEEDED AT THE APEX BY: Q	0.9240 Q	1.0947	WIDTH (FT)
0.5	0.3	49	0.66170	0.77496		6495

VELOCITY (FT/SEC)	DEPTH (FT)	DISCHARGE (CFS)	PROBABILITY OF DISCHARGE BEING EXCEEDED AT THE APEX BY: Q	0.9240 Q	1.0947	WIDTH (FT)
3.5	0.4	68	0.50597	0.64289		5388
4.5	0.6	238	0.09672	0.18423		1544
5.5	0.9	649	0.01467	0.03798		315

MODEL SET 4 -- UC1 NORTH STATISTICS

AVULSION FACTOR = 1.5000

FLOOD FREQUENCY CURVE DEFINED BY LEAST-SQUARES FIT OF DATA

RETURN INTERVAL (YEARS)	INPUT DISCHARGE (CFS)	BEST FIT DISCHARGE (CFS)
2	47	47
10	164	176
25	313	287
100	507	521

MEAN = 1.667730
STANDARD DEVIATION = 0.450972
SKEW = 0.0

SUMMARY OF DISCHARGES:

10-YEAR DISCHARGE = 176
50-YEAR DISCHARGE = 393
100-YEAR DISCHARGE = 521
500-YEAR DISCHARGE = 924

STATISTICS AFTER TRANSFORMATION OF Y=LOG(Q) TO Z=0.1871+LOG(Q)

MEAN OF Z = 1.854836
STANDARD DEVIATION = 0.450972
SKEW = 0.000000
TRANSFORMATION CONSTANT = 5.051723

SINGLE-CHANNEL REGION

ENERGY (FT)	DEPTH (FT)	DISCHARGE (CFS)	PROBABILITY OF DISCHARGE BEING EXCEEDED AT THE APEX BY: Q	1.5385 Q	1.0000	WIDTH (FT)
0.5	0.3	49	0.48410	0.64482		4597

VELOCITY (FT/SEC)	DEPTH (FT)	DISCHARGE (CFS)	PROBABILITY OF DISCHARGE BEING EXCEEDED AT THE APEX BY: Q	1.5385 Q	1.0000	WIDTH (FT)
3.5	0.4	68	0.36023	0.52134		3717
4.5	0.6	238	0.06013	0.12846		916

MODEL SET 4 -- UC-1 SOUTH STATISTICS

AVULSION FACTOR = 1.5000

FLOOD FREQUENCY CURVE DEFINED BY LEAST-SQUARES FIT OF DATA

RETURN INTERVAL (YEARS)	INPUT DISCHARGE (CFS)	BEST FIT DISCHARGE (CFS)
2	69	68
10	221	236
25	410	376
100	654	673

MEAN = 1.842139
STANDARD DEVIATION = 0.410860
SKEW = 0.1

SUMMARY OF DISCHARGES:

10-YEAR DISCHARGE = 236
50-YEAR DISCHARGE = 510
100-YEAR DISCHARGE = 673
500-YEAR DISCHARGE = 1187

STATISTICS AFTER TRANSFORMATION OF Y=LOG(Q) TO Z=0.1228+1.0193 LOG(Q)

MEAN OF Z = 2.000433
STANDARD DEVIATION = 0.418775
SKEW = 0.100000
TRANSFORMATION CONSTANT = 5.853971

SINGLE-CHANNEL REGION

ENERGY (FT)	DEPTH (FT)	DISCHARGE (CFS)	PROBABILITY OF DISCHARGE BEING EXCEEDED AT THE APEX BY: Q	1.3268 Q	1.0193	WIDTH (FT)
0.5	0.3	49	0.64177	0.76941		6356

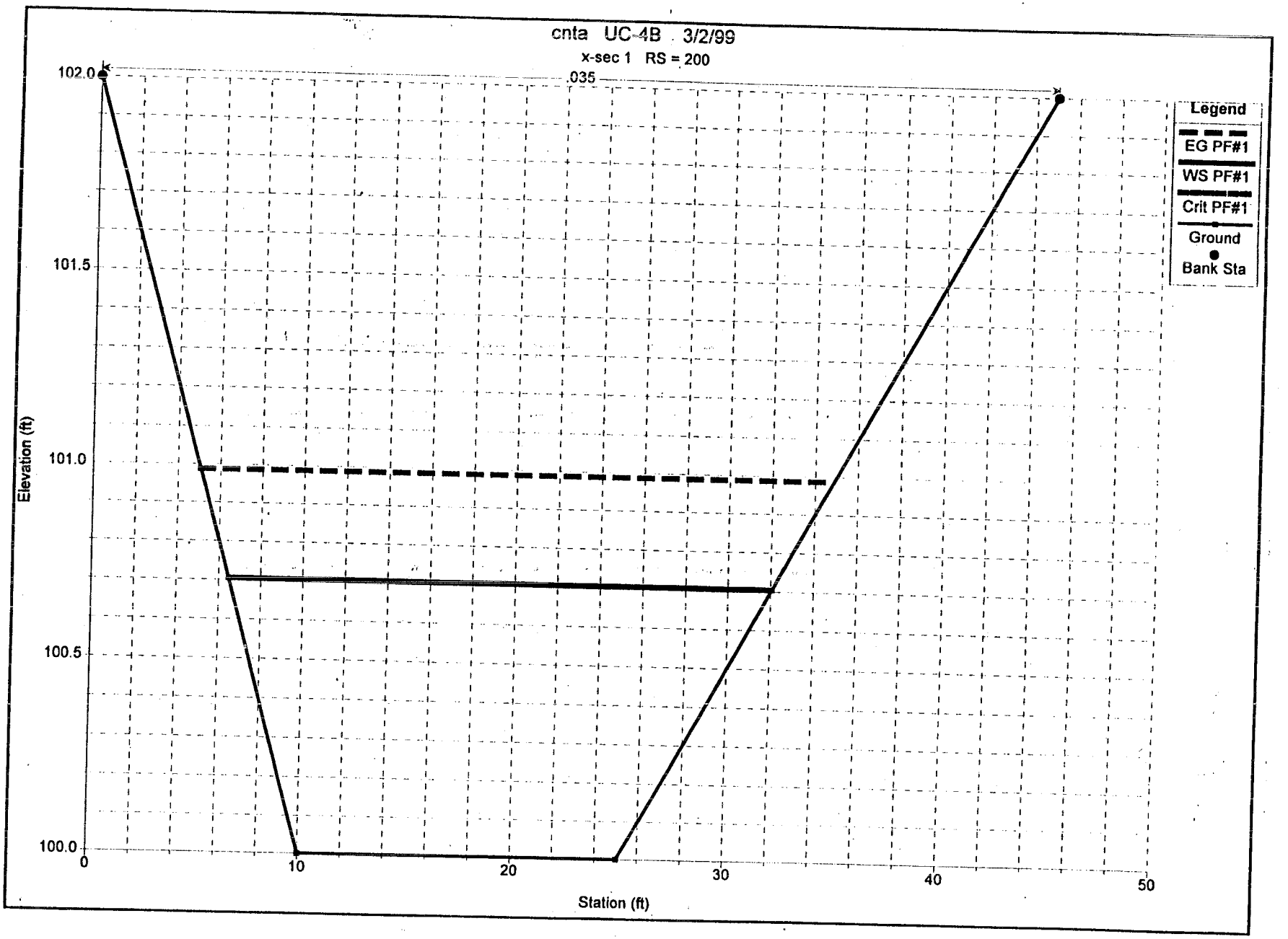
VELOCITY (FT/SEC)	DEPTH (FT)	DISCHARGE (CFS)	PROBABILITY OF DISCHARGE BEING EXCEEDED AT THE APEX BY: Q	1.3268 Q	1.0193	WIDTH (FT)
3.5	0.4	68	0.50457	0.65113		5379
4.5	0.6	238	0.09890	0.18656		1541
5.5	0.9	649	0.01133	0.02964		242

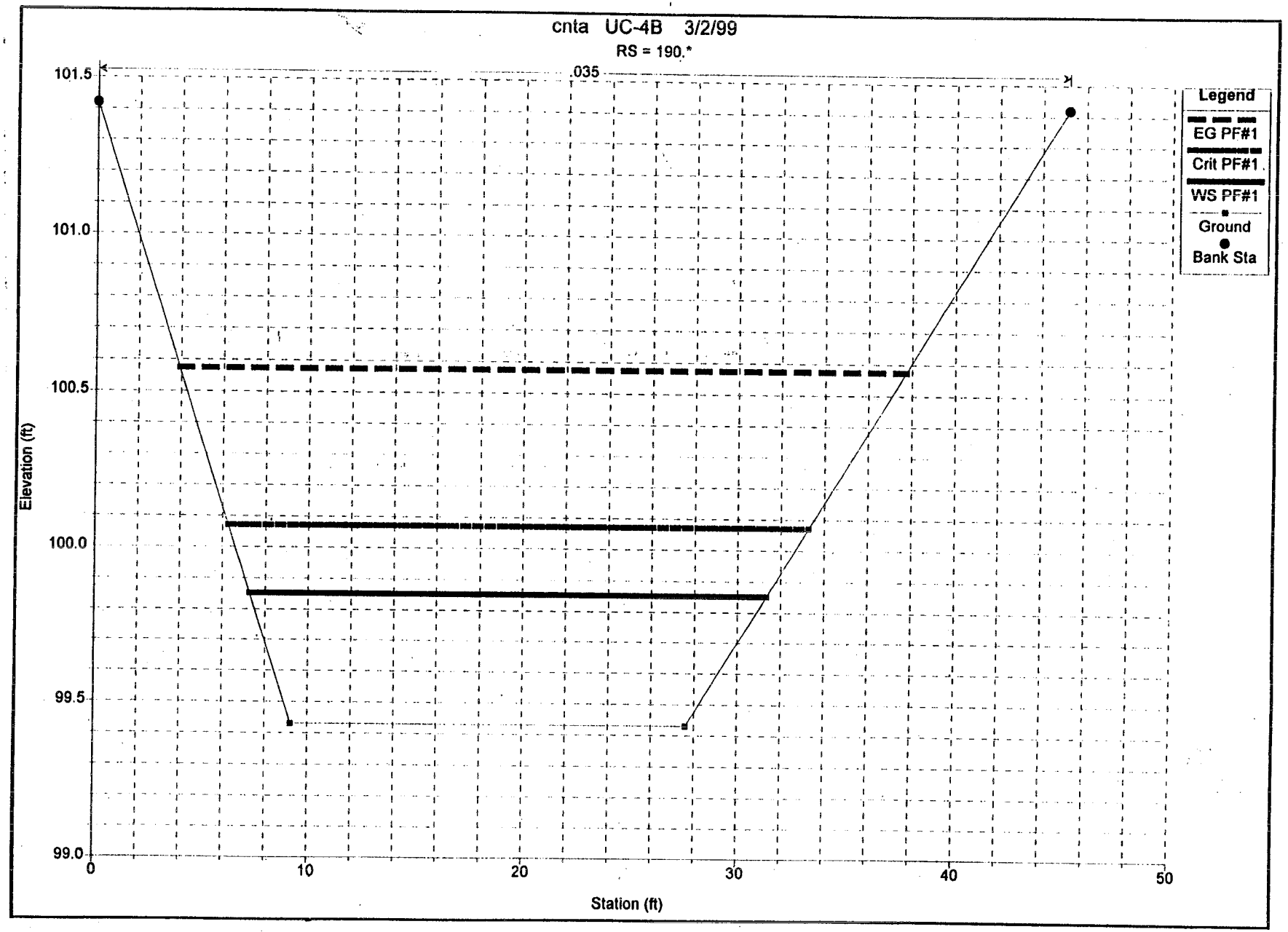
APPENDIX C

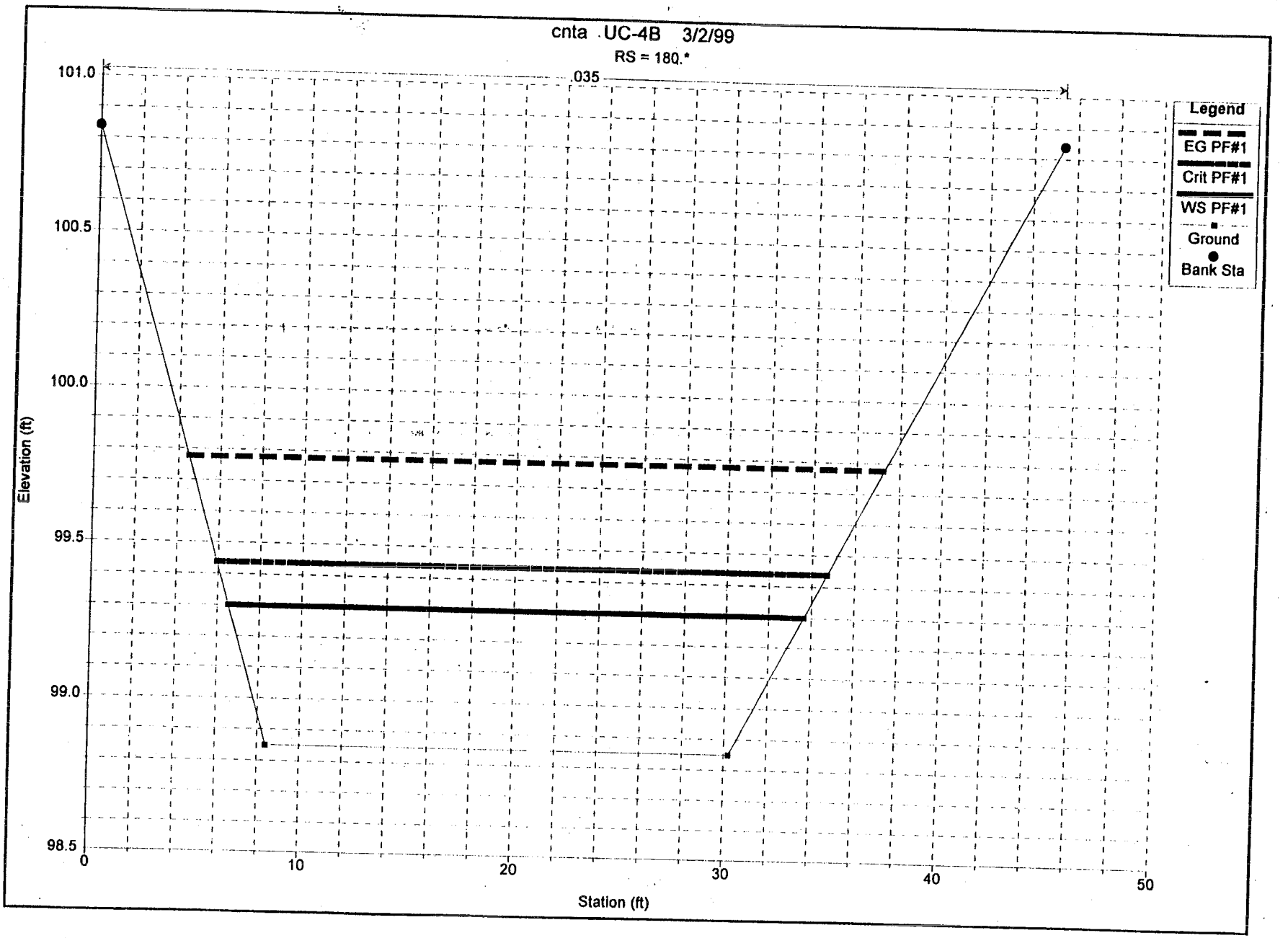
HEC-RAS MODEL OUTPUT

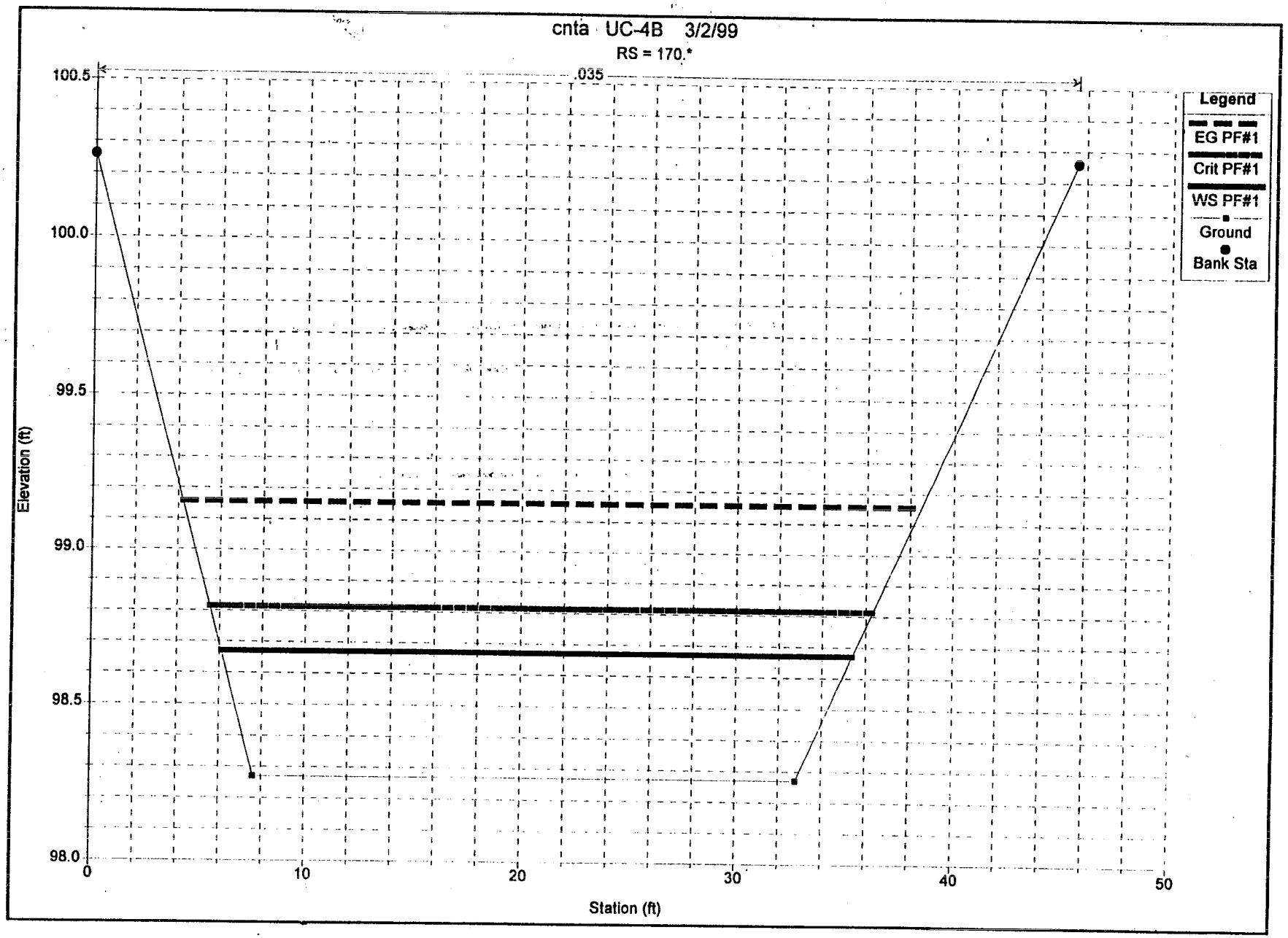
HEC-RAS Plan: UC-4B River: UC-4B Reach: UC-4B

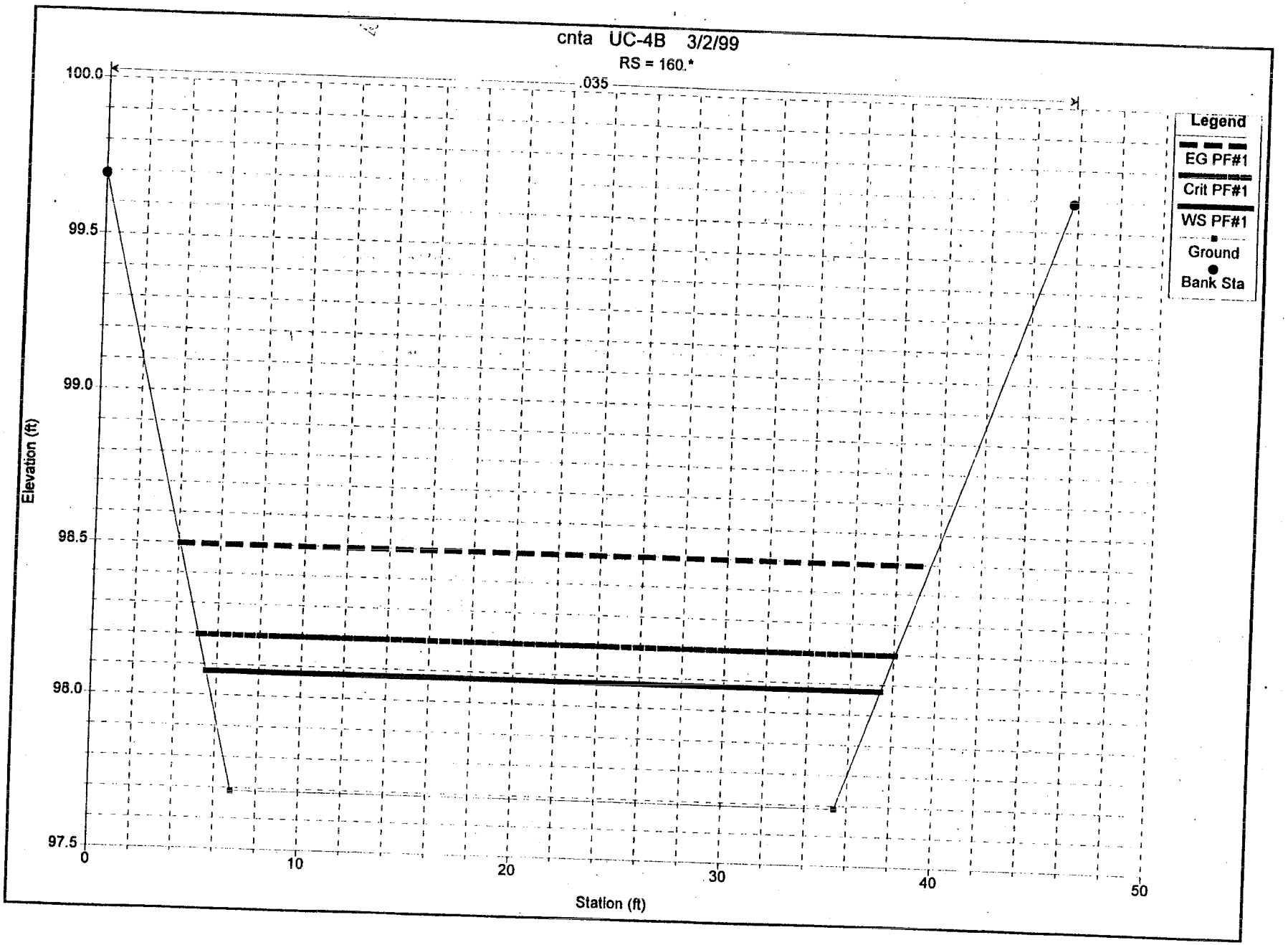
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	61.00	100.00	100.70	100.70	100.99	0.022097	4.27	14.29	25.57	1.01
[illegible]	61.00	99.43	99.85	100.07	100.57	0.097013	6.82	8.94	24.07	1.97
[illegible]	61.00	98.85	99.30	99.44	99.78	0.056680	5.53	11.03	27.14	1.53
[illegible]	61.00	98.27	98.67	98.81	99.16	0.065220	5.60	10.90	29.30	1.62
[illegible]	61.00	97.69	98.08	98.20	98.50	0.057235	5.20	11.73	31.93	1.51
[illegible]	61.00	97.10	97.45	97.57	97.88	0.066181	5.27	11.58	34.44	1.60
[illegible]	61.00	94.20	95.53	95.68	96.03	0.024667	6.43	13.41	25.16	1.01
[illegible]	61.00	93.63	94.85	95.11	95.65	0.039954	7.80	10.78	24.95	1.28
[illegible]	61.00	93.05	94.23	94.53	95.20	0.048327	8.42	9.80	24.87	1.40
[illegible]	61.00	92.47	93.64	93.95	94.67	0.052029	8.67	9.42	24.84	1.45
[illegible]	61.00	91.89	93.05	93.37	94.13	0.054569	8.83	9.17	24.82	1.48
[illegible]	61.00	91.31	92.47	92.79	93.53	0.053245	8.75	9.30	24.83	1.47
[illegible]	61.00	90.73	91.89	92.21	92.98	0.055309	8.88	9.10	24.81	1.49
[illegible]	61.00	90.15	91.31	91.63	92.39	0.054431	8.82	9.19	24.82	1.48
[illegible]	61.00	89.57	90.74	91.05	91.79	0.053014	8.73	9.32	24.83	1.46
[illegible]	61.00	88.99	90.15	90.47	91.24	0.055161	8.87	9.12	24.81	1.49
[illegible]	61.00	88.40	89.55	89.88	90.68	0.056833	8.98	8.97	24.80	1.51

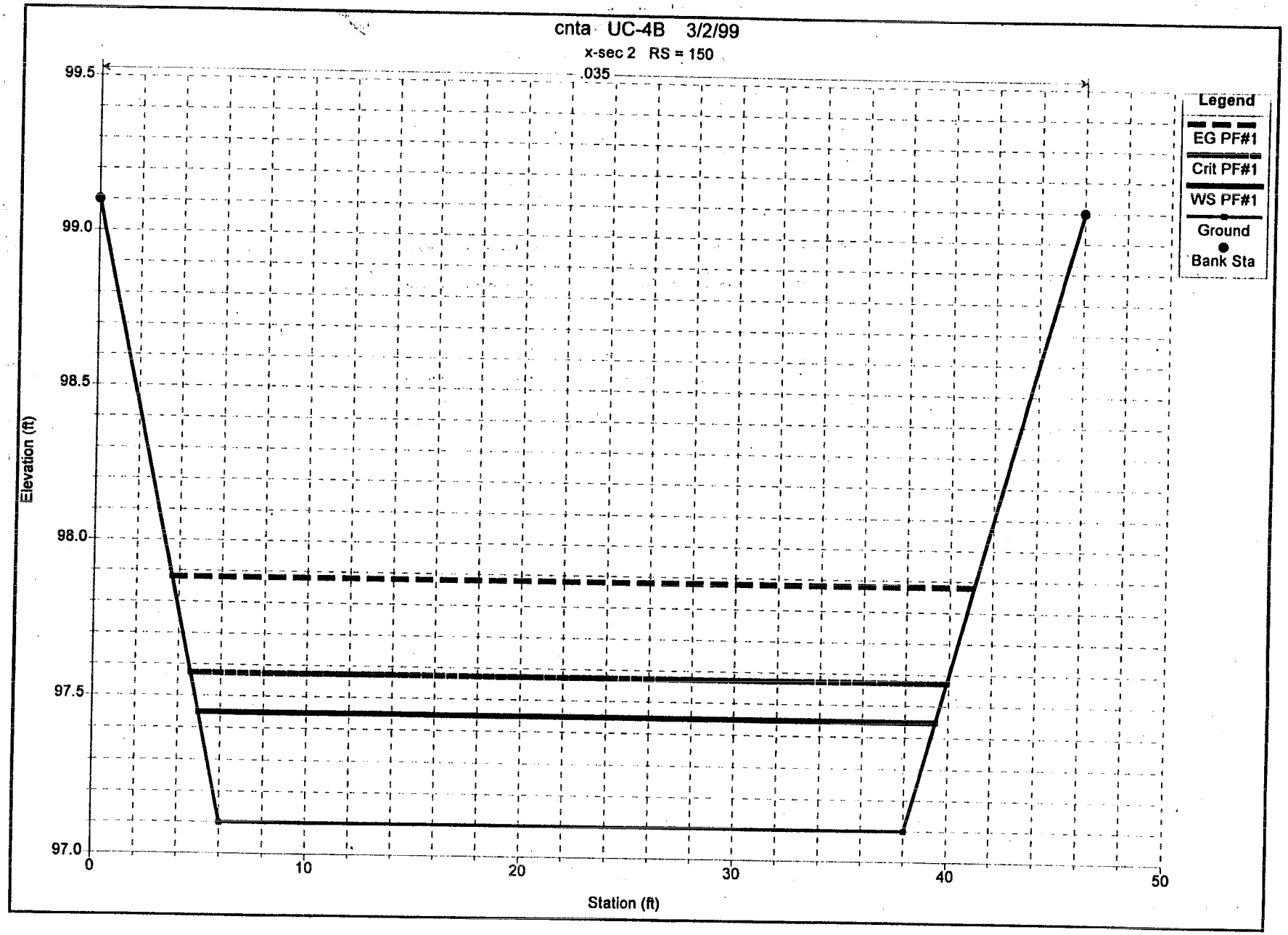

cnta UC-4B 3/2/99
x-sec 1 RS = 200
.035
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Bank Sta
Elevation (ft)
102.0
101.5
101.0
100.5
100.0
0
10
20
30
40
50
Station (ft)

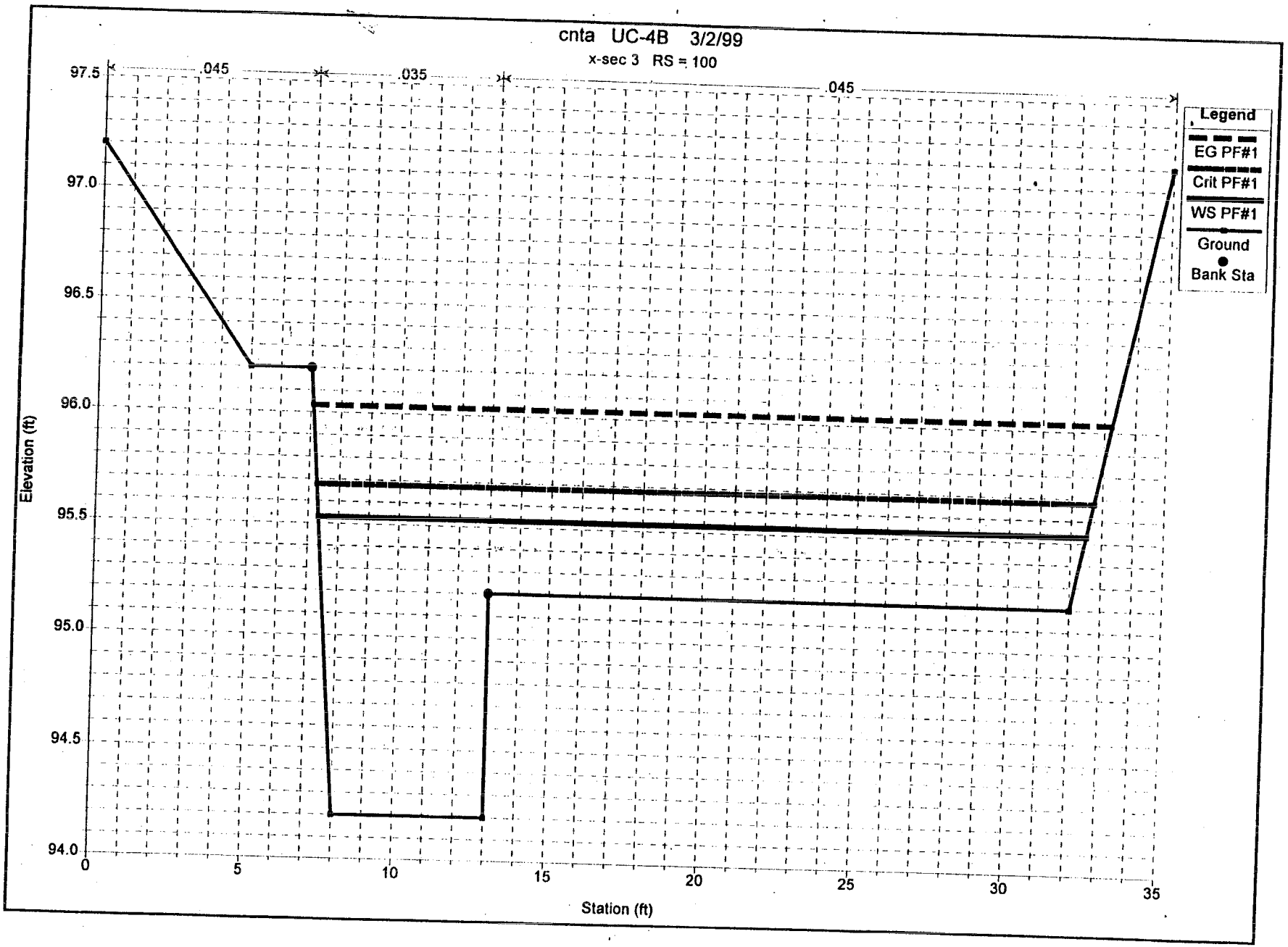

cnta UC-4B 3/2/99
RS = 190.*
.035
Legend
EG PF#1
Crit PF#1
WS PF#1
Ground
Bank Sta
Elevation (ft)
101.5
101.0
100.5
100.0
99.5
99.0
0
10
20
30
40
50
Station (ft)

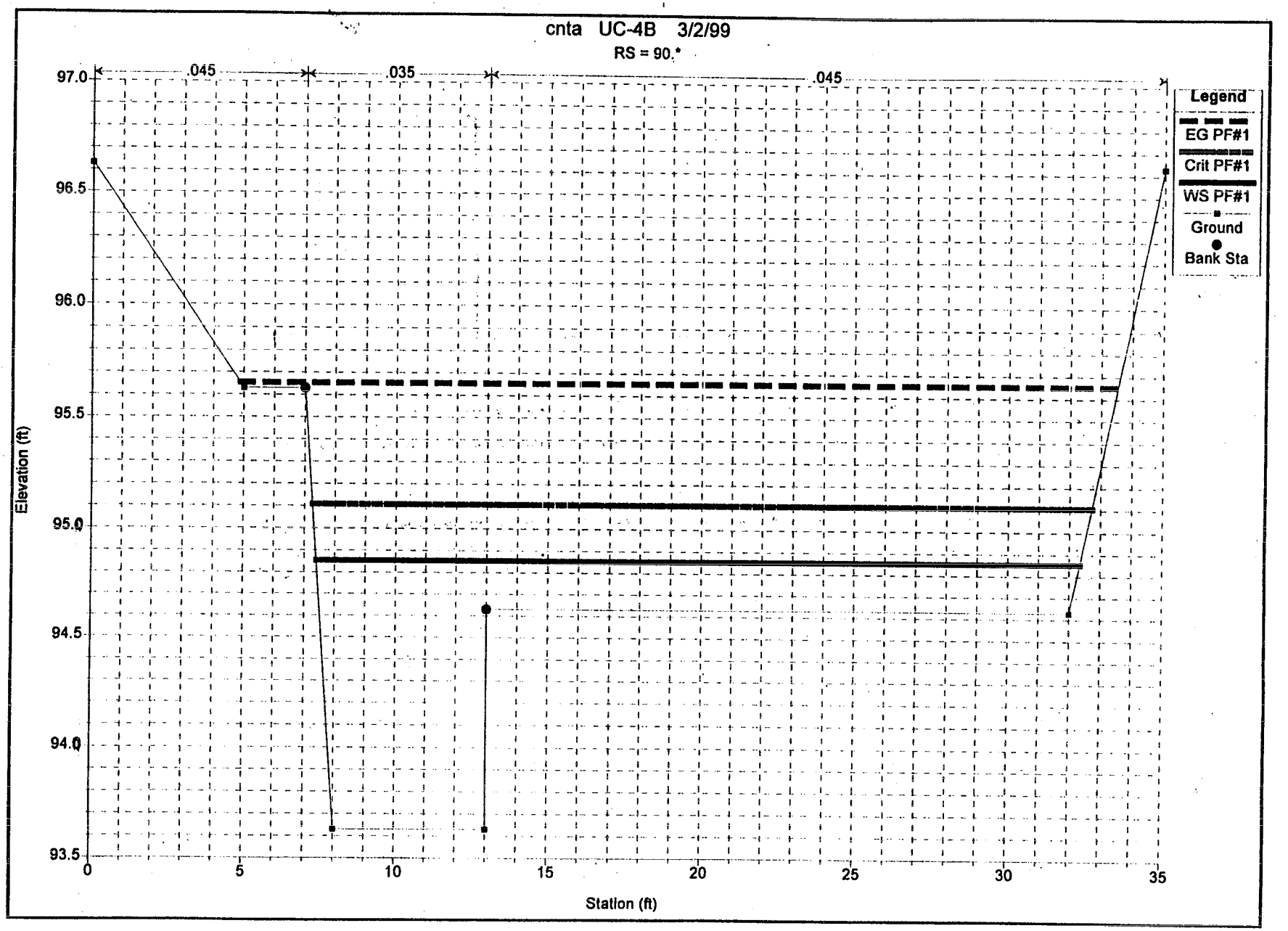

cnta UC-4B 3/2/99
RS = 180.*
.035
Legend
EG PF#1
Crit PF#1
WS PF#1
Ground
Bank Sta
Elevation (ft)
101.0
100.5
100.0
99.5
99.0
98.5
0
10
20
30
40
50
Station (ft)

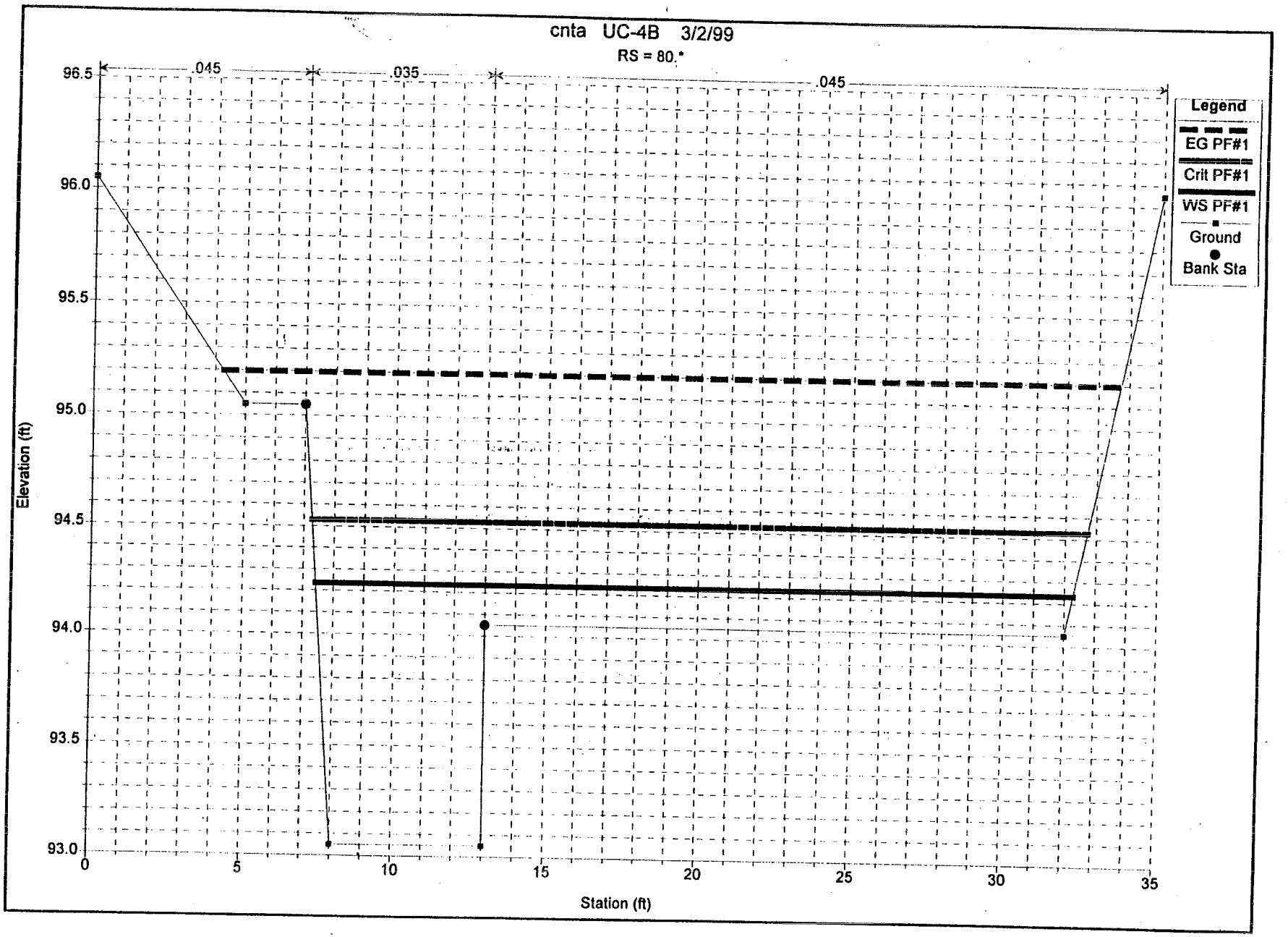

cnta UC-4B 3/2/99
RS = 170.*
.035
Legend
EG PF#1
Crit PF#1
WS PF#1
Ground
Bank Sta
Elevation (ft)
100.5
100.0
99.5
99.0
98.5
98.0
0
10
20
30
40
50
Station (ft)

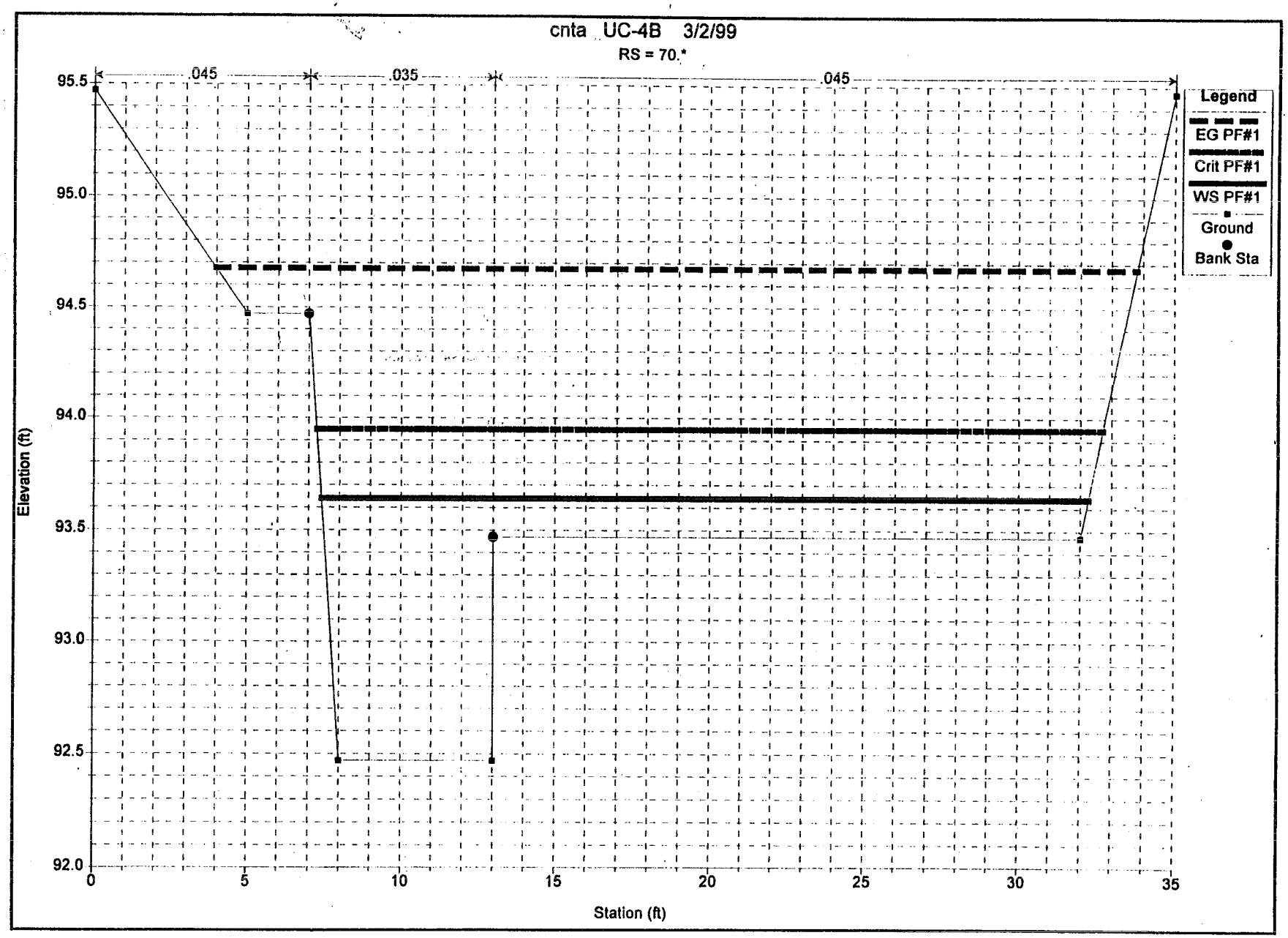

cnta UC-4B 3/2/99
RS = 160.*
.035
Legend
EG PF#1
Crit PF#1
WS PF#1
Ground
Bank Sta
Elevation (ft)
100.0
99.5
99.0
98.5
98.0
97.5
0
10
20
30
40
50
Station (ft)

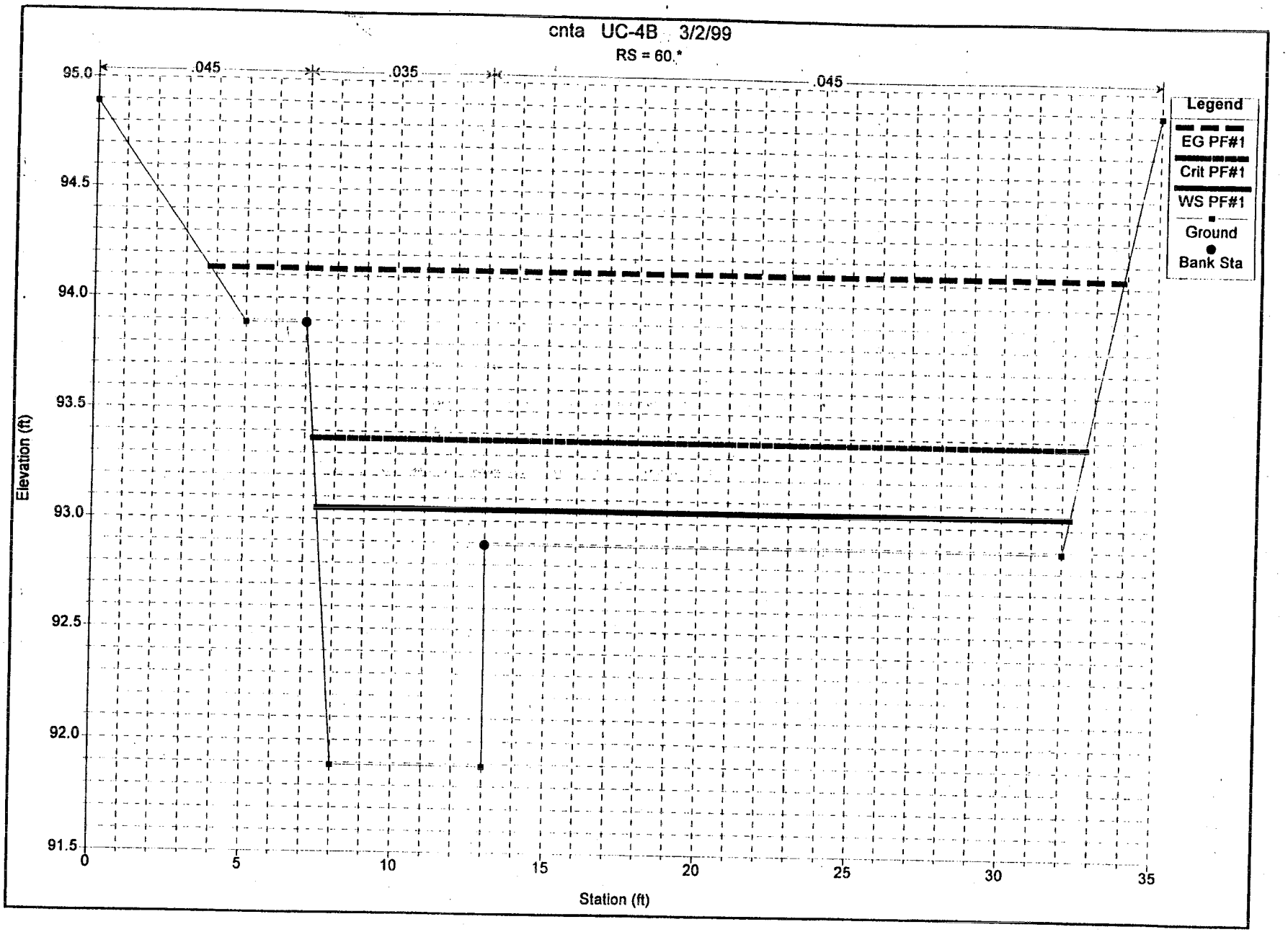

cnta UC-4B 3/2/99
x-sec 2 RS = 150
.035
Legend
EG PF#1
Crit PF#1
WS PF#1
Ground
Bank Sta
Elevation (ft)
99.5
99.0
98.5
98.0
97.5
97.0
0
10
20
30
40
50
Station (ft)

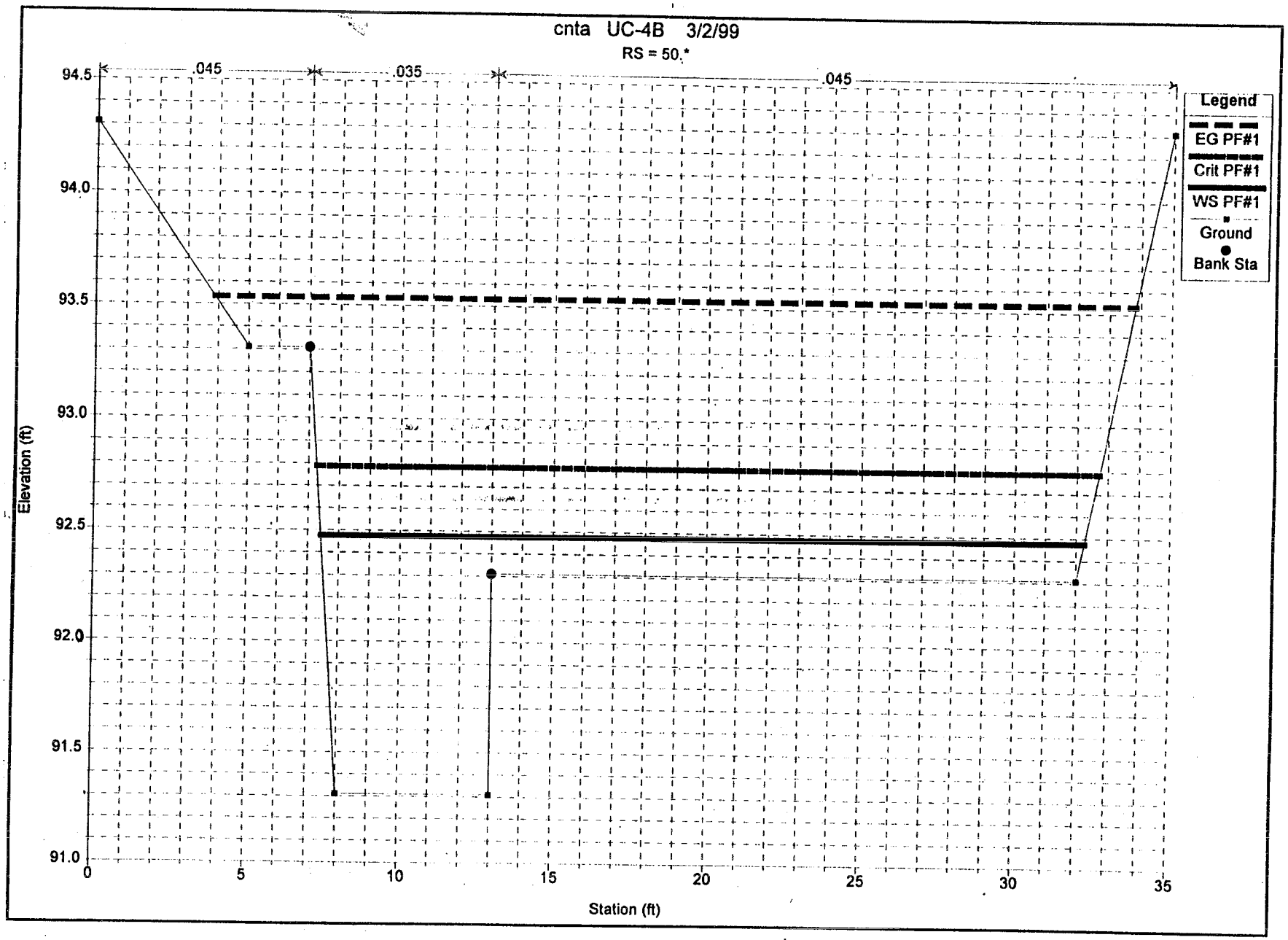

cnta UC-4B 3/2/99
x-sec 3 RS = 100
.045
.035
.045
Legend
EG PF#1
Crit PF#1
WS PF#1
Ground
Bank Sta
Elevation (ft)
97.5
97.0
96.5
96.0
95.5
95.0
94.5
94.0
0
5
10
15
20
25
30
35
Station (ft)

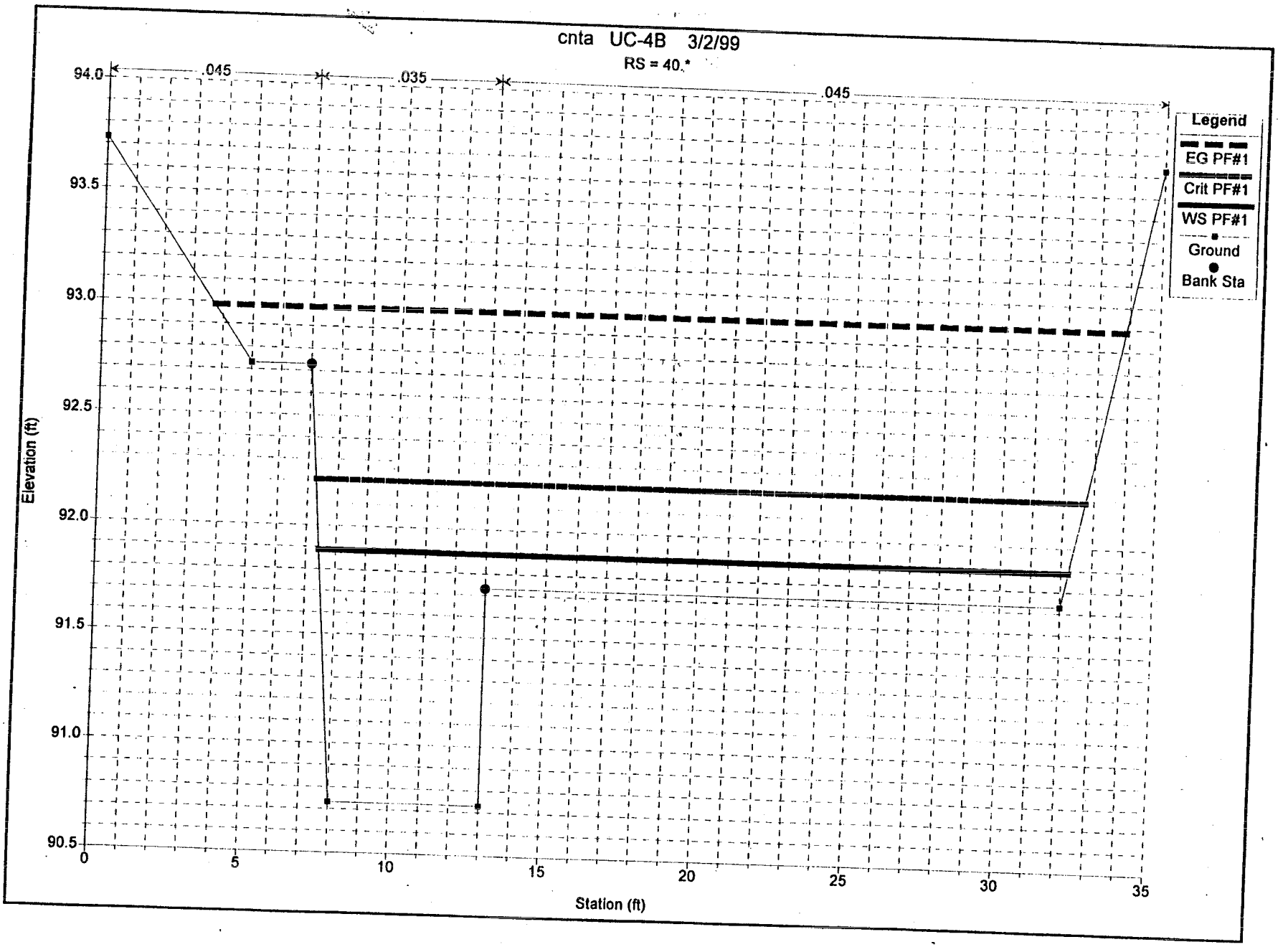

cnta UC-4B 3/2/99
RS = 90.*
.045
.035
.045
Legend
EG PF#1
Crit PF#1
WS PF#1
Ground
Bank Sta
Elevation (ft)
97.0
96.5
96.0
95.5
95.0
94.5
94.0
93.5
0
5
10
15
20
25
30
35
Station (ft)

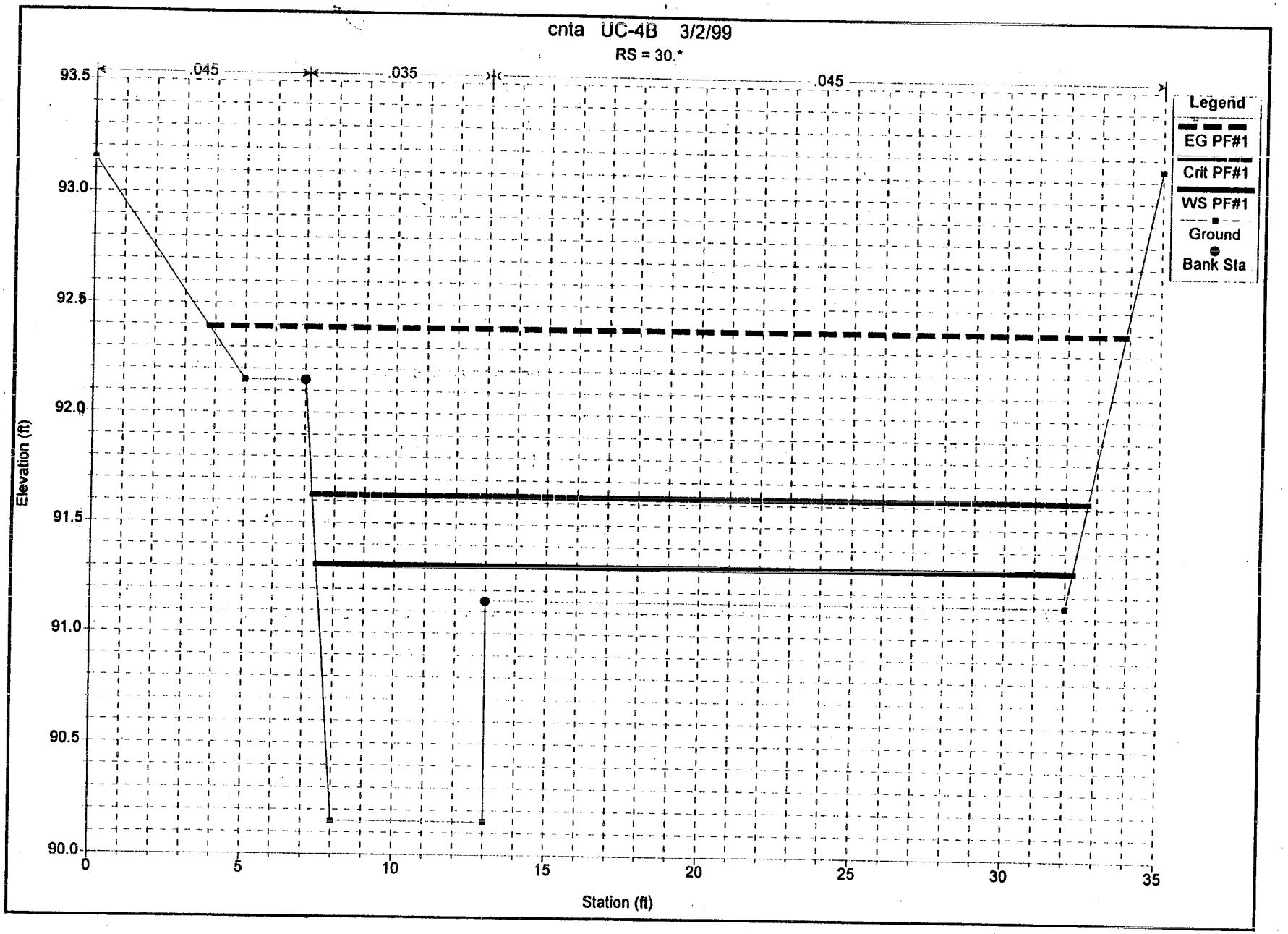

cnta UC-4B 3/2/99
RS = 80.*
.045
.035
.045
Legend
EG PF#1
Crit PF#1
WS PF#1
Ground
Bank Sta
Elevation (ft)
96.5
96.0
95.5
95.0
94.5
94.0
93.5
93.0
0
5
10
15
20
25
30
35
Station (ft)

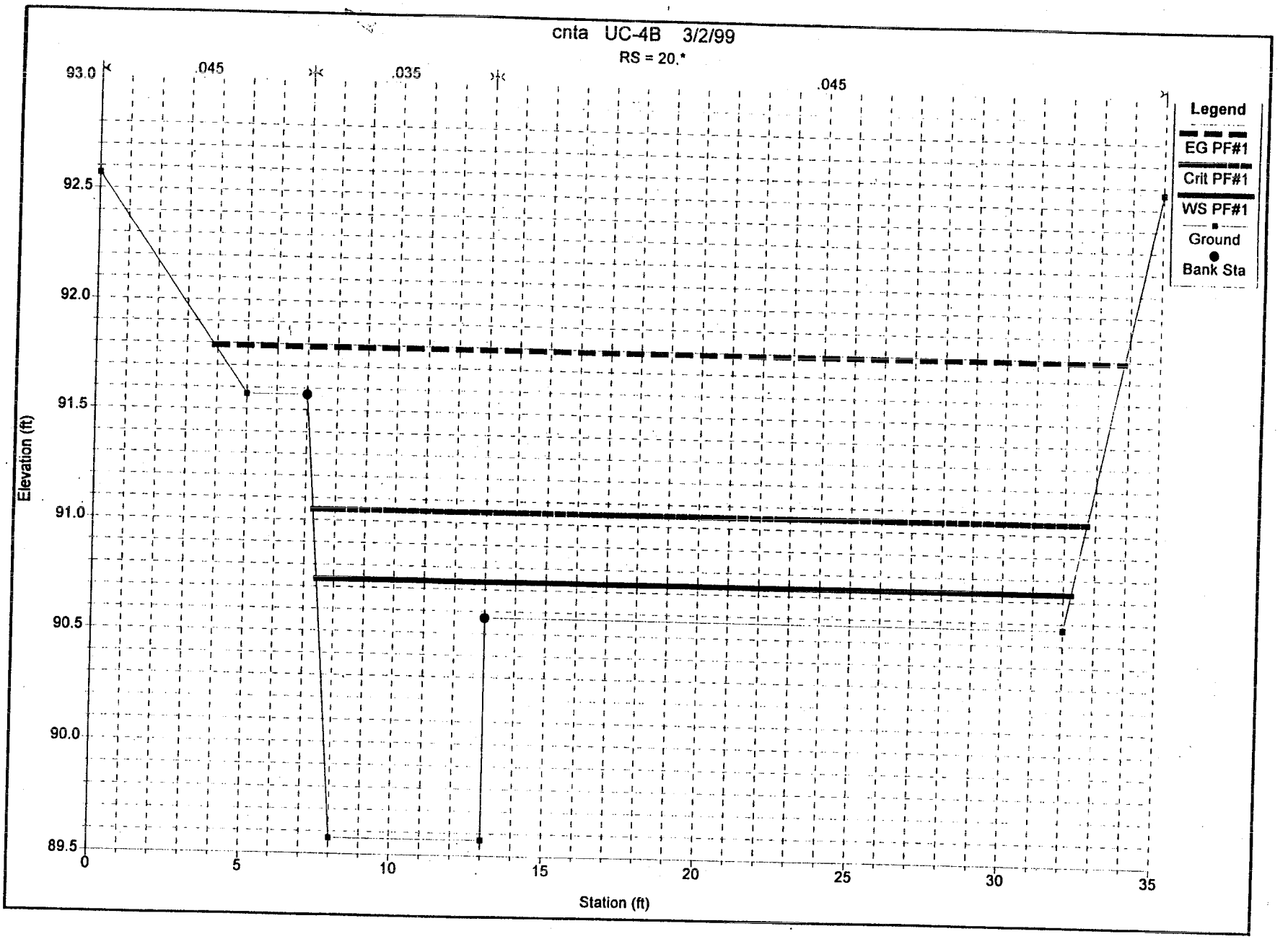

cnta UC-4B 3/2/99
RS = 70.*
.045
.035
.045
Legend
EG PF#1
Crit PF#1
WS PF#1
Ground
Bank Sta
Elevation (ft)
95.5
95.0
94.5
94.0
93.5
93.0
92.5
92.0
0
5
10
15
20
25
30
35
Station (ft)

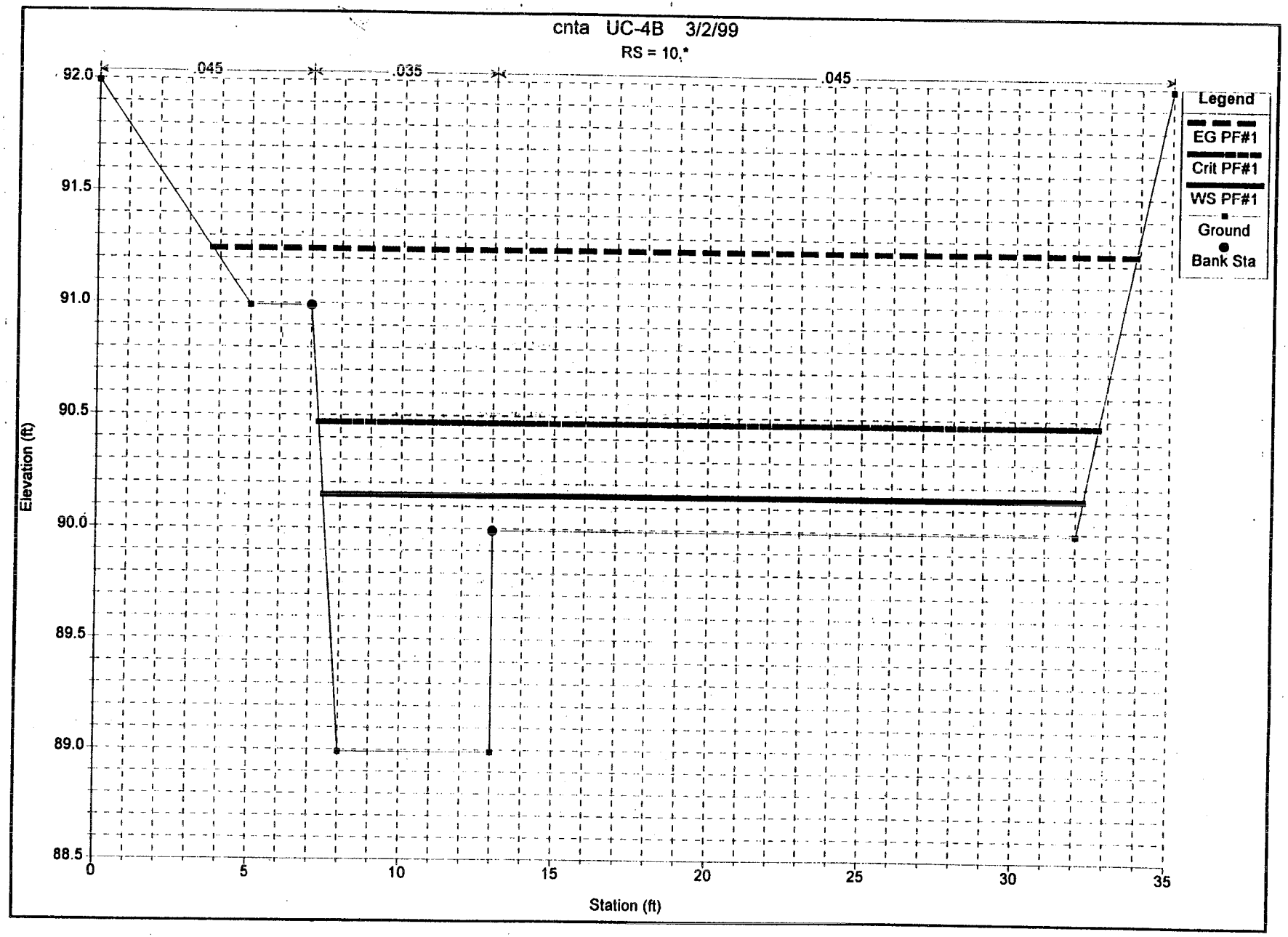

cnta UC-4B 3/2/99
RS = 60.*
.045
.035
.045
Legend
EG PF#1
Crit PF#1
WS PF#1
Ground
Bank Sta
Elevation (ft)
95.0
94.5
94.0
93.5
93.0
92.5
92.0
91.5
0
5
10
15
20
25
30
35
Station (ft)

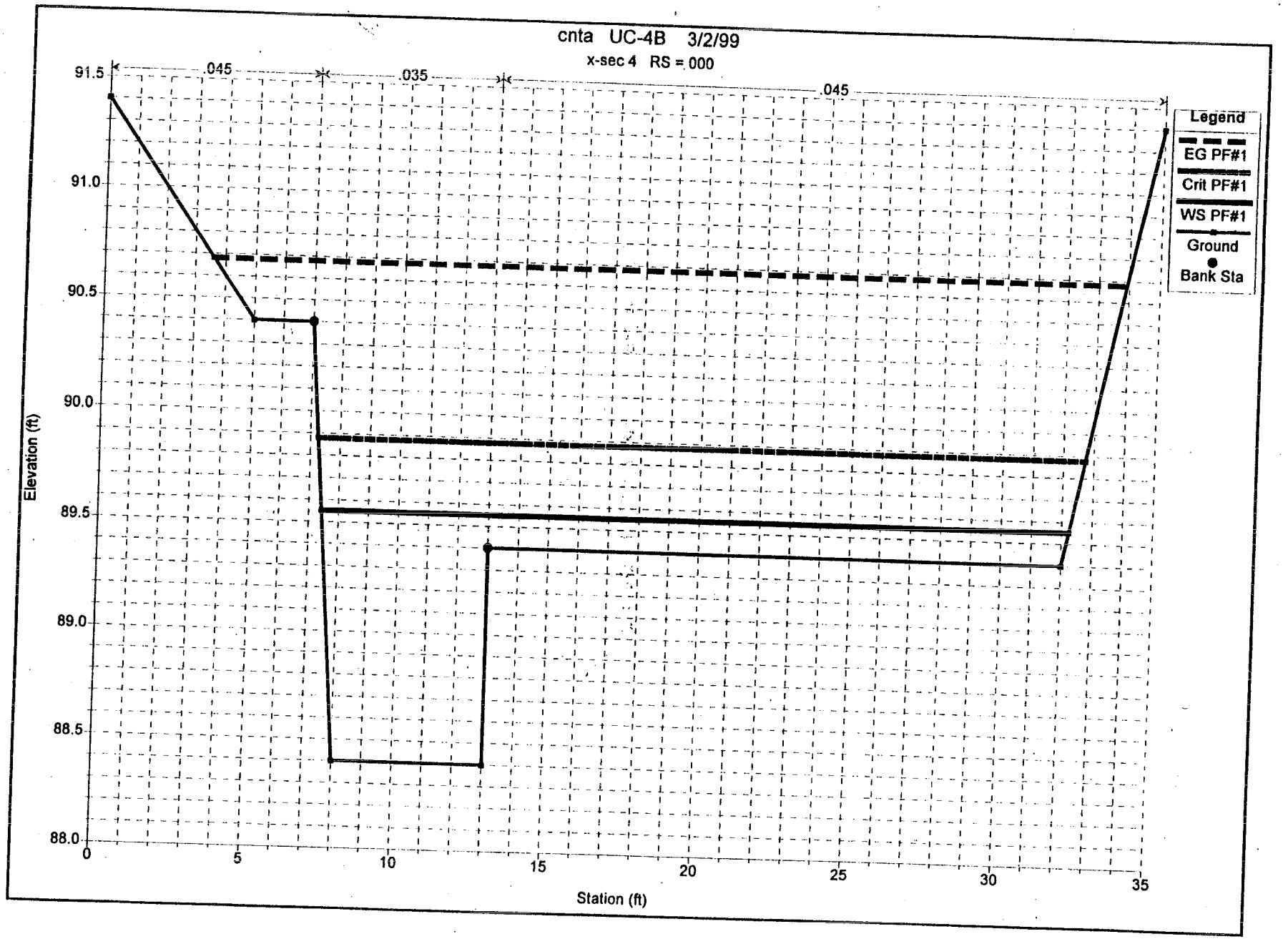

cnta UC-4B 3/2/99
RS = 50.*
.045
.035
.045
Legend
EG PF#1
Crit PF#1
WS PF#1
Ground
Bank Sta
Elevation (ft)
94.5
94.0
93.5
93.0
92.5
92.0
91.5
91.0
0
5
10
15
20
25
30
35
Station (ft)


cnta UC-4B 3/2/99
RS = 40.*
.045
.035
.045
Legend
EG PF#1
Crit PF#1
WS PF#1
Ground
Bank Sta
Elevation (ft)
94.0
93.5
93.0
92.5
92.0
91.5
91.0
90.5
0
5
10
15
20
25
30
35
Station (ft)


cnta UC-4B 3/2/99
RS = 30.*
.045
.035
.045
Legend
EG PF#1
Crit PF#1
WS PF#1
Ground
Bank Sta
Elevation (ft)
93.5
93.0
92.5
92.0
91.5
91.0
90.5
90.0
0
5
10
15
20
25
30
35
Station (ft)


cnta UC-4B 3/2/99
RS = 20.*
.045
.035
.045
Legend
EG PF#1
Crit PF#1
WS PF#1
Ground
Bank Sta
Elevation (ft)
93.0
92.5
92.0
91.5
91.0
90.5
90.0
89.5
0
5
10
15
20
25
30
35
Station (ft)


cnta UC-4B 3/2/99
RS = 10.*
.045
.035
.045
Legend
EG PF#1
Crit PF#1
WS PF#1
Ground
Bank Sta
Elevation (ft)
92.0
91.5
91.0
90.5
90.0
89.5
89.0
88.5
0
5
10
15
20
25
30
35
Station (ft)


cnta UC-4B 3/2/99
x-sec 4 RS = 000
.045
.035
.045
Legend
EG PF#1
Crit PF#1
WS PF#1
Ground
Bank Sta
Elevation (ft)
91.5
91.0
90.5
90.0
89.5
89.0
88.5
88.0
0
5
10
15
20
25
30
35
Station (ft)

APPENDIX D

SHEETFLOW CALCULATIONS

SHEETFLOW CALCULATIONS FOR UC-1

DISCHARGE (ft^3/sec)	WIDTH (ft)	MANNING COEFFICIENT	SLOPE (ft/ft)
854	1200	0.045	0.056

Q=DISCHARGE (ft^3/sec)
V=VELOCITY (ft/sec)
A=AREA (ft^2) (For a rectangular channel, area = depth * width)
R=HYDRAULIC RADIUS (ft) (For a shallow channel, assume R=depth)
S=SLOPE (ft/ft)
n=MANNING COEFFICIENT
W=WIDTH (ft)
d=DEPTH (ft)

EQUATIONS:

$$Q=VA$$

$$V=\frac{1.49}{n}R^{2/3}S^{1/2}$$

$$Q=\frac{1.49}{n}R^{2/3}S^{1/2}A$$

CALCULATIONS:

$$Q=\frac{1.49}{n}d^{2/3}S^{1/2}dW$$

$$Q=\frac{1.49}{n}d^{5/3}S^{1/2}W$$

$$d=\left(\frac{Qn}{(1.49)S^{1/2}W}\right)^{3/5}$$

DEPTH CALCULATION:

FLOW DEPTH = 0.24 ft

SHEETFLOW CALCULATIONS FOR UC-3

DISCHARGE (ft^3/sec)	WIDTH (ft)	MANNING COEFFICIENT	SLOPE (ft/ft)
760	600	0.045	0.066

Q=DISCHARGE (ft^3/sec)
V=VELOCITY (ft/sec)
A=AREA (ft^2) (For a rectangular channel, area = depth * width)
R=HYDRAULIC RADIUS (ft) (For a shallow channel, assume R=depth)
S=SLOPE (ft/ft)
n=MANNING COEFFICIENT
W=WIDTH (ft)
d=DEPTH (ft)

EQUATIONS:

$$Q = VA$$

$$V = \frac{1.49}{n} R^{2/3} S^{1/2}$$

$$Q = \frac{1.49}{n} R^{2/3} S^{1/2} A$$

CALCULATIONS:

$$Q = \frac{1.49}{n} d^{2/3} S^{1/2} dW$$

$$Q = \frac{1.49}{n} d^{5/3} S^{1/2} W$$

$$d = \left(\frac{Qn}{(1.49) S^{1/2} W} \right)^{3/5}$$

DEPTH CALCULATION:

FLOW DEPTH = 0.32 ft

SHEETFLOW CALCULATIONS FOR UC-4A

DISCHARGE (ft^3/sec)	WIDTH (ft)	MANNING COEFFICIENT	SLOPE (ft/ft)
108	400	0.045	0.058

Q=DISCHARGE (ft^3/sec)
V=VELOCITY (ft/sec)
A=AREA (ft^2) (For a rectangular channel, area = depth * width)
R=HYDRAULIC RADIUS (ft) (For a shallow channel, assume R=depth)
S=SLOPE (ft/ft)
n=MANNING COEFFICIENT
W=WIDTH (ft)
d=DEPTH (ft)

EQUATIONS:

$$Q = VA$$

$$V = \frac{1.49}{n} R^{2/3} S^{1/2}$$

$$Q = \frac{1.49}{n} R^{2/3} S^{1/2} A$$

CALCULATIONS:

$$Q = \frac{1.49}{n} d^{2/3} S^{1/2} dW$$

$$Q = \frac{1.49}{n} d^{5/3} S^{1/2} W$$

$$d = \left(\frac{Qn}{(1.49) S^{1/2} W} \right)^{3/5}$$

DEPTH CALCULATION:

FLOW DEPTH = 0.13 ft

APPENDIX B

RESULTS OF THE 1999 CNTA PHASE I FIELD ACTIVITIES

RESULTS OF THE 1999 CNTA PHASE I FIELD ACTIVITIES

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS iii

1.0 INTRODUCTION 1
1.1 Purpose 1
1.2 Scope 3

2.0 PHASE I FIELD ACTIVITIES 5
2.1 Site Preparation and Support Activities 5
2.1.1 Testing of Borrow Pit Materials 5
2.1.2 Placement of Submersible Pump in Well HTH-2 6
2.1.3 Sump Construction 6
2.1.4 Upgrade and Repair of Site Roads 6
2.1.5 Soil Conditioning and Site Dust Control 6
2.1.6 Tritium Monitoring of Water Pumped from the HTH-2 Well 7
2.2 UC-4 Mud Pit C Cover Construction 8
2.2.1 Construction of Berm/Relocation Trench 8
2.2.2 Relocation of Drilling Mud 11
2.2.3 Installation of Geogrid 11
2.2.4 Construction of Stabilization Layer 11
2.2.5 Construction of Shaping Layer 12
2.2.6 Construction of Bedding Layer 13
2.2.7 Installation of Geosynthetic Clay Liner 13
2.2.8 Construction of Buffer Layer 13
2.2.9 Construction of Erosion Control Layer 14
2.2.10 Installation of Fence, Signs, and Subsidence Monuments 14
2.3 Excavation of the UC-1 CMP Mud Relocation Trench 15
2.4 Installation of Monuments and Warning Signs 15
2.5 Relocation of CMP Drilling Mud and Construction of a Retention Berm 16
2.6 Phase I Field Activities Schedule as Completed 17

3.0 WASTE 19

TABLE OF CONTENTS (continued)

4.0 VERIFICATION TESTING RESULTS 21
4.1 Analytical Results 21
4.2 Compaction Results 21
4.2.1 UC-4 Mud Pit Relocation Berm 21
4.2.2 UC-4 Mud Pit C Cover Layers 22

5.0 FINDINGS AND RECOMMENDATIONS 29
5.1 Findings 29
5.2 Recommendations 29

6.0 REFERENCES 31

FIGURES

FIGURE 1 - CNTA CAS's REQUIRING CORRECTIVE ACTION 2

FIGURE 2 - PHASE I FIELD ACTIVITIES SCHEDULE AS COMPLETED 18

TABLES

TABLE 1 - SIEVE ANALYSIS RESULTS FOR BORROW SOILS 5

TABLE 2 - CNTA WELL HTH-2 GROUNDWATER TRITIUM MONITORING RESULTS . 9

TABLE 3 - UC-4 MUD PIT C EAST BERM COMPACTION RESULTS 23

TABLE 4 - UC-4 MUD PIT C COVER COMPACTION RESULTS 27

ACRONYMS AND ABBREVIATIONS

ASTM	American Society for Testing and Materials
BN	Bechtel Nevada
CADD	Corrective Action Decision Document
CAP	Corrective Action Plan
CAS	Corrective Action Site(s)
CAU	Corrective Action Unit
cm	Centimeter(s)
CMP	Central Mud Pit
CNTA	Central Nevada Test Area
DOE/NV	U.S. Department of Energy, Nevada Operations Office
ft	Foot (feet)
ft^2	Square foot (feet)
FY	Fiscal Year
gpm	gallons per minute
GCL	Geosynthetic Clay Liner
in.	Inch(es)
kg/m^3	Kilograms per cubic meter(s)
lb/ft^3	pounds per cubic foot
LGP	Low Ground Pressure
m	Meter(s)
m^2	Square meter(s)
m^3	Cubic meter(s)
NDEP	Nevada Division of Environmental Protection
TPH	Total Petroleum Hydrocarbons
SITA	Sampling, Inspection, Testing, and Acceptance (Plan)
MDA	Minimum detectable activity
MTL	Materials Testing Laboratory
pCi/L	picoCurie(s) per liter
PAL	Preliminary Action Levels

1.0 INTRODUCTION

As a result of a May 12, 1999, U.S. Department of Energy, Nevada Operations office (DOE/NV), Bechtel Nevada (BN), and Nevada Division of Environmental Protection (NDEP) meeting, a Work Plan was prepared which proposed field activities that would be conducted at the Central Nevada Test Area (CNTA) during fiscal year (FY) 1999. The activities proposed in the July 1999 Phase I Work Plan for UC-4 Mud Pit C Cover and Other Site Management Activities, Central Nevada Test Area, Corrective Action Unit 417 are:

- Design and construct a cover at the UC-4 Mud Pit C.
- Post signs at the 13 Corrective Action Sites (CASs) (16 locations) where the total petroleum hydrocarbon (TPH) Preliminary Action Levels (PALs) were exceeded.
- Relocate drilling muds from the southeast corner to the west side of the UC-1 Central Mud Pit (CMP).
- Construct a retention berm in the area of the removed drilling muds at the UC-1 CMP.
- Partially excavate contaminated soils and drilling muds from four CASs for use in constructing the UC-4 Mud Pit C cover.

The purpose of the cover construction activities at the UC-4 Mud Pit C was to obtain constructability and planning information which will be used to more effectively design and construct a similar cover at the UC-1 CMP. Site posting at 13 CASs, relocation of drilling muds at the CMP, and construction of a retention berm at the CMP were proposed to better manage the site until closure activities can be completed during FY 2000. The locations of the 13 CASs requiring corrective action are shown in Figure 1.

At the May 12, 1999, NDEP meeting, the NDEP indicated that permeability, precipitation run-on and run-off, consolidation, and maintenance and repair should be addressed in designing an engineered cover that is protective of the contents and the environment. BN evaluated these parameters to design the UC-4 Mud Pit C cover.

1.1 PURPOSE

The purpose of the Phase I work activities was to obtain information on the constructability of the UC-4 Mud Pit C cover design and planning information useful for FY 2000 construction

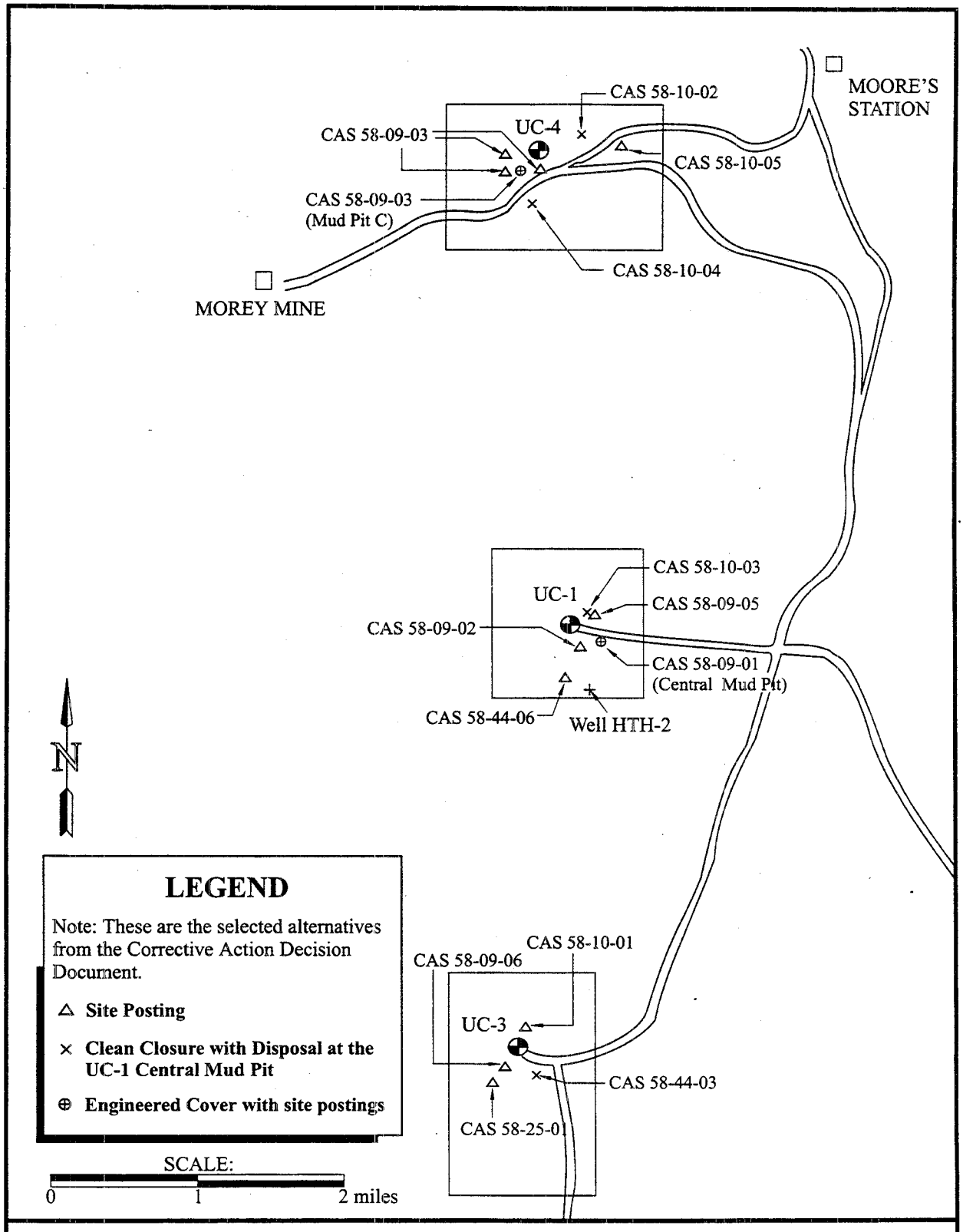


FIGURE 1
CNTA CAS's REQUIRING CORRECTIVE ACTION

activities at the UC-1 CMP. Phase I work activities were also proposed to better manage the site until FY 2000 closure activities could be performed. This included site posting of 13 CASs (16 sites), relocation of drilling muds at the UC-1 CMP, and construction of a retention berm at in the area of relocated drilling mud.

1.2 SCOPE

The scope of the work as stated in the Phase I Work Plan was to:

- Design and construct a cover for the UC-4 Mud Pit C.
- Post warning signs at 13 CASs (16 locations) where the TPH levels exceeded the Preliminary Action Level of 100 milligrams per kilogram (mg/kg).
- Relocate drilling muds from the southeast corner to the west side of the UC-1 CMP to the CMP mud relocation trench.
- Construct a retention berm where the drilling muds were removed at the UC-1 CMP.
- Partially excavate contaminated soils and drilling muds from four CASs for use in constructing the UC-4 Mud Pit C cover.

THIS PAGE INTENTIONALLY LEFT BLANK

2.0 PHASE I FIELD ACTIVITIES

This section details the activities that were implemented during the 1999 Phase I field activities.

2.1 SITE PREPARATION AND SUPPORT ACTIVITIES

2.1.1 Testing of Borrow Pit Materials

Prior to Phase I construction activities, samples were collected from two potential borrow pit source locations for geo-technical testing. Soil samples were collected for testing from the UC-1 mud relocation trench area near the CMP, and from a UC-3 borrow site located inside the existing fence line at UC-3. Sieve analyses (American Society for Testing and Materials [ASTM], 1997a) and modified proctor tests (ASTM, 1997b) were performed on the collected soil samples to determine the maximum density and size gradations. Testing results verified that UC-1 borrow pit soils and UC-3 borrow pit soils met the specifications stated in the Phase I CNTA Sampling, Inspection, Testing and Acceptance (SITA) Plan (Appendix A of the CNTA Corrective Action Plan). Sieve results for borrow soils are summarized in Table 1.

TABLE 1 - SIEVE ANALYSIS RESULTS FOR BORROW SOILS

Sieve No. / Size (inches [in.])	UC-1 Trench Borrow Source Percent Passing	UC-3 Borrow Source Percent Passing
3 in.	100 %	100 %
1.5 in.	100 %	100 %
0.75 (3/4 in.)	93 %	100 %
0.38 (3/8 in.)	89 %	100 %
No. 4	83 %	98 %
No. 10	70 %	93 %
No. 40	43 %	67 %
No. 100	29 %	48 %
No. 200	22.5 %	34.4 %

2.1.2 Placement of Submersible Pump in Well HTH-2

A Grundfos submersible pump was set in well HTH-2 at UC-1. Well HTH-2 is approximately 750 meters (m) (2,500 feet [ft]) southeast of the UC-1 emplacement hole (Figure 1). The pump was set at approximately 213 m (700 ft) below ground surface and has a pumping rate of approximately 455 liters per minute (120 gallons per minute [gpm]). Six-inch steel piping was run from the well head to two holding sumps located approximately 46 m (150 ft) west of the wellhead. The pump was run during daylight hours while personnel were present on site, for approximately eight hours or less. (At the beginning of the project the pump was run continuously for 24 hours to fill the southern sump.) The water was used during the 1999 Phase I activities for soil conditioning and dust control. Tritium monitoring was conducted and the results were evaluated from each sump prior to approving the water for use (see Section 2.1.6 for details on the monitoring activities).

2.1.3 Sump Construction

Two sumps were constructed approximately 46 m (150 ft) west of the HTH-2 wellhead for storage of the pumped water. Each sump is approximately 27 m (90 ft) long by 15 m (50 ft) wide at the top, and 3 m (10 ft) deep, with a holding capacity of approximately 946,353 liters (l) (250,000 gallons) of water. The sumps were lined with 30 Mil Herculine™ plastic liners. Water was transferred into water trucks using Hurricane pumps and used for dust control and soil conditioning.

2.1.4 Upgrade and Repair of Site Roads

The UC-1 access road and haul roads were graded to remove depressions, other erosion features, and large rocks. An approximate 20-square meter (m^2) (215-square foot [ft^2]) section of the UC-4 access road was repaired with approximately 23 cubic meters (m^3) (30 cubic yards [yd^3]) of compacted soil. Minimal grading was conducted in the Bureau of Land Management and U.S. Forest Service areas since a limited use permit was not obtained for extensive road work. The limited repair assisted in increasing safety on the haul roads and reduced cycle time of the haul equipment.

2.1.5 Soil Conditioning and Site Dust Control

Groundwater pumped from well HTH-2 was used to condition borrow soils used in the construction of the UC-4 cover, and was applied to site roads for dust suppression. Prior to using any groundwater obtained from well HTH-2, it was sampled, analyzed for tritium, and cleared for use by a qualified Radiation Control Technician. Based on the recorded pumping

times and an approximate pumping rate of 110 gpm, 2,725,500 liters (720,000 gallons) of water were withdrawn from well HTH-2 during the FY 1999 field activities. A more detailed discussion of the procedure and results of tritium screening is provided in Section 2.1.6.

2.1.6 Tritium Monitoring of Water Pumped from the HTH-2 Well

Tritium monitoring of groundwater pumped from well HTH-2 was performed to assure that groundwater tritium levels were below NDEP limits for surface discharge and was clean for construction use. In addition, monitoring was performed to obtain information to determine if tritium monitoring would be required during the construction activities to be conducted in FY 2000. The production zone for HTH-2 is approximately 168 m (550 ft) below ground surface in an alluvial aquifer. The Faultless device was detonated at approximately 975 m (3,200 ft) below ground surface in a volcanic aquifer. Past studies (Chapman, 1994) have shown there is no significant vertical communication or movement of water between the upper alluvial aquifer and underlaying volcanic aquifer. In addition, HTH-2 is part of the U.S. Environmental Protection Agency's Long Term Hydrologic monitoring program and has been sampled annually since the early 1980s. Tritium results for these samples have consistently been at or below background levels (DOE/NV, 1996). For this reason it was anticipated that groundwater pumped from HTH-2 would show tritium levels at or near background levels.

Pumping of HTH-2 during the Phase I activities was intermittent, with the goal being to fill the sumps for construction activities during working hours. The longest period of continuous pumping was approximately 24 hours at a rate of approximately 110 - 120 gpm. Groundwater samples for tritium analysis were collected from the piping running directly from the wellhead to the sumps one or more times throughout the day, and a composite sample was collected from the sump(s) being filled after pumping had ceased at the end of the day. Samples were transported to the BN field office at the Tonopah Test Range for counting. Tritium counting was performed using a Beckman Coulter liquid scintillation counter which was calibrated daily using quenched and unquenched tritium scintillation standards of known value. The tritium results for the collected 1999 groundwater samples are summarized in Table 2.

Tritium counting results indicate tritium levels at or near background tritium levels, with several samples yielding results below the calculated Minimum Detectable Activity (MDA) of the scintillation counter. For samples with tritium levels less than the MDA, the results are considered as instrument artifacts and are not considered valid reportable values, i.e., the true results could be anything between 0 picoCuries per liter (pCi/l) and the MDA. The results are included in the Table 2 to show that they are less than the MDA. A reported result of 0 pCi/l means that the sample had tritium levels equal to or less than the background tritium levels.

All tritium concentrations were well below 100,000 pCi/l (five times the Safe Water Drinking Act standard of 20,000 pCi/l), the level established by the Underground Test Area Fluid

Management Plan (DOE/NV, 1999c) for discharge of water to the surface. Based on 1999 groundwater tritium results (Table 2), tritium monitoring for FY 2000 field activities will not be necessary and are not planned to be performed.

2.2 UC-4 MUD PIT C COVER CONSTRUCTION

The UC-4 Mud Pit C cover design consisted of the following elements listed in the order in which they were performed/constructed:

- Construction of a berm along the east edge of the mud pit. This berm defined the drilling mud relocation trench.
- Relocation of drilling mud from UC-4 Area S (CAS 58-10-02) to fill the trench to the level of the mud in the mud pit.
- Covering the mud pit and relocation trench with geogrid material.
- Placement of a 0.6-m (2-ft) thick stabilization layer over the geogrid.
- Placement of a 0.6-m (2-ft) shaping layer over the stabilization layer.
- Placement of a 15.2-cm (6-in.) compacted bedding layer over the shaping layer.
- Placement of the Geosynthetic Clay Liner (GCL) on the bedding layer.
- Placement of a 15.2-cm (6-in.) compacted buffer layer over the GCL.
- Placement of a 0.3-m (1-ft) compacted erosion control layer over the buffer layer.
- Construction of a fence around the perimeter of the cover, placement of two subsidence monuments on the cover, and final topographic survey of cover.

The following sections provide details of the UC-4 cover system and construction activities.

2.2.1 Construction of Berm /Relocation Trench

A berm was constructed at the east end of UC-4 Mud Pit C to produce the UC-4 mud relocation trench. The trench measured approximately 18.3 m (60 ft) by 6.1 m (20 ft), and 1.5 m (5 ft) deep and was used to contain contaminated drilling mud relocated from UC-4 Area S. The berm was constructed prior to moving any drilling mud or placing the geogrid. Approximately 13,000 m^3 (17,00 yd^3) of clean soil from the UC-1 mud relocation trench borrow source area was used to construct the berm. The berm was constructed by laying successive lifts of borrow material and compacting each lift using a front-end loader and rubber tire roller. Each lift measured 15.2 to 20.3 centimeter (cm) (6 to 8 in.) in thickness when compacted. Lift compaction was tested by Materials Testing Laboratory (MTL) personnel and verified to meet the compaction specifications stated in the SITA plan before additional lifts were allowed to be placed. The berm was brought to final grade by a total of 12 compacted lifts. Results for the compaction tests are discussed in Section 4.0.

TABLE 2 - CNTA WELL HTH-2 GROUNDWATER TRITIUM MONITORING RESULTS

Date	Efficiency (percent)	MDA[1] pCi/l	Result pCi/l	Sample Location
8-12-1999	9%	7,366	0	South Sump
8-12-1999	9%	7,366	1,287	South Sump
8-12-1999	9%	7,366	0	North Sump
8-15-1999	9%	6,663	4,308	North Sump
8-16-1999	11%	6,753	0	Wellhead
8-16-1999	11%	6,753	0	North Sump
8-16-1999	11%	6,753	0	Wellhead
8-16-1999	11%	6,753	0	Wellhead
8-16-1999	11%	6,753	0	South Sump
8-17-1999	9%	6,413	4,308	Wellhead
8-17-1999	9%	6,413	8,715	Wellhead
8-17-1999	9%	6,413	6,560	Wellhead
8-17-1999	9%	6,413	5,484	North Sump
8-17-1999	9%	6,413	13,121*	Wellhead
8-18-1999	9%	6,960	0**	Wellhead
8-18-1999	9%	6,960	3,703	Wellhead
8-18-1999	9%	6,960	0	South Sump
8-18-1999	9%	6,960	0	South Sump
8-19-1999	9%	6,997	0	Wellhead
8-19-1999	9%	6,997	0	Wellhead
8-19-1999	9%	6,997	0	Wellhead
8-19-1999	9%	6,997	4,875	North Sump
8-19-1999	9%	6,997	1,378	Wellhead
8-19-1999	9%	6,997	2,014	Wellhead
8-19-1999	9%	6,997	2,226	Wellhead
8-19-1999	9%	6,997	4,452	South Sump
8-25-1999	8%	8,681	0	Wellhead
8-25-1999	8%	8,681	0	Wellhead

TABLE 2 - (Continued)

Date	Efficiency (percent)	MDA[1] pCi/l	Result pCi/l	Sample Location
8-25-1999	8%	8,681	0	Wellhead
8-25-1999	8%	8,681	2,815	North Sump
8-26-1999	8%	7,644	2,319	Wellhead
8-26-1999	8%	7,644	6,869	Wellhead
8-26-1999	8%	7,644	5,630	Wellhead
8-26-1999	8%	7,644	3,041	South Sump
8-30-1999	8%	7,625	2,252	Wellhead
8-30-1999	8%	7,625	6,081	Wellhead
8-30-1999	8%	7,625	8,333	Wellhead
8-30-1999	8%	7,625	8,671	North Sump
8-31-1999	8%	8,188	0	Wellhead
8-31-1999	8%	8,188	4,617	Wellhead
8-31-1999	8%	8,188	3,040	Wellhead
8-31-1999	8%	8,188	1,801	South Sump
9-1-1999	8%	7,737	7,094	Wellhead
9-1-1999	8%	7,737	9,009	Wellhead
9-1-1999	8%	7,737	6,306	Wellhead
9-1-1999	8%	7,737	5,405	North Sump
9-2-1999	8%	7,395	5,968	Wellhead
9-2-1999	8%	7,395	3,829	Wellhead
9-2-1999	8%	7,395	5,968	Wellhead
9-2-1999	8%	7,395	11,599	South Sump
9-7-1999	8%	7,930	5,646	Wellhead
9-7-1999	8%	7,930	2,643	Wellhead
9-7-1999	8%	7,930	3,724	Wellhead
9-7-1999	8%	7,930	8,288	North Sump

** - Recount of sample noted with *.

2.2.2 Relocation of Drilling Mud

Drilling mud was removed from the UC-4 Shaker Pad Area S (CAS 58-10-03) using a back-hoe and front-end loader. The mud was removed from a low area adjacent to the dirt access road and became very liquid when excavated. Approximately 138 m^3 (180 yd^3) of drilling mud was placed in the constructed relocation trench at the UC-4 Mud Pit C. The level of mud placed in the trench prior to installation of the geogrid was similar to the level of the existing mud in the mud pit. Over the course of a day, the relocated mud gained sufficient strength to support limited foot traffic.

2.2.3 Installation of Geogrid

A geogrid material manufactured by Huesker Inc. (product name Fornit 30 Geogrid) was placed directly over the surface of the mud in the mud pit and the relocation trench. The geogrid material was a heavy woven plastic that laterally distributed the weight of the overlying cover soils and of the heavy equipment used to place soil. Panels of the geogrid material were rolled out by hand from the west edge of the mud pit to the east edge of the relocation trench. Panels were sized to allow a minimum of 1.5 m (5 ft) overlap beyond the mud pit and relocation trench edges. Once the panels were cut to length, the east ends were pulled back on themselves to allow access to the relocation trench and to relocate drilling mud. Once the relocation trench was filled with drilling mud, the geogrid was extended across the filled trench and anchored on the perimeter. The anchoring layer was a 0.6-m (2-ft) thick layer of borrow soil that extended from the outside edge of the geogrid inward for 3 m (10 ft) around the entire perimeter of the pit. Edge overlaps of panels of the geogrid measured a minimum of 1.2 m (4 ft), and end overlaps of panels measured a minimum of 3 m (10 ft). The mud pit was completely covered, including pit and trench, the perimeter overlap, and the panel overlap, by a total of seven panels of geogrid material. Approximately 2,050 m^2 (22,058 ft^2) of geogrid was used to cover the mud pit and relocation trench. Placing the geogrid by hand was convenient and took approximately one half day. With 2 ft of soil placed on the geogrid, the layer easily supported the low ground pressure (LGP) dozer.

2.2.4 Construction of Stabilization Layer

The first layer of material placed on the geogrid was the stabilization layer, and was made up of petroleum hydrocarbon-impacted granular material excavated from four CASs, and clean fill from the UC-1 borrow pit. The amount of contaminated material removed from the four CASs and used in the UC-4 Mud Pit C cover was as follows:

CAS 58-10-03, UC-1 Area Shaker Pad Area S	~ 92 m^3 (120 yd^3)
CAS 58-44-03, UC-3 Drill Mud/Grout Area Z	~ 61 m^3 (80 yd^3)

CAS 58-10-04, UC-4 Shaker Pad Area W	~ 375 m^3 (490 yd^3)
CAS 58-10-02, UC-4 Area Shaker Pad Area S	~ 7.6 m^3 (10 yd^3)

The 0.6-m (2-ft) thick stabilization layer was placed on the geogrid from the west end of the mud pit and advancing material to the east end of the pit using a LGP dozer and front-end loader. The layer was compacted by repeated passes of the heavy equipment with the number of passes exceeding four as specified in the SITA plan (Section 2223). The hydrocarbon-impacted material comprised approximately 40 percent of this layer. The balance of the layer made up of borrow material from the UC-1 borrow pit approximately 1,300 m^3 (1,700 yd^3). The 2-ft thick lift of fill did not develop any soft or moist spots with repeated tracking with the LGP dozer, and easily supported the weight of the LGP dozer and the front-end loader. The final thickness and elevation of the stabilization layer was determined and documented as per the SITA plan.

An attempt was made to excavate granular material from UC-4 Shaker Pad Area S (CAS 58-10-02); however, it was discovered that the drilling mud content was higher than anticipated, and the planned 382 m^3 (500 yd^3) of granular material was not recoverable from this site. Exploratory excavations were conducted in the area to determine the extent of the drilling mud materials. The volume of drilling mud-containing material at CAS 58-10-02 was calculated to be approximately 5,200 m^3 (6,800 yd^3) based on observations of the excavations. This volume is similar to the estimate in the CADD (DOE/NV, 1999a).

During FY 2000 closure activities, the four CASs mentioned above will be clean closed. This will require that additional material be removed from each of the CASs and incorporated in the UC-1 CMP mud relocation trench and cover. The anticipated volumes to be removed from each CAS is as follows:

CAS 58-10-03, UC-1 Area Shaker Pad Area S	~ 1,011 m^3 (1,322 yd^3)
CAS 58-44-03, UC-3 Drill Mud/Grout Area Z	~ 734 m^3 (960 yd^3)
CAS 58-10-04, UC-4 Shaker Pad Area W	~ 38 m^3 (50 yd^3)
CAS 58-10-02, UC-4 Shaker Pad Area S	~ 5,200 m^3 (6,800 yd^3)

2.2.5 Construction of Shaping Layer

The shaping layer comprised of approximately 0.6-m (2-ft) thick layer of compacted clean soil was placed over the stabilization layer. Approximately 920 m^3 (1,203 yd^3) of clean fill material from the UC-1 CMP relocation trench borrow pit were used to construct this layer. The shaping layer was compacted by making repeated passes with the LGP dozer, front-end loader, and the grader. The 4-ft of material over the geogrid, the stabilization layer, and the shaping layer, supported scrapers and 10,000 gallon water masters with no difficulty. Density tests were performed to confirm that the compaction specification had been achieved. Results for the compaction tests are presented in Section 4.0 and Table 4. The final thickness and elevation of

the shaping layer were determined and documented to meet the SITA Plan specifications prior to initiating the next phase of cover construction.

2.2.6 Construction of Bedding Layer

A 15.2-cm (6-in.) compacted bedding layer of clean material, approximately 230 m^3 (300 yd^3) from the UC-1 relocation trench borrow pit, was placed over the stabilization layer to provide a suitable base for the GCL. All rocks and debris equal to or greater than 6 in. in size were manually removed during placement. No screening of material was required. The compaction specification was achieved by rolling the bedding layer with a rubber tire roller, front-end loader, and grader. Results for the compaction tests are presented in Section 4.0 and Table 4. The final thickness and elevation of the bedding layer were determined and documented as required by the SITA Plan before initiating the next phase of cover construction.

2.2.7 Installation of Geosynthetic Clay Liner

The GCL was placed on the bedding layer in accordance with the SITA Plan. The GCL rolls measured approximately 4.75 m (15.5 ft) wide by 46 m (150 ft) long. Each roll weighed approximately 998 kilogram (kg) (2,200 pounds [lbs]). The GCL was unrolled on the bedding layer from a steel dispenser attached to a front-end loader or forklift. GCL panels were laid in an east-west direction, and the edges were weighted with clean soil as the GCL was placed. Final positioning of the GCL panels was performed manually. A total of seven panels of GCL covered the cap. GCL edge joints were overlapped by a minimum of 25.5 cm (10 in.), and end joints were overlapped by a minimum of 30 cm (1 ft). (The center panel overlapped the adjacent panels by 3 to 4 ft along the edges.) All joints were sealed by placing a 10.2-cm (4-in.) wide bead of granular bentonite clay along the entire length of the joint. The bead of granular bentonite clay was placed using a chalk applicator (commonly used to mark playing fields). The panels of GCL were laid in a shingle-like pattern with the center panel capping (overlapping) each of adjacent panels. Approximately 1,860 m^2 (20,000 ft^2) of GCL material (including joint overlaps) was used in the cover. The GCL layer was completely covered with clean soil from the UC-3 borrow source area before the end of the work shift to prevent any precipitation from wetting the clay material (see Section 2.2.8 for details on the Buffer Layer).

2.2.8 Construction of Buffer Layer

A 15.2-cm (6-in.) compacted buffer layer of clean material, approximately 230 m^3 (300 yd^3) from the UC-3 borrow pit source, was placed over the GCL layer to protect the GCL. The borrow soil from the UC-3 pit was clean and contained no material larger than 5.1 cm (2 in.) in size; screening of borrow material was not required to meet the SITA Plan specification. The

buffer layer was compacted and tested in accordance with the SITA Plan. Compaction test results are provided in Section 4.0 and Table 4. The final thickness and elevation of the buffer layer was determined and documented as required in the SITA Plan prior to beginning the next phase of cover construction.

2.2.9 Construction of Erosion Control Layer

The erosion control layer consisted of a final 0.3-m (1-ft) compacted layer of UC-1 trench borrow material. Approximately 450 m^3 (588 yd^3) was placed over the buffer layer, and graded to the specified slope. This layer was compacted and tested according to the SITA Plan. Compaction test results are provide in Section 4.0 and Table 3. The final thickness and elevation of the erosion control layer was determined by a topographical survey for as-built purposes. Grade and survey results were documented as required in the SITA Plan before the associated construction hold point was released and the cover construction was considered complete.

2.2.10 Installation of Fence, Signs, and Subsidence Monuments

To discourage unauthorized excavation into the UC-4 Mud Pit C cover, a four-stand barbed wire fence was installed around the perimeter of the cover. The fence is 1.2 m (4 ft) in height and built of standard fencing T-posts spaced at 4.6-m (15-ft) centers. The fence corners are of three 7.6 cm (3 in.) outside diameter galvanized fence posts set in concrete and braced with and stabilizing rails supporting cross threaded rods. A double-panel gate was installed at the center of the western fence line. In addition, at approximately the center of each side of the fence, a warning sign was attached reading as follow:

WARNING
PETROLEUM IMPACTED SOIL.
NO EXCAVATION, DRILLING, AND/OR
REMOVAL OF MATERIALS IS PERMITTED
CONTACT:
U.S. DEPARTMENT OF ENERGY
ENVIRONMENTAL RESTORATION
DIVISION P.O. BOX 89518
LAS VEGAS, NEVADA 89193-8518
(702) 295-7063

Two subsidence monuments were placed on the cover. The monuments were positioned approximately over the center-line of the mud pit and the mud relocation trench. The monuments were cast in place with concrete and were recessed approximately 7.6 cm (3 in.) into the cover. A brass survey cap was installed in each monument as a survey point to determine

monument elevation.

2.3 EXCAVATION OF THE UC-1 CMP MUD RELOCATION TRENCH

The UC-1 mud relocation trench, measuring approximately 11 m (36 ft) by 50.3 m (165 ft) at the bottom and 5.8 m to 6.4 m (19 ft to 21 ft) deep, was excavated to the west of the CMP. This trench was the source of most of the material used to construct the UC-4 Mud Pit C cover and was designed to hold approximately 1,147 m^3 (1,500 yd^3) of drilling mud that would be removed from the CMP in the area of the fault scarp. The discovery that the approximately 5,200 m^3 (6,800 yd^3) of hydrocarbon-impacted material at UC-4 Shaker Pad Area S (CAS 58-10-02) was predominantly drilling mud rather than granular material resulted in delaying the relocation of any muds into the trench until FY 2000. See Section 2.6 for further discussion.

2.4 INSTALLATION OF MONUMENTS AND WARNING SIGNS

Signs warning of the presence of buried contaminated soil were posted at 13 CASs (16 sites) to provide increased management of the areas and to reduce the potential of inadvertent intrusion. There is an error in the Phase I Work Plan regarding the number of CASs to be posted. There are 16 sites in 13 CASs requiring corrective action at the CNTA rather than 16 CASs. The error is the result of counting four sites that comprise CAS 58-09-03 as individual CASs. A minimum of two signs were posted at each of the 16 sites in accordance with the Phase I Work Plan. Signs warning of the presence of buried contaminated soil were attached to each monument.

Concrete monuments with brass survey markers and warning signs were placed to mark the perimeter of the following nine sites:

CAS Number	Description
58-09-02	UC-1 Mud Pit A
58-09-05	UC-1 Mud Pit E
58-44-06	UC-1 Borrow Pit Area Y
58-09-06	UC-3 Mud Pit E
58-10-01	UC-3 Shaker Pad Area S
58-25-01	UC-3 Spill Southern Outlier Area E
58-09-03	UC-4 Mud Pit A
58-09-03	UC-4 Mud Pit B
58-09-03	UC-4 Mud Pit D

Warning signs were posted on the perimeter fences at two sites:

CAS Number	Description
58-09-01	UC-1 CMP
58-09-03	UC-4 Mud Pit C

Warning signs were posted on T-posts at the following five sites:

CAS Number	Description
58-10-03	UC-1 Shaker Pad Area S
58-44-03	UC-3 Drill Mud/Grout Spill Area Z
58-10-02	UC-4 Shaker Pad Area S
58-10-04	UC-4 Shaker Pad Area W
58-10-05	UC-4 Shaker Pad Area X

Because future closure activities could disturb the postings at these sites, temporary posting of the warning signs was conducted until closure activities will be completed in FY 2000.

2.5 RELOCATION OF CMP DRILLING MUD AND CONSTRUCTION OF A RETENTION BERM

Approximately 1,147 m^3 (1,500 yd^3) of drilling mud from the southeast corner of the UC-1 CMP was to be relocated to a relocation trench adjacent to the western side of the CMP. In addition, a retention berm was to be constructed in the area where the CMP muds were moved from. These planned activities were not completed during FY 1999 field activities.

These activities were not initiated because design issues/concerns were not resolved regarding potential impacts on the CMP cover design. The potential impacts are the result of the observation of approximately 5,200 m^3 (6,800 yd^3) of material containing drilling mud at the UC-4 Shaker Pad Area S rather than granular. These materials will be relocated to the CMP relocation trench since the low strength of drilling mud-containing material is not suitable for incorporation into the stabilization layer of the UC-1 CMP cover. If any drilling muds were relocated to the trench prior to resolution of the design issues/concerns, there was the potential that this material would have to be handled a second time, i.e., if the trench design was changed to accommodate the additional volume of drilling mud. The trench was designed in the Phase I Work Plan to hold the 1,147 m^3 (1,500 yd^3) of drilling mud from the CMP fault area, which would put the height of the mud in the trench at a similar elevation to the existing CMP mud pit surface. Placement of an additional approximate 5,200 m^3 (6,800 yd^3) of drilling mud material from the UC-4 Shaker Pad Area S in the UC-1 trench would raise the elevation of the mud in the trench approximately 5.5 to 3 m (8 to 10 ft) above the existing CMP mud surface. This change could result in a significant increase in the volume of material needed to construct the CMP

cover and result in an unacceptable slope from west to east. The revised engineering design for the UC-1 relocation trench is discussed and provided in the Corrective Action Plan.

The objective of the mud relocation activity was to allow the disturbed mud time to settle and gain strength prior to constructing the cover on the CMP in FY 2000. However, the disturbed mud strength is less of a concern than originally anticipated since cover construction activities over the UC-4 Mud Pit C mud relocation trench were successful.

2.6 PHASE I FIELD ACTIVITIES SCHEDULE AS COMPLETED

The 1999 Phase I field activities were completed in a timely manner. A detailed schedule of the 1999 Phase I field activities as completed is shown in Figure 2.

Central Nevada Test Area (CNTA)
CAU 417 Closure Activities

Activity ID	Activity Description	Cal ID	Actual Start	Actual Finish
BM1010	Installl Submersible Pump In Well HTH-2	2	30JUN99	30JUN99
BM1020	Mobile Equipment	2	02AUG99	17AUG99
BM1030	Lodging, Meals, Travel	2	02AUG99	09SEP99
BM1040	Construct Sump	2	09AUG99	12AUG99
BM1050	Construct UC-4 Cover	2	09AUG99	09SEP99
BM1060	Place Monuments and Attach Signs	2	17AUG99	09SEP99
BM1070	Construct UC-1 Trench	2	12AUG99	09SEP99
BM1080	Demobilze Equipment	2	09SEP99	15OCT99
BM1090	Topographical Surveys of Erosion Control Layer	2	09SEP99	09SEP99
BM1100	Baseline Settlement Survey	2	12OCT99	12OCT99
BM1110	M/S - Phase I Field Work Complete	1	15OCT99	

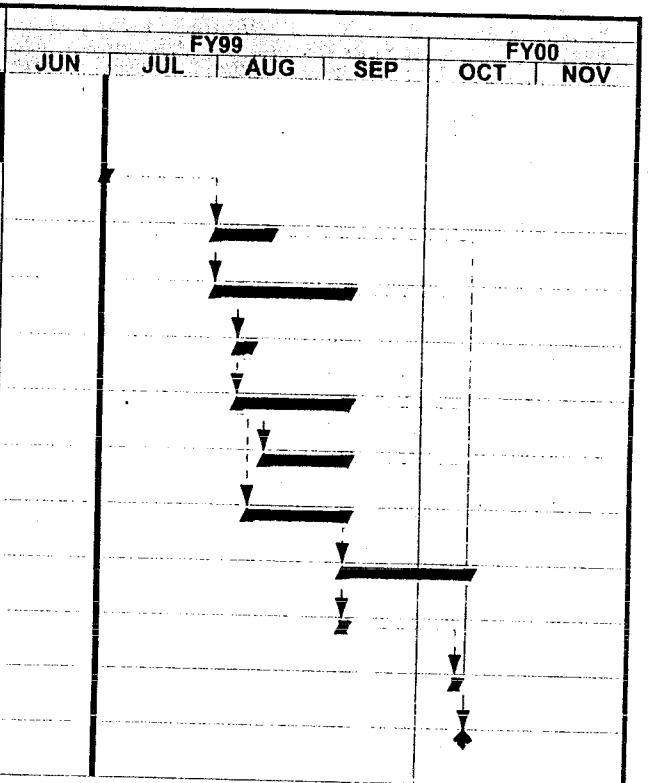


FIGURE 2 PHASE I FIELD ACTIVITIES SCHEDULE AS COMPLETED

Sheet 1 of 1

3.0 WASTE

Two types of waste were generated during 1999 field activities: sanitary waste and hydrocarbon-impacted waste.

A small volume of construction waste was generated at CNTA from site activities. Sanitary waste included paper, plastic, wire, and wood and construction debris generated during normal construction activities. This waste was packaged in trash bags and transported to the Tonopah Test Range for disposal.

Hydrocarbon-impacted materials were removed from equipment during cleaning activities. The cleaning activities were conducted on equipment used for the placement of the stabilization layer, and the materials were incorporated into the UC-4 Mud Pit C cover stabilization layer.

THIS PAGE INTENTIONALLY LEFT BLANK

4.0 VERIFICATION TESTING RESULTS

Two types of verification testing were to be performed during the 1999 field activities: analytical testing of soil samples collected from the CMP mud relocation area and geo-technical testing of the UC-4 cover lifts to verify that each lift met engineering specifications.

4.1 ANALYTICAL RESULTS

Planned 1999 field activities for the UC-1 CMP included relocating approximately 1,147 m^3 (1,500 yd^3) of drilling mud from the southeast corner of the CMP to the UC-1 mud relocation trench. Due to the discovery of large quantity of contaminated drilling mud at UC-4 Area S (58-10-02) and the possibility that this mud my be relocated to the UC-1 relocation trench in FY 2000, this planned activity was delayed. Relocating an additional 5,200 m^3 (6,800 yd^3) of drilling mud from UC-4 to the UC-1 relocation trench would effect the final height of mud in this trench, and hence, the final cap elevation over the relocation trench. Because no mud was moved from the CMP, soil verification samples from beneath the relocated drilling mud were not collected. Relocation of CMP drilling mud will occur during FY 2000 field activities.

4.2 COMPACTION RESULTS

Maximum density tests (ASTM, 1997b) and sieve analyses (ASTM, 1997a) were performed on all soil samples collected from potential borrow pit locations prior to construction activities. Two borrow source areas were used in the construction of the UC-4 Mud Pit C cover: the UC-1 CMP mud relocation trench borrow area, and the UC-3 borrow pit area. Soil from the UC-1 CMP mud relocation trench borrow source were used to construct the UC-4 Mud Pit C berm and cover. UC-1 CMP borrow soils used for construction had a maximum density range of 2,117 kilograms per cubic meter (kg/m^3) (132.3 pounds per cubic foot [lb/ft^3]) to 2,128 kg/m^3 (133.0 lb/ft^3). The UC-3 borrow pit soils used for the buffer layer in the cap had a maximum density of 2,096 kg/m^3 (131.0 lb/ft^3). The maximum density was used to determine the percent compaction from the field moisture content and density tests (ASTM, 1997c, 1997d). Geo-technical test results are discussed below in Sections 4.2.1 and 4.2.2 and presented in Table 3 and Table 4.

4.2.1 UC-4 Mud Pit Relocation Berm

A total of 12 compacted lifts were placed to construct the UC-4 Mud Pit C relocation trench berm. The compaction requirement for each berm lift was a minimum of 90 percent of maximum density as stated in the SITA Plan (DOE/NV, 1999d). Each lift was compacted using

a rubber tire roller, front-end loader, and grader to an approximate thickness of 15.2 to 20.3 cm (6 to 8 in.). Three compaction tests were performed at random locations along each berm lift (ASTM, 1997c, 1997d). If a compaction test did not meet the specification, the area was reworked and a compaction retest was performed in the approximate location of the original failed test. Before the lift was approved, three compaction tests were passed as specified in the SITA Plan Compaction testing was performed and documented on-site by MTL personnel and the BN Site Supervisor. Compaction test results for the UC-4 Mud Pit C berm are presented in Table 3.

4.2.2 UC-4 Mud Pit C Cover Layers

Compaction requirements for the layers of the UC-4 Mud Pit C cover as stated in the SITA Plan were 85 percent of maximum density for the shaping, bedding, and buffer layers, and 90 percent of maximum density for the erosion control layer. No compaction testing of the stabilization layer was required. Compaction was achieved using a rubber tire roller, LGP dozer, front-end loader, grader, water master, and/or scrapers, depending on the strength of the layer. Six compaction tests were performed at random locations on each layer (ASTM, 1997c, 1997d). If a compaction test did not meet the specification, the area of the layer was reworked and a compaction retest was performed in the approximate location of the original failed test. Compaction testing was performed and documented on-site by MTL personnel and the BN Site Supervisor. Compaction test results for the UC-4 Mud Pit C cover layers are presented in Table 4.

TABLE 3 - UC-4 MUD PIT C EAST BERM COMPACTION TEST RESULTS

TEST LOCATION	LAB NUMBER	LIFT NUMBER	TEST DEPTH	PERCENT COMPACTION
1	2077	Lift 1 20.3 cm (8 in.)	15.2 cm (6 in.)	93.0
2	2078	Lift 1 20.3 cm (8 in.)	15.2 cm (6 in.)	93.5
3	2079	Lift 1 20.3 cm (8 in.)	15.2 cm (6 in.)	90.1
4	2080	Lift 2 20.3 cm (8 in.)	15.2 cm (6 in.)	83.2
5	2081	Lift 2 20.3 cm (8 in.)	15.2 cm (6 in.)	91.4
6	2082	Lift 2 20.3 cm (8 in.)	15.2 cm (6 in.)	89.2
4R	2083	Lift 2 20.3 cm (8 in.)	15.2 cm (6 in.)	91.6
6R	2084	Lift 2 20.3 cm (8 in.)	15.2 cm (6 in.)	87.9
6RR	2085	Lift 2 20.3 cm (8 in.)	15.2 cm (6 in.)	90.1
7	2086	Lift 3 20.3 cm (8 in.)	15.2 cm (6 in.)	85.6
8	2087	Lift 3 20.3 cm (8 in.)	15.2 cm (6 in.)	86.1
9	2088	Lift 3 20.3 cm (8 in.)	15.2 cm (6 in.)	89.2
10	2089	Lift 3 20.3 cm (8 in.)	15.2 cm (6 in.)	83.6
7R	2090	Lift 3 20.3 cm (8 in.)	15.2 cm (6 in.)	93.5
8R	2091	Lift 3 20.3 cm (8 in.)	15.2 cm (6 in.)	88.6
9R	2092	Lift 3 20.3 cm (8 in.)	15.2 cm (6 in.)	90.1
8RR	2093	Lift 3 20.3 cm (8 in.)	15.2 cm (6 in.)	90.2

TABLE 3 - (Continued)

TEST LOCATION	LAB NUMBER	LIFT NUMBER	TEST DEPTH	PERCENT COMPACTION
10R	2118	Lift 3 20.3 cm (8 in.)	15.2 cm (6 in.)	92.5
11	2094	Lift 4 20.3 cm (8 in.)	15.2 cm (6 in.)	93.5
12	2095	Lift 4 20.3 cm (8 in.)	15.2 cm (6 in.)	87.6
13	2096	Lift 4 20.3 cm (8 in.)	15.2 cm (6 in.)	90.5
12R	2097	Lift 4 20.3 cm (8 in.)	15.2 cm (6 in.)	90.0
14	2098	Lift 5 20.3 cm (8 in.)	15.2 cm (6 in.)	90.8
15	2099	Lift 5 20.3 cm (8 in.)	15.2 cm (6 in.)	90.8
16	2100	Lift 5 20.3 cm (8 in.)	15.2 cm (6 in.)	91.2
17	2101	Lift 6 20.3 cm (8 in.)	15.2 cm (6 in.)	87.8
18	2102	Lift 6 20.3 cm (8 in.)	15.2 cm (6 in.)	88.3
19	2103	Lift 6 20.3 cm (8 in.)	15.2 cm (6 in.)	89.8
17R	2104	Lift 6 20.3 cm (8 in.)	15.2 cm (6 in.)	84.9
18R	2105	Lift 6 20.3 cm (8 in.)	15.2 cm (6 in.)	88.7
19R	2106	Lift 6 20.3 cm (8 in.)	15.2 cm (6 in.)	90.7
17RR	2107	Lift 6 20.3 cm (8 in.)	15.2 cm (6 in.)	90.0
18RR	2108	Lift 6 20.3 cm (8 in.)	15.2 cm (6 in.)	90.6
20	2109	Lift 7 20.3 cm (8 in.)	15.2 cm (6 in.)	90.8

TABLE 3 - (Continued)

TEST LOCATION	LAB NUMBER	LIFT NUMBER	TEST DEPTH	PERCENT COMPACTION
21	2110	Lift 7 20.3 cm (8 in.)	15.2 cm (6 in.)	88.2
22	2111	Lift 7 20.3 cm (8 in.)	15.2 cm (6 in.)	89.4
21R	2112	Lift 7 20.3 cm (8 in.)	15.2 cm (6 in.)	83.8
22R	2113	Lift 7 20.3 cm (8 in.)	15.2 cm (6 in.)	90.1
21RR	2114	Lift 7 20.3 cm (8 in.)	15.2 cm (6 in.)	90.2
23	2115	Lift 8 20.3 cm (8 in.)	15.2 cm (6 in.)	91.7
24	2116	Lift 8 20.3 cm (8 in.)	15.2 cm (6 in.)	92.0
25	2117	Lift 8 20.3 cm (8 in.)	15.2 cm (6 in.)	90.0
26	2119	Lift 9 20.3 cm (8 in.)	15.2 cm (6 in.)	86.2
27	2120	Lift 9 20.3 cm (8 in.)	15.2 cm (6 in.)	90.1
28	2121	Lift 9 20.3 cm (8 in.)	15.2 cm (6 in.)	93.8
26R	2122	Lift 9 20.3 cm (8 in.)	15.2 cm (6 in.)	91.2
29	2123	Lift 10 20.3 cm (8 in.)	15.2 cm (6 in.)	92.2
30	2124	Lift 10 20.3 cm (8 in.)	15.2 cm (6 in.)	88.1
31	2125	Lift 10 20.3 cm (8 in.)	15.2 cm (6 in.)	88.8
30R	2126	Lift 10 20.3 cm (8 in.)	15.2 cm (6 in.)	90.0
31R	2127	Lift 10 20.3 cm (8 in.)	15.2 cm (6 in.)	90.5

TABLE 3 - (Continued)

TEST LOCATION	LAB NUMBER	LIFT NUMBER	TEST DEPTH	PERCENT COMPACTION
32	2128	Lift 11 20.3 cm (8 in.)	15.2 cm (6 in.)	90.5
33	2129	Lift 11 20.3 cm (8 in.)	15.2 cm (6 in.)	91.4
34	2130	Lift 11 20.3 cm (8 in.)	15.2 cm (6 in.)	90.0
35	2131	Lift 12 20.3 cm (8 in.)	15.2 cm (6 in.)	92.6
36	2132	Lift 12 20.3 cm (8 in.)	15.2 cm (6 in.)	89.0
37	2133	Lift 12 20.3 cm (8 in.)	15.2 cm (6 in.)	90.5
36R	2134	Lift 12 20.3 cm (8 in.)	15.2 cm (6 in.)	91.8

R - a retest was performed at approximately the same location after the lift was reworked.

TABLE 4 - UC-4 MUD PIT C COVER COMPACTION RESULTS

TEST LOCATION	LAB NUMBER	LIFT	TEST DEPTH	PERCENT COMPACTION
1	2162	Shaping	15.2 cm (6 in.)	90.6
2	2163	Shaping	15.2 cm (6 in.)	91.0
3	2164	Shaping	15.2 cm (6 in.)	92.1
4	2165	Shaping	15.2 cm (6 in.)	94.3
5	2166	Shaping	15.2 cm (6 in.)	95.8
6	2167	Shaping	15.2 cm (6 in.)	91.5
1	2168	Bedding	15.2 cm (6 in.)	94.9
2	2169	Bedding	15.2 cm (6 in.)	87.2
3	2170	Bedding	15.2 cm (6 in.)	93.7
4	2171	Bedding	15.2 cm (6 in.)	89.7
5	2172	Bedding	15.2 cm (6 in.)	88.5
6	2173	Bedding	15.2 cm (6 in.)	92.4
1	2180	Buffer	15.2 cm (6 in.)	95.8
2	2181	Buffer	15.2 cm (6 in.)	93.6
3	2182	Buffer	15.2 cm (6 in.)	91.5
4	2183	Buffer	15.2 cm (6 in.)	86.9
5	2184	Buffer	15.2 cm (6 in.)	86.2
6	2185	Buffer	15.2 cm (6 in.)	85.9
1	2186	Erosion	15.2 cm (6 in.)	92.1
2	2187	Erosion	15.2 cm (6 in.)	88.8
3	2188	Erosion	15.2 cm (6 in.)	91.9
4	2189	Erosion	15.2 cm (6 in.)	93.8
5	2190	Erosion	15.2 cm (6 in.)	94.3
6	2191	Erosion	15.2 cm (6 in.)	95.0
2R	2187R	Erosion	15.2 cm (6 in.)	91.1

R - a retest was performed at approximately the same location after the lift was reworked.

THIS PAGE INTENTIONALLY LEFT BLANK

5.0 FINDINGS AND RECOMMENDATIONS

5.1 FINDINGS

The following findings are made based on the completed 1999 field activities and the information presented in this report:

- An engineered cover was constructed at UC-4 Mud Pit C. The cover was constructed in accordance with the engineering design. Since this was accomplished, the cover design was determined to be constructable, and the design criteria (permeability, precipitation run-on and run-off, consolidation, and maintenance and repair) were satisfied. In addition, information was obtained to apply to the design/specifications and plan field activities for the UC-1 CMP cover. The information included cycle times and capabilities/limitations of site equipment, material handling and workability, and lodging/meal/travel/fuel/communication logistics.

- The CMP mud relocation trench was excavated at the CMP. The UC-1 mud relocation trench, measuring approximately 36 by 165 ft at the bottom and 19 to 21 ft deep, was excavated to the west of the CMP. The relocation trench may have to be enlarged in FY 2000 to accommodate newly discovered quantities of drilling mud at UC-4.

- Warning signs and monuments were installed at 16 sites in 13 CASs. The sites were posted to provide increased management of the impacted areas since warnings were not previously present to reduce the potential of inadvertent intrusion.

- Geogrid and stabilization layer placed over disturbed drilling mud in the relocation trench supported equipment and material loads.

5.2 RECOMMENDATIONS

Based on the lessons learned during the 1999 Phase I Work Activities, the following recommendations are suggested:

- Settlement time for relocated drilling muds to the UC-1 trench from UC-4 and from the CMP will not be necessary. At the UC-4 Mud Pit C, relocated drilling mud from the UC-4 Shaker Pad Area S settled/consolidated quickly, within one day of relocation. Placing the geogrid over the relocated muds immediately after the trench was full provided ample support for cover construction activities.

- Increase the thickness of the buffer layer placed over the GCL to 0.3 m (1 ft). This will provide additional protection to the GCL during layer grading and shaping activities.

- No need for tritium monitoring of withdrawn groundwater from well HTH-2 for FY 2000 field activities. Based on the duration of pumping, the amount of groundwater withdrawn, and the observed tritium levels no monitoring of future groundwater withdrawals will be required. Results of all tritium analyses for collected groundwater samples were at or below background levels, well below the 100,000 pCi/L (five times the Nevada Drinking Water Standard) level accepted by the NDEP for discharge to the ground.

- Increase the volume of the UC-1 CMP mud relocation trench. Due to the discovery of larger quantities of drilling mud at the UC-4 Shaker Pad Area S (58-10-02), the volume of the UC-1 CMP relocation trench will be increased to accommodate the additional drilling muds and allow the cap over the trench to be blended effectively with the cap over the CMP without producing any unsatisfactory slope breaks and potential for erosion.

- Upgrade the haul road between UC-1 and UC-4. This will prevent damage to the existing public roads and increase the efficiency of transporting material between the two locations.

6.0 REFERENCES

ASTM, see American Society for Testing and Materials.

American Society for Testing and Materials, 1997a. Method D 422-90: Standard Test Method for Particle-Size Analysis of Soils, and Method D 1140-92: Standard Test Method for Amount of Material in Soils Finer Than the No. 200 Sieve, 1997 Annual Book of ASTM Standards, Volume 04.08, Soil and Rock (I): D 420 - D 4914.

American Society for Testing and Materials, 1997b. Method D 1557-91: Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort, 1997 Annual Book of ASTM Standards, Volume 04.08, Soil and Rock (I): D 420 - D 4914.

American Society for Testing and Materials, 1997c. Method D 2922-96: Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth), 1997 Annual Book of ASTM Standards, Volume 04.08, Soil and Rock (I): D 420 - D 4914.

American Society for Testing and Materials, 1997d. Method D 3017-96: Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth), 1997 Annual Book of ASTM Standards, Volume 04.08, Soil and Rock (I): D 420 - D 4914.

Chapman, J. B., T. M. Mihevc, and B. F. Lyles. 1994. The Application of Borehole Logging to Characterize the Hydrogeology of the Faultless Site, Central Nevada Test Area, Desert Research Institute, Water Resources Center publication #45119, U.S. Department of Energy, Nevada Operations Office, Report DOE/NV/10845-35.

DOE, see U.S. Department of Energy.

DOE/NV, see U.S. Department of Energy, Nevada Operations Office.

FFACO, see Federal Facility Agreement and Consent Order.

Federal Facility Agreement and Consent Order. 1996. Agreed to by the State of Nevada , U.S. Department of Energy, and the U.S. Department of Defense.

NDEP, see Nevada Division of Environmental Protection.

Nevada Division of Environmental Protection. 1999. Letter from Paul J. Liebendorfer to Runore C. Wycoff, *Approval of Corrective Action Decision Document Corrective Action Unit 417, Central Nevada Test Area Surface Federal Facilities Agreement and Consent Order.*

U.S. Department of Energy, Nevada Operations Office. June 1996. *Central Nevada Test Area Preliminary Site Characterization Report, Nye County, Nevada*, DOE/NV-448 Rev. 0, Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. January 1997. *Corrective Action Investigation Plan for Central Nevada Test Area CAU No. 417*, DOE/NV-450 Rev. 0, Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. April 1999a. *Corrective Action Decision Document for Corrective Action Unit 417: Central Nevada Test Area Surface, Nevada*, DOE/NV--524 Rev. 1, Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. July 1999b. *Phase I Work Plan for UC-4 Mud Pit C Cover and Other Site Management Activities, Central Nevada Test Area, Corrective Action Unit 417*, Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. July 1999c. *Fluid Management Plan for the Underground Test Area Project*, DOE/NV-370 Rev. 2, Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. July 1999d. Sampling, Inspection, Testing, and Acceptance (SITA) Plan, Appendix D of *Phase I Work Plan for UC-4 Mud Pit C Cover and Other Site Management Activities, Central Nevada Test Area, Corrective Action Unit 417*, Las Vegas, NV.

APPENDIX C

UC-4 MUD PIT C SETTLEMENT and MONITORING PLAN

Central Nevada Test Area, Corrective Action Unit 417

UC-4, Mud Pit C Cover

Post-Construction Monitoring Plan

1. 0 Introduction

1.1 Background

The Central Nevada Test Area (CNTA), located in Hot Creek Valley, Nye County, Nevada, is one of the sites designated for environmental restoration by the Department of Energy, Nevada Operations (DOE/NV). The Federal Facility Agreement and Consent Order (FFACO) between State of Nevada and DOE/NV includes UC-4, Mud Pit C to be remediated under Corrective Action Unit (CAU) 417. An engineered cover over the UC-4 Mud Pit C was constructed during FY-99. The details of the planned remedial action were included in the Phase I work plan, which was submitted to the State of Nevada, Division of Environmental Protection (NDEP).

1.2 Scope

This monitoring plan describes the requirements and frequency for conducting settlement monitoring surveys and visual inspections of the cover system.

1.3 Purpose

The purpose of this plan is to establish requirements for monitoring the performance of the engineered cover installed over the UC-4, Mud Pit C. The data gathered will be assessed, evaluated and incorporated in to the design and installation of a similar cover at the UC-1, Central Mud Pit (CMP).

1.4 Site Description

The UC-4 land withdrawal area covers approximately 2.9 km^2 (1.4 mi^2). The cover over Mud Pit C is approximately 100 ft by 180 ft. Barbed-wire fencing is installed around the perimeter of the mud pit cover. A locked double swing gate provides controlled access into the cover area. Two concrete monuments are installed to monitor the settlement of the cover system. The entire site is graded to ensure positive drainage from the area of the cover system. The top elevation of the cover system is above the 100-year flood elevation.

2.0 Monitoring

2.1 Visual Inspection

Visual inspection will be performed by the project personnel and the results of the inspection will be documented. The area of the cover system will be inspected to document the potential occurrence of erosion rills, gullies, local depressions, seeps, animal burrows, cracks, growth of plants and vegetation, water logging, and the condition of the perimeter fencing and the posted signs. The locations of these features will be noted on the project design drawing. An inspection checklist is included in Attachment B.

2.2 Settlement Monitoring

The settlement markers will be surveyed and the results will be tabulated for evaluation and assessment. Spot elevation of the cover area will be recorded at pre-established reference points at no more than 100-foot intervals. The elevations shall be recorded to hundredth of a foot and all surveys shall be closed loop. Calibration of the surveying instruments shall be current and comply with project procedures.

2.3 Monitoring Frequency

The visual inspection and settlement monitoring shall be performed once a month for the first six months after completion of construction. Subsequently, the cover system shall be monitored on a semi-annual (twice per year) basis for two (2) consecutive years. The frequency after the second year will be determined by the BN Project Engineer, with DOE/NV and NDEP concurrence, based on the results of the previous inspections. Additional, unscheduled inspections may be required after severe weather events such as heavy rainfall, flash flooding, and high winds.

2.4 Documentation

The inspection reports and the settlement monitoring survey results shall be transmitted to the Project Engineer within 10 days upon completion. The collected information will be evaluated, assessed and will be appropriately incorporated in to the design of the UC-1 CMP cover. All inspection reports and settlement monitoring surveys shall be maintained in the project files.

2.5 Photographs

Photographs shall be taken as necessary to denote the condition of the site features. A photo log of all photographs taken will be made and included in the annual Post-Closure Monitoring Report.

3.0 Maintenance and Repair

If inspection results indicate that maintenance and repair of the cover is needed, DOE/NV will be notified by BN. Upon obtaining DOE/NV and NDEP concurrence, repair actions will be initiated and completed within 90 days. All repair and maintenance activities will be documented and included in the annual Post-Closure Monitoring Report to DOE/NV.

4.0 Health and Safety

All field activities shall be performed in accordance with project Health and Safety Plan.

5.0 Attachments

A. Sample Inspection Checklist.

APPENDIX D

UC-1 CENTRAL MUD PIT HYDROLOGICAL MODELING RESULTS

ACRONYMS AND ABBREVIATIONS

cc	non-native cover crop
cm	Centimeter(s)
cm/s	Centimeters per second
CMP	Central Mud Pit
CNTA	Central Nevada Test Area
ft	feet (foot)
in.	inch(es)
km	kilometer(s)
LAI	Leaf Area Index
m	meter(s)
mm	millimeter(s)
T	Transplants
SN	Seeded native

CENTRAL MUD PIT COVER INFILTRATION MODELING: VEGETATED MONOLAYER COVER

SUMMARY

Simulations of infiltration into a 1.2 m (4-ft) thick soil monolayer cover at the Central Nevada Test Area (CNTA) central mud pit (CMP) were conducted using the unsaturated flow model UNSAT-H. Five different scenarios were simulated, four with partial vegetative cover, and one with a bare-soil (no vegetation) cover. Model results indicate that all four vegetated covers will eventually dry out an initially wet cover, and keep it dry. One of the vegetation scenarios, seeded native plants only, will prevent infiltration into the underlying material, but will require decades to reach steady-state. The bare-soil cover will not prevent infiltration of water into the underlying material.

LOCATION

The CNTA is approximately 10.4 square kilometers (4 square miles) of land area located in Nye County approximately 90.5 kilometers (km) (60 miles [mi]) northeast of Tonopah, and approximately 48 km (30 mi) north of Warm Springs. One event, Project Faultless, was conducted at this site in 1968. The elevation of CNTA is approximately 1861 meters (m) (6104 feet [ft]). Refer to Figure 1 for a map showing the location of CNTA.

UNSAT-H MODEL

UNSAT-H is a one-dimensional model for calculating the flow of heat and water in unsaturated porous media. This model is capable of simulating the dynamic processes of infiltration, drainage, redistribution, evaporation, uptake of water by plants, soil heat flow, and the surface energy balance (Fayer and Jones, 1990). This model has been used previously for investigations of water movement in protective barriers at the Hanford site (Fayer et al., 1992). Some limitations of UNSAT-H include the inability to simulate non-isothermal flow with vegetation. Simulations must be run without plants in order to model non-isothermal flow. However, one previous study indicate little difference between isothermal and non-isothermal simulations (Levitt et al., 1996).

The accuracy of model prediction using UNSAT-H was tested by comparing simulations of soil water storage over a four-year period to soil water storage measured directly and accurately using a precision weighing lysimeter in Area 5 of the Nevada Test Site (NTS). This type of model calibration with precision weighing lysimeters has been described in several studies including Fayer et al. (1992) and Levitt et al. (1999).

Results of the comparisons between UNSAT-H and the bare-soil weighing lysimeter, and the vegetated weighing lysimeter are illustrated in Figures 2 and 3. Although there is some divergence from the lysimeter data, this divergence is never greater than 9 mm of total soil water storage per meter of soil for the bare-soil lysimeter, and never greater than 19 mm of total soil water storage per meter of soil for the vegetated lysimeter.

These results were obtained without adjusting parameters in the model. Such modeling studies usually include efforts to adjust certain hydraulic or plant parameters in order to calibrate the model to better match the lysimeter data. These model results indicate that UNSAT-H can

adequately predict evaporation, evapotranspiration, drainage, and total soil water storage, even before calibrating the model by adjusting various parameters.

MODEL GEOMETRY

Simulations were one-dimensional. Nodal discretization had very fine spacing near the surface boundary (0.1 centimeters [cm]), and wider spacing (up to 5 cm) near the lower boundary. The simulations were run with a total of 66 nodes.

ATMOSPHERIC BOUNDARY CONDITIONS

The average annual rainfall at CNTA is approximately 20 cm (8 inches [in.]) (DOE, 1996). The total annual potential evapotranspiration (PET) is approximately 1200 millimeters (mm) at a similar site (Central Nevada Field LA) located approximately 80 km (50 mi) from CNTA and at a similar elevation of 1817 m (5960 ft) (Shevenell, 1996).

Since site-specific rainfall and PET data were not readily available, the 1998 rainfall record from the Area 5 Radioactive Waste Management Site (RWMS) at the NTS was used for the rainfall record. The total rainfall recorded in 1998 at that location was 24.4 cm (9.6 in.). This rainfall record included two storms, each one delivering about 1.8 in. Daily rainfall for 1998 was repeated for multi-year simulations.

Total PET for 1998 was calculated from measurements made at a meteorological station at the Area 5 RWMS at the NTS. The total PET for that year was approximately 1500 mm. Daily estimates of PET were scaled by a factor of 0.8 to total 1200 mm per year. The scaled daily PET record was repeated for multi-year simulations. 1998 PET and precipitation are shown in Figure 4.

LOWER BOUNDARY CONDITION

The lower boundary condition was treated as an impermeable layer.

INITIAL CONDITIONS

The upper 0.6 m (2 ft) of cover soil was initially set to a volumetric water content of 10%, and the lower 0.6 m (2 ft) of cover soil was initially set to a volumetric water content of 36.5% (fully- saturated). The excess water in the lower 0.6 m (2 ft) of the cover was assumed to be compressed out of the underlying drilling mud by the weight of the cover material.

SOIL PROPERTIES

Soil hydraulic properties were taken from a report by Tom Fitzmaurice titled "Central Mud Pit Cover Infiltration Modeling". All soil properties were the same as in that report with the exception of residual water content. A value of 0.04 was used instead of the value of 0.03 reported in the Fitzmaurice report. Soil water retention curves were approximated using the van Genuchten (1980) model. Soil hydraulic properties are given in Table 1.

VEGETATION SCENARIOS

A total of five vegetation scenarios were simulated for a 30-year period:

1) A combination of transplants, seeded natives, and a non-native cover crop (T,SN,CC);
2) A combination of transplants and seeded natives (T,SN);

3) Seeded natives only (SN);
4) A vegetative cover of 20 percent with a leaf area index (LAI) of 1 (VEG); and
5) No vegetation (BARE).

PLANT PROPERTIES

Plant properties for each of the three revegetation types (transplants, seeded natives, and cover crop) include percent cover, leaf area index (LAI), rooting depth, and active growth period, and were obtained from Dave Anderson, Ecological Monitoring, Bechtel Nevada. These plant properties were then combined to obtain one set of vegetation properties to simulate the first three vegetation scenarios. The fourth vegetation scenario simply assumed 20 percent cover and 1.2–m (4-ft) rooting depth from the first year onward, which provides an upper bound on the expected success of revegetation. Table 1 lists model settings, and some soil and plant properties compared with the properties used in the model calibration. Table 2 lists details of the plant properties used for each of the four vegetation scenarios.

TABLE 1. UNSAT-H Parameters Used For This Study And The Model Calibration Study.

Model Settings	CNTA Study	Calibration Study
Vapor Flow	On	On
Heat Flow	Off	Off
Soil Parameters	**CNTA Study**	**Calibration Study**
alpha	0.05714 per cm	0.067 per cm
n	1.24	1.318
RWC	0.04	0.00
SWC	0.365	0.369
Ksat	1.0E-4 cm/s	1.6E-4 cm/s
Max dryness	10,000 bars	10,000 bars
Plant Parameters	**CNTA Study**	**Calibration Study**
Plant wilt point	65 bars	65 bars
Plant stress pointt	5 bars	5 bars

TABLE 2. Details Of Plant Properties Used For This Study.

	Year	% Cover	Root Depth (inches)	When Active	Leaf Area Index (LAI)
Transplants	1	7.5	15-20	March to October	0.25 on May 1
	2	10	20-30		0.7 on June 28
	3	13	30-40		
	4	13	40-48		
	5	13	48		
Seeded Natives	1	0	0	March to October	0.25 on May 1
	2	2	6		0.7 on June 28
	3	5	12-24		
	4	8	24-30		
	5	12-15	36		
	6	15	36		
Cover Crop	1	20-25	6-8	March to October	
	2	15-20	6-8		
	3	10-13	6-8		
	4	5-8	6-8		
	5	<5	6-8		
Scenario 1:					
Transplants	1	30	12	March to October	0.25 on May 1
Seeded Natives	2	30	15		0.7 on June 28
Cover Crop	3	30	20		
	4	27	30		
	5	27	36		
	6	28	42		
Scenario 2:					
Transplants	1	7.5	17.5	March to October	0.25 on May 1
Seeded Natives	2	12	20		0.7 on June 28
	3	18	30		
	4	21	35		
	5	25	42		
	6	28	42		
Scenario 3:					
Seeded Natives	1	0	0	March to October	0.25 on May 1
	2	2	6		0.7 on June 28
	3	5	12-24		
	4	8	24-30		
	5	12-15	36		
	6	15	36		
Scenario 4:					
20% Veg Cover	1-30	20	48	April to November	1.0

MODEL RESULTS

Figure 5 illustrates soil water storage in the cover, expressed as percent total saturation of the cover, and as an integrated volumetric water content averaged throughout the cover. Figure 5 shows the seasonal cycling of water in the covers, as well as the drying or wetting trend over a multiple-year period. Figures 6 through 10 illustrate the volumetric water content profiles with time for each of the modeled scenarios.

All scenarios with vegetation resulted in the eventual drying of the cover. Scenarios 1 and 2 took approximately 10 years to reach a steady-state equilibrium cycle, while scenario 4 took about six years to reach steady-state. Scenarios 1, 2, and 4, all prevented infiltration into the underlying material, and resulted in approximately the same, and the driest profiles.

Scenario 3 resulted in an increased wetting of the cover for five years, then a progressive dry-down for the next 25 years through the end of the simulation, although scenario 3 did not result in the driest profile. Scenario 3 will prevent infiltration into the underlying material after about five years, but will require decades to reach steady-state.

The bare-soil cover increased in total saturation for 5 years, and then reached steady-state, cycling between 84 and 97 percent total saturation for the rest of the 30-year simulation. The lower 42 cm (17 in.) of the bare-soil cover remained saturated for most of the 30-year period of interest. The bare-soil cover will not prevent infiltration of water into the underlying material.

CONCLUSIONS

All four vegetated covers will eventually dry out an initially wet cover, and keep it dry. One of the vegetation scenarios, seeded native plants only, will prevent infiltration into the underlying material, but will require decades to reach steady-state. The bare-soil cover will not prevent infiltration of water into the underlying material. All modeled scenarios were done conservatively; therefore the estimated time for the cover to dry out will likely be less in reality.

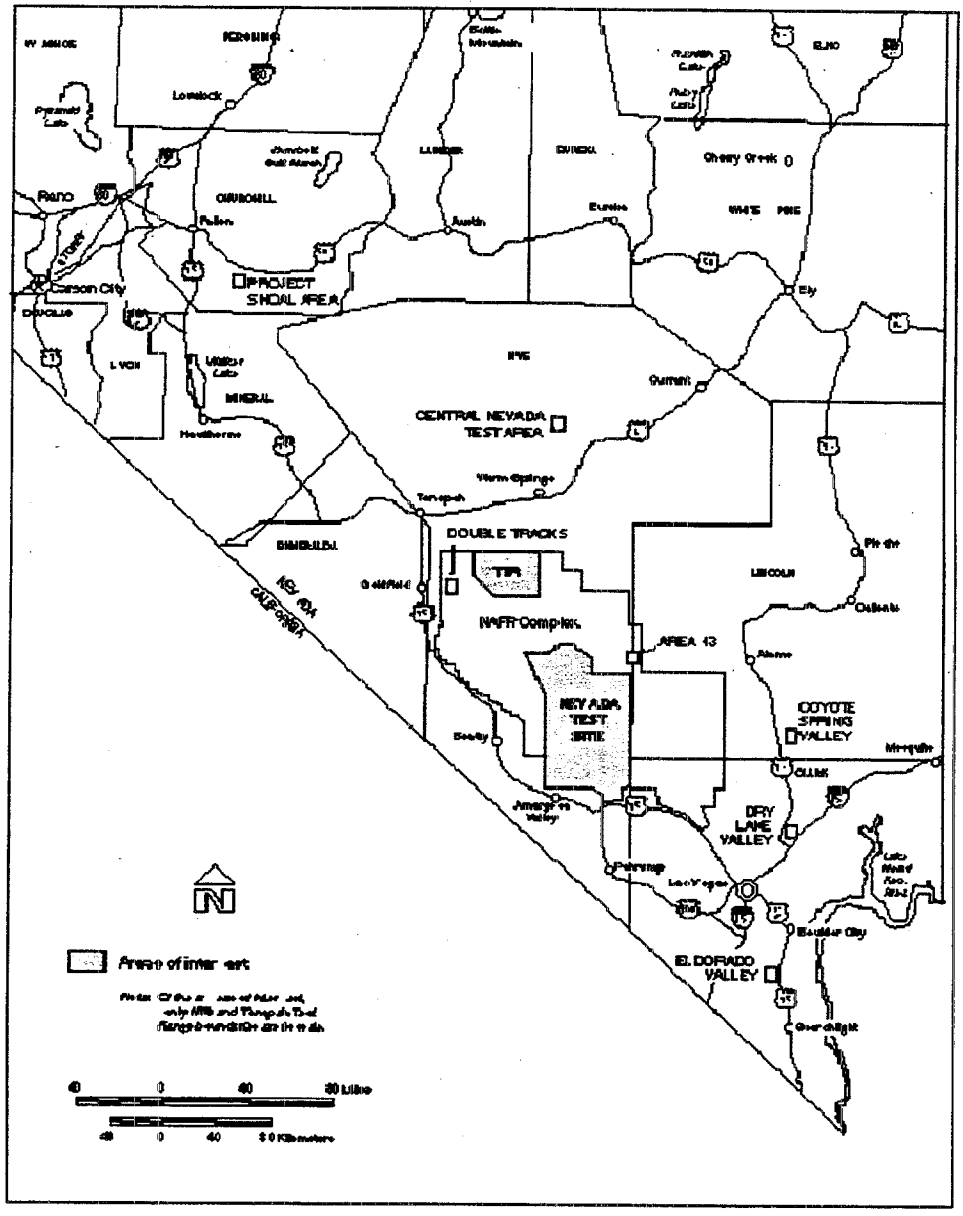


Figure 1. Map of Nevada with location of Central Nevada Test Area.

REFERENCES

DOE, 1996. Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada, DOE/EIS 0243, U.S. Department of Energy, Nevada Operations Office, Las Vegas, Nevada. http://www.nv.doe.gov/news%26pubs/publications/envm/eis/, October 1999.

Fayer, M.J. and T.L. Jones, 1990. UNSAT-H Version 2.0: Unsaturated soil water and heat flow model. Pacific Northwest Laboratory, Richland, WA. PNL-6779 UC-702.

Fayer, M.J., M.L. Rockhold, and M.D. Campbell, 1992. Hydrologic modeling of protective barriers: Comparison of field data and simulation results. Soil Sci. Soc. Am. J. 56: 690-700.

Levitt, D.G., M.J. Sully and C.F. Lohrstorfer, 1996. Calibration and Verification of Water and Heat Flow Models for NTS Radioactive Waste Management Site Performance. Report to U. S. Dept. of Energy Nevada Operations Office. Bechtel Nevada. September 30, 1996.

Levitt, D.G., C.F. Lohrstorfer, M.J. Sully and J.M. Ginanni, 1996. An Arid Zone Lysimeter Facility for Performance Assessment and Closure Investigations at the Nevada Test Site. Proceedings of Waste Management '96 Conference, Tucson, Arizona.

Levitt, D.G., M.J. Sully, B.L. Dozier and C.F. Lohrstorfer, 1999. Determining the Performance of an Arid Zone Radioactive Waste Site Through Site Characterization, Modeling and Monitoring. Proceedings of Waste Management '99 Conference, Tucson, Arizona.

Shevenell, L., 1996. Statewide Potential Evapotranspiration Maps for Nevada. Nevada Bureau of Mines and Geology report 48. ftp://ftp.nbmg.unr.edu/NBMG/pdf/r48.pdf , October 1999.

van Genuchten, M. Th., 1980. A closed-form equation for predicting the hydraulic conductivity of unsaturated soils. Soil Sci. Soc. Am. J. 44:892-898.

APPENDIX E

SAMPLING, INSPECTION, TESTING, and ACCEPTANCE (SITA) PLAN

Bechtel Nevada

CORRECTIVE ACTION UNIT 417
CENTRAL NEVADA TEST AREA
SURFACE, NEVADA

SAMPLING, INSPECTION, TESTING, AND ACCEPTANCE PLAN
PHASE II:
UC-1 CENTRAL MUD PIT COVER AND OTHER SITE CORRECTIVE ACTIONS

Document No. CQAP-98228A58-0003 Revision 0

APRIL 2000

U.S. Department of Energy
Nevada Operations Office

Prepared by Bechtel Nevada

CORRECTIVE ACTION UNIT 417
CENTRAL NEVADA TEST AREA SURFACE, NEVADA

SAMPLING, INSPECTION, TESTING, AND ACCEPTANCE PLAN
PHASE II: UC-1 CENTRAL MUD PIT COVER
AND OTHER SITE CORRECTIVE ACTIONS

BECHTEL NEVADA

Prepared by: Julie A. Sarola for Date: 4/5/00
R. S. Hunter, Senior Engineer
Environmental Management Engineering

Approved by: [signature] Date: 4/5/00
K. M. Schechter, Manager
Design Engineering

Approved by: Michael Shotton Date: 4-6-00
M. D. Shotton, Project Engineer
Environmental Restoration

Approved by: Michael Shotton Date: 4-6-00
for **W. F. Johnson, Project Manager**
Environmental Restoration

TABLE OF CONTENTS

SECTION IPlan Narrative 1

1.0 BACKGROUND 1
- 1.1 Project Site/Task 1
- 1.2 Project-Specific Design Criteria 1
- 1.3 Sampling, Inspection, Testing, and Acceptance (SITA) Plan Outline 1

2.0 ORGANIZATION AND PERSONNEL 2
- 2.1 Functional Organizations 2
- 2.2 Key Personnel 3
- 2.3 SITA Delegate System 3

3.0 INSPECTION AND OBSERVATION 3
- 3.1 Inspection and Observation Procedures 3

4.0 SAMPLING AND TESTING 4
- 4.1 Sampling and Testing Procedures 4

5.0 ACCEPTANCE AND APPROVALS 4
- 5.1 Acceptance and Approvals Procedures 4

6.0 DOCUMENTATION AND RECORDS 5
- 6.1 Overview 5
- 6.2 Project Files 5
- 6.3 Photography 6
- 6.4 Closure Report 6

7.0 REFERENCES 6

Figure 2.1 Project Functional Organization Chart 2

SECTION II - SITA Plan Tables and Guides

SECTION III - Engineering Drawings

SECTION IV - Construction Specifications

SECTION V - Design Calculations, and Materials Test Data

SECTION I

PLAN NARRATIVE

SECTION I
Plan Narrative

1.0 BACKGROUND

1.1 Project Site/Task

The Corrective Action Unit (CAU) 417, Central Nevada Test Area (CNTA) Surface, Nevada has 16 impacted areas at 13 Corrective Action Sites (CASs). A breakdown of the impacted areas within the CASs is as follows:

- Four (4) are hydrocarbon-impacted soil areas that will be clean closed (impacted soils removed);
- Two (2) are mud pits that receive the contaminated soils followed by a closure cover, fencing, monuments, and postings (signs)—one (1) pit closure was completed in Phase I and one (1) pit closure will be completed in Phase II;
- Ten (10) are areas requiring monuments and postings (signs) only. The CASs are shown on the project-specific design drawings in Section III.

1.2 Project-Specific Design Criteria

The project-specific design criteria have been summarized in the *Engineering Plan for CAU 417 CNTA Surface, Nevada*. The basic closure cap performance/technical objectives criteria are to:

- Function with minimum maintenance
- Promote drainage and minimize erosion or abrasion of the cover
- Accommodate settling and subsidence to maintain integrity of cover
- Limit precipitation infiltration and remove moisture from the cover system

1.3 Sampling, Inspection, Testing, and Acceptance (SITA) Plan Outline

This SITA Plan was developed to implement a Quality Assurance/Quality Control (QA/QC) Program for this project and is consistent with the Environmental Protection Agency (EPA) Technical Guidance Document, *Quality Assurance and Quality Control for Waste Containment Facilities."* Application of the guidelines are listed below and are addressed in detail later in this project document.

- Organization and Personnel
- Inspection and Observation
- Sampling and Testing - Not Applicable
- Acceptance and Approvals
- Documentation and Records
- References

2.0 ORGANIZATION AND PERSONNEL

2.1 Functional Organizations

The organizations actively involved in regulating, designing, and constructing functions during the CAU 417 CNTA Surface CASs remediation project are listed below:

- U.S. Department of Energy (DOE) — Owner
- State of Nevada (NDEP) — Regulating agency (Nevada Division of Environmental Protection)
- Bechtel Nevada (BN) — Environmental Restoration, Engineering, Construction, and Support Services
- Other (Subcontract[s]) — QA/QC and Engineering Support Services

The relationships, roles, and responsibilities of the principal organizations are depicted in the Project Functional Organization Chart (Figure 2.1).

CAU 417 CNTA SURFACE -- Project Functional Organization Chart

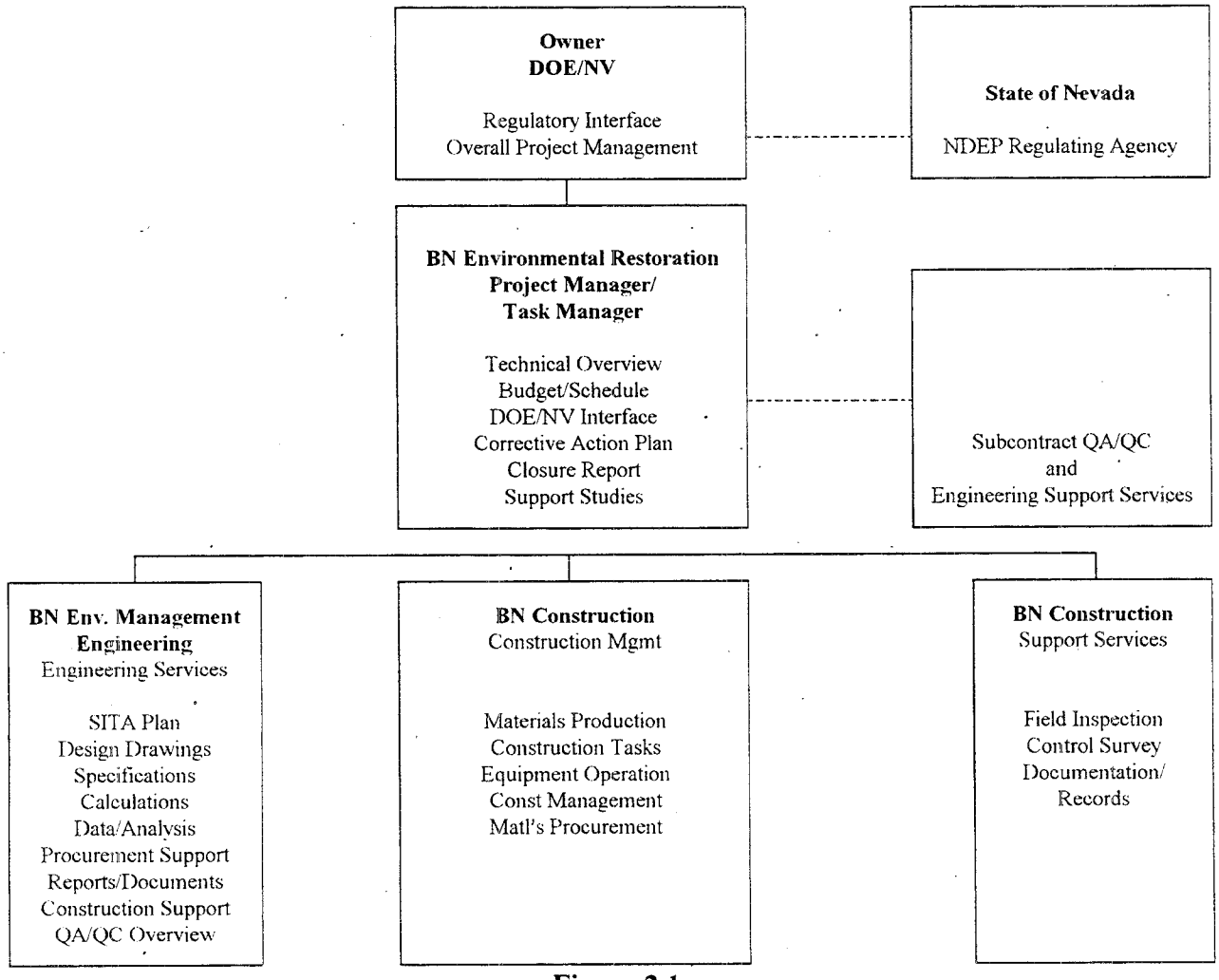


Figure 2.1

2.2 Key Personnel

Key personnel for this project are listed below; however, personnel are subject to change and it is suggested that the BN/ER Project Manager be contacted for further information.

Project Manager	W. F. Johnson
Project Engineer	M. D. Shotton*
Task Manager	D. D. Madsen*
Senior Design Engineer	J. A. Sorola*
Senior Engineer	R. S. Hunter*
Senior Engineer Assistant	G. G. Hudak*
Civil Design Engineer	N. D. Jackson*
Geotechnical Engineer	E. A. Strassburger*
Technical Lead	K. B. Campbell*
Construction Manager (ER)	J. F. Mattson*
Field Coordinator	P. F. Brown*
Construction Superintendent	J. S. Pennington*
Construction Engineer	J. A. Joines*
Survey Supervisor	R. S. Remington*
Materials Testing Supervisor	C. D. Herrington

* *SITA Delegates* (see below)

2.3 SITA Delegate System

To ensure optimum productivity and ensure design compliance during construction, the SITA delegate system was developed. The SITA delegate selection and assignments are delegated by the Project Manager. Using this method permits numerous construction tasks to be achieved with a minimum number of personnel required to be on site at any given time.

3.0 INSPECTION AND OBSERVATION

3.1 Inspection and Observation Procedures

The itemized SITA Plan Tables and Guides section contains specific guidance for inspection and acceptance operations for this project (see Section II). A completed copy of the SITA Plan Tables will become a part of the closure report at project completion.

Inspection and observation personnel (SITA delegates) will be responsible for Title III (construction) acceptance functions, and shall provide acceptance/rejection and inspection/ observation activities in conjunction with procedures shown in the SITA Plan Tables and Guides. Acceptance shall be in accordance with current design requirements specified in the technical documents (design drawings/specifications) contained herein (see Sections III and IV).

The SITA delegate's observations will be used to verify that the materials, equipment, and methods of construction meet all design criteria and plans, and are documented, as a minimum, in the project daily log book and daily report(s).

The SITA Tables contain a column listing mandatory construction task HPs. These task HPs shall be addressed and the task approved by the responsible SITA delegate(s) prior to continuing with the construction sequence.

4.0 SAMPLING AND TESTING

4.1 Sampling and Testing Procedures - Not Applicable

5.0 ACCEPTANCE AND APPROVALS

5.1 Acceptance and Approvals Procedures

The procedure(s) for acceptance and/or approvals for various construction tasks, as specified in the SITA Plan Tables, drawings, and specifications, have been addressed in Section 3.0 above.

5.1.1 The ultimate BN authorization authority is the authorized representative (AR) for the project. This assignment is filled by the Project Manager (with guidance by other key personnel).

5.1.2 The AR is supported by a team of technically qualified environmental personnel, as specified in Part 2.2, *Key Personnel*. This team of key personnel is identified as the *SITA Delegates*, and either individually or collectively, will perform acceptance and/or approvals, as the requirement arises. The titles Project Manager Delegate and SITA Delegate are synonymous.

5.1.3 As previously discussed, the construction tasks requiring acceptance and/or approvals include, but are not limited to, the following:

- Material test results
- Adherence to specifications
- Compliance with drawings
- Deviations to plans/procedures
- Survey field data
- Alterations for performance improvements
- SITA Plan Tables task HPs

5.1.4 Acceptance and/or approvals of construction tasks controlled by HPs, or proposed alteration of any task specified in the engineering technical documents contained within this SITA Plan, must have the concurrence of a Design Engineering SITA delegate. Refer to Part 2.2, Key Personnel list, for names of engineering delegates.

5.1.5 Acceptance and/or approvals of construction and non-construction tasks controlled by a "Check Point" (CP) only requires acceptance by a SITA Delegate, i.e., sign off on the applicable SITA Table, followed by notification to other delegates when convenient, with no work stoppage or other delays.

6.0 DOCUMENTATION AND RECORDS

6.1 Overview

The document types which will be generated or referenced as part of this SITA Plan by the various organizations involved in this project include:

- Project Corrective Action Plan (CAP) and Closure Report (CR)
- Conference reports
- Project schedule(s)
- Materials field sampling/testing tables and guides (Section II)
- Design drawings and their revisions (Section III)
- Construction specifications and their revisions (Section IV)
- Design calculations and material test data (Section V)
- Project-specific daily log book (maintained by the Technical Lead)
- Project-specific construction work plan*
- Project-specific inspection plan*
- Geosynthetic material(s) procurement specifications
- Daily construction/site activity summary reports/memos (maintained by the Technical Lead)
- Inspection or observation document(s) (provided by SITA delegates)
- In-field survey data sheets
- Design interim change (Design Change Notice, Field Change Notice)
- Deficiency documents (correctable deficiency log/nonconformance reports)
- Final inspection/survey as-built drawings

* Supervisory personnel review/concurrence with this SITA Plan prior to start of construction/inspection activities will waive the requirement for separate documents. SITA delegates will also have reviewed and understand their responsibilities before performing any Title III construction tasks.

In addition, other miscellaneous documents, i.e., memos, sketches, audits, etc., will become a part of the project records file.

6.2 Project Files

The project files will be located at the job site and will include a current copy of each of the following:

- Approved SITA Plan
- Project drawings and specifications— "as-builts"
- Inspection/observations
- Project-specific daily log
- Survey data

The project files will be maintained by the Field Coordinator and/or Technical Lead. After construction, the project files will be located in the BN/ER project files, Dorm B, Mercury, Nevada Test Site (NTS). Original as-built drawings will be retained at the Archives Records Center (ARC) in Mercury, NTS. Any copies required in the future can be provided by the ARC in hard copy or electronic form.

6.3 Photography

Preparing and maintaining a photographic log of all note-worthy construction activities, including sampling/testing activities, is the responsibility of the Technical Lead. Photographs will be clearly marked as to photographer identity, date, time, and brief description of each activity, and will be kept in a separate log as part of the project file.

6.4 Closure Report

A final construction/project CR will be prepared and will contain or reference the following:

- Copy of the signed-off (approved) SITA Plan Tables
- Summary documentation of design and construction activities
- Daily logs, intermediate reports, and other related documentation to support in-situ (as constructed) conditions
- Copies of as-built drawings and sketches
- Photographs of the completed project site (if requested/required by DOE/NDEP)

7.0 REFERENCES

American Society for Testing and Materials (ASTM), Annual Book of ASTM Standards. 1999.

B-A20/96.01, *Bechtel Nevada Performance Assurance Management Plan*. April 24, 1997.

Engineering Plan for Corrective Action Unit 417 Central Nevada Test Area Surface, Nevada. Revision 2. November 1999. BN.

Environmental Protection Agency Technical Guidance Document, *Quality Assurance and Quality Control for Waste Containment Facilities*. EPA/600/R-93/182. September 1993.

U.S. Department of Energy, *Corrective Action Plan for CAU 417 CNTA Surface*, DOE/NV-588, February, 2000.

U.S. Department of Energy Order 451.1A, *National Environmental Policy Act Compliance Program*, DOE 1997.

U.S. Department of Energy Order 430.1, *Life-Cycle Asset Management*. 1999.

U.S. Department of Energy Order 5700.6C, *Quality Assurance*. 1991.

SECTION II

SITA PLAN TABLES AND GUIDES

SITA PLAN TABLES AND GUIDES INDEX

TABLES

I UC-1 Central Mud Pit -- Preclosure Tasks

II UC-1 Central Mud Pit -- Closure Tasks

III UC-1 Trench -- Closure Tasks

GUIDES - NON APPLICABLE

SECTION II
SITA Plan Table I
Site: UC-1 Central Mud Pit -- Preclosure Tasks

REVISION : 0
DATE: 04-05-00

General instructions for using the SITA Plan Tables:

1. Acceptance and/or approval of tasks will be made by one (or more) of the SITA delegates (see Section I, Part 2.2 and Part 5.0 for guidance)
2. All task HPs shall be initialed by the responsible SITA delegate prior to continuance to the next phase of construction.

Construction Phase	SITA Task	SITA Method(s)	Sample/Test Quantity/Frequency	Sample/Location/ Requirement		Task Acceptance		Task Check Point (CP)
			Other Instructions	Stockpile/ Source	Per Lift Typical	Yes (or) No	Initials and Date	Task Hold Point (HP)
General Information	**GENERAL INSPECTIONS/OBSERVATIONS -- See Specification Section 01050**							
	General project support	Visual, plus basic measurements, include survey/material data where applicable	100% during construction	yes	yes			
	Lift/layer thickness	Grade check lift/layer thickness, as required	As required per lift/layer (see check points)	N/A	yes			
	As-built topographic survey	Survey check: thickness, elevations, slopes, as required	As required per construction phase (see hold points)	N/A	yes			
1	**WEST DIVERSION CHANNEL EXCAVATION -- See Specification Section 02222 and Drawing No. C34**							
	As-built topographic survey	Survey check: elevations, slopes, as required	After excavation completion	N/A	N/A			CP
2	**NORTH DIVERSION CHANNEL EXCAVATION -- See Specicfic Section 02222 and Drawing No. C35**							
	As-built topographic survey	Survey check: elevations, slopes, as required	After excavation completion	N/A	N/A			HP
3	**TRENCH EXCAVATION -- See Specification Section 02222 and Drawing No. C29**							

Construction Phase	SITA Task	SITA Method(s)	Sample/Test Quantity/Frequency	Sample/Location/ Requirement		Task Acceptance		Task Check Point (CP)
			Other Instructions	Stockpile/ Source	Per Lift Typical	Yes (or) No	Initials and Date	Task Hold Point (HP)
	As-built topographic survey	Survey check: elevations, slopes, as required	After excavation completion	N/A	N/A			HP
4	**IMPACTED MUD MATERIAL PLACEMENT (from Corrective Action Sites [CASs]) See Drawing C29**							
	Placement only	Visual verification of mud placement in relocation trench completion	None	N/A	N/A			CP
	As-built grade check	Grade check: thickness/elevations, as required	After mud placement completion	N/A	N/A			HP
5	**WEST BERM SOIL REMOVAL (Between Relocation Trench and CMP) -- See Specification Section 02222 and Drawing No. C29**							
	As-built grade check	Grade check: elevations, slopes, as required	After excavation completion	N/A	N/A			HP
6	**AGITATOR TOWER REMOVAL EIGHT LOCATIONS -- See Drawing No. C28**							
	Tower removal	Removal of the pipe towers, as specified on the drawings	None	N/A	N/A			CP
	Removal verified (8 locations)	Visual verification of completion and survey record location data as required	Photographs recommended	N/A	N/A			CP
	Disposal	Towers placed in holding area for disposal	As directed by the Construction Superintendent	N/A	N/A			CP
7	**CMP EXISTING BERMS BENCHING -- See Specification Section 02222 and Drawing Nos. C30 and C31**							
	As-built grade check	Grade check: elevations, slopes, as required	After benching and grade sloping completion	N/A	N/A			HP

SECTION II

REVISION: 0
DATE: 04-05-00

SITA Plan Table II
Site: UC-1 Central Mud Pit -- Closure Tasks

General instructions for using the SITA Plan Tables:

1. Acceptance and/or approval of tasks will be made by one (or more) of the SITA delegates (see Section I, Part 2.2 and Part 5.0 for guidance)
2. All task HPs shall be initialed by the responsible SITA delegate prior to continuance to the next phase of construction.

Construction Phase	SITA Task	SITA Method(s)	Sample/Test Quantity/Frequency	Sample/Location/ Requirement		Task Acceptance		Task Check Point (CP)
			Other Instructions	Stockpile/ Source	Per Lift Typical	Yes (or) No	Initials and Date	Task Hold Point (HP)
General Information	**GENERAL INSPECTIONS/OBSERVATIONS -- See Specification Section 01050**							
	General project support	Visual, plus basic measurements, include survey/material data where applicable	100% during construction	yes	yes			
	Lift/layer thickness	Grade check lift/layer thickness, as required	As required per lift/layer (see check points)	N/A	yes			
	As-built topographic survey	Survey check: thickness, elevation, slope, as required	As required per construction phase completion (see hold points)	N/A	yes			
1	**GEOGRID LAYER PLACEMENT -- See Specification Section 07537 and Drawings C30 and C31**							
	Preplacement notification	Contact DOE/PM and NDEP at least 48 hours prior to geogrid placement	None	N/A	N/A			HP
	Placement only	Visual verification of completion	None	N/A	N/A			HP
2	**STABILIZATION LAYER PLACEMENT (Contaminated Material from CASs)**							

Construction Phase	SITA Task	SITA Method(s)	Sample/Test Quantity/Frequency	Sample/Location/ Requirement		Task Acceptance		Task Check Point (CP)
			Other Instructions	Stockpile/ Source	Per Lift Typical	Yes (or) No	Initials and Date	Task Hold Point (HP)
	Placement only	Visual verification of completion	None	N/A	N/A			CP
	As-built grade check	Grade check: thickness, elevations, as required	After contaminated material layer placement completion	N/A	N/A			CP
3	**STABILIZATION LAYER PLACEMENT (Native Material) -- See Specification Section 02223 and Drawings C32 and C33**							
First	2-ft layer placement	Compaction process: minimum four passes with LGP equipment	None	N/A	yes			CP
Second	2-ft layer placement	Compaction process: minimum four passes with LGP equipment	None	N/A	yes			CP
	Grade check	Grade check: thickness, elevations, slopes, as required	After each layer/lift placement completion	N/A	yes			CP
	As-built topographic survey	Survey check: thickness, elevations, slopes, as required	After native material layer placement completion	N/A	yes			HP
4	**MONUMENTS, FENCING, & SIGNAGE PLACEMENT -- See Specification Sections 02831& 03001 and Drawings C32 and C36**							
	Monuments	Installation/survey data	Completion	N/A	N/A			CP
	Fencing	Installation	Completion	N/A	N/A			CP
	Signage	Installation	Completion	N/A	N/A			CP
	Survey	Cap surface - final topographic survey -- as-built drawings	Final	N/A	N/A			HP
5	**VEGETATIVE LAYER PROCEDURE (Placed Stabilization Layer Material)**							
	Prepare cover only	Site prep: prior to placement of any vegetation disc/plow cover surface - avoiding the subsidance monuments	None	N/A	N/A			HP
6	**UC-1 CMP CLOSURE CAP CONSTRUCTION COMPLETION**							
	Site tour	Establish with DOE/PM (and notify	None	N/A	N/A			HP

Construction Phase	SITA Task	SITA Method(s)	Sample/Test Quantity/Frequency	Sample/Location/ Requirement		Task Acceptance		Task Check Point (CP)
			Other Instructions	Stockpile/ Source	Per Lift Typical	Yes (or) No	Initials and Date	Task Hold Point (HP)
	confirmation	NDEP) closure acceptance tour date/time						
	Site tour	Closure acceptance/Sign-off	Final	N/A	N/A			HP

SECTION II

REVISION: 0
DATE: 04-05-00

SITA Plan Table III
Site: UC-1 Trench -- Closure Tasks

General instructions for using the SITA Plan Tables:

1. Acceptance and/or approval of tasks will be made by one (or more) of the SITA delegates (see Section I, Part 2.2 and Part 5.0 for guidance)
2. All task HPs shall be initialed by the responsible SITA delegate prior to continuance to the next phase of construction.

Construction Phase	SITA Task	SITA Method(s)	Sample/Test Quantity/Frequency	Sample/Location/ Requirement		Task Acceptance		Task Check Point (CP)
			Other Instructions	Stockpile/ Source	Per Lift Typical	Yes (or) No	Initials and Date	Task Hold Point (HP)
General Information	**GENERAL INSPECTIONS/OBSERVATIONS -- See Specification Section 01050**							
	General project support	Visual, plus basic measurements, include survey/material data where applicable	100% during construction	yes	yes			
	Lift/layer thickness	Grade check lift/layer thickness, as required	As required per lift/layer (see check points)	N/A	yes			
	As-built topographic survey	Survey check: thickness, elevation, slope, as required	As required per construction phase completion (see hold points)	N/A	yes			
1	**GEOGRID LAYER PLACEMENT -- See Specification Section 07537 and Drawings C30 and C31**							
	Preplacement notification	Contact DOE/PM and NDEP at least 48 hours prior to geogrid placement	None	N/A	N/A			HP
	Placement only	Visual verification of completion	None	N/A	N/A			HP
2	**STABILIZATION LAYER PLACEMENT (Contaminated Material from CASs**							

Construction Phase	SITA Task	SITA Method(s)	Sample/Test Quantity/Frequency	Sample/Location/ Requirement		Task Acceptance		Task Check Point (CP)
			Other Instructions	Stockpile/ Source	Per Lift Typical	Yes (or) No	Initials and Date	Task Hold Point (HP)
	Placement only	Visual verification of completion	None	N/A	N/A			CP
	As-built grade check	Grade check: thickness, elevations, as required	After contaminated material layer placement completion	N/A	N/A			CP
3	**STABILIZATION LAYER PLACEMENT (Native Material) -- See Specification Section 02223 and Drawings C32 and C33**							
First	2-ft layer placement	Compaction process: minimun four passes with LGP equipment	None	N/A	yes			CP
Second	2-ft layer placement	Compaction process: minimun four passes with LGP equipment	None	N/A	yes			CP
	Grade check	Grade check: thickness, elevations, slopes, as required	After each layer/lift placement completion	N/A	yes			CP
	As-built topographic survey	Survey check: thickness, elevations, slopes, as required	After native material layer placement completion	N/A	yes			HP
4	**MONUMENTS, FENCING, & SIGNAGE PLACEMENT -- See Specification Sections 02831 & 03001 and Drawings C32 and C36**							
	Monuments	Installation/survey data	Completion	N/A	N/A			CP
	Fencing	Installation	Completion	N/A	N/A			CP
	Signage	Installation	Completion	N/A	N/A			CP
	Survey	Cap surface - final topographic survey -- as-built drawings	Final	N/A	N/A			HP
5	**VEGETATIVE LAYER PROCEDURE (Placed Stabilization Layer Material)**							
	Prepare cover only	Site prep: prior to placement of any vegetation disc/plow cover surface - avoiding the subsidance monuments	None	N/A	N/A			HP
6	**UC-1 TRENCH CLOSURE CAP CONSTRUCTION COMPLETION**							
	Site tour	Establish with DOE/PM (and notify	None	N/A	N/A			HP

Construction Phase	SITA Task	SITA Method(s)	Sample/Test Quantity/Frequency	Sample/Location/ Requirement		Task Acceptance		Task Check Point (CP)
			Other Instructions	Stockpile/ Source	Per Lift Typical	Yes (or) No	Initials and Date	Task Hold Point (HP)
	confirmation	NDEP) closure acceptance tour date/time						
	Site tour	Closure acceptance/Sign-off	Final	N/A	N/A			HP

SECTION III

ENGINEERING DRAWINGS

UNITED STATES DEPARTMENT OF ENERGY

NEVADA OPERATIONS OFFICE

LAS VEGAS, NEVADA

CENTRAL NEVADA TEST AREA (CNTA)
CAU 417 CLOSURE

AREA 58

INDEX

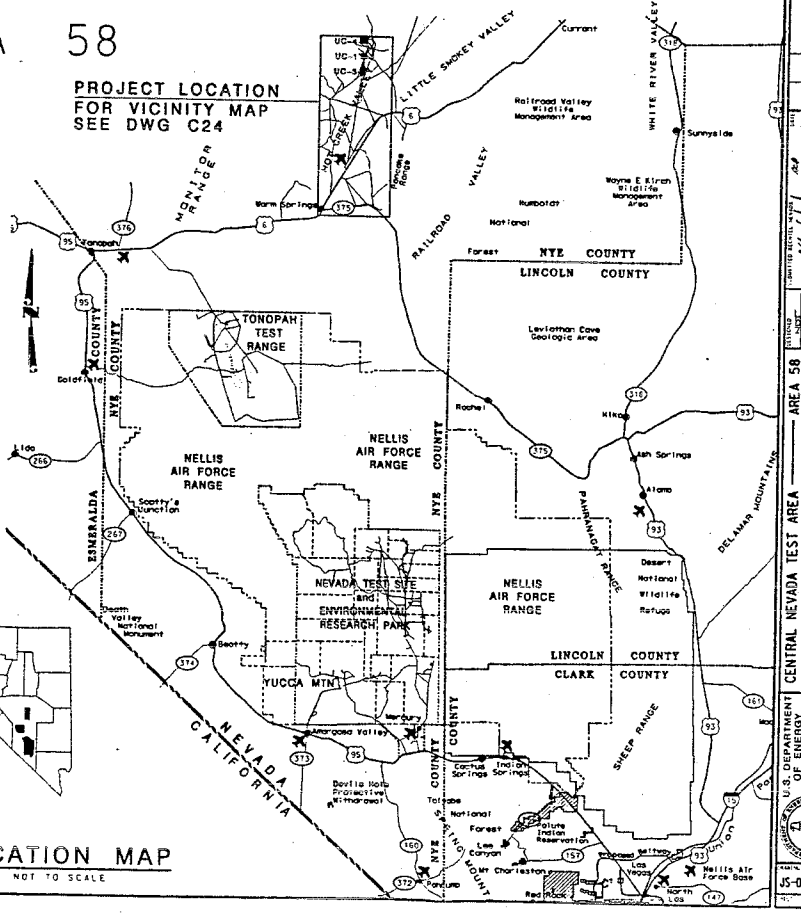
DRAWING NUMBER		DRAWING TITLE
TITLE		
JS-058-98228-T2	REV 0	TITLE SHEET
CIVIL		
JS-058-98228-C24	REV 0	VICINITY MAP
JS-058-98228-C25	REV 0	AREA UC-1 CLEAN CLOSURE SITES
JS-058-98228-C26	REV 0	AREA UC-3 CLEAN CLOSURE SITES
JS-058-98228-C27	REV 0	AREA UC-4 CLEAN CLOSURE SITES
JS-058-98228-C28	REV 0	SITE PLAN
JS-058-98228-C29	REV 0	MUD PIT EXTENSION SITE AND GRADING PLAN & SECTIONS
JS-058-98228-C30	REV 0	GEOGRID BENCH SITE & GRADING PLAN
JS-058-98228-C31	REV 0	GEOGRID BENCH SECTIONS
JS-058-98228-C32	REV 0	CLOSURE CAP SITE & GRADING PLAN
JS-058-98228-C33	REV 0	CLOSURE CAP SECTIONS
JS-058-98228-C34	REV 0	WEST DIVERSION CHANNEL PLAN & PROFILE
JS-058-98228-C35	REV 0	NORTH DIVERSION CHANNEL GRADING PLAN
JS-058-98228-C36	REV 0	DETAILS

SCOPE OF WORK

THE FY 2000 SCOPE OF WORK FOR THIS PROJECT INCLUDES MODIFICATION OF THE EXISTING MUD RELOCATION TRENCH, CONSTRUCTION OF A FLOOD DIVERSION CHANNEL, CONSTRUCTION OF A BREACH THRU THE SCARP AT EAST END OF UC1-CMP AND CONSTRUCTION OF A CAP OVER BOTH UC1-CMP AND THE MUD RELOCATION TRENCH. WORK WILL ALSO INCLUDE CLEAN CLOSURE OF 4 CAS'S, AS-BUILT SURVEYING OF SUBSIDENCE MONUMENTS, AND STAMPING OF SURVEY MARKERS.

PROJECT NOTES

ALL CONSTRUCTION DOCUMENTATION, SPECIAL FEATURES, MATERIALS, TESTS AND DETAILS SHALL CONFORM TO THE "CONSTRUCTION SPECIFICATIONS FOR CAU 417 CLOSURE" AND THE "CORRECTIVE ACTION UNIT 417 CENTRAL NEVADA TEST AREA SURFACE, NEVADA SAMPLING, INSPECTION, TESTING, AND ACCEPTANCE (SITA) PLAN".



LOCATION MAP

NOT TO SCALE

0		ISSUED FOR CONSTRUCTION 01/05/00	
NO	DATE	REVISION DESCRIPTION	

DESIGNED		
DRAWN		
CHECKED		
APPROVED		
CONTRACT NO.	N/A	
PROJECT NO.	N/A	
PROJECT CODE	C9001358	
PROJECT TITLE	98228A58	

CENTRAL NEVADA TEST AREA — AREA 58

CAU 417 CLOSURE

TITLE SHEET

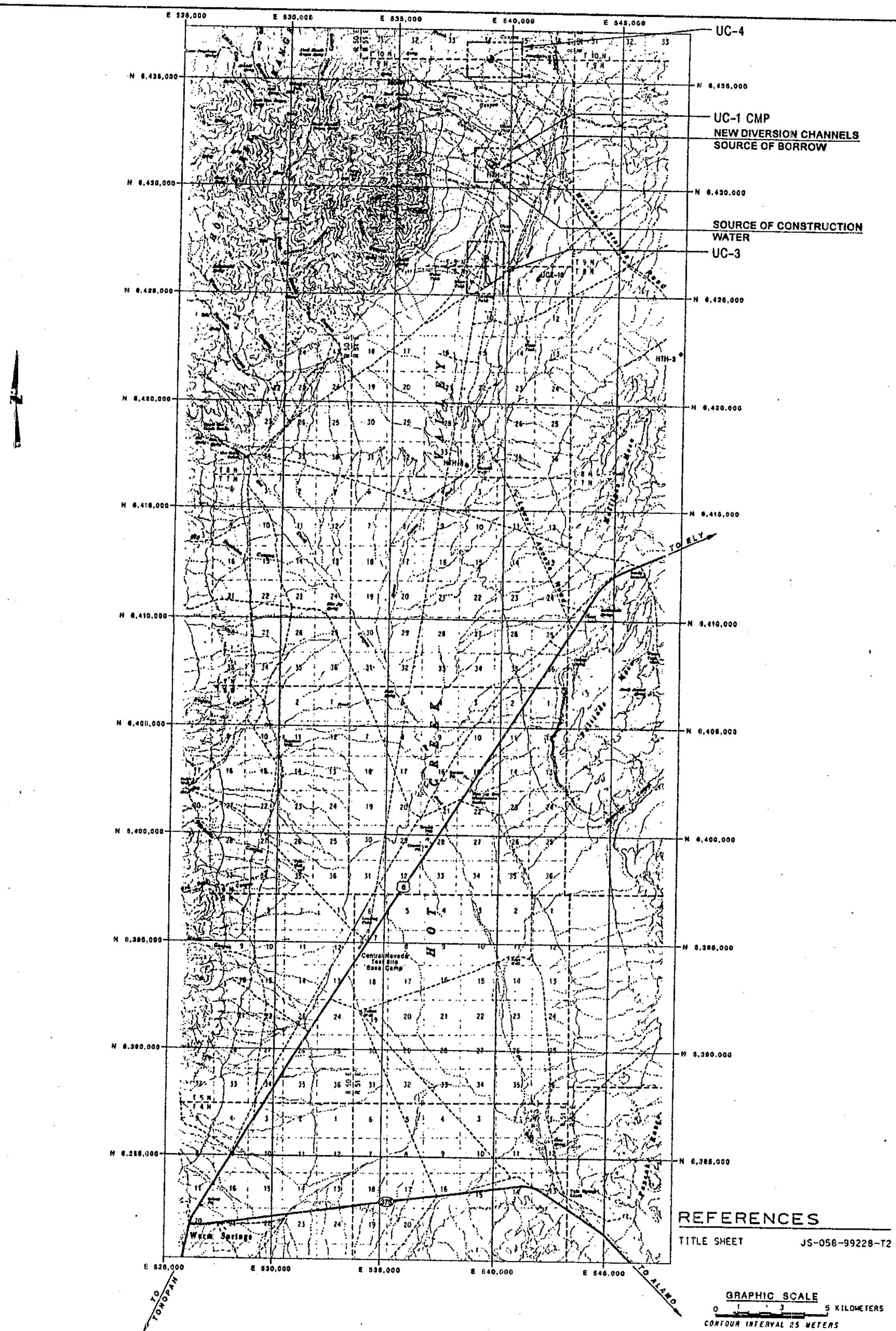
U.S. DEPARTMENT OF ENERGY

NEVADA OPERATIONS OFFICE

Bechtel Nevada

JS-058-98228-T2

D



REFERENCES

TITLE SHEET JS-058-99228-T2

U.S. DEPARTMENT OF ENERGY

Bechtel Nevada

CENTRAL NEVADA TEST AREA — AREA 58
CAU 417 CLOSURE

VICINITY MAP

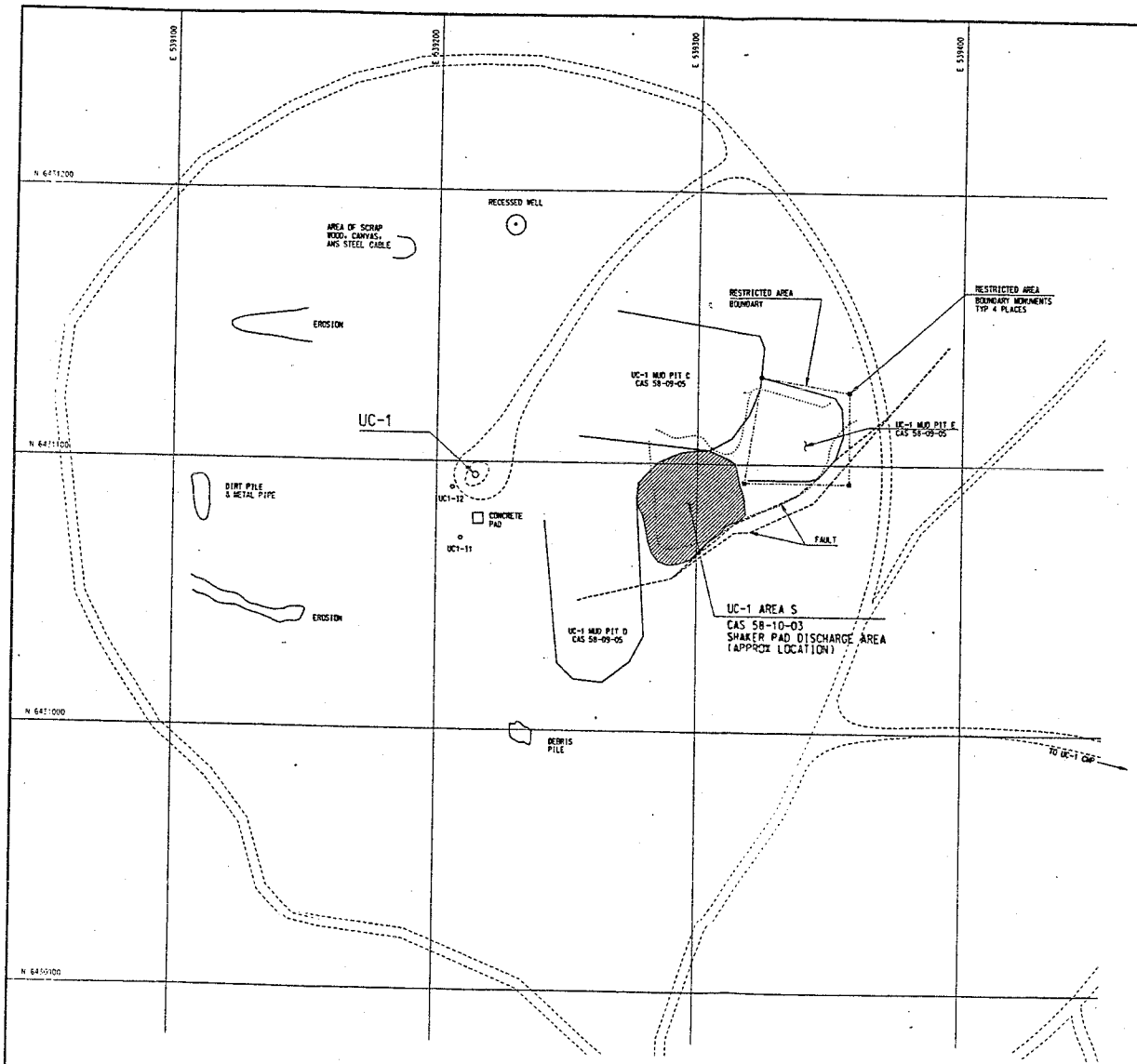
N/A

98228A58 N/A C8G01388

0 ISSUED FOR CONSTRUCTION 04/05/00

JS-058-98228-C24

0



UC-1 CLEAN CLOSURE SITES

SCALE : 1:800

NOTE

1. MATERIAL REMOVED FROM CAS 58-10-03 SHALL BE USED AS FILL MATERIAL FOR THE STABILIZATION LAYER AT UC1-CMP (SEE DWG C33).

REFERENCES

TITLE SHEET	JS-058-98228-T2
CLOSURE CAP SECTIONS	JS-058-98228-C33

GRAPHIC SCALE

0 20 40 60 80 100

SCALE: 1:800 METERS

REV	DATE	REVISION DESCRIPTION	DRAWN	CHK'D	APP'D
0	04/05/00	ISSUED FOR CONSTRUCTION			

SUBMITTED BECHTEL NEVADA: Kim Dick 4/5/00 DATE
APPROVED: Arnold Hunter 4-5-00 DATE
TITLE: PROJECT ENGINEER
APPROVED: Mike Sandy 4/5/00 DATE
CERCLIS FILE NO. CES01101
CERCLIS SITE NO. CES0110001

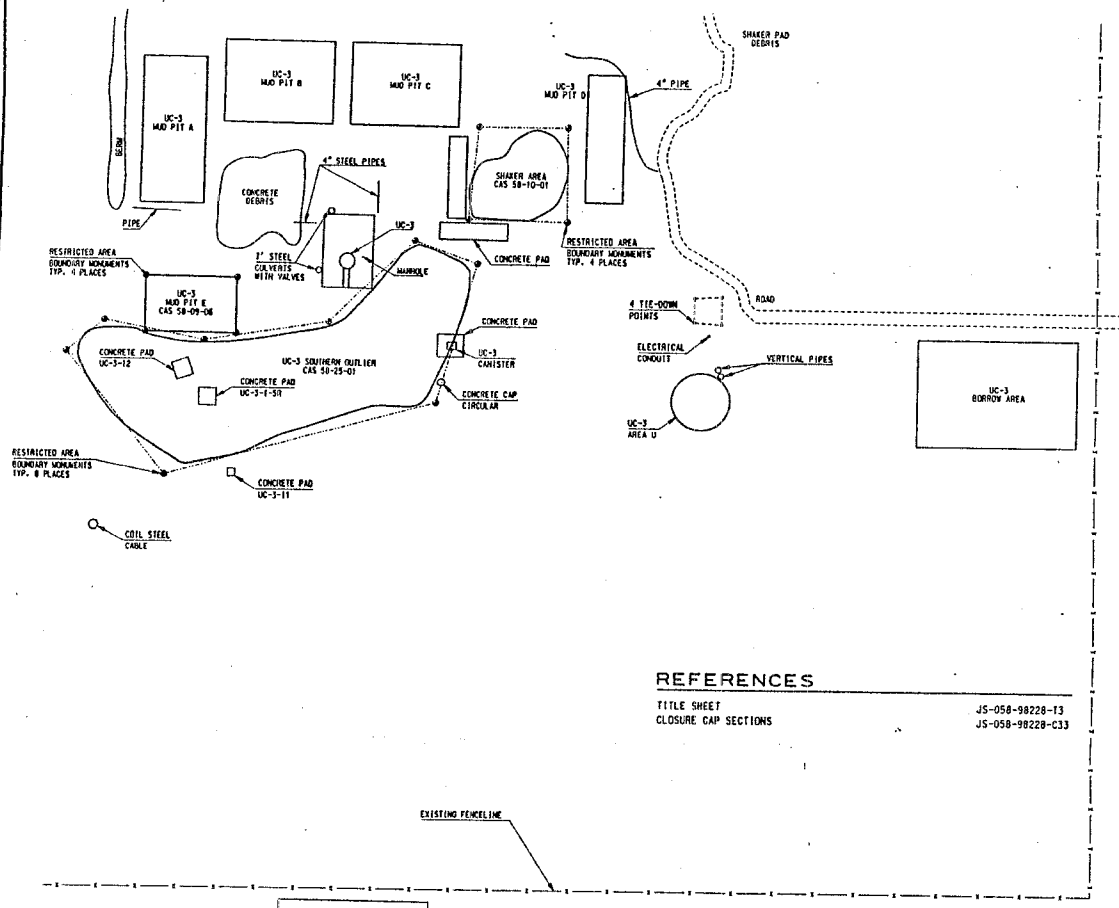
STATUS: ISSUED
SCALE: N/A
SHEET SIZE: 22 x 34
DRAWN BY: N/A
PROJECT NO. 98228A58
PROJECT CAD NO. N/A
DATE: N/A

CENTRAL NEVADA TEST AREA — AREA 58
CAU 417 CLOSURE
AREA UC-1
CLEAN CLOSURE SITES

U.S. DEPARTMENT OF ENERGY
NEVADA OPERATIONS OFFICE
LAS VEGAS, NEVADA
Bechtel Nevada

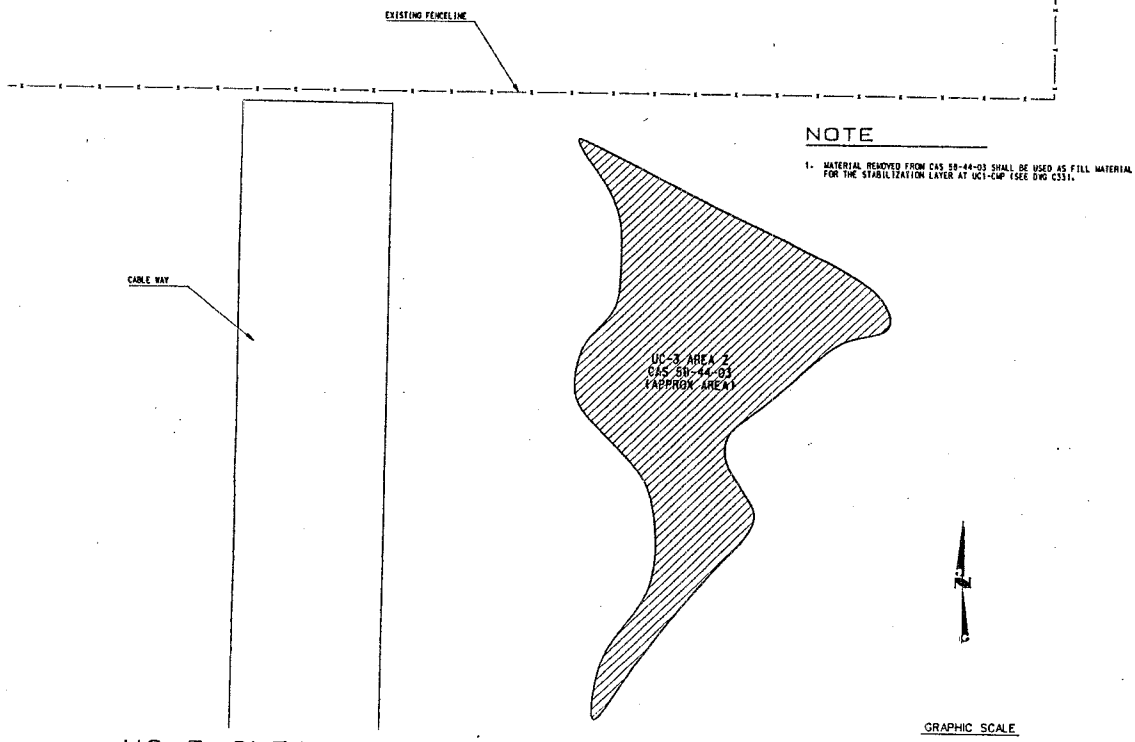
DRAWING NUMBER: J5-058-98228-C25
REV: 0

04/05/00 02:11:02 PM g:\Dgn\98228a58\uc1\Option B\c25.dgn



REFERENCES

TITLE SHEET	JS-058-98228-T3
CLOSURE CAP SECTIONS	JS-058-98228-C33



NOTE

1. MATERIAL REMOVED FROM CAS 58-44-03 SHALL BE USED AS FILL MATERIAL FOR THE STABILIZATION LAYER AT UC1-CMP (SEE DWG C33).

UC-3 CLEAN CLOSURE SITES

SCALE : 1:750

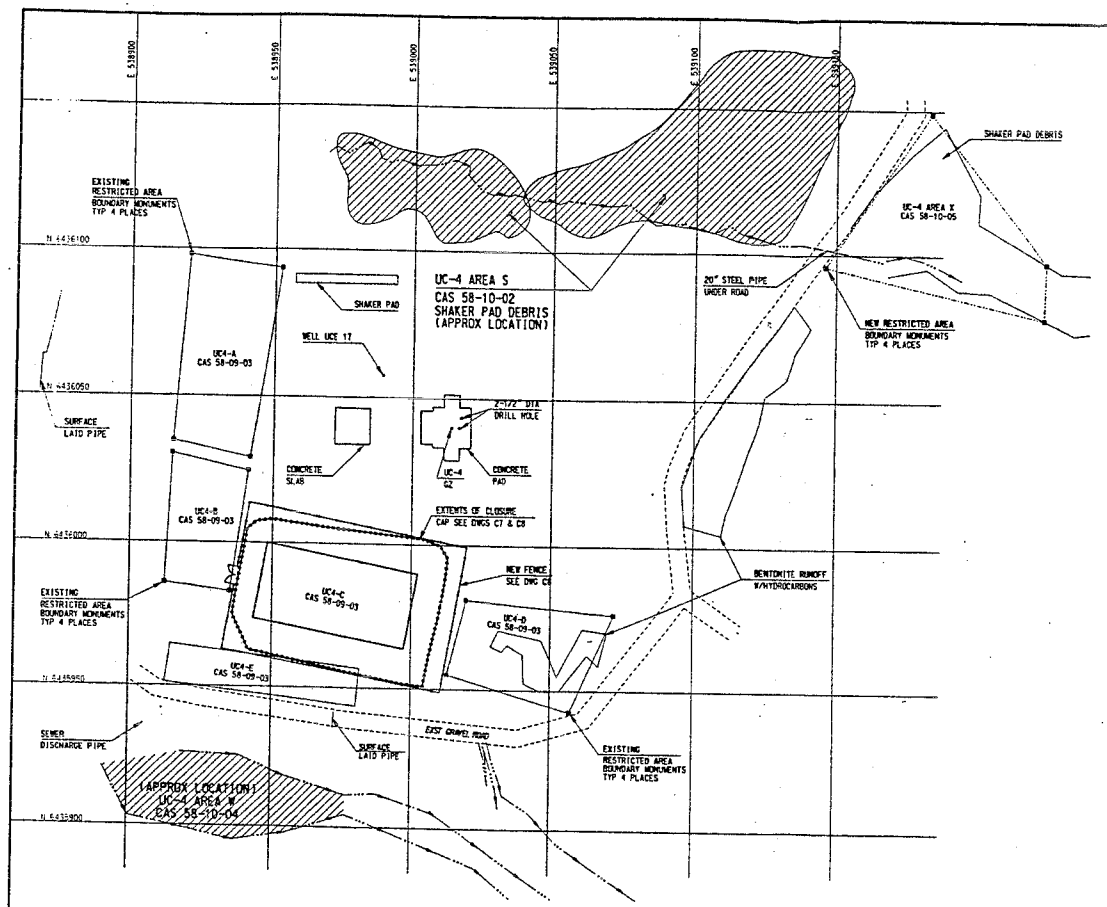
GRAPHIC SCALE

0 30 60 90'

SCALE 1:750 METERS

U.S. DEPARTMENT OF ENERGY	CENTRAL NEVADA TEST AREA — AREA 58 CAU 417 CLOSURE	DESIGNED NDT DRAWN NDT CHECKED JAS APPROVED N/A DWG REF. NO. N/A	SUBMITTED BECHTEL NEVADA DCP 4/5/00 USER Michael Hutton 4-6-00 PROJECT ENGINEER Monica Donahey 4/7/00	0	ISSUED FOR CONSTRUCTION 04/05/00
Bechtel Nevada	AREA UC-3 CLEAN CLOSURE SITES		PROJECT NUMBER 98228A58 · PROJECT ALPHA NO. N/A · DRAWING NO. C8G0138B	NO.	DATE

SCZ-058-98228-C35



UC-4 CLEAN CLOSURE SITES

SCALE 1:1800

NOTE

1. MATERIAL REMOVED FROM UC-4 AREA S (CAS 58-10-02) SHALL BE RELOCATED TO THE MUD RELOCATION TRENCH AT UC1-CMP (SEE DWG C29).
2. MATERIAL REMOVED FROM UC-4 AREA W (CAS 58-10-04) SHALL BE USED AS FILL MATERIAL FOR THE STABILIZATION LAYER AT UC1-CMP (SEE DWG C33).

REFERENCES

TITLE SHEET	JS-058-98228-T2
MUD PIT EXTENSION SITE & GRADING PLAN (PHASE 1 WORK PLAN)	JS-058-98228-C7
CLOSURE CAP GRADING PLAN & SECTIONS (PHASE 1 WORK PLAN)	JS-058-98228-C8
MUD PIT EXTENSION GRADING PLAN & SECTIONS	JS-058-98228-C29
CLOSURE CAP SECTIONS	JS-058-98228-C33

GRAPHIC SCALE

0 20 40 60 80 100

SCALE: 1:800 METERS

NO	DATE	REVISION DESCRIPTION
0		ISSUED FOR CONSTRUCTION 04/05/00

SUBMITTED RECEIVED ACCEPTED

DATE 4/5/00 DATE 4-6-00 DATE 4/7/00

SCALE N/A

CAD FILE NO. N/A

CONTRACT NO. DE-AC08-96N21989

U.S. DEPARTMENT OF ENERGY

NEVADA OPERATIONS OFFICE

Bechtel Nevada

CENTRAL NEVADA TEST AREA — AREA 58

CAU 417 CLOSURE

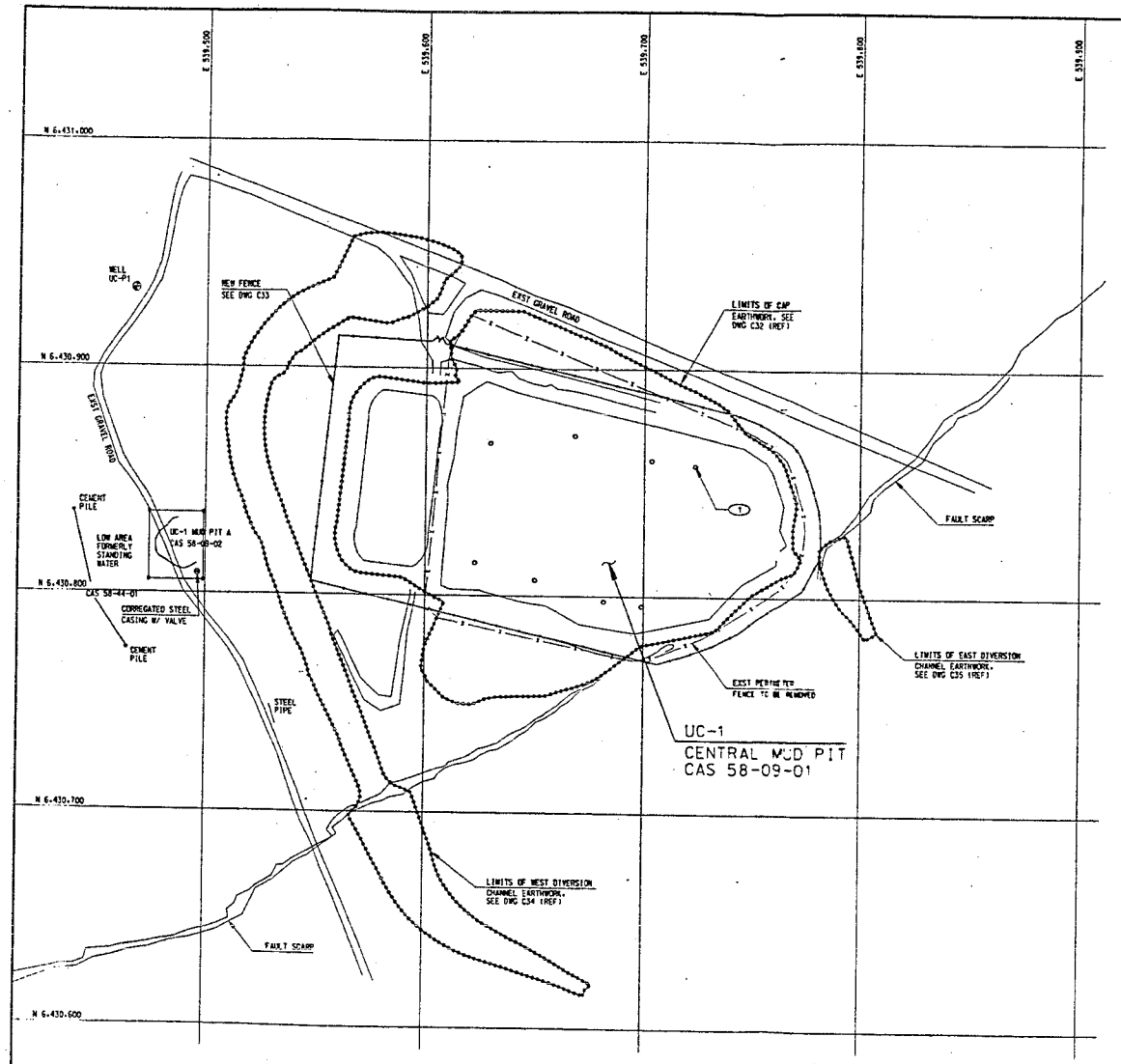
AREA UC-4

CLEAN CLOSURE SITES

DRAWING & SHEET JS-058-98228-C27

SHEET 0

04/03/00 02:12:09 P:\dgn\98228a58\uc1\Option B\c27.dgn



SITE PLAN

SCALE : 1:1000

GRAPHIC SCALE

0 20 40 60 80 100 120

SCALE 1:1000 METERS

PROJECT NOTES

1. BORROW SOILS SHALL BE OBTAINED FROM THE WEST DIVERSION CHANNEL (SEE DWG C34), TRENCH MODIFICATIONS (SEE DWG C29), THE GEOGRID BENCH (SEE DWG C30), AND THE EXST BERMS AROUND UC1-CMP (SEE DWG C32).
2. SOURCE OF CONSTRUCTION WATER WILL BE WELL NTH-2, LOCATED AT UC1, SOUTH OF UC1-CMP. SEE VICINITY MAP, DRAWING C24.
3. BASIS FOR HORIZONTAL CONTROL IS THE NORTH AMERICAN DATUM OF 1983, STATE PLANE, NEVADA CENTRAL ZONE, METERS.
4. BASIS FOR VERTICAL CONTROL IS THE NORTH AMERICAN VERTICAL DATUM OF 1929, METERS.

MATERIAL QUANTITY TABLE	
MATERIAL	QTY
NATIVE MATERIAL STABILIZATION FILL	36781M^3
CHANNEL EXCAVATION	14320M^3
EXST BERM EXCAVATION	14451M^3
GEOGRID BENCH EXCAVATION	6320M^3
TRENCH EXCAVATION	6550M^3
GEOGRID (54 ROLLS WIN)	2039OM^2

* QTY'S ARE BANKED M^3
CF = 1.3
FF = 1.3

GEOGRID QTY INCLUDES 10% FOR WASTE/ DAMAGE

KEY NOTE

(1) EXISTING EXPOSED PIPES TO BE CUT A MINIMUM DISTANCE OF 610mm BELOW MUD SURFACE.

REFERENCES

TITLE SHEET	JS-058-98228-T2
VICINITY MAP	JS-058-98228-C24
MUD PIT EXTENSION GRADING PLAN & SECTIONS	JS-058-98228-C29
GEOGRID BENCH SITE & GRADING PLAN	JS-058-98228-C30
CLOSURE CAP SITE & GRADING PLAN	JS-058-98228-C32
WEST DIVERSION CHANNEL PLAN & PROFILE	JS-058-98228-C34
EAST DIVERSION CHANNEL GRADING PLAN	JS-058-98228-C35

REVISION DESCRIPTION	DATE	REV
ISSUED FOR CONSTRUCTION 04/05/00		0

CONSTRUCTION REVIEW: DATE 4/5/00
DESIGNED: DATE 4/5/00
DRAWN: DATE 4/5/00
CHECKED: DATE 4/5/00
CAP SET NO. N/A
CHIEF OF SERVICE PROJ. ENGINEER: DATE 4-6-00
PROJECT NO. 98228458
DESIGN ORG. N/A
DESIGN ORG. EBGD1388

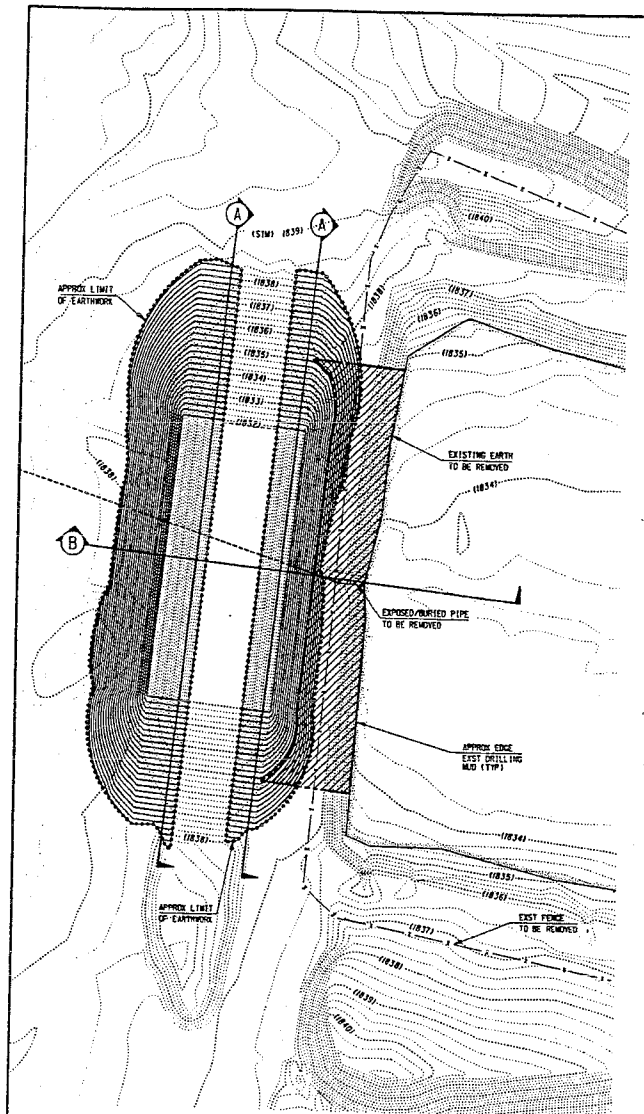
U.S. DEPARTMENT OF ENERGY
NEVADA OPERATIONS OFFICE
LAS VEGAS, NEVADA
Bechtel Nevada
MANAGEMENT & OPERATING CONTRACTOR

CENTRAL NEVADA TEST AREA — AREA 58
CAU 417 CLOSURE

SITE PLAN

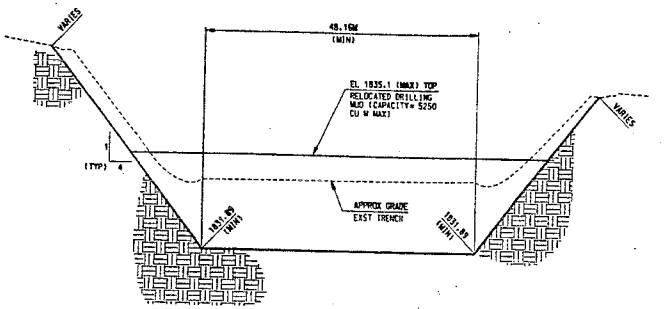
ORIGINAL NUMBER JS-058-98228-C28
SHEET 0

04/05/00 02:12:34 P:\dgn\98228058\uc1\Option B\c28.dgn



SITE PLAN

SCALE : 1:400
CONTOUR INTERVAL = 0.25M

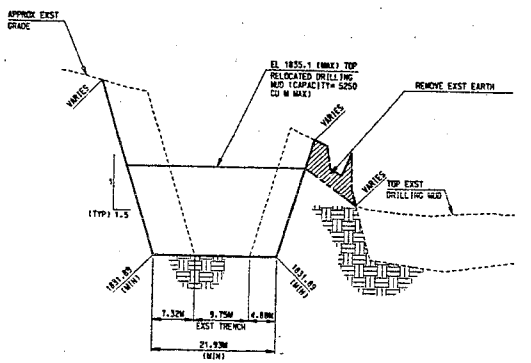


SECTION (A)

SCALE : HORIZ. = 1:400
VERT. = 1:80

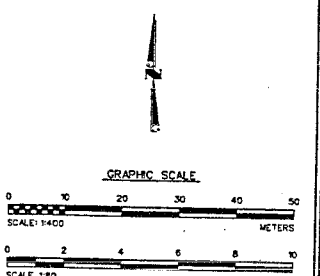
REFERENCES

TITLE SHEET JS-058-98228-T3



SECTION (B)

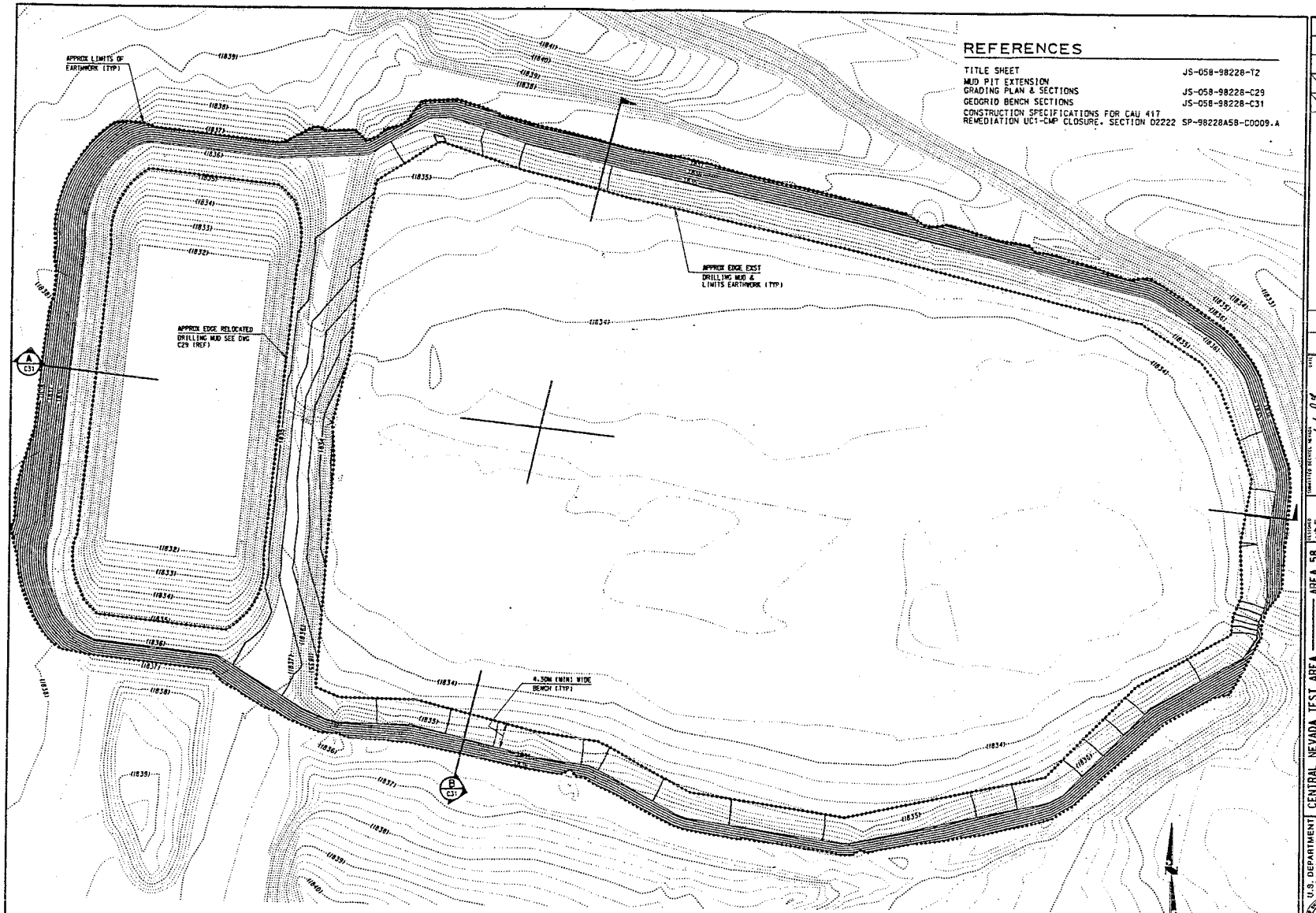
SCALE : HORIZ. = 1:400
VERT. = 1:80



0	ISSUED FOR CONSTRUCTION	04/05/00	
REV	REVISION DESCRIPTION	DATE	

SUBMITTED BY: Rob Elliott DATE 4/5/00
APPROVED BY: Richard Wilson DATE 4-6-00
APPROVED BY: Jim Lacy DATE 4/7/00
PROJECT NUMBER: 98228A58
PROJECT SUB-NO: N/A
ESTIMATE CODE: CEC0013B8
DRAWING NO. T
SHEET 1 OF 1
SCALE: N/A
CENTRAL NEVADA TEST AREA — AREA 58
CAU 417 CLOSURE
MUD PIT EXTENSION
GRADING PLAN & SECTIONS
U.S. DEPARTMENT OF ENERGY
Bechtel Nevada
JS-058-98228-C29
REV 0

04/05/00 02:12:57 P:\dgn\98228a58\ust\Option B\c29.dgn



REFERENCES

TITLE SHEET	JS-058-98228-T2
MUD PIT EXTENSION GRADING PLAN & SECTIONS	JS-058-98228-C29
GEOGRID BENCH SECTIONS	JS-058-98228-C31
CONSTRUCTION SPECIFICATIONS FOR CAU 417 REMEDIATION UC1-CMP CLOSURE. SECTION 02222	SP-98228A58-C0009.A

SITE & GRADING PLAN

SCALE : HORIZONTAL: 1:300

NOTE

EXCAVATION SHALL MEET THE REQUIREMENTS OF SPECIFICATION SECTION 02222. (REF)

GRAPHIC SCALE

0 5 10 15 20 25 30 35

SCALE 1:300 METERS

NO	DATE	REVISION DESCRIPTION	DRWN	CHKD	APPR	DSGN
0		ISSUED FOR CONSTRUCTION 04/05/00				

SUBMITTED BECHTEL NEVADA — DATE 4/5/00
VIEWED — DATE 4-6-00
DEPT. ENGR. PROJECT ENGINEER — DATE 4/7/00
SUP. REF. NO. N/A
PROJECT NUMBER 98228A58
PROJECT NUM. NO. N/A
ATTACHMENT CODE C0001388

CENTRAL NEVADA TEST AREA — AREA 58
CAU 417 CLOSURE
GEOGRID BENCH
SITE & GRADING PLAN

U.S. DEPARTMENT OF ENERGY
NEVADA OPERATIONS OFFICE
LAS VEGAS, NEVADA

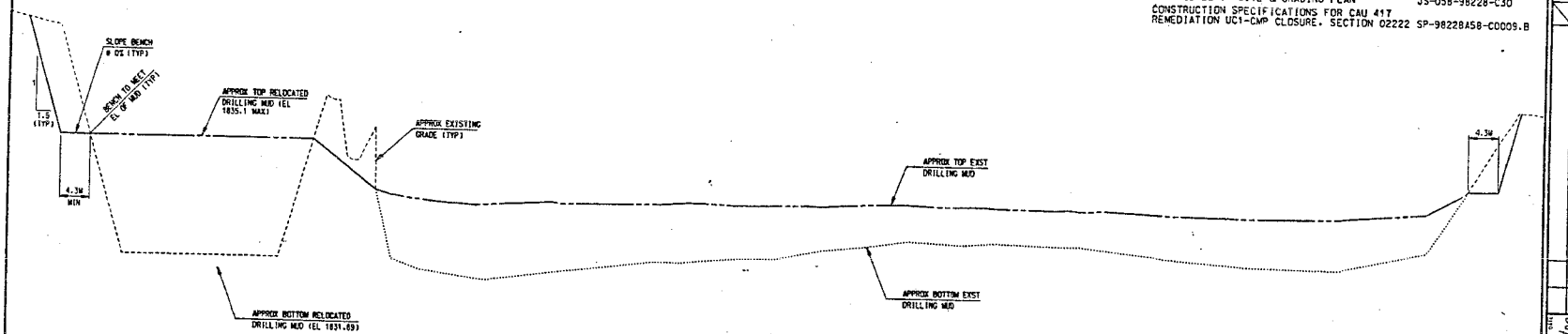
Bechtel Nevada

DRAWING NUMBER JS-058-98228-C30
SHEET 2 — REV 0

04/05/00 02:13:21 PM g:\Dgn\98228a58\uc1\Option 8\c30.dgn

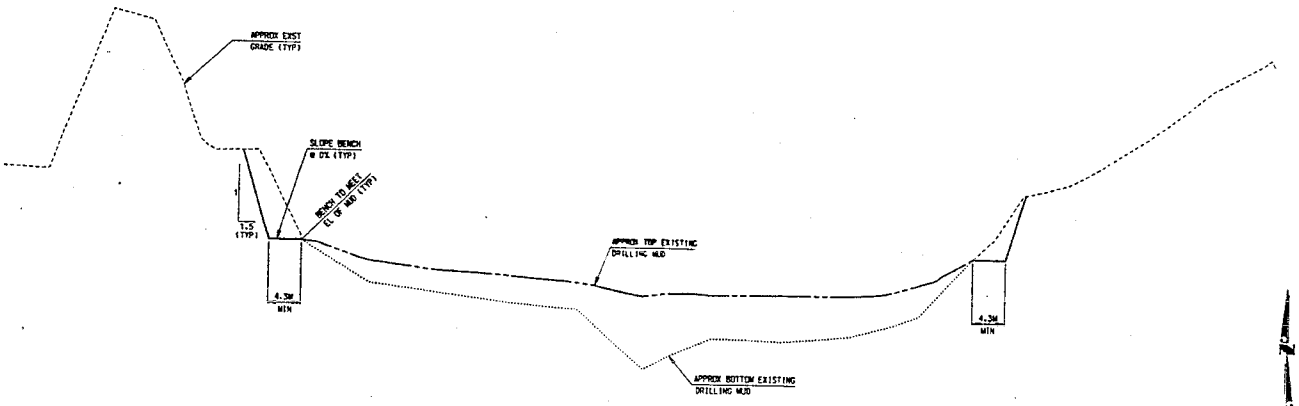
REFERENCES

TITLE SHEET	JS-058-98228-T2
MUD PIT EXTENSION GRADING PLAN & SECTIONS	JS-058-98228-C29
GEOGRID BENCH SITE & GRADING PLAN	JS-058-98228-C30
CONSTRUCTION SPECIFICATIONS FOR CAU 417 REMEDIATION UC1-CMP CLOSURE. SECTION 02222	SP-98228A58-C0009.B



SECTION (A) C30

SCALE : HORIZ. = 1:300
VERT. = 1:60



SECTION (B) C30

SCALE : HORIZ. = 1:300
VERT. = 1:60

GRAPHIC SCALE

0 5 10 15 20 25 30 35 METERS
SCALE 1:300

0 1 2 3 5 7 METERS
SCALE 1:60

REV	DATE	REVISION DESCRIPTION	CHK'D	APP'D
0		ISSUED FOR CONSTRUCTION 04/05/00		

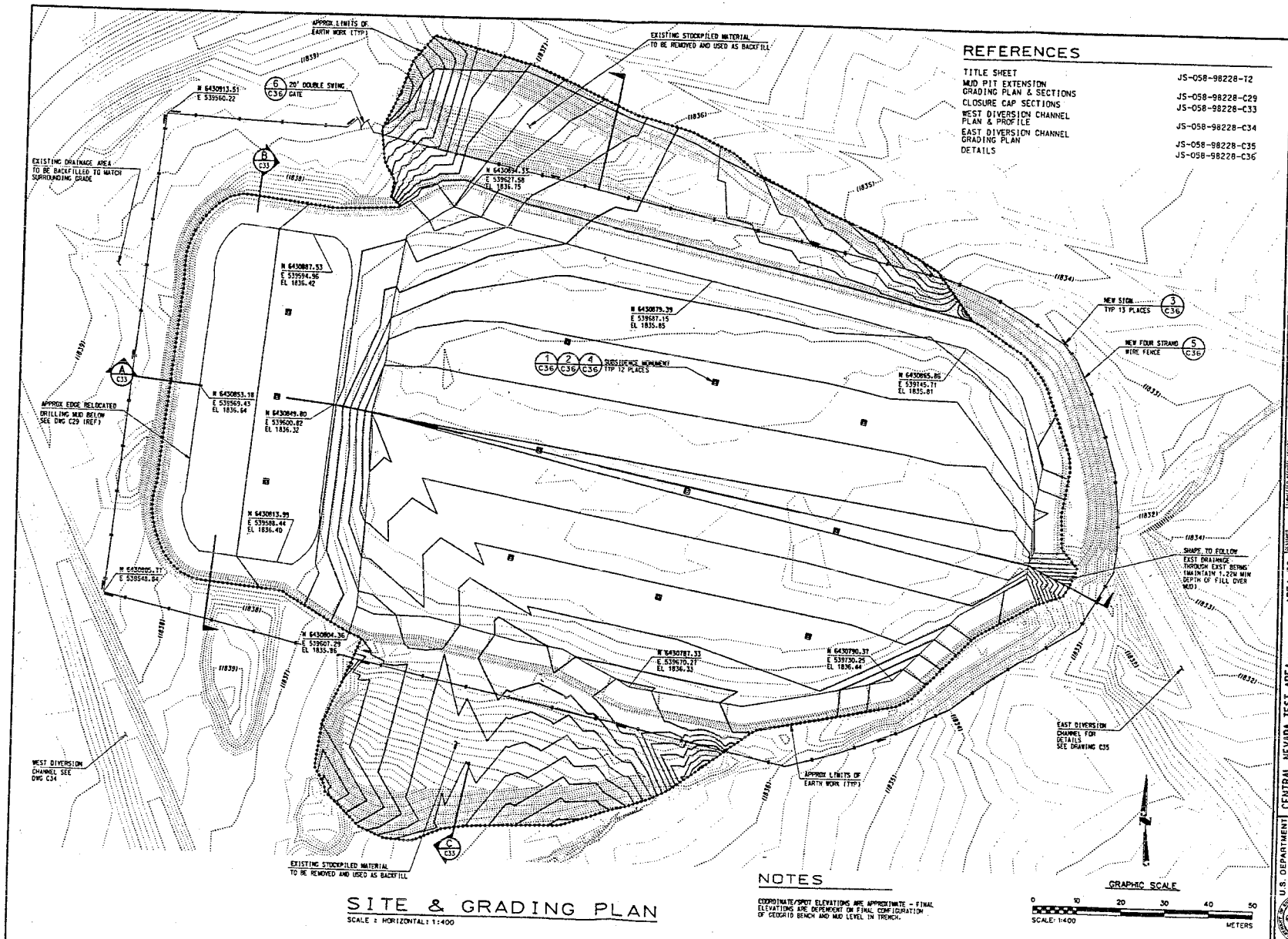
SUBMITTED BENTEL NEVADA — DATE 4/5/00
APPROVED DOE — DATE 4-5-00
DESIGNED — DATE 4/7/00
CHECKED — DATE
DRAWN — DATE
SCALE N/A
TEST PIT NO. N/A
PROJECT NO. N/A
PROJECT NAME 98228A58
CONTRACT NO. DE-AC52-96NV11718
CAGE CODE 1J096

U.S. DEPARTMENT OF ENERGY
NEVADA OPERATIONS OFFICE
LAS VEGAS, NEVADA
Bechtel Nevada

CENTRAL NEVADA TEST AREA — AREA 58
CAU 417 CLOSURE
GEOGRID BENCH
SECTIONS

DRAWING NUMBER JS-058-98228-C31
SHEET 3 REV 0

04/10/00 02:13:50 PM@:\Dgn\98228a58\uc1\Option B\c31.dgn



REFERENCES

TITLE SHEET	JS-058-98228-T2
MUD PIT EXTENSION GRADING PLAN & SECTIONS	JS-058-98228-C29
CLOSURE CAP SECTIONS	JS-058-98228-C33
WEST DIVERSION CHANNEL PLAN & PROFILE	JS-058-98228-C34
EAST DIVERSION CHANNEL GRADING PLAN	JS-058-98228-C35
DETAILS	JS-058-98228-C36

SITE & GRADING PLAN

SCALE : HORIZONTAL: 1:400

NOTES

COORDINATE/SPOT ELEVATIONS ARE APPROXIMATE - FINAL ELEVATIONS ARE DEPENDENT ON FINAL CONFIGURATION OF GEOGRID BENCH AND MUD LEVEL IN TRENCH.

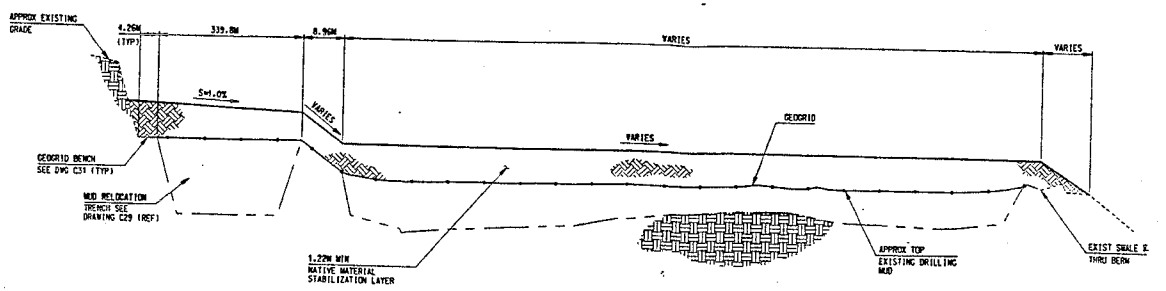
REV	DATE	REVISION DESCRIPTION	DRAWN	CHK'D	APP'D
0		ISSUED FOR CONSTRUCTION 04/05/00			

SUBMITTED BEHALF OF NEVADA — DATE 4/5/00
CHIEF CONSTRUCTION PROJECT ENGINEER — DATE 4/7/00
PROJECT NO. 98228A59
CONTROL NO. CN00-1308
N/A

CENTRAL NEVADA TEST AREA — AREA 58
CAU 417 CLOSURE
CLOSURE CAP
SITE & GRADING PLAN

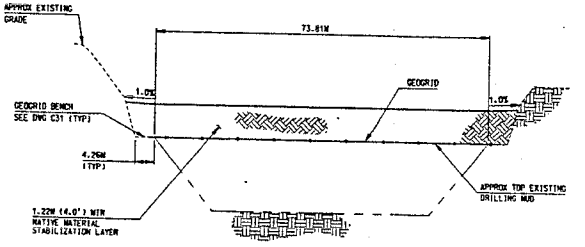
U.S. DEPARTMENT OF ENERGY
NEVADA OPERATIONS OFFICE
Bechtel Nevada
DRAWING NUMBER JS-058-98228-C32
SHEET 0 REV 0

Carrigan 02/14/14 PMg \Dgn\98228a58\ucl\Option B\c32.dgn



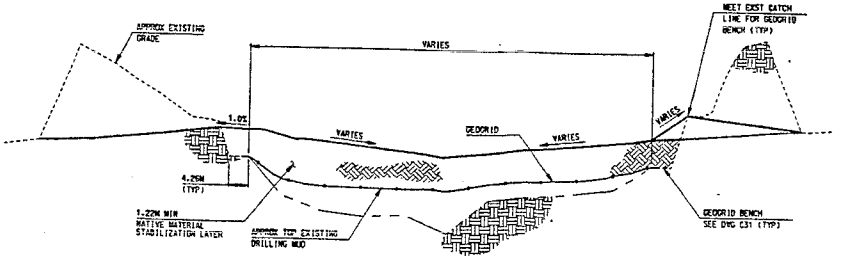
SECTION (A) C32

SCALE : HORIZONTAL: 1:500
VERTICAL : 1:100



SECTION (B) C32

SCALE : HORIZONTAL: 1:500
VERTICAL : 1:100



SECTION (C) C32

SCALE : HORIZONTAL: 1:500
VERTICAL : 1:100

PROJECT NOTES

1. STABILIZATION LAYER SHALL MEET THE REQUIREMENTS OF SPECIFICATION SECTION 02223. (REF)
2. GEOGRID SHALL MEET THE REQUIREMENTS OF SPECIFICATION SECTION 07537.
3. ALL DIMENSIONS/ELEVATIONS ARE MINIMUMS, UNLESS INDICATED OTHERWISE.

REFERENCES

TITLE SHEET	JS-058-98228-T2
MUD PIT EXTENSION GRADING PLAN & SECTIONS	JS-058-98228-C29
GEOGRID BENCH SITE & GRADING PLAN	JS-058-98228-C30
CLOSURE CAP SITE & GRADING PLAN	JS-058-98228-C32
CONSTRUCTION SPECFICATION FOR CAU 417 REMEDIATION UC1-CMP CLOSURE	SP-98228A58-C0009.B

GRAPHIC SCALES

0 5 15 30 60
SCALE 1:500 METERS

0 1 2 3 4 5 6 7 8 9 10 11 12
SCALE 1:100 METERS

REV	DATE	REVISION DESCRIPTION	DRAWN	CHKD	APPD
D		ISSUED FOR CONSTRUCTION 04/05/00			

SUBMITTED BY: 4/5/00
APPROVED BY: 4/7/00
PROJECT NO. 98228A58
CREATED FROM: 98228A58 C0009.DGN

ISSUED: NOT SCALE
SCALE: 1:500 1:100
SHT SIZE: N/A
N/A

U.S. DEPARTMENT OF ENERGY
NEVADA OPERATIONS OFFICE
LAS VEGAS, NEVADA

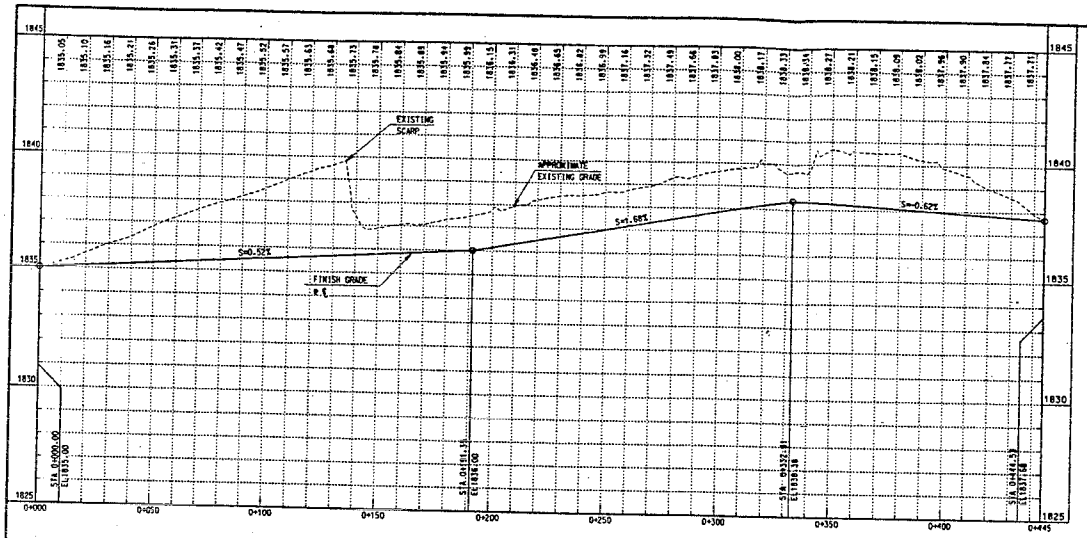
Bechtel Nevada

CENTRAL NEVADA TEST AREA — AREA 58
CAU 417 CLOSURE

CLOSURE CAP SECTIONS

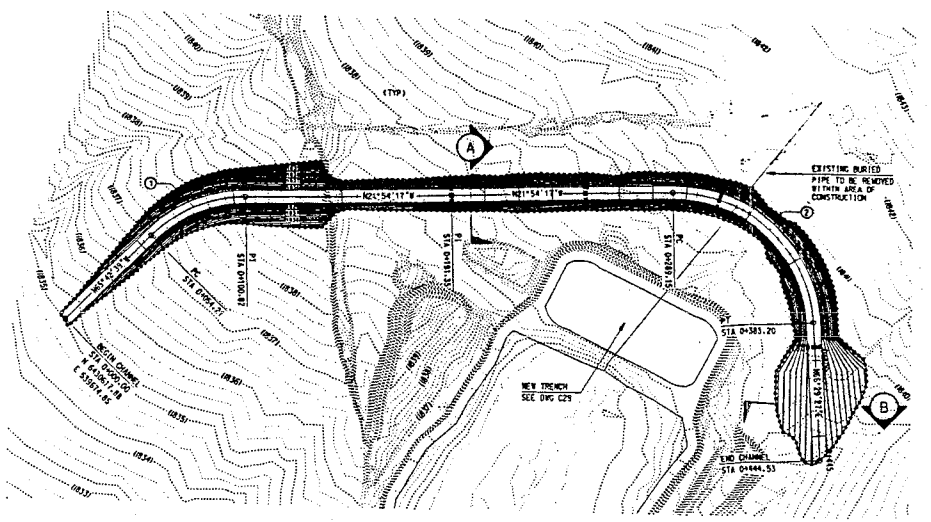
DRAWING NUMBER
JS-058-98228-C33
SHEET 0 OF 0 REV 0

04/07/00 03:14:37 PM:\Dgn\98228a58\uc1\Option B\c33.dgn



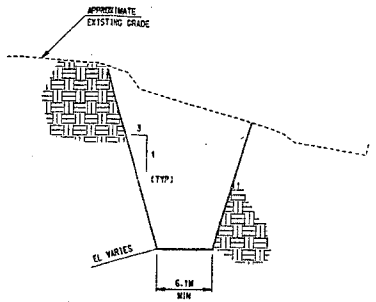
PROFILE

SCALE : HORIZONTAL: 1:1000 VERTICAL : 1:100



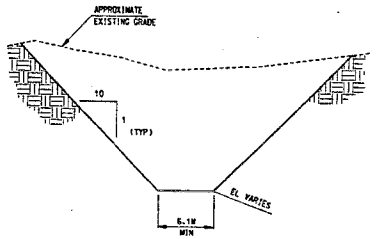
PLAN

SCALE : HORIZONTAL: 1:1000 CONTOUR INTERVAL = 0.25M



SECTION A

SCALE : HORIZ 1:250
VERT 1:25



SECTION B

SCALE : HORIZ 1:250
VERT 1:25

CURVE DATA				
NO	Δ	R	T	L
1	43°48'22"	60.96M	24.51M	46.61M
2	88°23'44"	60.96M	59.28M	94.05M

REFERENCES

TITLE SHEET J5-058-98228-T3
MUD PIT EXTENSION SITE & GRADING PLAN J5-058-98228-C29

GRAPHIC SCALES

SCALE 1:25 — 0, 1, 2, 3 METERS
SCALE 1:100 — 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 METERS
SCALE 1:250 — 0, 10, 20, 30 METERS
SCALE 1:1000 — 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120 METERS

NO	DATE	REVISION DESCRIPTION	DRAWN	CHK	APP
0		ISSUED FOR CONSTRUCTION 04/09/00			

SUBMITTED BENCH REVIEW: DATE 4/5/00
DATE 4-6-00
CHIEF, ENERGY PROJECT ENGINEER 4/6/00
PROJECT NO. 98228A58
PROJECT NO. (FOR AE) N/A
VICINITY MAP CAU 417 CLOSURE

AUTOCAD DWG. NAME: JS-058-98228-C34
DRAWN BY: JAS
CHK'D BY: DJ/A
DWG. SET NO. N/A

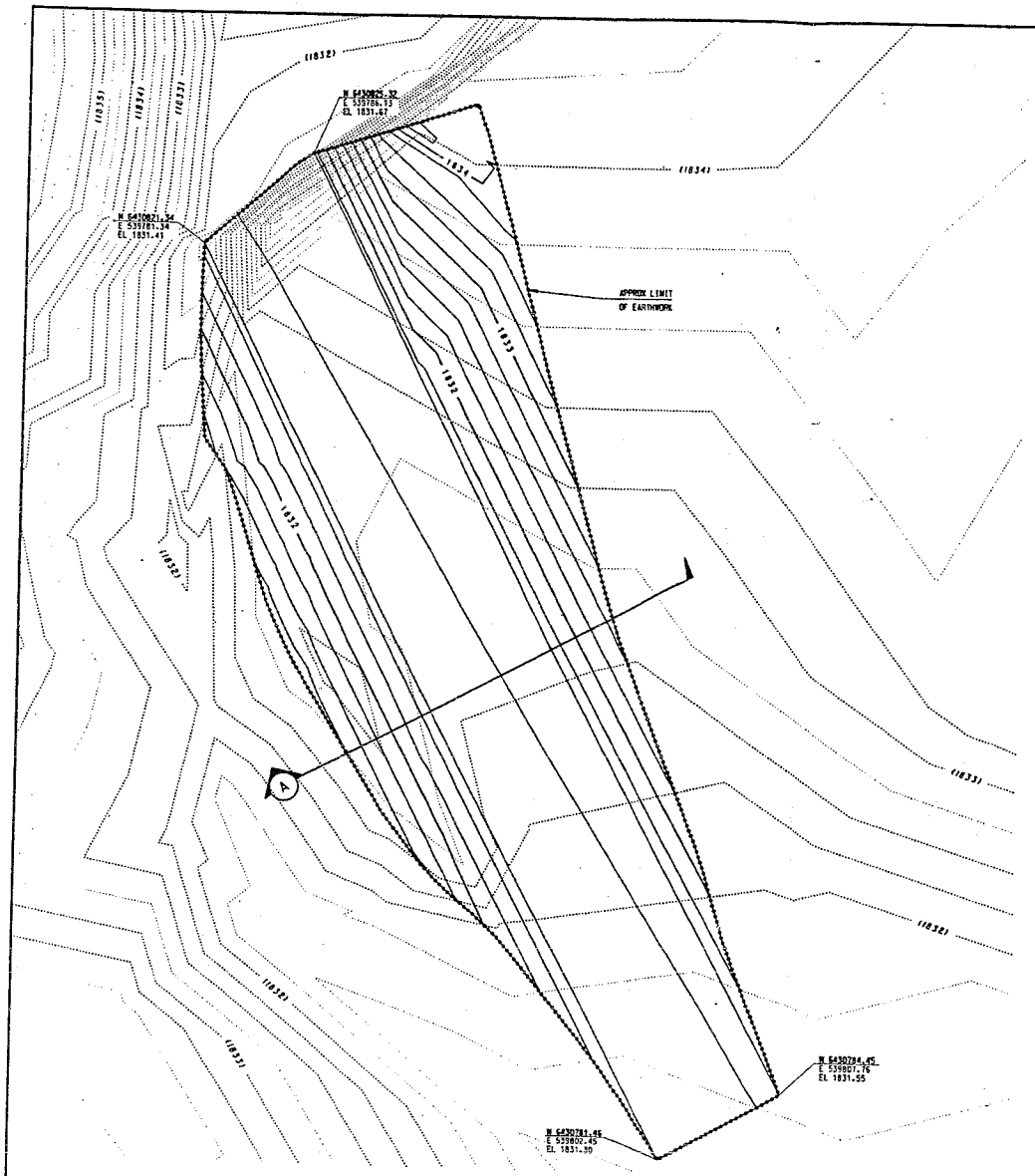
U.S. DEPARTMENT OF ENERGY
NEVADA OPERATIONS OFFICE
Bechtel Nevada

CENTRAL NEVADA TEST AREA — AREA 58
CAU 417 CLOSURE

WEST DIVERSION CHANNEL PLAN & PROFILE

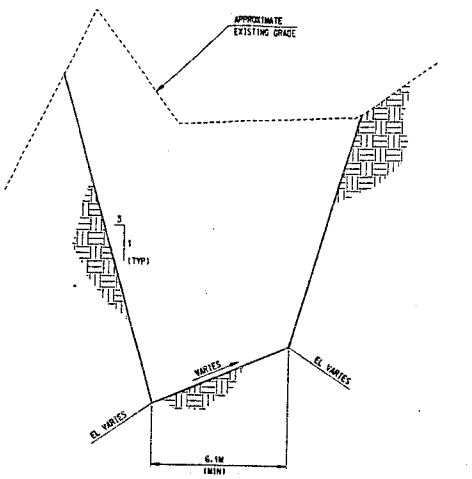
DRAWING NUMBER JS-058-98228-C34
SHEET 0 REV. 0

04/05/00 02:15:00 P:\dgn\98228a58\wct\Option B\c34.dgn



PLAN

SCALE : 1:100



SECTION

SCALE : HORIZONTAL: 1:100
VERTICAL : 1:20

A

REFERENCES

TITLE SHEET JS-058-98228-T2

CONSTRUCTION SPECIFICATIONS FOR CAU 417 REMEDIATION UC1-CMP CLOSURE, SECTION 02222 SP-98228A58-C0009.B

GRAPHIC SCALES

0 1 1.5 2 2.5
SCALE 1:20 METERS

0 1 2 3 4 5 6 7 8 9 10 11 12
SCALE 1:100 METERS

NO	DATE	REVISION DESCRIPTION
0		ISSUED FOR CONSTRUCTION 04/05/00

DESIGN: BC
DRAWN: JAS
CHECKED: JAS
CHECKED: N/A
SUBMITTED BECHTEL NEVADA: 4/5/00
DATE: 4/5/00
DEPT OF ENERGY PROJECT MANAGER: 4/7/00
DATE: 4/7/00
FACILITY CODE: C60013BB
PROJECT NUMBER: N/A
FACILITY NUMBER: 98228A58
N/A

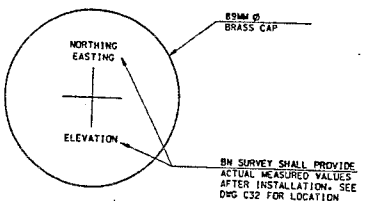
CENTRAL NEVADA TEST AREA — AREA 58
CAU 417 CLOSURE

EAST DIVERSION CHANNEL
GRADING PLAN

U.S. DEPARTMENT OF ENERGY
NEVADA OPERATIONS OFFICE
Bechtel Nevada

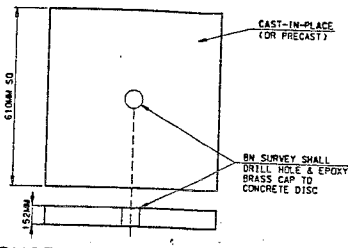
DRAWING NUMBER: JS-058-98228-C35
SHEET 9 OF 0

04/05/00 02:15:25 PMg:\Dgn\98228a58\uc1\Option 8\c35.dgn



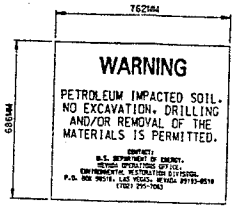
BRASS CAP DETAIL (1) C32

NOT TO SCALE



CONCRETE MONUMENT DETAIL (2) C32

NOT TO SCALE

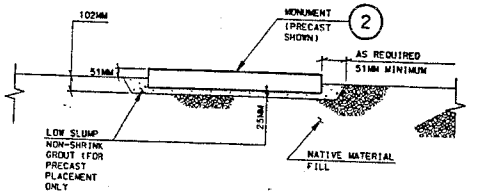


SIGN DETAIL (3) C32

NOT TO SCALE

SIGN NOTES

1. THIS DETAIL APPLIES TO SIGNS ON FENCE ONLY
2. SIGN SHALL BE WHITE WITH BLACK LETTERING.
3. MINIMUM LETTER/WORD HEIGHT SHALL BE:
   DANGER = 76MM
   INFORMATION = 38MM
   CONTACT = 19MM
4. SIGN STOCK THICKNESS SHALL BE 16 GAGE/0.0635 OR GREATER



INSTALLATION DETAIL (4) C32

NOT TO SCALE

DETAIL NOTES

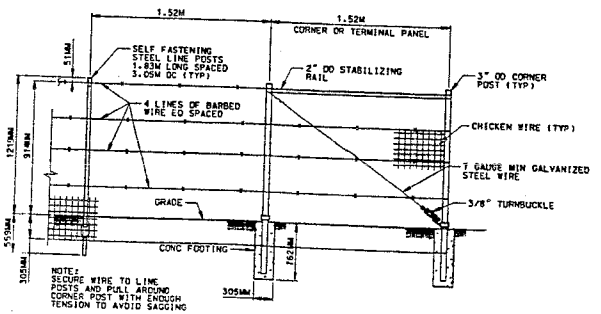
1. DETAIL 2 - SHOWS CONTROLLED DIMENSIONS FOR MONUMENT.
2. DETAIL 4 - FORM CAST-IN-PLACE CONCRETE MONUMENT TO THE DIMENSIONS SHOWN.

FENCE NOTES

1. FENCING SHALL MEET THE REQUIREMENTS OF SPECIFICATION SECTION 02831.
2. ALL FENCING COMPONENT DIMENSIONS SHOWN ARE NOMINAL. SEE NOTE 1.

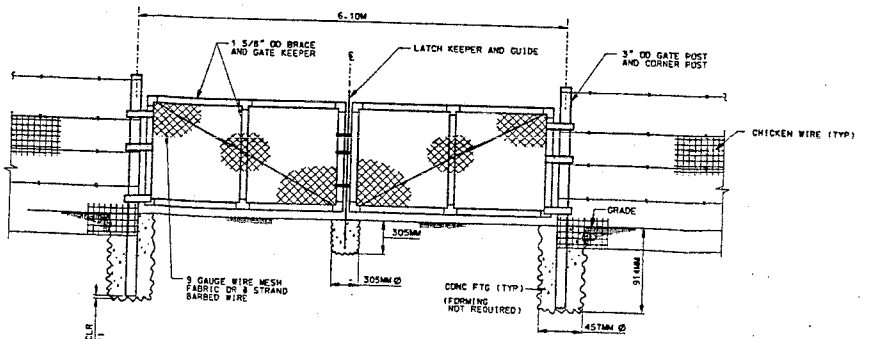
REFERENCES

TITLE SHEET	JS-058-99228-T2
CLOSURE CAP SITE & GRADING PLAN	JS-058-98228-C32
CLOSURE CAP SECTIONS	JS-058-99228-C33
CONSTRUCTION SPECIFICATION FOR CAU 417 REMEDIATION UCI-CMP, SECTION 02831	SP-98228A58-C0009.8



3 WIRE FENCE (5) C32

NOT TO SCALE



GATE DETAIL (6) C32

NOT TO SCALE

REV	DATE	REVISION DESCRIPTION	DRAWN	CHK	APP
0	9	ISSUED FOR CONSTRUCTION 04/05/00			

DESIGNED / DRAWN / CHECKED / SUPV ENGR / SUBMITTED RECEIVED / DATE / USA / PROJECT ENGINEER / DATE / CONTRACTOR / CONTRACT NO. / PROJECT NO. / PROJECT NO. / N/A

U.S. DEPARTMENT OF ENERGY

NEVADA OPERATIONS OFFICE

Bechtel Nevada

CENTRAL NEVADA TEST AREA — AREA 58

CAU 417 CLOSURE

DETAILS

DRAWING NUMBER JS-058-98228-C36

SHEET 32 REV 0

04-01-00 02:15:46 PWD:\Dgn\98228a58\uci\Option B\c36.dgn

SECTION IV

CONSTRUCTION SPECIFICATIONS

CONSTRUCTION SPECIFICATIONS

FOR

CAU 417 CLOSURE

NO.	DATE	REVISION	ORIG / CHECK	SAFETY / ENVIR	QA / PE/ENGR	USER / DOE
0		ISSUED FOR CONSTRUCTION 4/5/00				

U.S. DEPARTMENT OF ENERGY

NEVADA OPERATIONS OFFICE — LAS VEGAS, NEVADA

ORIGINATOR	CHECK	SAFETY	ENVIRONMENTAL	QA
Julie A. Sarola	J.H. Blumer / JW D. PETERSON	N/A	N/A	N/A

SUBMITTED (TO CHIEF ENGINEER)	USER	APPROVAL BLOCK	
Kim Schmit	Michael Shotton	DEPT OF ENERGY PROJ ENGR: Monica Sanchez	DATE: 4/7/00
BECHTEL NEVADA			

Bechtel Nevada

P.O. BOX 3936 NORTH LAS VEGAS, NV 89036

P. A. NO. N/A

ACTIVITY CODE C8GU13BA

PROJ. NO. 98228A58

SPECIFICATION NUMBER SP-98228A58-C0009.0

SHEET _____ OF _____

CONSTRUCTION SPECIFICATIONS
FOR
CAU 417 CLOSURE

PREPARED BY:

Bechtel Nevada

April, 2000

CONSTRUCTION SPECIFICATIONS
FOR
CAU 417 REMEDIATION
UC1-CMP CLOSURE

TABLE OF CONTENTS

DIVISION 1	GENERAL	
01050		Field Surveying
DIVISION 2	SITE WORK	
02110		Site Clearing
02222		Excavation
02223		Native Material Fill
02831		Fences
DIVISION 3	CONCRETE	
03001		Plain Concrete
DIVISION 4	NOT USED	
DIVISION 5	NOT USED	
DIVISION 6	NOT USED	
DIVISION 7	THERMAL AND MOISTURE PROTECTION	
07537		Geosynthetic (Geogrid) Reinforcement
DIVISION 8	NOT USED	
DIVISION 9	NOT USED	
DIVISION 10	NOT USED	
DIVISION 11	NOT USED	
DIVISION 12	NOT USED	
DIVISION 13	NOT USED	
DIVISION 14	NOT USED	
DIVISION 15	NOT USED	
DIVISION 16	NOT USED	

SECTION 01050 FIELD SURVEYING

TABLE OF CONTENTS

Paragraph	Title	Page No.
PART 1	GENERAL	
1.01	Work Included	1
1.02	Related Work	1
1.03	References	1
1.04	Submittals	1
1.05	Quality Assurance	1
PART 2	PRODUCTS	
2.01	Project Record Documents	1
PART 3	EXECUTION (NOT USED)	

SECTION 01050

FIELD SURVEYING

PART 1 GENERAL

1.01 WORK INCLUDED

A. Surveys for acceptance and as-builts

1.02 RELATED WORK

Not Used

1.03 REFERENCES

Not used

1.04 QUALITY ASSURANCE

A. Surveyor: The field survey data will be reviewed by a registered Land Surveyor.

PART 2 PRODUCTS

2.01 PROJECT RECORD DOCUMENTS

A. Maintain complete, accurate log of control and survey work as it progresses.

B. Location and thickness information shall be recorded on lift diagrams.

1. Record approximate overall dimensions of lift, thickness of lift, approximate location of thickness measurement, and location of lift (i.e., stabilization layer lift 1).

2. Record coordinate locations of grade stakes set for thickness measurements (if required), and target/final elevations at each grade stake location.

C. All survey requirements and documentation shall be performed as indicated in the approved Sampling, Inspection, Testing, and Acceptance (SITA) Plan.

D. Submit survey information showing dimensions, coordinate locations, bearings, and elevations for the final surface of each design component (channels, relocation trench, etc) of the closure as shown on the engineering drawings.

1. Data shall be submitted to the SITA Engineering Delegate.

2. Data shall be submitted in ASCII file format and contain sufficient data points to create digital terrain models of each closure component to facilitate as-builting of the Project Drawings.

PART 3 EXECUTION

NOT USED

SECTION 02110 SITE CLEARING

TABLE OF CONTENTS

Paragraph	Title	Page No.
PART 1	GENERAL	
1.01	Work Included	1
1.02	Related Work	1
PART 2	PRODUCTS (NOT USED)	
PART 3	EXECUTION	
3.01	Preparation	1
3.02	Protection	1
3.03	Clearing	1
3.04	Removal	2

SECTION 02110

SITE CLEARING

PART 1 GENERAL

1.01 WORK INCLUDED

A. Removal of surface debris

B. Removal of plants and grass

C. Removal of root systems

1.02 RELATED WORK

A. Section 02222 - Excavation

PART 2 PRODUCTS

Not used

PART 3 EXECUTION

3.01 PREPARATION

A. Verify that existing plant life and features designated to remain are tagged or identified.

3.02 PROTECTION

A. Protect bench marks and existing work from damage or displacement

B. Notify the Construction Superintendent immediately when existing utility lines, or other man-made objects whether or not shown on the Drawings, are encountered or damaged. See Section 02222 for goldaking guidance.

C. Apply water as necessary to control dust and maintain air quality in conformance with applicable local, state, and federal regulations.

3.03 CLEARING

A. Clear areas required for access to site and execution of work.

B. Remove shrubs and grass within marked areas. Remove main root balls and root systems, to a depth of 18 inches (457 mm).

C. Remove rocks and boulders larger than 6 inches (152 mm) in diameter, as directed by the Construction

Superintendent.

3.04 REMOVAL

A. Remove debris, rocks, and extracted plant life from site.

B. Relocate all debris to a site as directed by the Construction Superintendent.

C. Burning of waste materials on the site will not be permitted.

END OF SECTION

SECTION 02222 EXCAVATION

TABLE OF CONTENTS

Paragraph	Title	Page No.
PART 1	GENERAL	
1.01	Work Included	1
1.02	Related Work	1
1.03	References	1
1.04	Quality Assurance	1
1.05	Protection	1
PART 2	PRODUCTS	
2.01	Materials	2
2.02	Equipment	2
PART 3	EXECUTION	
3.01	Preparation	2
3.02	Excavation	2
3.03	Compaction	3

SECTION 02222

EXCAVATION

PART 1 GENERAL

1.01 WORK INCLUDED

A. Excavation adjacent to Central Mud Pit (CMP) for Mud Relocation Trench.

B. Excavation of CMP cover material borrow areas.

C. Excavation of Bench for Geogrid Installation.

D. Miscellaneous Excavations (V-ditches, existing berms shaping, and four CASs to be clean closed).

1.02 RELATED WORK

A. Section 01050 - Field Surveying

B. Section 02223 - Native Material Fill

1.03 REFERENCES

A. Code of Federal Regulations (CFR) 29 CFR:

OSHA 1926 Safety and Health Regulations for Construction

1.04 QUALITY ASSURANCE

Inspections/Observations shall be performed to verify compliance with Parts 3.02 and 3.03 of this specification in accordance with the approved Sampling, Inspection, Testing, and Acceptance (SITA) Plan.

1.05 PROTECTION

A. Notify the Construction Superintendent of unexpected subsurface conditions and discontinue affected work in area until notified to resume work.

B. The exact location and depth of burial of unidentified utilities or man made objects (if any encountered) shall be confirmed/documented (goldaking) by the Construction Superintendent and provided to the Technical Lead.

PART 2 PRODUCTS

2.01 MATERIALS

A. Native material from excavations shall be stockpiled until required, or transported directly for the mud pit closure cover construction.

B. Excavated native material shall be obtained from locations shown on the drawings.

2.02 EQUIPMENT

A. Equipment shall meet the applicable requirements of OSHA 1926.

PART 3 EXECUTION

3.01 PREPARATION

A. Identify required lines, levels, contours, and datum. See Section 01050.

B. Check, as required, and mark any unidentified buried utilities/manmade objects before any excavation work begins. Utilize any existing goldaking documents to minimize additional efforts.

3.02 EXCAVATION

A. Excavate to the lines, grades, and elevations as shown on the Drawings.

B. Survey shall verify that grade slope banks meet OSHA 1926 requirements.

C. Remove all lumped subgrade soil and rocks over 6 inches (152 mm) in diameter.

D. Perform excavations (except bench for geogrid placement) such that adequate drainage is maintained.

E. Use the excavations to obtain stabilization fill.

1. Dispose of overburden and other spoil materials as directed by the Construction Superintendent.

2. Trim the side slopes neatly after the excavation is completed.

F. Stockpile excavated material in an area designated by the Construction Superintendent.

G. Stockpile excavated borrow material to a height not exceeding 15 feet (4.57 m).

3.03 COMPACTION

A. Mud Relocation Trench/Geogrid Bench

1. No compaction testing for acceptance required.

B. CMP Cover Material Borrow Area

1. No compaction testing for acceptance required.

C. Miscellaneous Excavations

1. V-Ditches - No compaction testing for acceptance required.

2. Existing Berms

a) Remaining surfaces of existing berms where soils are removed for use in the cap construction shall be shaped to drain away from the mud pit.

b) No compaction testing for acceptance required.

3. Four (4) CASs to be clean closed - no compaction testing for acceptance required.

END OF SECTION

SECTION 02223 NATIVE MATERIAL FILL

TABLE OF CONTENTS

Paragraph	Title	Page No.
PART 1	GENERAL	
1.01	Work Included	1
1.02	Related Work	1
1.03	References	1
1.04	Quality Assurance	1
PART 2	PRODUCTS	
2.01	Materials	1
2.02	Equipment	1
PART 3	EXECUTION	
3.01	Inspection	2
3.02	Equipment	2
3.03	Placement	2
3.04	Field Quality Control	3

SECTION 02223

NATIVE MATERIAL FILL

PART 1 GENERAL

1.01 WORK INCLUDED

A. Stabilization Fill Layer Placement

1.02 RELATED WORK

A. Section 02222 - Excavation

B. Section 07537 - Geosynthetic (Geogrid) Reinforcement Layer

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM):

ASTM D2487-98 Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)

B. Code of Federal Regulations (CFR) 29 CFR:

OSHA 1926 Safety and Health Regulations for Construction

1.04 QUALITY ASSURANCE

A. Inspection/Observation Personnel shall be as stated in the approved Sampling, Inspection, testing, and Acceptance (SITA) Plan.

PART 2 PRODUCTS

2.01 MATERIALS

A. Fill material shall be excavated native material obtained from excavations as shown on the drawings.

B. Stabilization Fill Layer: Material shall be a well graded, natural soil containing not more than 50 percent fines, with rocks larger than 6 inches, brush, roots, and all debris removed. Well graded shall be per ASTM D2487, where the sieve opening passing 60 percent of the material is 4 or more times greater than the size passing 10 percent of the material.

2.02 EQUIPMENT

A. Equipment shall meet the applicable requirements of OSHA 1926

PART 3 EXECUTION

3.01 INSPECTION

A. Documentation shall be in accordance with the approved SITA Plan.

B. Verify that areas to be backfilled are free of debris, water, and rocks larger than 6 inches.

C. Verify that all items under Part 3.04 are complete after placement of each lift.

3.02 EQUIPMENT

A. No equipment shall be allowed on the pond surface prior to geogrid and initial stabilization layer placement.

B. Stabilization layer (4 foot [1.22 m] min thickness) shall be placed with low ground pressure (LGP) equipment with a maximum track pressure of 5 psi or less. Lighter equipment is preferred.

C. Truck traffic should only be allowed on the pond after placement of a minimum 4 feet (1.22 m) of stabilization fill and achievement of a firm surface.

3.03 PLACEMENT (Refer to Section 07537 also)

A. Geogrid shall be placed in accordance with specification section 07537, prior to stabilization fill placement.

B. Stabilization Fill:

1. Stabilization Fill Layer

a. The stabilization fill layer shall be comprised of 2-2 foot (0.61 m) thick lifts, for a minimum completed thickness of 4 feet (1.22 m).

b. Drain or pump any free water from the surface of the pond area.

c. Place fill material in a manner to minimize movement of the geogrid. Track equipment shall not be allowed on exposed geogrid reinforcement.

d. Prior to placement of stabilization fill on the pond surface, cover the geogrid at the edge of the pond, on the geogrid bench, with a layer of at least 2 feet thick (610 mm) of fill material.

e. Push stabilization fill inward to provide minimum 10 feet (3.05 m) of embedment of the

geogrid panels at the pond edge.

f. After anchorage of the geogrid at the pond edge, commence placement of the first lift of the stabilization layer out over the pond surface.

g. A 2 foot (610 mm) minimum fill thickness must be maintained under the dozer at all times. Loads of fill material must be dumped at the pond edge and pushed in by the dozer (beginning of first lift only).

   1) The LGP dozer shall track perpendicular to the face of the fill during spreading operations. At no time should the dozer track parallel to the face of the fill in close proximity to the leading edge.

h. Material shall be compacted by track walking with not less than 4 passes of the LGP equipment over each lift of the stabilization fill layer.

   1) Hauling equipment shall only be allowed on the fill in areas where the thickness is a minimum of 4 feet after compaction.

   2) Heavy equipment shall not be permitted less than 50 feet (15.24m) from the leading edge of all fill areas with a 4 foot (1.22m) minimum compacted thickness.

i. If any localized soft areas are found on the pond surface, which worsen under compaction (more likely to occur during placement of the first lift), cease compaction in that area and avoid further disturbance. Place additional layers of geogrid over the affected area, and place additional fill (2 feet [0.69 m] minimum thickness) over the geogrid. This additional fill shall be compacted with at least 4 passes of the LGP dozer.

   1) For mud relocation trench, see Section 07537 Part 3.01.B.2.a.

j. If widespread instability occurs during placement or compaction of the first lift, immediately cease work and contact the Project Manager, or his delegate.

3.04 FIELD QUALITY CONTROL

A. GRADE CONTROL

1. The final surface of the stabilization fill material shall be shaped to follow existing

drainage patterns across the mud pit, UC1-CMP. Elevations/slopes indicated on the drawings are approximate only. Final acceptance is dependent on analysis of asbuilt survey data by the SITA engineering delegate.

B. THICKNESS CONTROL

1. Lift thickness shall be verified and documented per Section II of the approved SITA Plan, and specification section 01050.

C. INSPECTION

1. Inspection/observations shall be performed and documented as indicated in Section II of the approved SITA Plan.

END OF SECTION

TABLE OF CONTENTS

Paragraph	Title	Page No.
PART 1	GENERAL	
1.01	Work Included	1
1.02	Related Work	1
1.03	References	1
1.04	Quality Assurance	1
PART 2	PRODUCTS	
2.01	Barbed Wire Fence	1
2.02	Concrete	2
PART 3	EXECUTION	
3.01	General	2
3.02	Barbed Wire Fencing	2
3.03	Signs	3

SECTION 02831

FENCES

PART 1 GENERAL

1.01 WORK INCLUDED

A. Barbed wire fencing

B. Gates

1.02 RELATED WORK

A. Section 03001 - Plain Concrete

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM):

ASTM A121-92 Rev A	Standard Specification for Zinc-Coat (Galvanized) Steel barbed wire
ASTM A123-89 Rev A	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

B. Federal Specifications (FS):

FS RR-F-183	Fence Posts, Gates, and Accessories
FS RR-F-221	Fencing Wire (Barbed Wire, Woven Wire, and Netting) Fence Posts and Accessories

1.04 QUALITY ASSURANCE

NOT USED

PART 2 PRODUCTS

2.01 BARBED WIRE FENCE

A. Wire: furnish barbed wire consisting of two twisted strands of 12 1/2 gauge wire, with 4 point barbs spaced not more than 5 inches (127 mm) apart conforming to FS RR-F-221.

B. Posts: furnish drive-type and corner/end-type posts for barbed wire fencing of the length shown on the Drawings.

C. Coatings: galvanized coating is standard for barbed wire, gate assemblies, and corner/end posts. Galvanized coating for drive-type (intermediate) posts is preferred.

D. Fencing components size, shape, and dimensions vary by manufacturer. Nominal information is indicated on the drawings, and the selected vendor may provide alternate sizes, shapes, and dimensions of fencing components.

2.02 CONCRETE

A. Furnish an approved, pre-mixed concrete having a compressive strength of 2,000 psi (14 MPa) at 28 days as specified in Section 03001. Testing is not required.

PART 3 EXECUTION

3.01 GENERAL

A. Grading

1. The ground along the fence line shall be graded such that the vertical clearance between bottom of lower fence strand and ground will not be less than 6 inches (153 mm) unless otherwise shown on the Drawings or approved by the Bechtel Nevada (BN) Project Manager, or his delegate.

B. Excavation

1. Excavation for posts and other concrete-embedded items shall be of the dimensions indicated on the Drawings.

2. Waste material from excavation shall be spread where directed.

3. Post holes to receive concrete shall be thoroughly cleared of loose material.

C. Footings

1. Footing dimensions for corners and end (terminal) posts shall be as shown on the drawings.

3. Finish concrete footings by neatly shaping at the finish grade line to provide shedding of water away from the posts.

3.02 BARBED WIRE FENCE

A. Erection

1. Assemble and erect fences as specified and in accordance with detailed instructions furnished by the fencing manufacturer.

B. Fence posts

1. Drive posts shall be spaced as shown on the Drawings and driven to the depth required to provide the

fence height indicated.

2. Corner and end posts shall be installed as shown on the drawings and/or manufacturers instructions.

3. Cut posts, if required, to achieve fence height specified on the drawings.

C. Barbed wire

1. Barbed wire shall be spaced as indicated to provide the number of strands shown on the Drawings.

2. Barbed wire shall be fastened as required by the types of posts used in the fence assembly.

3. Chicken wire shall be attached to the outside of the barbed wire fence. Wire shall extend 3 feet (914mm) above grade and be embedded a minimum of 1 foot (305mm) below grade.

D. Gates

1. Gates shall be of the design indicated on the Drawings, or as approved by the manufacturer.

2. Gate security hinges shall have tight, nonremovable pins; latches shall be provided with means for padlocking.

3.03 SIGNS

A. All signs to be installed on the fence shall be at the approximate locations shown on the drawings. Signs shall be spaced a minimum of 200 feet (60.96 m) on center.

B. Signage Size, type, and color of letters shall be as shown on the drawings.

END OF SECTION

SECTION 03001 PLAIN CONCRETE

TABLE OF CONTENTS

Paragraph	Title	Page No.
PART 1	GENERAL	
1.01	Work Included	1
1.02	Related Work	1
1.03	References	1
1.04	Quality Control	1
PART 2	PRODUCTS	
2.01	Concrete Materials	1
2.02	Concrete Mix	2
PART 3	EXECUTION	
3.01	Placing Concrete	2
3.02	Finishing	2
3.03	Curing	2
3.04	Concrete Inspection	3

SECTION 03001

PLAIN CONCRETE

PART 1 GENERAL

1.01 WORK INCLUDED

A. Concrete for Fence Footings

B. Concrete for Survey Location Monuments

1.02 RELATED WORK

A. Section 02831 Fences

1.03 REFERENCES

A. American Concrete Institute (ACI):

ACI 301-89	Structural Concrete for Buildings
ACI 305R-91	Hot Weather Concreting
ACI 306R-88	Cold Weather Concreting

B. American Society for Testing and Materials (ASTM):

ASTM C33-93	Standard Specification for Concrete Aggregates
ASTM C94-92	Standard Specification for Ready-Mixed Concrete
ASTM C150-92	Standard Specification for Portland Cement

1.04 QUALITY CONTROL

A. Perform work in accordance with ACI 301.

B. Hot weather concreting shall be in accordance with ACI 305R-91. Cold weather concreting shall be in accordance with ACI 306R-88.

PART 2 PRODUCTS

2.01 CONCRETE MATERIALS

A. Use one brand and type of pre-mixed concrete throughout project unless otherwise shown on the Drawings.

B. Cement (used in pre-mixed concrete) - conforming to ASTM C150, Type II, No color required.

2.02 CONCRETE MIX

B. Provide an approved, Pre-mixed concrete having a compressive strength of 2,000 psi (14 MPa) in 28 days unless otherwise shown on the Drawings. Testing is not required.

PART 3 EXECUTION

3.01 PLACING CONCRETE

A. Place concrete in accordance with ACI 301.

B. Verify that fence posts are in place and kept vertical.

3.02 FINISHING

A. Concrete finishes

1. Dusting of finish surfaces with dry materials will not be permitted.

2. Additions of water to finish surfaces will not be permitted.

3. Survey location monument finishing

a. Screed and float concrete with straight edges to bring surface to required level with no coarse aggregate visible.

b. Float concrete while still soft to a true, even plane.

c. Trowel surfaces to required finish after surface moisture has disappeared, leaving no coarse aggregate visible.

4. Fence post footing finishing

a. Slope top surface to drain away from fence post.

3.03 CURING (Survey Location Monuments Only)

A. Protect from moisture loss all concrete surfaces not covered by forms.

1. Begin curing immediately after finishing.

2. Cure for not less than seven days.

3. Shade concrete surfaces from direct sun during the curing period.

4. Keep surfaces free of any traffic (foot or vehicle) during the curing period.

B. Curing shall be accomplished by the following method.

1. Curing Compound

3.04 CONCRETE INSPECTION

A. Inspect all concrete surfaces immediately after pouring concrete.

B. Excessive honeycomb or embedded debris in concrete is not acceptable and must be replaced.

C. Modify or replace concrete not conforming to required levels and lines, details, and elevations.

D. Repair or replace concrete not properly placed or not of the specified type.

END OF SECTION

DIVISION 7 THERMAL AND MOISTURE PROTECTION

SECTION 07537 GEOSYNTHETIC (GEOGRID) REINFORCEMENT

TABLE OF CONTENTS

Paragraph	Title	Page No.
PART 1	GENERAL	
1.01	References	1
1.02	Quality Assurance / Quality Control	1
1.03	Delivery, Storage, and Handling	3
PART 2	PRODUCTS	
2.01	Materials	3
PART 3	EXECUTION	
3.01	Preparation	5
3.02	Protection	6
3.03	Installation Quality Control	7
3.04	Quality Control for Acceptance	7

SECTION 07537

GEOSYNTHETIC (GEOGRID) REINFORCEMENT

PART 1 GENERAL

1.01 REFERENCES

A. American Society of Testing and Materials

1.	ASTM D1777-64	Standard Method for Measuring Thickness of Textile Materials.
2.	ASTM D4595-86	Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method.
3.	ASTM D4759-88	Standard Practice for Determining the Specification Conformance of Geosynthetics.
4.	ASTM D4873-88	Standard Guide for Identification, Storage, and Handling of Geotextiles.
5.	ASTM D4884-90	Standard Test Method for Seam Strength of Sewn Geotextiles.

B. Other References

1.	EPA 600/R-93/192	Quality Assurance/Quality Control for Waste Containment Facilities, September 1993.

1.02 QUALITY ASSURANCE / QUALITY CONTROL

A. Documentation

1. The geogrid vendor shall provide adequate documentation, labels, and tags to fully identify each roll and its source, as per ASTM D-4873, Identification, Storage, and Handling of Geotextiles.

B. Materials General Information

1. The geogrid vendor shall provide the following items identified below in accordance with the recommended procedures detailed in the Environmental Protection

Agency Technical Guidance Document Quality Assurance/Quality Control for Waste Containment Facilities, EPA 600/R-93/182.

a. Material Properties test data for minimum average roll values (MARV).

b. Material sample of the actual geogrid material and lap joint connections proposed.

c. A copy of the product technical specifications.

d. A copy of the material installation procedures.

C. Installation Equipment

1. The geogrid vendor shall identify in their submittal any special construction equipment which may be necessary to handle, place, and prepare lap joints, if applicable, of the geogrid material.

2. The geogrid vendor shall also document if the vendor has the necessary equipment available for rental.

3. No equipment will be allowed on the drilling mud surface in the pond for safety reasons.

D. Material's Written Confirmation

1. The geogrid vendor shall upon completion of material delivery, provide a written confirmation that the material was properly fabricated, packaged, and delivered in accordance with vendor procedures.

2. The geogrid vendor shall upon completion of material delivery, provide a written confirmation that the product warranty is in place with no restrictions.

E. Damaged Materials

1. Any material damaged during the installation process is not the responsibility of the geogrid vendor.

2. All products delivered in a damaged condition or damaged during off-loading shall be removed from the construction site and be replaced. See Paragraph 1.04C for responsibility of replacement.

F. Materials Verification

1. On-site SITA Delegates shall check the geogrid material delivered to the site as proper and intended material. This check is done by verifying the identification label and its coding and by visual identification of the product.

1.03 DELIVERY, STORAGE, AND HANDLING

A. The geogrid vendor shall package/wrap all products in a manner that will provide adequate protection during transport and temporary outdoor staging at the job storage site, per ASTM D-4873, Identification, Storage, and Handling of Geotextiles.

B. All geogrid products shipped to the site shall be delivered to the specified staging/storage area.

C. All products delivered in a damaged condition (Vendor Responsibility) or damaged during off-loading (Contractor Responsibility) shall be removed from the construction site and be replaced.

D. All geogrid products shall be handled and stored at the job storage site, per ASTM D-4873, Identification, Storage, and Handling of Geotextiles.

E. All geogrid products shall be stored at the site on a prepared surface (not wooden pallets) and shall be covered or otherwise protected from grease, mud, mechanical abrasions, excessive heat, ultra-violet exposure, or other causes of damage.

F. All geogrid rolled material should be stored flat and should be covered with a light colored tarpaulin to prevent long-term exposure to sunlight.

PART 2 PRODUCTS

2.01 MATERIALS

A. General Information

1. Geogrid materials are reinforcement geosynthetics formed by intersecting and joining sets of longitudinal and transverse ribs with resulting open spaces called "apertures" and shall have the following technical

requirements:

a. Geogrid Materials

1. Geogrid shall be one (or more) of the following materials:

a. Polyester.

b. Polyethylene.

c. Polypropylene.

2. The geogrid vendor to supply a sample of the proposed geogrid type material which can be applied using construction personnel by manual methods.

2. Tensile Strength

a. The minimum tensile strength at 5% strain shall be 1,000 pounds per foot (lb/ft), and shall be documented per ASTM D-4595, Tensile Properties of Geotextiles by Wide Width Strip Method. This minimum tensile strength requirements apply to both directions of the geogrid [(longitudinal - machine direction) and (transverse - cross machine direction)].

3. Elongation

a. The minimum elongation at break shall be 10% per ASTM D-4595, Tensile Properties of Geotextiles by Wide Width Strip Method.

4. Open Area

a. The minimum open area shall be 60%.

5. Grid Aperture Size

a. The minimum grid aperture size is 0.6 inches (1.5 cm).

6. Material Handling Limitations

a. The geogrid material rolls to be supplied to the job site shall have the following general limitations.

1. The roll width range will be 15 feet to 18 feet wide.

2. The roll length range will be between 120 feet to 320 feet.

3. The roll total weight range will be between 120 pounds and 600 pounds.

7. Material Joints - Mechanical Connections (when applicable)

a. The geogrid vendor shall specify all materials, such as staples, plastic/wire ties, mechanical connectors, or other equally approved method/ material required to make the lap joints.

PART 3 EXECUTION

3.01 PREPARATION

A. Soil Preparation

1. Existing slopes outside of mud extents shall be benched as indicated on the drawings and conform to Specification Section 02222.

2. The excavation area shall be cleaned of all excess material and debris.

B. Geogrid Placement (Refer to Section 02223 also)

1. Reinforcement shall be rolled out on the pond surface in a regular pattern oriented either across the pond or along the length, but the roll length should be oriented in the direction of fill progression (place fill along the length of each roll, not across the rolls).

a. Geogrid does not have to be placed across the entire pond surface prior to start of backfill operations.

2. If multiple layers of grid are used, the layers should be placed at right angles.

a. A minimum of 2 layers of geogrid shall be used in the area of the mud relocation trench. Extreme caution shall be exercised when beginning fill

placement. At any sign of instability (operators discretion), work shall cease and additional layers of geogrid placed (1 at a time) before commencing placement of backfill until a firm surface (with 2' minimum of backfill) is attained.

3. Adjacent rolls shall be placed with an overlap of at least 4 feet.

4. End laps should be avoided, but when required, the end lap should be at least 10 feet.

5. Each panel should extend at least 5 feet beyond the limits of the pond mud.

6. The geogrid should be tensioned by hand until it is taut, free of wrinkles and lying flat.

7. If mechanical connections are made between adjacent rolls, they should be made using hog rings, wire ties or other appropriate means recommended by the manufacturer.

8. Weather conditions may require the geogrid to be held in place by staples, pins, sandbags, fill material, or other appropriate means recommended by the manufacturer.

9. If geogrid material cutting is required, use scissors, sharp knives, razor blades or abrasive saws as appropriate. The geogrid material should be cut to length to avoid extra splices.

10. Care should be taken to prevent mud, wet cement, epoxy and other similar materials which may permanently affix themselves to the grid work from coming in contact with the geogrid.

C. Soil Backfill

1. Backfill over geogrid shall meet the requirements of section 02223.

3.02 PROTECTION

A. The installation contractor shall not utilize any equipment or tools that might damage the geogrid or

underlying substrate by handling, trafficking, or other means.

3.03 INSTALLATION QUALITY CONTROL

A. Defects

1. The geogrid shall be inspected for defects, and any sign of contamination by foreign matter. The surface of the geogrid shall be free of mud, grease, or any other material that may inhibit defect inspection or the intended function of the geogrid.

B. Repairs

1. All defective (damaged) areas of placed geogrid shall be repaired in accordance with the manufacturer's recommendations.

3.04 QUALITY CONTROL FOR ACCEPTANCE

A. Testing and Inspection

1. All testing and inspection shall be performed in accordance with the approved SITA Plan.

END OF SECTION

SECTION V

DESIGN CALCULATIONS AND MATERIALS TEST DATA

Bechtel Nevada Engineering Department Sheet 1 of 5

ANALYSIS / CALCULATION (A/C) COVER SHEET

Project Title: CAU 417 Remediation	Project/Tracking No.: 98228A58	Analysis/Calculation No.: FD-DA-C-111

Subject:
Placement of Cap on UC1 CMP and UC4-C

Analysis / Calculation Status Designation: ☐ Preliminary ☒ Final ☐ Superseded

Computer Program / Title	Mainframe / PC	Program No.	Version / Release No.
UTEXAS3	PC		1.206

Rev 0 – Initial calculation, with checker comments attached
Rev. 1- Section 3.4 added to reflect use of initial fill layer only around edges of pond 1 area.
Settlement calculations also augmented

(1) See "checkers notes for Rev 0."
(2) See "Checkers notes for Rev 1."

Record of Revisions

Revision No.	Reason for Revision	Date	Prepared	Checked	Approval
0	Initial Issue	7/7/99	[illegible]	RJD (1)	
1	Construction Methodology Changes	11/9/99	[illegible]	RJD (2)	[illegible]

NTS CENTRAL NEVADA TEST SITE
PLACEMENT OF CAP ON UC-1 AND UC-4 PONDS
23220-247, 11/23/1999
CHECKERS NOTES FOR REV 1.
REVIEW OF CALCULATION DTD 11/09/99

This memorandum presents my comments on Rev. 1 to subject calculation.

Rev. 1 addresses a change in design to limit the perimeter thickness of fill over the pond mud surface to the initial lift thickness of 2 ft. This purpose of this change is to reduce construction costs.

Depending of the condition of the pond surface (wet, dry, desiccated, equipment, etc.) at the time of construction, the two feet of fill may not be stable under repeated dozer and truck traffic. The construction plan should account for this possibility.

The original construction concept was to advance an initial lift of fill across the pond, by limiting the advancing edge to 2 ft while progressively increasing the thickness of fill behind the leading edge to provide an adequate thickness for support of continuous hauling, dumping and spreading operations. Equipment would be routed over the fill to avoid repeated tracking that might overstress and cause progressive deterioration of the subgrade and to provide compaction of the fill.

The restriction of the perimeter fill to 2 ft will probably necessitate a revised placement procedure. The perimeter thickness may be overbuilt to support construction traffic and then trimmed back to design grade, local haul roads may be constructed of thicker fill to bridge the 2-ft thick perimeter, or a combination of both procedures may be used.

The condition of the pond surface at the time of construction, i.e. wet, dry desiccated, etc., will affect the method adopted. If soft spots develop in the fill during construction, they should be corrected immediately by additional fill, additional geogrid plus fill, etc. Continued operation on soft subgrade may lead to delays, design changes and/or escalation of costs.

Rudy J. Dietrich

NTS CENTRAL NEVADA TEST SITE
PLACEMENT OF CAP ON UC-1 AND UC-4 PONDS
23220-247, 7/25/99
CHECKERS NOTES FOR REV 0
REVIEW OF CALCULATION DTD 06/09/99

This memorandum presents my comments on subject calculation.

The recommended construction method is to cover the pond with geogrid and an initial, 2-ft layer of sand to establish a working surface for further placement of sand. The calculation addresses the stability of the initial layer and bearing capacity of equipment working on this surface. Stability of subsequent layers of fill and long-term settlement were also addressed.

Soil Parameters

The adopted soil parameters appear reasonable based on the data that are available. It should be noted that measurement of in situ mud , mud sampling and laboratory tests were based on simplified methods of limited scope. The application of these data requires appropriate conservatism.

Stability of a Two-foot lift

The stability of a 2-ft lift of initial fill has been analyzed by a separate, simplified calculation. Using the adopted soil properties, the calculated factor of safety is about 1.75. It should be noted that the LPG dozer which will be used to spread the initial lift will constitute a transient load with tracks oriented perpendicular to the face of the fill layer. This load may be neglected in the stability calculations.

Bearing Capacity of the Initial Two-foot Layer

The LGP dozer will develop a ground pressure of 5 psi on a 24-in. wide track. The bearing capacity factor of safety is estimated to be on the order of 1.25. This calculation also is based on the adopted soil properties.

Summary

While the factors of safety for stability and bearing capacity appear to be adequate without the use of geogrid reinforcement, it is considered prudent to specify the use of this material to compensate for uncertainties in the soils data and in the actual construction methods and equipment to be used.

Settlement Estimates

The estimated settlements are based on simplified consolidation tests and samples of limited quality. The estimates of settlement for UC-1 appear reasonable based on available data but are considered to be conservative. The estimates of settlement for UC-4 appear to be of the correct order of magnitude but are so small that they will not affect the design.

Construction Comments

The initial fill should be placed with a light LPG dozer (D-6 size). A 2-ft thickness of fill should be maintained at the leading edge. The thickness should be increased to about 4 ft at a distance of roughly 50 ft or more behind the leading face as required to support hauling and dumping operations. The dozer spreading the fill should be tracking perpendicular to the face of the fill and should not track parallel to the face in close proximity to the edge of fill. Repeated tracking on a uniform, 2-ft layer by the dozer or other equipment is not recommended and may be detrimental to the stability and bearing capacity of the fill. Hauling equipment should not be permitted near than 50 ft to face of the fill. Subsequent layers of fill may be of uniform thickness.

The initial fill should be compacted by systematically routing the dozer and hauling equipment over the fill. The subgrade of the lining system should be prepared, compacted, and proof rolled to provide a firm foundation for the engineered components of the cover system. It should be noted that the long-term behavior of the cap system for UC-1 will be largely controlled by settlement of the mud.

East Dike of UC-1

It is understood that the mud and dike along the east side of the pond will be removed to provide clearance from the ground displacement scarp. This material will be redeposited in a separate pit located to the west of UC-1.The excavation would then be backfilled to provide a relocated confinement dike for the pond which is set-back from the scarp.

It should be noted that the mud will vary from a very soft consistency solid to a highly plastic, viscous semi-fluid when remolded. The material may be difficult to remove from trucks and it can only be dumped in one layer. Trucks will not be able to travel on this material to place subsequent layers. Depending on the dimensions of the disposal area, a track-hoe or clam bucket may be required to place the material in the trench. Consideration should be given to spreading and partially drying this material before placing it in the disposal trench.

Rudy J. Dietrich

ABBREVIATIONS 3
1.0 PURPOSE 3
2.0 DESIGN BASIS 4
3.0 CALCULATION APPROACH 4
3.1 BASIC PROPERTIES AND DIMENSIONS 4
3.2 EVALUATE BEARING CAPACITY 6
3.3. EVALUATE SLOPE STABILITY OF INTERIM SLOPES 8
4.0 SETTLEMENT ANALYSES 10
6.0 REFERENCES 13
7.0 FIGURES AND TABLES 14
ATTACHMENT ..... A

20

ABBREVIATIONS

The following is a list of the abbreviations used in this calculation:

C_u - undrained strength
c_v – Coefficient of Consolidation
B – footing width
$C_{\varepsilon c}$ - strain related Virgin compression
$C_{\varepsilon r}$ - strain related recompression
D – depth of deposit (i.e. mud)
N – normal force
N_c - bearing capacity factor
P_c – Preconsolidation pressure
pcf. – pound per cubic foot
plf - pounds per liner foot
psf - pounds per square foot
tsf – tons per square foot
ϕ - Friction angle

1.0 PURPOSE

This document presents the analysis for placement of a closure cap over the existing bentonite muds in both UC-1 and UC-4 at the Central Nevada Test Site. The muds are essentially pure bentonite clay, but are contaminated with oils and chromium, thereby requiring closure with a cap. The mud pits have been investigated utilizing both field and laboratory test procedures to determine appropriate engineering properties for the mud, and the depths of the muds have been determined by probes at various locations.

This calculation presents an analysis showing that the ponds can be capped by placement of a geogrid directly on the exposed mud (they both have a surface crust of sufficient strength to allow pedestrian traffic on the pond surface), followed by placement of soil with construction equipment. This calculation presents the required properties of the geogrid, and shows the placement can be safely carried out with light-weight construction equipment. The presence of the geogrid is assumed to not affect the long term performance of the facility, but rather to allow for placement of the initial layers of fill over the soft mud deposits.

2.0 DESIGN BASIS

For the initial placement of soils over the bentonite muds, a geogrid reinforcement layer will be placed directly on the surface of the mud. Successive layers of soil fill will then be placed until sufficient bearing capacity is obtained for truck traffic. Over time, the bentonite muds will consolidate and gain strength, and the geogrid will be unnecessary for stability of the overlying soils.

3.0 CALCULATION APPROACH

For the analysis, the basic dimensions of Mud Pit UC-1 were used. Mud Pit UC-4 is shallower, smaller and contains stiffer muds, so that the design developed for UC-1 can be conservatively applied to UC-4.

The analysis included evaluation of bearing capacity, slope stability of the partially covered mud pit, and determination of the minimum acceptable strength of the geogrid to attain sufficient strength to safely cap the facility. Since the capping is a short term event, seismicity was not considered. The calculated factors of safety are short-term factors applicable only during construction. The long term factors of safety are significantly higher, but are not evaluated in this calculation.

The analysis is based on a 2-ft thick layer of initial fill over the geogrid-reinforced mud pit surface.

3.1 BASIC PROPERTIES AND DIMENSIONS

The analysis is performed on Mud Pit UC-1, and the design then conservatively applied to Mud Pit UC-4. Therefore all properties are for UC-1 unless otherwise noted.

<u>Mud Properties</u>

Depth of Mud = 5 ft (actually 2-4 ft average, with maximum recorded depth of 6.25 ft)
Mud Strength – From Field Vane testing – see Figure 1.

> Note: the readings shown on the Figure are the corrected peak vane readings, in which the peak rod readings (test apparatus without the vane tip), have been subtracted from the peak vane readings (test apparatus with the vane tip). In general, the rod readings were very high with respect to the vane readings, thereby producing corrected peak strength values which are lower than the strengths which will be actually attained in the mud. Thus the strengths are therefore conservative. Also note, that in many cases, negative strengths are shown. This is because the reading

with the rod only was higher than the strength reading obtained with both the rod and vane combined. Obviously, these results are erroneous, but are shown because no justifiable correction factors could be readily derived.

Based on Figure 1, the following strength profile was generated:

Depth	Corrected undrained strength
0-8 in.	3.5 psi = 500 psf
8-24 in.	0.8 psi = 115 psf
below 24 in.	0.5 psi = 72 psf

Density – from lab data summary sheet (Table 1)

Dry density = 30 pcf

Total density = 80 pcf

Groundwater is below the bottom of the mud deposit.

UC-4 mud strengths are shown on Figure 2 and are significantly higher than those of UC-1.

Overlying fill Properties

Total Density = 115 pcf (85% of Standard Proctor, since significant compaction of the initial layers of fill neither desired or needed.)

Strength – based on sieve analysis (12% gravel, 28% fines, low plasticity) the material is an SC,

a) by Navfac 7.1-149, ϕ= 30-35 degrees

b) by lab testing, measured ϕ = 32.5%

Use ϕ= 32°

Loads

The load from a placement dozer with a track pressure of 5 psi on 2-ft wide tracks placed 2 ft above the mud surface produces a surface pressure at the mud surface 6 ft wide at 1.67 psi, or 240 psf. This will be the initial equipment load.

3.2 EVALUATE BEARING CAPACITY

From the basic equation for a large loaded area
$FS = N_c \times C_u / \gamma \times H$, or $FS = C_u \times N_c$ / load,

Where:
C_u is the undrained mud strength,
N_c is the bearing capacity coefficient, and
load is the net load (track load).

Several methods should be considered for evaluation of bearing capacity . These are:

a) The effects of the geogrid are accounted for , but the underlying mud is assumed to be no stronger than its lowest strength;
b) The effects of the geogrid are ignored, but the effect of the crust over the weak mud is accounted for, and ;
c) The geogrid affects the selection of N_c, but the mud strength is the average strength over the length of the circular failure zone, not the weakest strength.

Case a) Geogrid reinforcement only
From the Mirafi Design Guide pg. 26 (see references), where B is very large (say over 25 ft on the pond surface), depth of mud D = 5 ft, B>.61 D, and the dry fill over the mud crust will be a rough interface, then,

$$N_c = 4.14+0.5B/D; \text{ or } N_c=4.14+0.5 * 25 \text{ ft}/5 \text{ ft} = 6.6$$

So FS = 6.6 × 72 psf (mud strength at depth) /load

Load = 2 ft × 115 pcf (2 ft of fill) + 240 psf (dozer load) = 470 psf

So FS = 6.6*72 psf / 470 psf = 1.01 for a 5 psi dozer load

For comparison, for a 1-ft soil cover thickness, FS = 1.00, and for a 3-ft thick fill cover thickness, FS = 0.91. This implies that about a 2-ft initial lift thickness is optimal.

Case b) Crust effects only
From Navfac, Pg 7.2-137, where c_1 is the crust with a 24 inch thickness and a strength of 115 psf, and c_2 is the lower mud with a strength of 72 psf, then $c_2/c_1 = 72/115 = 0.62$
For T/B where T = thickness of upper crust, and B= 25 feet, then T/B = 0.08 ≅ 0, then N_c is approximately 3.5, and

FS = 3.5 × 115 psf / 470 psf = 0.86 for a 5 psi dozer load

Case c) Geogrid and average subsurface strength
From Case a) above, $N_c = 6.6$
For the average shear strength, compute the average strength over the length of the failure circle through the mud, where the strengths by depth are given above in Section 3.1, and the total failure surface length is ½ of 2 x π x r (5'), or 15.7 feet.. An 8 inch thick layer subtends an angle of $\tan^{-1}$ (8"/60") = 7.6°, and the top 24 inches subtends a angle of $\tan^{-1}$ (24"/60") = 21.8°, so the second layer subtends 21.8° – 7.6° or 14.2°

Thus, the average shear strength becomes

C_u = [(500 psf x 2 x 7.6°/180° x 15.7') + (115 psf x 2 x 14.2°/180° x 15.7')
+(72 psf x (180° - 7.6° - 7.6° - 14.2° - 14.2°)/180° x 15.7')] / 15.7' = 115.2 psf

Now using the bearing capacity equation, with C_u = 115 psf and N_c = 6.6, the resulting FS is 1.61. This is not only the highest factor of safety from the three methods, but also the most representative as it includes the effects of both the geogrid and the variable strength of the system.

Summary
Thus, with grid, the factor of safety against bearing capacity failure of equipment on the pond is acceptable (see Case c).

Rev 2 Addition
Due to the desire to reduce the thickness of the cap, it has been postulated to reduce the thickness of the initial cover layer at the edge of the Pond 1 cap to 2 feet. The slope towards the center of the cap will be approximately 3% upwards. Thus, at the edge of the pond, the initial bulldozed layer will be the subgrade for the cap layers. For low ground pressure loads (i.e. LGP dozer, this has been shown to be acceptable. For a loaded truck, however, the following applies:

- C of mud = 115 psf (since mud is thin, lower strength material is not present)
- Truck load on one side of rear = 0.4 x 80k, = 32kips This load is spread over a tire area of 22" x 65" (approx.), and at a 2' depth, is spread over an area of approx. 6' x 9', yielding a load of 32k/54sf = 592 psf. Also add soil load of 2' at 105 pcf, = 592psf + 210 psf = 802 psf.
- N_c = 5.14 for B/D=1 (per Mirafi chart 5.2)

For FS = N_c x C / Load

$$= 5.14 \times 115 \text{ psf} / 802 \text{ psf} = 801 \text{ psf}/802 \text{ psf} = 1.0$$

This factor of safety is unacceptable for a loaded dump truck, since a bearing capacity failure would lead to catastrophic failure (a truck stuck in the mud).

Thus – the edge of the cap can be two foot thick instead of four feet provided:

1) Truck traffic is only allowed on areas where the fill is at least 4 foot thick.
2) Dozer activity is minimized in the areas with a thin cover, since the design is based on peak strengths, and with repeated disturbance, these strengths may degrade to the lower residual strengths.
3) Slopes approaching the thinner cover are nearly flat (i.e. less than 5%), so as to minimize the potential for slope instability (addressed in more detail below).
4) Construction crews are watchful for and act upon signs of pumping of the mud and slope instability. If areas are found to be degrading due to operations, remove the equipment from the mud surface, push fill over the thinned edges from the edge of the pond to thicken the cover of the area, and do not further disturb the area until sufficient time has passed for the area to regain a suitable degree of strength. All of these actions must be based on field observations and the acceptability of risk.

If significant softening of the cap edge is found, fill the entire area with 4 feet of cover initially, and then, just prior to cap subgrade preparation, remove the excess material from the pond edges. Do not remove the 2 foot of material providing the geogrid anchorage.

3.3 EVALUATE SLOPE STABILITY OF INTERIM SLOPES

During placement of the new fill over the mud pit, there will be a leading edge which must be evaluated for stability, including the weight of a dozer at some distance behind the slope face. Two cases were evaluated with the geogrid for this case.

Case 1

The first case evaluates the stability of the placement of the first lift over the mud. This is the lower profile shown on Figure 3, attached, and includes a dozer load as shown. The mud strength profile varies with depth in accordance with the design parameters established above.

Various potential configurations of failure surfaces were evaluated using the searching routines of UTEXAS3 (see references). Maximum tensile capacities of the geogrid were tried, and the following factors of safety were obtained using the method indicated.

Run name	Geogrid strength	Strength used in run	FS	Method
UC11	1000 plf	764 plf	2.03	Spencer's
UC12	700 plf	535 plf	1.64	Spencer's
UC13	400 plf	306 plf	1.31	Spencer's
UC13a	400 plf	not given	1.31	Bishops
UC13NR	none used	0	1.09	Spencer's

The results of Run UC13, including an output profile are included in Attachment A of this calculation. Note the factor of safety drops significantly if no geogrid is used.

Based on these analyses, we need a tensile strength of at least 400 plf. Per Bonaparte (see references), this strength should be developed with 4-6% strain. Additionally, per Koerner, a construction damage factor of safety of 1.6 should be added. So, specify a material with a strength of 640 plf – say 800 plf at 5% strain based on typical materials on the market.

A woven fabric could also attain this strength, but a longer embedment would be needed to develop the anchorage (material is slipperier).

Case 2

After the first 2-ft lift is placed, a second lift must be placed prior to deployment of trucks on the surface. The second case evaluated included the operation of trucks on top of a second 2-ft thick lift (4 ft total fill thickness). For the analysis, extend the grid only to the toe of the current slope, and NOT under the already placed fill in what is now the toe area. To do so, makes the computer analysis load the geogrid compressively, which is not realistic. After further trials, it was also found that Spencer's method of analysis produces negative normal loads in the fill at the toe, which is unrealistic and numerically destabilizing. Bishops method was found to produce more reasonable forces. Therefore, Bishops method was used for this case.

Load of 10 cy soil + truck = 37,000 lb. on 10 tires, or 3700 lb./tire, which is equivalent to 1,250 psf.

The tested configuration is shown in DASHED pattern on Figure 3, and includes the truck wheel load 7 ft behind the top of slope.

For case UC15b, in which 400 plf geogrid was used, an acceptable run was obtained (see Attachment A), and a factor of safety of 1.16 was obtained. When the geogrid strength was increased to 1,000 plf, the factor of safety increased, but the numerical distribution of forces become questionable. Therefore, the result for the 400 plf geogrid is presented, with the

recognition that stronger grid will produce a more stable embankment. This is acceptable, since the grid is used for support only during construction activities.

Conclusion and Embedment required

Geogrid material with a strength of 1,000 plf should be acceptable. Lateral spreading (sliding) is not of concern as long as the "slopes" are low. The pond muds will drain and gain strength with time, so long-term stability is not of concern.

Calculate embedment length required to develop 1000 plf.

Pullout = N tan (0.9*ϕ) = 2 ft * 115 pcf * tan (0.9*32°) = 126 lb./ft of embedment.
Therefore, 1,000 plf requires 7.9 ft embedment – say 10 ft.

For the cross machine direction, use 700 plf and a 4-ft panel overlap.

4.0 SETTLEMENT ANALYSES

Mud Pit UC-1

In Mud Pit UC-1 (see laboratory test summary Table 1, samples 550 and 551), the following properties were developed:

$C_{\varepsilon c}$ = 0.53 (strain related Virgin compression index)
$C_{\varepsilon r}$ = 0.07 (strain related recompression index)
P_c = .15 tsf = 300 psf (preconsolidation pressure)
D = 5 ft (depth of mud)
c_v = 0.006 ft^2/day

Using the in-house computer program Settler (see references) with varying amounts of fill placed over the mud pit, the following settlements (See Attachment A for selected computer runs) were calculated.

REV 2 additions/corrections

Mud Thickness	Fill Thickness	Fill Load	Settlement
2 ft	2 ft	210 psf	1.1 in
	4 ft	440 psf	3.0 in
	5 ft	550 psf	4.1 in
	10 ft	1100 psf	7.6 in
	15 ft	1650 psf	9.7 in
	20 ft	2200 psf	11.2 in
5 ft	2 ft	210 psf	1.7 in
	4 ft	440 psf	5.6 in
	5 ft	550 psf	7.9 in.
	10 ft	1100 psf	15.6 in.
	15 ft	1650 psf	20 in.
	20 ft	2200 psf	24. in
11 ft	2 ft	210 psf	2.4 in
	4 ft	440 psf	8.8 in
	5 ft	550 psf	12.7 in
	10 ft	1100 psf	27 in
	15 ft	1650 psf	36 in
	20 ft	2200 psf	43 in

A plot of the expected settlement for various mud thickness's and fill loads is shown on Figure 4.

For 90% consolidation with single drainage (assuming the lower surface of the mud is blinded off at the interface with the natural materials),

$$t = H^2/c_v T$$

Where:

t = time in years for consolidation to occur
H= effective drainage path length (5 ft)
T = Time factor = .848 for 90% consolidation

Then $t = (5ft)^2 / 0.006\ ft^2/day * .848 = 4{,}413$ days = 13.5 years, for 90% consolidation
If double drainage occurs (H= 2.5 ft), then t = 1,100 days = 3 years.

So settlement of Mud Pit UC-1 will be less than 2 feet, and 90% of the settlement will occur within 3 to 13.5 years.

Mud Pit UC-4

In Mud Pit UC-4 (see laboratory test summary, Table 1), the following properties were developed:

$C_{\varepsilon c} = 0.12$ (strain related Virgin compression index)
$C_{\varepsilon r} = 0.015$ (strain related recompression index)
$P_c = 400$ psf
$D = 2$ to 4 ft (depth of mud)
$c_v = 0.05$ ft^2/day

With varying amounts of fill placed over the mud pit, the following settlements were calculated.

Mud Thickness	Fill Load	Settlement
2 feet	200 psf	0.2 in.
	400 psf	0.3 in.
	600 psf	0.75 in.
	800 psf	1.1 in.
4 feet	200 psf	0.3 in.
	400 psf	0.5 in.
	600 psf	1.25 in.
	800 psf	1.8 in.

Ninety percent consolidation with single drainage of the 4-ft thick deposit (assuming the lower surface of the mud is blinded off at the interface with the natural materials), can be expected in about 1 year after fill placement. If double drainage occurs, that time is reduced to about 1/4 year. The thinner edge deposits will consolidate much more quickly.

So settlement of Mud Pit UC-4 will be less than 2 in., and 90% of the settlement will occur within 1 year.

6.0 REFERENCES

Bonaparte and Christopher, "Design and Construction of Reinforced Embankments over Weak Foundations", Transportation Research Record #1153, Jan 1987.

Koerner – Designing with Geosynthetics, 3rd edition, 1994.

Mirafi - Deign Methodology for Mirafi Reinforced Soil Slopes and Embankments, December 1992.

Navfac – Soil Mechanics Design Manuals, Department of the Navy, Naval Facilities Engineering Command, May 1982.

Settler – Settlement computer program written by Eric Strassburger, 1987.

UTEXAS3 – A Computer Program for Slope Stability Calculations, by S.G. Wright, Ver. 1.206, September 1991

7.0 FIGURES AND TABLES

Table 1 – Summary of Laboratory test Data

Figure 1- UC-1 Peak Strength (from Field Vane Data)

Figure 2 – UC-4 Peak Strength (from Field Vane Data)

Figure 3 – Stability Profiles analyzed using Utexas3

Figure 4 – Consolidation Settlement of CNTA UC-1

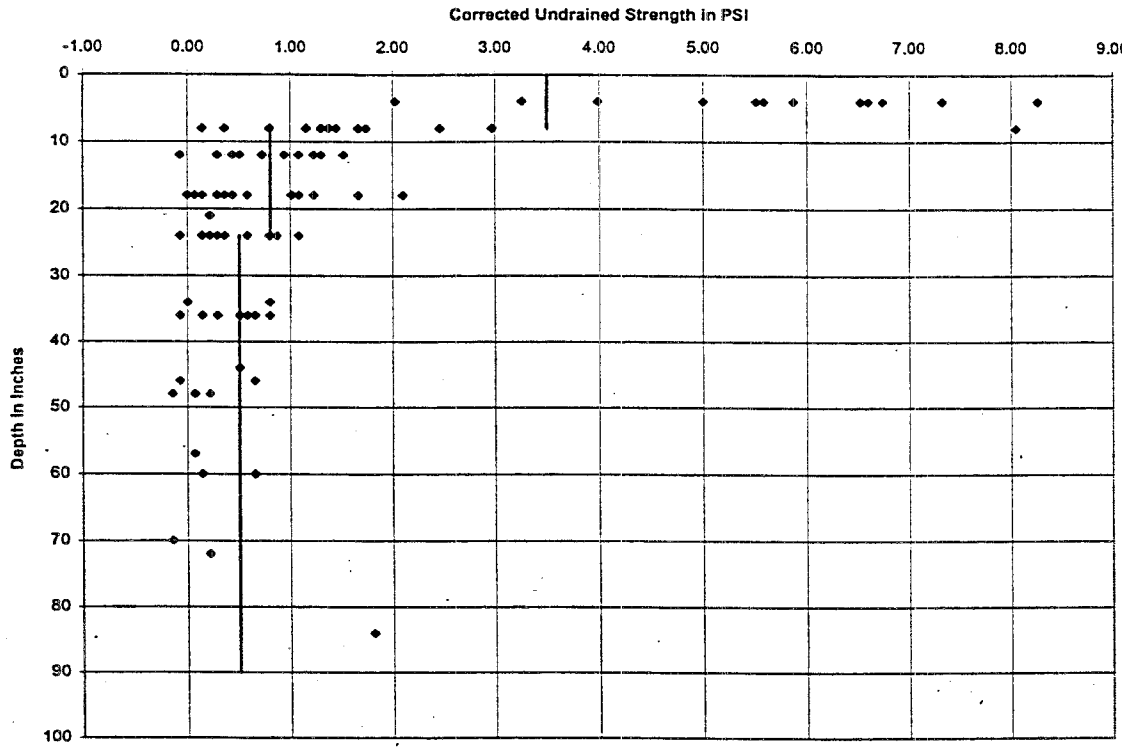
Summary of Laboratory Test Data, NTS CNTA Site

Central Nevada Test Site Laboratory Test Data							Atterberg Limits		Sieve						Consolidation				Strength			Compaction Tests		Rock Corrected				
Sample ID	Location	Material	Tested by	Dry Density	Total Density	Moisture Content	LL	PI	<#4	<# 40	<#200	USCS Class	Specific Gravity	Perm-eability cm/sec	Ccc	Ccr	Cv ft²/da	Pc tsf	Test Typ	c psf	Phi deg	Dry Den	Opt. m/c	Dry Den	Opt. m/c	% +3/4"	Other	Notes
548	Pit	Mud	MTL	26.5	79.8	201.1																						
550	Pit	Mud	MTL	27.3	77.8	185						CH			0.54	0.07	0.006	0.15										
551	Pit	Mud	MTL	26.8	76.8	186.4						CH			0.53	-	0.002	0.13										
600	Pit	Mud	MTL	29.9	81.7	173.1	162	122																				
615	Pit	Mud	MTL	32.1	82.7	157.6																						
616	Pit	Mud	MTL	32.3	81.8	153.2						CH			0.49	0.05	0.008	0.25										
617	Pit	Mud	MTL	39.4	88.8	125.3						CH			0.36	0.07	0.010	0.45										
618	Pit	Mud	MTL	32.5	82.7	154.6													UU	?	?						bad UU results	
430-439	Top of Pit	Mud	MTL																								pH vs % Lime, and %Bentonite = 10.6 to 12.6	
600a	Top of Pit	Mud	MTL				159	119	100	100	100	CH	2.662														pH vs % Lime = 12.0 to 12.6, Swell index = 14.5ml/2gm	
600b	Top of Pit	Mud	MTL				154	114	100	100	100	CH	2.66														Swell Index = 14.5ml/2gm	
600c	Top of Pit	Mud	MTL						100	100	100	CH	2.674															
	3'E of 4456	Mud	KP			56.1	91	69	100	3	94	CH	2.57															
	SW of CMP-3	Mud	KP			186.6	140	119	100	100	100	CH	2.57														60'S, 235'W of CMP-3	
	12'N of U4C5	Mud	KP			37.5		NP	100	100	92	ML	2.59															
	30'W of Comp3	Mud	KP			155.2	149	120	100	100	100	CH	2.67															
	3'N of CMP-6	Mud	KP		0.0	160.5	127	101	100	100	100	CH	2.58															
1235	UC-4	Mud	MTL	61.2	99.1	62									0.12	0.02	0.058	0.25										
1237	UC-4 @ 18"	Mud	MTL	70.7	107.3	51.7									0.11	0.01	0.013	0.20										
548	UC-1	Native	MTL											1.7E-03														From trench
553	UC-1	Native	MTL	102.8		9.3													UU	792	23						Questionable curve, remolded to field density	
553	Under Pit	Native	MTL	102.8		9.3																						
553	UC-1	Native	MTL			9.7			78	37	18	SM/SC?																
2001	W-1	Native	MTL			3.6			95	58	34	SM	2.633															
2002	W-2	Native	MTL			4			63	41	28	SC	2.63															
2003	W-3	Native	MTL			4.5			94	49	28	SM	2.633															
2004	N-1	Native	MTL			4.3			96	61	27	SM	2.632															
2005	N-2	Native	MTL			5.7			91	63	36	SM	2.641															
2006	N-3	Native	MTL			4.3			96	60	28	SM	2.633															
2007	E-1	Native	MTL			2.9			77	44	21	SM	2.634															
2008	E-2	Native	MTL			2.9			87	20	9	SC	2.649															
2009	S of Pit	Native	MTL	130.3		8.9								1.3E-06														Perm on remolded sample
2009	S of Pit	Native	MTL	129.8		9.8								3.0E-06														Perm on remolded sample
2009	S of Pit	Native	MTL	127.4		10.6								9.8E-06														Perm on remolded sample
2009	S of Pit	Native	MTL	124.0		6.9								1.8E-06														Perm on remolded sample
2009	S of Pit	Native	MTL	122.2		12.9								7.1E-08														Perm on remolded sample
2009	S of Pit	Native	MTL	117.4		9.3													UU	1150	33							UU at 90% RC at Opt m/c
2009	S of Pit	Native	MTL																			131	9.3				Modified Proctor	
2009	S of Pit	Native	MTL			5.1	27	8	66	49	28	SC	2.664														Rodded Unit Wt=108.9pcf, n=34.5%	
2009a	S of Pit	Native	MTL	120.5		13.1								1.7E-07														
2009a	S of Pit	Native	MTL	120.3		11.0								4.2E-05														
2009a	S of Pit	Native	MTL	118.4		14.1								1.5E-07														
2009a	S of Pit	Native	MTL	116.7		14.7								2.1E-08														
2009a	S of Pit	Native	MTL	110.0		8.7								2.5E-04														
2009a	S of Pit	Native	MTL																			123	11.8				Stnd Proctor	
2009b	S of Pit	Native	MTL	121.6		13.2								1.8E-07														
2009b	S of Pit	Native	MTL	116.5		15.0								4.1E-08														
2009b	S of Pit	Native	MTL	113.2		16.1								6.1E-08														
2009b	S of Pit	Native	MTL	111.5		11.4								1.2E-04														
2009b	S of Pit	Native	MTL	102.8		9.3								2.6E-04														
2009b	S of Pit	Native	MTL																			122	13.2				Reduced Stnd Proctor	
430, a, b	Pit mud w/4.5% lime		MTL				113	59																			4.5% lime added to mud	
1739	DT1,2-3.5'&DT5,3	UC-1 natl	MTL			3.5	20	NP	58	18	8	SP/SM	2.47									132	7.6	137	6.0	28	Mod. Proctor	
1740	DT2,2.5'&DT4,1'	UC-1 natl	MTL			5.5	26	10	81	45	24	SC	2.38									131	8.6	133	7.8	12	Mod. Proctor	
1741	DT2,7.5'&DT4,9'	UC-1 natl	MTL			3.7	20	NP	77	29	12	SM	2.28									132	8.8	133	8.1	10	Mod. Proctor	
1742	DT5,10'&DT6,10'	UC-1 natl	MTL			3.3	20	NP	55	21	7	SP/SM	2.45									130	7.7	135	6.1	25	Mod. Proctor	
1743	DT10, 5'	UC-1 natl	MTL			3.9	21	NP	58	26	11	SP/SM	2.38									130	7.7	134	6.2	27	Mod. Proctor	
1744	DT12,7'	UC-1 natl	MTL			4.4	23	3	58	29	13	SM	2.39									132	8.3	137	6.4	30	Mod. Proctor	

Calculation Sheet

Originator	Eric Strassburger	Date	11/9/99	Calc No.	C-111	Rev. No.	1
Project	NTS Central Nevada Site	Job No.	23220-247	Checked		Date	
Subject	Placement of Cap on UC-1 and UC-4					Sheet No.	16

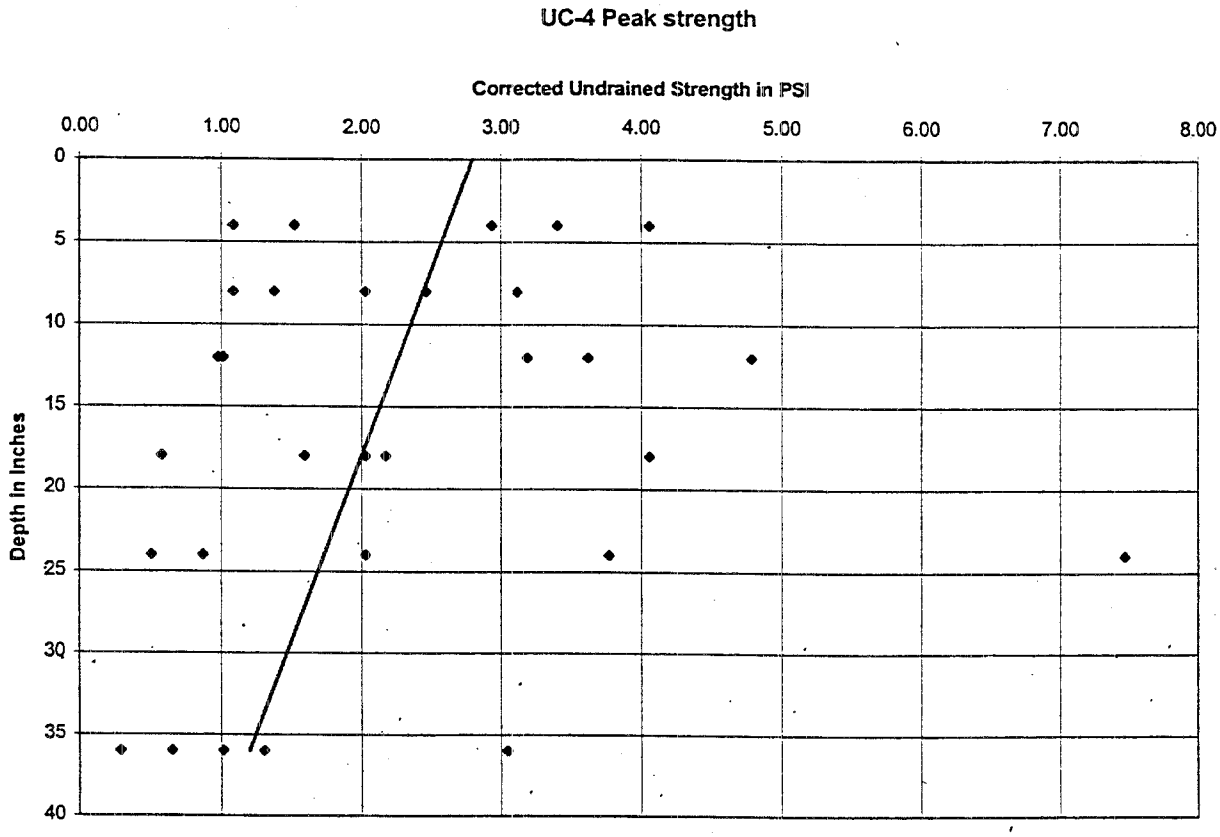
Figure 1 – UC-1 Peak Strength



Calculation Sheet

Originator	Eric Strassburger	Date	11/9/99	Calc No.	C-111	Rev. No.	1
Project	NTS Central Nevada Site	Job No.	23220-247	Checked		Date	
Subject	Placement of Cap on UC-1 and UC-4					Sheet No.	17

Figure 2 - UC-4 Peak Strength



Bechtel

Calculation Sheet

Originator Eric Strausburger Date 9/20/99 Calc. No. C-111 Rev. No. ~~0~~ 1

Project NTS CNTA Job No. Checked Date

Subject Placement of Cap on UC-1 Sheet No. ~~16~~ 18

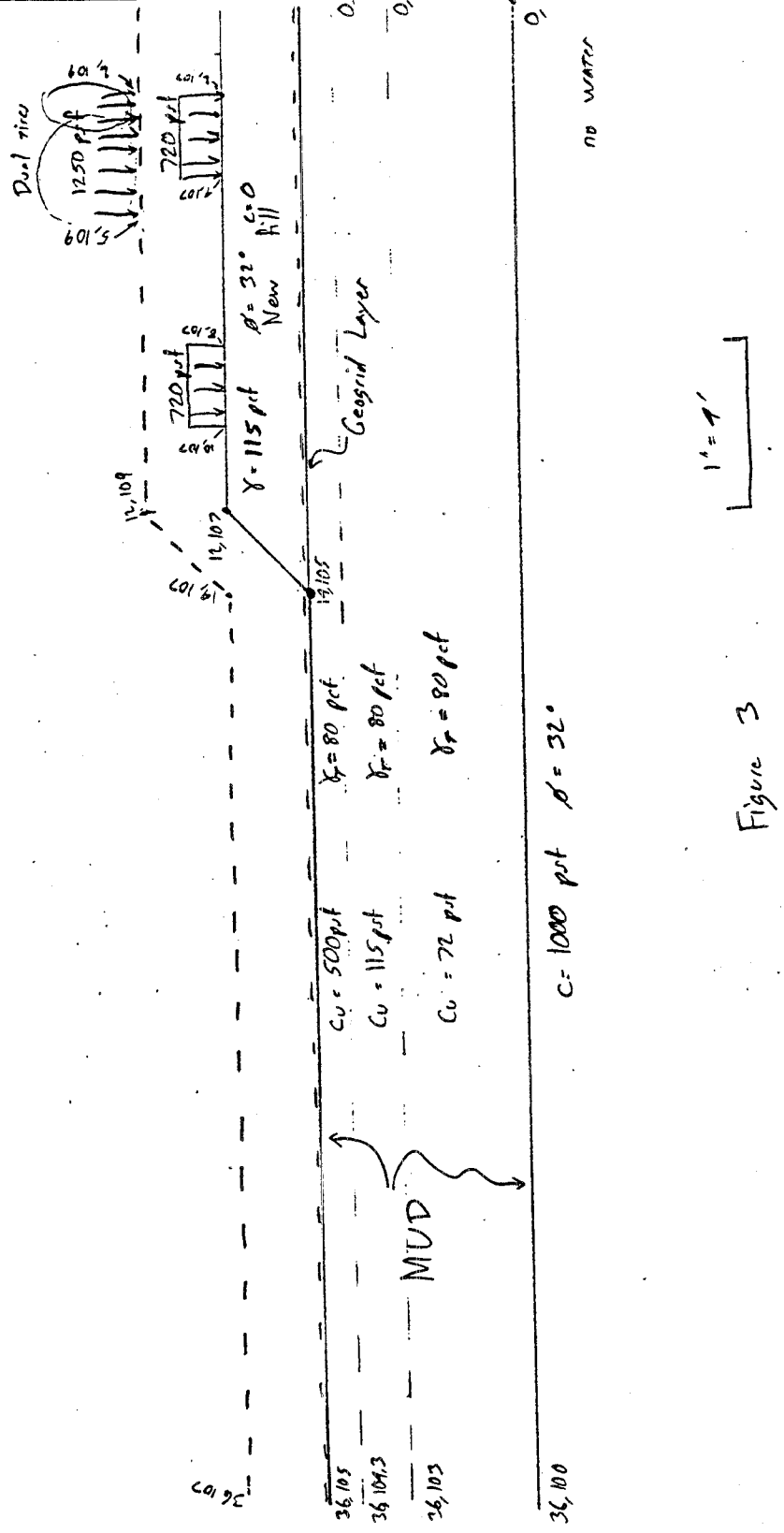
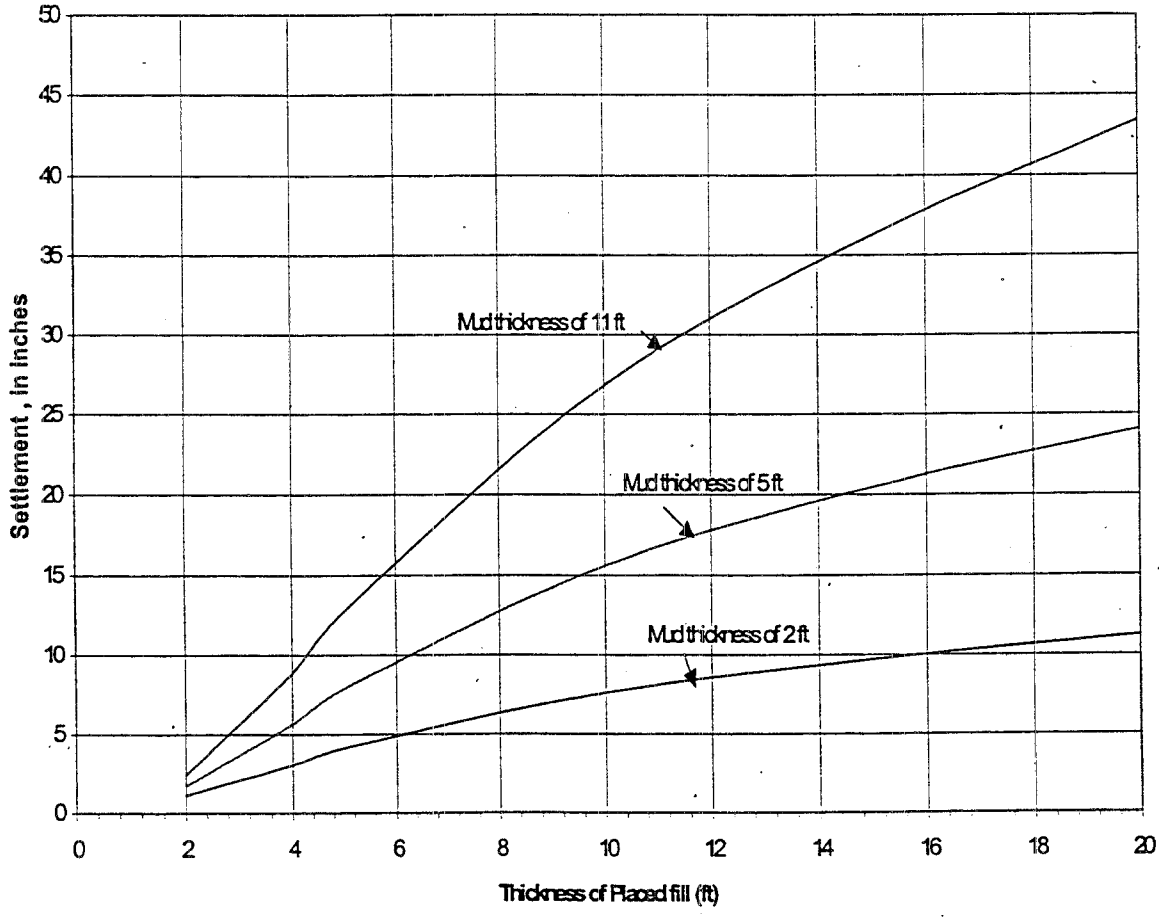


Figure 3

Calculation Sheet

Originator	Eric Strassburger	Date	11/9/99	Calc No.	C-111	Rev. No.	1
Project	NTS Central Nevada Site	Job No.	23220-247	Checked		Date	
Subject	Placement of Cap on UC-1 and UC-4					Sheet No.	19

Figure 4
Consolidation Settlement of CNTA UC-1



ATTACHMENT A

UTEXAS3 Computer Output
File UC13.
File UC13.ut3 output (plot)
File UC15b

Settler Computer Program Output
3 pages

```
1       UTEXAS3 - VER. 1.206 -  6/ 4/96 - (C) 1985-1996 S. G. WRIGHT
        One (1) copy licensed to Bechtel Corporation, Oak Ridge, TN
        Date:  7: 6:1999   Time: 18:45:31   Input file: uc13.utt

        TABLE NO. 1
        ****************************************
        * COMPUTER PROGRAM DESIGNATION - UTEXAS3 *
        * Originally Coded By Stephen G. Wright  *
        * Version No. 1.206                      *
        * Last Revision Date  6/ 4/96            *
        * (C) Copyright 1985-1996 S. G. Wright   *
        * All Rights Reserved                    *
        ****************************************

        ***************************************************************
        *                                                             *
        *      RESULTS OF COMPUTATIONS PERFORMED USING THIS COMPUTER *
        * PROGRAM SHOULD NOT BE USED FOR DESIGN PURPOSES UNLESS THEY *
        * HAVE BEEN VERIFIED BY INDEPENDENT ANALYSES, EXPERIMENTAL   *
        * DATA OR FIELD EXPERIENCE. THE USER SHOULD UNDERSTAND THE   *
        * ALGORITHMS AND ANALYTICAL PROCEDURES USED IN THE COMPUTER  *
        * PROGRAM AND MUST HAVE READ ALL DOCUMENTATION FOR THIS      *
        * PROGRAM BEFORE ATTEMPTING ITS USE.                         *
        *                                                             *
        *      NEITHER SHINOAK SOFTWARE NOR STEPHEN G. WRIGHT        *
        * MAKE OR ASSUME LIABILITY FOR ANY WARRANTIES, EXPRESSED OR  *
        * IMPLIED, CONCERNING THE ACCURACY, RELIABILITY, USEFULNESS  *
        * OR ADAPTABILITY OF THIS COMPUTER PROGRAM.                  *
        *                                                             *
        ***************************************************************
1       UTEXAS3 - VER. 1.206 -  6/ 4/96 - (C) 1985-1996 S. G. WRIGHT
        One (1) copy licensed to Bechtel Corporation, Oak Ridge, TN
        Date:  7: 6:1999   Time: 18:45:31   Input file: uc13.utt
        CNTA, UC-1 pond analysis, geogrid reinforcement over soft mud
        2 foot cover with 5psi LGP dozer.
        Strength (plf) = 400, 3'embedment req'd

        TABLE NO.  2
        *************************
        * NEW PROFILE LINE DATA *
        *************************

        PROFILE LINE  1 - MATERIAL TYPE =  1
        Placed Fill

            Point       X             Y

              1          .000       107.000
              2        12.000       107.000
              3        14.000       105.000

        PROFILE LINE  2 - MATERIAL TYPE =  2
        Upper crust of mud

            Point       X             Y

              1          .000       105.000
              2        14.000       105.000
              3        36.000       105.000

        PROFILE LINE  3 - MATERIAL TYPE =  3
        Middle crust of mud

            Point       X             Y
```

```
      1          .000        104.300
      2        36.000        104.300

PROFILE LINE  4 - MATERIAL TYPE =  4
Lower soft mud

     Point       X              Y

      1          .000        103.000
      2        36.000        103.000

PROFILE LINE  5 - MATERIAL TYPE =  5
Foundation soils

     Point       X              Y

      1          .000        100.000
      2        36.000        100.000

All new profile lines defined - No old lines retained

TABLE NO.  3
*********************************************************************
* NEW MATERIAL PROPERTY DATA - CONVENTIONAL/FIRST-STAGE COMPUTATIONS *
*********************************************************************

DATA FOR MATERIAL TYPE  1
Placed Fill

     Unit weight of material =  115.000

     CONVENTIONAL (ISOTROPIC) SHEAR STRENGTHS
     Cohesion - - - - - - - -          .000
     Friction angle - - - - -  32.000 degrees

     No (or zero) pore water pressures

DATA FOR MATERIAL TYPE  2
Upper crust

     Unit weight of material =   80.000

     CONVENTIONAL (ISOTROPIC) SHEAR STRENGTHS
     Cohesion - - - - - - - -      500.000
     Friction angle - - - - -     .000 degrees

     No (or zero) pore water pressures

DATA FOR MATERIAL TYPE  3
Middle crust of mud

     Unit weight of material =   80.000

     CONVENTIONAL (ISOTROPIC) SHEAR STRENGTHS
     Cohesion - - - - - - - -      115.000
     Friction angle - - - - -     .000 degrees

     No (or zero) pore water pressures

DATA FOR MATERIAL TYPE  4
Lower soft mud

     Unit weight of material =   80.000

     CONVENTIONAL (ISOTROPIC) SHEAR STRENGTHS
     Cohesion - - - - - - - -       72.000
     Friction angle - - - - -     .000 degrees
```

No (or zero) pore water pressures

DATA FOR MATERIAL TYPE 5
Foundation soils

Unit weight of material = 125.000

CONVENTIONAL (ISOTROPIC) SHEAR STRENGTHS
Cohesion - - - - - - - - 1000.000
Friction angle - - - - - 32.000 degrees

No (or zero) pore water pressures

All new material properties defined - No old data retained

TABLE NO. 10
****
* NEW SURFACE PRESSURE DATA - CONVENTIONAL/FIRST-STAGE COMPUTATIONS *
****

ALL NEW DATA INPUT - NO OLD DATA RETAINED

Surface Pressures -

Point	X	Y	Normal Pressure	Shear Stress
1	2.000	107.000	720.000	.000
2	4.000	107.000	720.000	.000
3	4.000	107.000	.000	.000
4	8.000	107.000	.000	.000
5	8.000	107.000	720.000	.000
6	10.000	107.000	720.000	.000

TABLE NO. 14
****
* NEW REINFORCEMENT LINE DATA *
* (USED FOR FIRST-STAGE AND SECOND-STAGE OF COMPUTATIONS) *
****

REINFORCEMENT LINE 1

Maximum rotation angle: 45.00
Option = 1 - Net reinforcement force on slice base
and boundaries applied

Point	X	Y	Longitudinal Force	Transverse Force
1	.000	105.000	.40000E+03	.00000E+00
2	10.000	105.000	.40000E+03	.00000E+00
3	14.000	105.000	.00000E+00	.00000E+00

All new reinforcement lines defined - No old lines retained

TABLE NO. 15
****
* NEW ANALYSIS/COMPUTATION DATA *
****

Circular Shear Surface(s)

Automatic Search Performed

Starting Center Coordinate for Search at -
X = 14.000
Y = 110.000

Required accuracy for critical center (= minimum
spacing between grid points) = .200

Critical shear surface not allowed to pass below Y = 90.000

For the initial mode of search
all circles are tangent to horizontal line at -
Y = 100.000

THE FOLLOWING REPRESENT EITHER DEFAULT OR PREVIOUSLY DEFINED VALUES:

Initial trial estimate for the factor of safety = 3.000

Initial trial estimate for side force inclination = 15.000 degrees
(Applicable to Spencer's procedure only)

Maximum number of iterations allowed for
calculating the factor of safety = 40

Allowed force imbalance for convergence = 100.000

Allowed moment imbalance for convergence = 100.000

Initial trial values for factor of safety (and side force inclination
for Spencer's procedure) will be kept constant during search

Maximum subtended angle to be used for subdivision of the
circle into slices = 3.00 degrees

Depth of crack = .000

Search will be continued to locate a more critical shear
surface (if one exists) after the initial mode is complete

Depth of water in crack = .000

Unit weight of water in crack = 62.400

Seismic coefficient = .000

Conventional (single-stage) computations to be performed

Procedure used to compute the factor of safety: SPENCER

TABLE NO. 16
****
* NEW SLOPE GEOMETRY DATA *
****

NOTE - NO DATA WERE INPUT, SLOPE GEOMETRY DATA
WERE GENERATED BY THE PROGRAM

Slope Coordinates -

Point	X	Y
1	.000	107.000
2	12.000	107.000
3	14.000	105.000
4	36.000	105.000

TABLE NO. 18
INFORMATION FOR CURRENT MODE OF SEARCH - All Circles Are Tangent
to a Horizontal Line at Y = 100.000

```
-----------------------------------------------------------------
                                    1-Stage
Center Coordinates                  Factor  Side Force
                                      of    Inclination
     X          Y        Radius    Safety   (degrees)   Iterations


      8.00    104.00      4.00 Center of circle is below lowest
                                point of slope - CIRCLE REJECTED
     14.00    104.00      4.00 Center of circle is below lowest
                                point of slope - CIRCLE REJECTED
     20.00    104.00      4.00 Center of circle is below lowest
                                point of slope - CIRCLE REJECTED
      8.00    110.00     10.00 See Message on Next Line(s)
CIRCLE DOES NOT INTERSECT SLOPE
     14.00    110.00     10.00 See Message on Next Line(s)
Last Trial Values =                2.049       6.53          4
(Last Trial Values Shown Above Are Not Correct Final Values)
VALUE OF SIDE FORCE INCLINATION BECAME OUTSIDE RANGE OF
FROM  -80.00 TO   10.00 DEGREES
     20.00    110.00     10.00  18.287       -.28         36
      8.00    116.00     16.00 See Message on Next Line(s)
CIRCLE DOES NOT INTERSECT SLOPE
     14.00    116.00     16.00   1.490        .74          6
     20.00    116.00     16.00   2.386      -2.70          4

      8.00    122.00     22.00 See Message on Next Line(s)
CIRCLE DOES NOT INTERSECT SLOPE
     14.00    122.00     22.00 See Message on Next Line(s)
CIRCLE DOES NOT INTERSECT SLOPE
     20.00    122.00     22.00   2.756       -.01          4

     13.00    115.00     15.00   1.438       1.84          6
     14.00    115.00     15.00   1.492        .41          6
     15.00    115.00     15.00   1.676       -.11          6
     13.00    116.00     16.00 See Message on Next Line(s)
CIRCLE DOES NOT INTERSECT SLOPE
     15.00    116.00     16.00   1.598       -.44          5
     13.00    117.00     17.00 See Message on Next Line(s)
CIRCLE DOES NOT INTERSECT SLOPE
     14.00    117.00     17.00   1.497       1.23          6
     15.00    117.00     17.00   1.598        .07          5

     12.00    114.00     14.00 See Message on Next Line(s)
CIRCLE DOES NOT INTERSECT SLOPE
     13.00    114.00     14.00   1.402       1.14          6
     14.00    114.00     14.00   1.496       -.30          6
     12.00    115.00     15.00 See Message on Next Line(s)
CIRCLE DOES NOT INTERSECT SLOPE
     12.00    116.00     16.00 See Message on Next Line(s)
CIRCLE DOES NOT INTERSECT SLOPE

     12.00    113.00     13.00   1.390       2.46          6
     13.00    113.00     13.00   1.409        .66          6
     14.00    113.00     13.00   1.618        .37          6

     11.00    112.00     12.00   1.481       4.02          6
     12.00    112.00     12.00   1.343       1.51          6
     13.00    112.00     12.00   1.440       -.23          6
     11.00    113.00     13.00 See Message on Next Line(s)
CIRCLE DOES NOT INTERSECT SLOPE
     11.00    114.00     14.00 See Message on Next Line(s)
CIRCLE DOES NOT INTERSECT SLOPE

     11.00    111.00     11.00   1.363       3.05          6
     12.00    111.00     11.00   1.362        .57          6
     13.00    111.00     11.00   1.646       1.28          6
```

11.40	111.40	11.40	1.325	2.43	6
12.00	111.40	11.40	1.353	1.08	6
12.60	111.40	11.40	1.418	-.20	6
11.40	112.00	12.00	1.393	2.97	6
12.60	112.00	12.00	1.388	.47	6
11.40	112.60	12.60	1.461	3.50	6
12.00	112.60	12.60	1.348	2.14	6
12.60	112.60	12.60	1.380	1.01	6
10.80	110.80	10.80	1.386	3.35	7
11.40	110.80	10.80	1.329	1.67	6
12.00	110.80	10.80	1.367	.20	6
10.80	111.40	11.40	1.459	4.05	6
10.80	112.00	12.00	See Message on Next Line(s)		

CIRCLE DOES NOT INTERSECT SLOPE

11.20	111.20	11.20	1.343	2.74	6
11.40	111.20	11.20	1.320	1.91	6
11.60	111.20	11.20	1.332	1.63	6
11.20	111.40	11.40	1.372	2.89	6
11.60	111.40	11.40	1.328	1.75	6
11.20	111.60	11.60	1.390	3.10	6
11.40	111.60	11.60	1.348	2.64	6
11.60	111.60	11.60	1.324	1.83	6
11.20	111.00	11.00	1.320	2.51	6
11.40	111.00	11.00	1.325	1.81	6
11.60	111.00	11.00	1.336	1.48	6
11.00	110.80	10.80	1.339	2.84	6
11.20	110.80	10.80	1.319	1.99	6
11.00	111.20	11.20	1.387	3.23	6
11.00	110.60	10.60	1.315	2.17	6
11.20	110.60	10.60	1.324	1.86	6
11.40	110.60	10.60	1.335	1.49	6
10.80	110.40	10.40	1.337	2.92	6
11.00	110.40	10.40	1.321	2.06	6
11.20	110.40	10.40	1.330	1.69	6
10.80	110.60	10.60	1.362	3.16	7

At the end of the current mode of search the most critical circle which was found has the following values -
X-center = 11.00 Y-center = 110.60 Radius = 10.60
Factor of Safety = 1.315 Side Force Inclination = 2.17

TABLE NO. 19
INFORMATION FOR CURRENT MODE OF SEARCH - All Circles Have the Same Radius - Radius = 10.600

Center Coordinates X	Center Coordinates Y	Radius	1-Stage Factor of Safety	Side Force Inclination (degrees)	Iterations
5.00	104.60	10.60	Center of circle is below lowest point of slope - CIRCLE REJECTED		
11.00	104.60	10.60	Center of circle is below lowest point of slope - CIRCLE REJECTED		
17.00	104.60	10.60	Center of circle is below lowest point of slope - CIRCLE REJECTED		
5.00	110.60	10.60	See Message on Next Line(s)		

CIRCLE DOES NOT INTERSECT SLOPE

17.00	110.60	10.60	1.671	-.11	6

```
     5.00     116.60     10.60 Opposite slope face - CIRCLE REJECTED
    11.00     116.60     10.60   3.811      -6.57          6
    17.00     116.60     10.60 See Message on Next Line(s)
CIRCLE DOES NOT INTERSECT SLOPE

    10.00     109.60     10.60 See Message on Next Line(s)
CIRCLE DOES NOT INTERSECT SLOPE
    11.00     109.60     10.60 See Message on Next Line(s)
Last Trial Values =              4.000     -21.47         41
(Last Trial Values Shown Above Are Not Correct Final Values)
FATAL ERROR IN CALCULATING FACTOR OF SAFETY
SOLUTION DID NOT CONVERGE WITHIN  40 ITERATIONS
    12.00     109.60     10.60   7.039      -8.50         12
    10.00     110.60     10.60   1.595       5.51          6
    12.00     110.60     10.60   1.380       -.14          6
    10.00     111.60     10.60   1.676       2.16          5
    11.00     111.60     10.60   1.564        .06          6
    12.00     111.60     10.60   1.737       -.78          6

    10.40     110.00     10.60 See Message on Next Line(s)
Last Trial Values =              5.000     -23.79         41
(Last Trial Values Shown Above Are Not Correct Final Values)
FATAL ERROR IN CALCULATING FACTOR OF SAFETY
SOLUTION DID NOT CONVERGE WITHIN  40 ITERATIONS
    11.00     110.00     10.60 See Message on Next Line(s)
Last Trial Values =              4.000     -26.16         41
(Last Trial Values Shown Above Are Not Correct Final Values)
FATAL ERROR IN CALCULATING FACTOR OF SAFETY
SOLUTION DID NOT CONVERGE WITHIN  40 ITERATIONS
    11.60     110.00     10.60   6.106      -7.63         11
    10.40     110.60     10.60   1.468       4.44          6
    11.60     110.60     10.60   1.346       1.02          6
    10.40     111.20     10.60   1.501       2.49          6
    11.00     111.20     10.60   1.451       1.02          6
    11.60     111.20     10.60   1.472       -.48          6

    10.80     110.40     10.60   4.643      -4.92          8
    11.00     110.40     10.60   4.442      -5.37          7
    11.20     110.40     10.60   4.281      -6.12          7
    10.80     110.60     10.60   1.362       3.16          7
    11.20     110.60     10.60   1.324       1.86          6
    10.80     110.80     10.60   1.370       2.61          6
    11.00     110.80     10.60   1.356       1.81          6
    11.20     110.80     10.60   1.365       1.48          6

At the end of the current mode of search the most critical
circle which was found has the following values -
X-center =     11.00     Y-center =    110.60     Radius =     10.60
Factor of Safety =   1.315     Side Force Inclination =   2.17

TABLE NO. 21
*****  1-STAGE FINAL CRITICAL CIRCLE INFORMATION  *****
X Coordinate of Center - - - - - - -    11.000
Y Coordinate of Center - - - - - - -   110.600
Radius - - - - - - - - - - - - - - -    10.600
Factor of Safety - - - - - - - - - -     1.315
Side Force Inclination - - - - - - -      2.17

Number of circles tried  - - - - - -  102
No. of circles F calc. for - - - - -   76

TABLE NO. 26
*************************************************************
*  Coordinate, Weight, Strength and Pore Water Pressure     *
*  Information for Individual Slices for Conventional       *
*  Computations or First Stage of Multi-Stage Computations. *
*  (Information is for the Critical Shear Surface in the    *
```

* Case of an Automatic Search.) *

****

Slice No.	X	Y	Slice Weight	Matl. Type	Cohesion	Friction Angle	Pore Pressure
	1.0	107.0					
1	1.1	106.7	6.0	1	.00	32.00	.0
	1.2	106.5					
2	1.3	106.2	20.3	1	.00	32.00	.0
	1.5	106.0					
3	1.6	105.7	37.2	1	.00	32.00	.0
	1.7	105.5					
4	1.9	105.2	56.6	1	.00	32.00	.0
	2.0	105.0					
5	2.0	105.0	.8	1	.00	32.00	.0
	2.0	105.0					
6	2.0	105.0	.0	2	500.00	.00	.0
	2.0	105.0					
7	2.2	104.8	75.9	2	500.00	.00	.0
	2.3	104.5					
8	2.4	104.4	47.0	2	500.00	.00	.0
	2.5	104.3					
9	2.6	104.1	103.6	3	115.00	.00	.0
	2.8	103.9					
10	3.0	103.7	122.9	3	115.00	.00	.0
	3.2	103.4					
11	3.4	103.2	142.7	3	115.00	.00	.0
	3.6	103.0					
12	3.6	103.0	17.5	3	115.00	.00	.0
	3.6	103.0					
13	3.8	102.8	157.4	4	72.00	.00	.0
	4.0	102.6					
14	4.2	102.5	184.5	4	72.00	.00	.0
	4.4	102.3					
15	4.6	102.1	204.6	4	72.00	.00	.0
	4.9	102.0					
16	5.1	101.8	224.1	4	72.00	.00	.0
	5.3	101.6					
17	5.6	101.5	243.0	4	72.00	.00	.0
	5.8	101.4					
18	6.1	101.2	260.9	4	72.00	.00	.0
	6.3	101.1					
19	6.6	101.0	277.7	4	72.00	.00	.0
	6.8	100.9					
20	7.1	100.8	293.1	4	72.00	.00	.0
	7.3	100.7					
21	7.6	100.6	306.9	4	72.00	.00	.0
	7.8	100.5					
22	7.9	100.5	93.3	4	72.00	.00	.0
	8.0	100.4					
23	8.3	100.4	322.3	4	72.00	.00	.0
	8.5	100.3					
24	8.8	100.2	331.9	4	72.00	.00	.0
	9.1	100.2					
25	9.4	100.1	339.6	4	72.00	.00	.0
	9.6	100.1					
26	9.8	100.1	232.7	4	72.00	.00	.0
	10.0	100.0					
27	10.3	100.0	347.5	4	72.00	.00	.0
	10.6	100.0					
28	10.8	100.0	281.0	4	72.00	.00	.0
	11.0	100.0					
29	11.3	100.0	349.2	4	72.00	.00	.0
	11.6	100.0					
30	11.8	100.0	279.4	4	72.00	.00	.0
	12.0	100.0					

31	12.3	100.1	326.1	4	72.00	.00	.0
	12.6	100.1					
32	12.8	100.2	285.5	4	72.00	.00	.0
	13.1	100.2					
33	13.4	100.3	243.9	4	72.00	.00	.0
	13.6	100.3					
34	13.8	100.4	141.0	4	72.00	.00	.0
	14.0	100.4					
35	14.3	100.5	189.3	4	72.00	.00	.0
	14.5	100.6					
36	14.8	100.7	178.1	4	72.00	.00	.0
	15.0	100.8					
37	15.3	100.9	165.7	4	72.00	.00	.0
	15.6	101.0					
38	15.8	101.2	152.2	4	72.00	.00	.0
	16.0	101.3					
39	16.3	101.4	137.8	4	72.00	.00	.0
	16.5	101.6					
40	16.8	101.7	122.7	4	72.00	.00	.0
	17.0	101.9					
41	17.2	102.0	107.1	4	72.00	.00	.0
	17.4	102.2					
42	17.7	102.4	91.2	4	72.00	.00	.0
	17.9	102.5					
43	18.1	102.7	75.4	4	72.00	.00	.0
	18.3	102.9					
44	18.3	103.0	16.5	4	72.00	.00	.0
	18.4	103.0					
45	18.6	103.2	55.9	3	115.00	.00	.0
	18.8	103.4					
46	19.0	103.6	40.9	3	115.00	.00	.0
	19.1	103.8					
47	19.3	104.0	26.6	3	115.00	.00	.0
	19.5	104.2					
48	19.5	104.3	2.2	3	115.00	.00	.0
	19.5	104.3					
49	19.7	104.5	12.0	2	500.00	.00	.0
	19.8	104.8					
50	19.9	104.9	1.5	2	500.00	.00	.0
	20.0	105.0					

TABLE NO. 27

```
*************************************************************
*  Seismic Forces and Forces Due to Surface Pressures for   *
*  Individual Slices for Conventional  Computations or the  *
*  First Stage of Multi-Stage Computations.                 *
*  (Information is for the Critical Shear Surface in the    *
*  Case of an Automatic Search.)                            *
*************************************************************
```

				FORCES DUE TO SURFACE PRESSURES			
Slice No.	X	Seismic Force	Y for Seismic Force	Normal Force	Shear Force	X	Y
1	1.1	0.	106.9	0.	0.	1.1	107.0
2	1.3	0.	106.6	0.	0.	1.3	107.0
3	1.6	0.	106.4	0.	0.	1.6	107.0
4	1.9	0.	106.1	0.	0.	1.9	107.0
5	2.0	0.	106.0	0.	0.	2.0	107.0
6	2.0	0.	106.0	0.	0.	2.0	107.0
7	2.2	0.	105.9	220.	0.	2.2	107.0
8	2.4	0.	105.8	122.	0.	2.4	107.0
9	2.6	0.	105.6	246.	0.	2.6	107.0
10	3.0	0.	105.5	262.	0.	3.0	107.0
11	3.4	0.	105.3	277.	0.	3.4	107.0
12	3.6	0.	105.2	32.	0.	3.6	107.0

13	3.8	0.	105.1	280.	0.	3.8	107.0
14	4.2	0.	104.9	0.	0.	4.2	107.0
15	4.6	0.	104.8	0.	0.	4.6	107.0
16	5.1	0.	104.6	0.	0.	5.1	107.0
17	5.6	0.	104.5	0.	0.	5.6	107.0
18	6.1	0.	104.4	0.	0.	6.1	107.0
19	6.6	0.	104.2	0.	0.	6.6	107.0
20	7.1	0.	104.1	0.	0.	7.1	107.0
21	7.6	0.	104.1	0.	0.	7.6	107.0
22	7.9	0.	104.0	0.	0.	7.9	107.0
23	8.3	0.	104.0	386.	0.	8.3	107.0
24	8.8	0.	103.9	391.	0.	8.8	107.0
25	9.4	0.	103.8	395.	0.	9.4	107.0
26	9.8	0.	103.8	268.	0.	9.8	107.0
27	10.3	0.	103.8	0.	0.	10.3	107.0
28	10.8	0.	103.8	0.	0.	10.8	107.0
29	11.3	0.	103.8	0.	0.	11.3	107.0
30	11.8	0.	103.8	0.	0.	11.8	107.0
31	12.3	0.	103.7	0.	0.	12.3	106.7
32	12.8	0.	103.4	0.	0.	12.8	106.2
33	13.4	0.	103.1	0.	0.	13.4	105.6
34	13.8	0.	102.8	0.	0.	13.8	105.2
35	14.3	0.	102.8	0.	0.	14.3	105.0
36	14.8	0.	102.9	0.	0.	14.8	105.0
37	15.3	0.	103.0	0.	0.	15.3	105.0
38	15.8	0.	103.1	0.	0.	15.8	105.0
39	16.3	0.	103.2	0.	0.	16.3	105.0
40	16.8	0.	103.4	0.	0.	16.8	105.0
41	17.2	0.	103.5	0.	0.	17.2	105.0
42	17.7	0.	103.7	0.	0.	17.7	105.0
43	18.1	0.	103.9	0.	0.	18.1	105.0
44	18.3	0.	104.0	0.	0.	18.3	105.0
45	18.6	0.	104.1	0.	0.	18.6	105.0
46	19.0	0.	104.3	0.	0.	19.0	105.0
47	19.3	0.	104.5	0.	0.	19.3	105.0
48	19.5	0.	104.6	0.	0.	19.5	105.0
49	19.7	0.	104.8	0.	0.	19.7	105.0
50	19.9	0.	104.9	0.	0.	19.9	105.0

TABLE NO. 28

```
*****************************************************************
*  Forces Due to Internal Soil Reinforcement for Conventional   *
*  Computations or First Stage of Multi-Stage Computations.     *
*  (Information is for the Critical Shear Surface in the        *
*  Case of an Automatic Search.)                                *
*****************************************************************
```

Slice No.	Horizontal Force	Vertical Force	Moment about Center of Slice Base	Resultant Force	Angle (degs.)
1	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
2	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
3	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
4	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
5	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
6	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
7	.1172E+03	.2828E+03	-.7033E+02	.3061E+03	67.50
8	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
9	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
10	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
11	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
12	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
13	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
14	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
15	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00

16	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
17	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
18	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
19	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
20	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
21	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
22	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
23	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
24	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
25	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
26	-.4000E+03	.0000E+00	.1973E+04	.4000E+03	180.00
27	.3446E+03	.0000E+00	-.1713E+04	.3446E+03	.00
28	-.4463E+02	.0000E+00	.2230E+03	.4463E+02	180.00
29	-.5548E+02	.0000E+00	.2770E+03	.5548E+02	180.00
30	-.4452E+02	.0000E+00	.2212E+03	.4452E+02	180.00
31	-.5509E+02	.0000E+00	.2710E+03	.5509E+02	180.00
32	-.5467E+02	.0000E+00	.2645E+03	.5467E+02	180.00
33	-.5409E+02	.0000E+00	.2558E+03	.5409E+02	180.00
34	-.3615E+02	.0000E+00	.1669E+03	.3615E+02	180.00
35	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
36	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
37	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
38	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
39	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
40	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
41	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
42	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
43	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
44	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
45	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
46	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
47	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
48	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
49	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
50	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00

TABLE NO. 38

```
*****************************************************************
*  Final Results for Stresses Along the Shear Surface           *
*  (Results for Critical Shear Surface in Case of a Search.)    *
*****************************************************************
```

SPENCER'S PROCEDURE USED TO COMPUTE FACTOR OF SAFETY
Factor of Safety = 1.315 Side Force Inclination = 2.17 Degrees

-------- VALUES AT CENTER OF BASE OF SLICE---------

Slice No.	X-center	Y-center	Total Normal Stress	Effective Normal Stress	Shear Stress
1	1.1	106.7	13.9	13.9	6.6
2	1.3	106.2	44.6	44.6	21.2
3	1.6	105.7	78.3	78.3	37.2
4	1.9	105.2	114.4	114.4	54.3
5	2.0	105.0	133.4	133.4	63.4
6	2.0	105.0	935.6	935.6	380.2
7	2.2	104.8	-566.7	-566.7	380.2
8	2.4	104.4	477.8	477.8	380.2
9	2.6	104.1	954.4	954.4	87.4
10	3.0	103.7	997.2	997.2	87.4
11	3.4	103.2	1037.2	1037.2	87.4
12	3.6	103.0	1058.6	1058.6	87.4
13	3.8	102.8	1110.5	1110.5	54.7
14	4.2	102.5	397.8	397.8	54.7

15	4.6	102.1	429.6	429.6	54.7
16	5.1	101.8	459.1	459.1	54.7
17	5.6	101.5	486.2	486.2	54.7
18	6.1	101.2	510.9	510.9	54.7
19	6.6	101.0	533.3	533.3	54.7
20	7.1	100.8	553.3	553.3	54.7
21	7.6	100.6	571.0	571.0	54.7
22	7.9	100.5	581.4	581.4	54.7
23	8.3	100.4	1317.7	1317.7	54.7
24	8.8	100.2	1328.3	1328.3	54.7
25	9.4	100.1	1336.7	1336.7	54.7
26	9.8	100.1	1301.2	1301.2	54.7
27	10.3	100.0	647.1	647.1	54.7
28	10.8	100.0	623.1	623.1	54.7
29	11.3	100.0	624.4	624.4	54.7
30	11.8	100.0	624.0	624.0	54.7
31	12.3	100.1	589.9	589.9	54.7
32	12.8	100.2	522.5	522.5	54.7
33	13.4	100.3	453.7	453.7	54.7
34	13.8	100.4	395.2	395.2	54.7
35	14.3	100.5	369.6	369.6	54.7
36	14.8	100.7	357.4	357.4	54.7
37	15.3	100.9	343.3	343.3	54.7
38	15.8	101.2	327.2	327.2	54.7
39	16.3	101.4	309.3	309.3	54.7
40	16.8	101.7	289.7	289.7	54.7
41	17.2	102.0	268.6	268.6	54.7
42	17.7	102.4	246.0	246.0	54.7
43	18.1	102.7	222.1	222.1	54.7
44	18.3	103.0	206.8	206.8	54.7
45	18.6	103.2	221.8	221.8	87.4
46	19.0	103.6	199.2	199.2	87.4
47	19.3	104.0	176.4	176.4	87.4
48	19.5	104.3	164.0	164.0	87.4
49	19.7	104.5	538.0	538.0	380.2
50	19.9	104.9	555.4	555.4	380.2

```
CHECK SUMS - (ALL SHOULD BE SMALL)
SUM OF FORCES IN VERTICAL DIRECTION     =          .00  (=  .253E-03)
     SHOULD NOT EXCEED      .100E+03
SUM OF FORCES IN HORIZONTAL DIRECTION   =          .00  (=  .165E-02)
     SHOULD NOT EXCEED      .100E+03
SUM OF MOMENTS ABOUT COORDINATE ORIGIN =          5.97  (=  .597E+01)
     SHOULD NOT EXCEED      .100E+03
SHEAR STRENGTH/SHEAR FORCE CHECK-SUM    =          .00  (=  .804E-04)
     SHOULD NOT EXCEED      .100E+03

***** CAUTION ***** EFFECTIVE OR TOTAL NORMAL STRESS ON SHEAR
                    SURFACE IS NEGATIVE AT POINTS ALONG THE
                    UPPER ONE-HALF OF THE SHEAR SURFACE - A
                    TENSION CRACK MAY BE NEEDED.
```

TABLE NO. 39

```
*****************************************************************
*  Final Results for Side Forces and Stresses Between Slices.  *
*  (Results for Critical Shear Surface in Case of a Search.)   *
*****************************************************************

SPENCER'S PROCEDURE USED TO COMPUTE FACTOR OF SAFETY
Factor of Safety =  1.315     Side Force Inclination =   2.17 Degrees

    --------------- VALUES AT RIGHT SIDE OF SLICE ----------------

                          Y-Coord. of   Fraction   Sigma     Sigma
Slice                Side  Side Force      of        at        at
```

No.	X-Right	Force	Location	Height	Top	Bottom
1	1.2	6.	106.7	.507	11.8	10.8
2	1.5	24.	106.4	.378	6.1	39.9
3	1.7	53.	106.0	.354	4.3	65.2
4	2.0	92.	105.7	.346	3.7	88.8
5	2.0	93.	105.7	.346	3.6	89.1
6	2.0	93.	105.7	.346	3.6	89.1
7	2.3	-169.	103.8	BELOW	252.3	-389.3
8	2.5	-120.	103.6	BELOW	156.1	-245.2
9	2.8	268.	104.3	.136	-100.7	271.1
10	3.2	654.	103.9	.135	-218.6	586.1
11	3.6	1035.	103.7	.162	-268.6	791.3
12	3.6	1077.	103.7	.165	-271.6	810.0
13	4.0	1456.	103.5	.187	-293.3	960.8
14	4.4	1574.	103.4	.236	-195.5	862.8
15	4.9	1693.	103.3	.272	-124.3	794.6
16	5.3	1810.	103.2	.298	-70.9	746.1
17	5.8	1922.	103.2	.319	-29.7	710.6
18	6.3	2027.	103.1	.335	2.9	683.9
19	6.8	2124.	103.0	.348	29.4	662.7
20	7.3	2210.	102.9	.358	51.6	645.1
21	7.8	2284.	102.9	.367	70.8	629.4
22	8.0	2303.	102.9	.369	76.0	625.0
23	8.5	2462.	102.7	.362	62.5	670.9
24	9.1	2585.	102.6	.358	56.3	700.8
25	9.6	2670.	102.6	.358	56.2	716.1
26	10.0	2304.	102.1	.297	-71.5	733.9
27	10.6	2644.	102.5	.358	57.0	698.7
28	11.0	2580.	102.5	.358	55.0	681.7
29	11.6	2485.	102.5	.358	51.9	659.1
30	12.0	2396.	102.5	.357	49.2	639.5
31	12.6	2271.	102.6	.387	115.8	600.7
32	13.1	2137.	102.6	.423	201.1	549.0
33	13.6	1996.	102.7	.465	314.3	479.3
34	14.0	1901.	102.7	.500	414.8	417.2
35	14.5	1809.	102.8	.510	436.3	386.2
36	15.0	1710.	103.0	.521	459.4	354.5
37	15.6	1604.	103.1	.534	485.0	322.3
38	16.0	1495.	103.3	.547	513.6	289.5
39	16.5	1383.	103.5	.560	546.0	256.5
40	17.0	1270.	103.7	.574	583.4	224.3
41	17.4	1158.	103.8	.588	626.7	194.9
42	17.9	1048.	104.0	.599	676.6	172.5
43	18.3	943.	104.2	.605	731.5	167.6
44	18.4	918.	104.2	.604	745.5	171.5
45	18.8	796.	104.4	.613	831.7	160.3
46	19.1	680.	104.5	.600	916.6	230.0
47	19.5	573.	104.6	.509	805.8	721.3
48	19.5	562.	104.6	.486	736.5	867.8
49	19.8	196.	104.9	.489	745.5	852.5
50	20.0	0.	104.1	BELOW	.0	.0

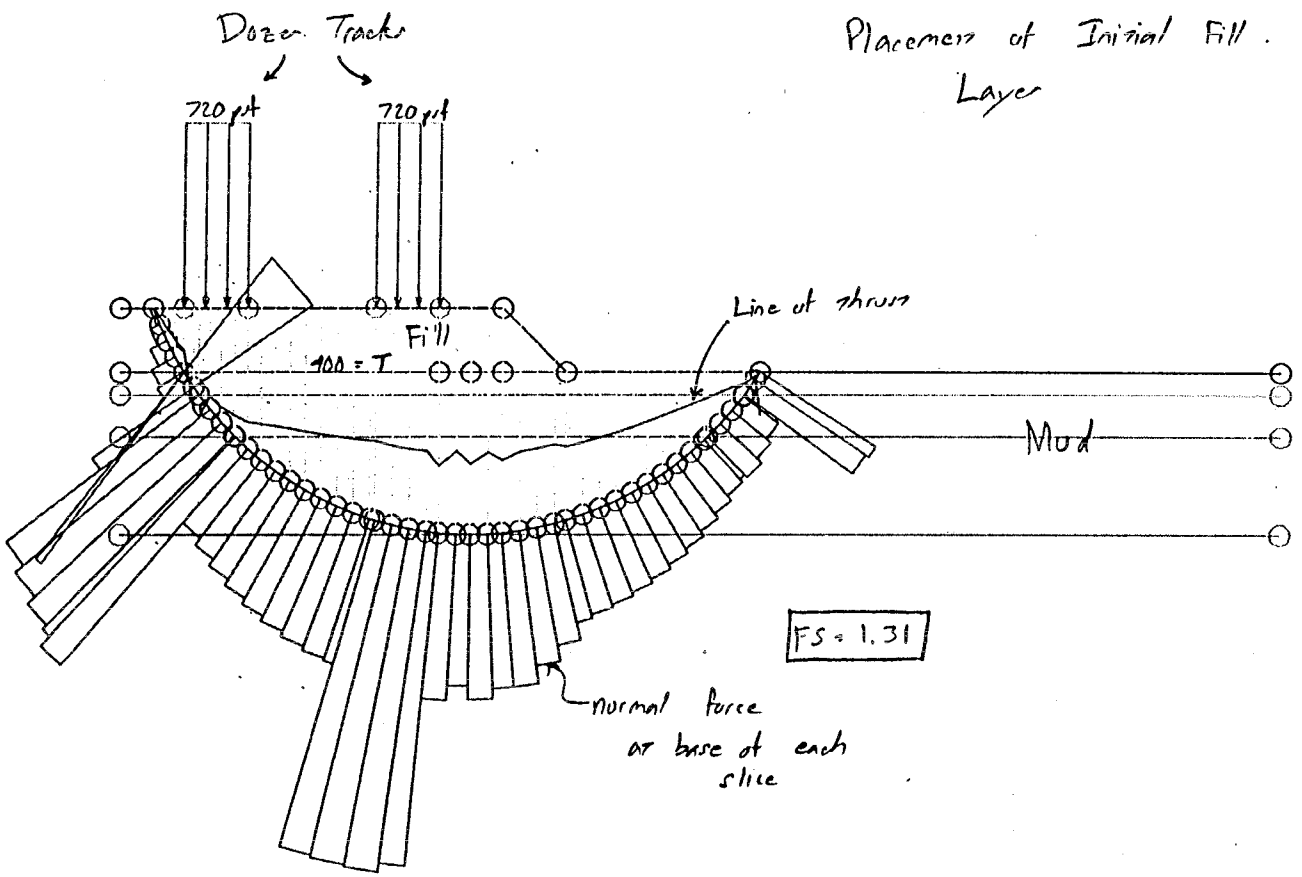
```
CHECK SUMS - (ALL SHOULD BE SMALL)
SUM OF FORCES IN VERTICAL DIRECTION     =          .00   (=  .253E-03)
     SHOULD NOT EXCEED      .100E+03
SUM OF FORCES IN HORIZONTAL DIRECTION   =          .00   (=  .165E-02)
     SHOULD NOT EXCEED      .100E+03
SUM OF MOMENTS ABOUT COORDINATE ORIGIN  =         5.97   (=  .597E+01)
     SHOULD NOT EXCEED      .100E+03
SHEAR STRENGTH/SHEAR FORCE CHECK-SUM    =          .00   (=  .804E-04)
     SHOULD NOT EXCEED      .100E+03

***** CAUTION ***** FORCES BETWEEN SLICES ARE NEGATIVE AT POINTS
                    ALONG THE UPPER ONE-HALF OF THE SHEAR SURFACE -
                    A TENSION CRACK MAY BE NEEDED.
```

```
***** CAUTION ***** SOME OF THE FORCES BETWEEN SLICES ACT AT POINTS
                    ABOVE THE SURFACE OF THE SLOPE OR BELOW THE
                    SHEAR SURFACE - EITHER A TENSION CRACK MAY BE
                    NEEDED OR THE SOLUTION MAY NOT BE A VALID SOLUTION.

END-OF-FILE ENCOUNTERED WHILE READING COMMAND
WORDS - END OF PROBLEM(S) ASSUMED
```

Placement of Initial Fill Layer



no scale

file
UCB.ut3

```
1         UTEXAS3 - VER. 1.206 -  6/ 4/96 - (C) 1985-1996 S. G. WRIGHT
          One (1) copy licensed to Bechtel Corporation, Oak Ridge, TN
          Date:  7: 6:1999   Time: 18:58:43   Input file: uc15b.utt


          TABLE NO. 1
          ******************************************
          * COMPUTER PROGRAM DESIGNATION - UTEXAS3 *
          * Originally Coded By Stephen G. Wright  *
          * Version No. 1.206                      *
          * Last Revision Date  6/ 4/96            *
          * (C) Copyright 1985-1996 S. G. Wright   *
          * All Rights Reserved                    *
          ******************************************

          ***************************************************************
          *                                                             *
          *      RESULTS OF COMPUTATIONS PERFORMED USING THIS COMPUTER *
          * PROGRAM SHOULD NOT BE USED FOR DESIGN PURPOSES UNLESS THEY *
          * HAVE BEEN VERIFIED BY INDEPENDENT ANALYSES, EXPERIMENTAL   *
          * DATA OR FIELD EXPERIENCE. THE USER SHOULD UNDERSTAND THE   *
          * ALGORITHMS AND ANALYTICAL PROCEDURES USED IN THE COMPUTER  *
          * PROGRAM AND MUST HAVE READ ALL DOCUMENTATION FOR THIS      *
          * PROGRAM BEFORE ATTEMPTING ITS USE.                         *
          *                                                             *
          *      NEITHER SHINOAK SOFTWARE NOR STEPHEN G. WRIGHT        *
          * MAKE OR ASSUME LIABILITY FOR ANY WARRANTIES, EXPRESSED OR  *
          * IMPLIED, CONCERNING THE ACCURACY, RELIABILITY, USEFULNESS  *
          * OR ADAPTABILITY OF THIS COMPUTER PROGRAM.                  *
          *                                                             *
          ***************************************************************
1         UTEXAS3 - VER. 1.206 -  6/ 4/96 - (C) 1985-1996 S. G. WRIGHT
          One (1) copy licensed to Bechtel Corporation, Oak Ridge, TN
          Date:  7: 6:1999   Time: 18:58:43   Input file: uc15b.utt
          CNTA, UC-1 pond analysis, geogrid reinforcement over soft mud
          2 to 4 ft cover with truck at 9' back, BISHOPS
          Strength (plf) = 400 extending only to toe

          TABLE NO.  2
          *************************
          * NEW PROFILE LINE DATA *
          *************************

          PROFILE LINE  1 - MATERIAL TYPE =  1
          Placed Fill

              Point       X             Y

                1          .000       109.000
                2        22.000       109.000
                3        24.000       107.000
                4        46.000       107.000

          PROFILE LINE  2 - MATERIAL TYPE =  2
          Upper crust of mud

              Point       X             Y

                1          .000       105.000
                2        46.000       105.000

          PROFILE LINE  3 - MATERIAL TYPE =  3
          Middle crust of mud

              Point       X             Y
```

```
      1          .000       104.300
      2        46.000       104.300

PROFILE LINE  4 - MATERIAL TYPE =  4
Lower soft mud

     Point      X             Y

      1          .000       103.000
      2        46.000       103.000

PROFILE LINE  5 - MATERIAL TYPE =  5
Foundation soils

     Point      X             Y

      1          .000       100.000
      2        46.000       100.000

All new profile lines defined - No old lines retained

TABLE NO.  3
*********************************************************************
* NEW MATERIAL PROPERTY DATA - CONVENTIONAL/FIRST-STAGE COMPUTATIONS *
*********************************************************************

DATA FOR MATERIAL TYPE  1
Placed Fill

     Unit weight of material =  115.000

     CONVENTIONAL (ISOTROPIC) SHEAR STRENGTHS
     Cohesion - - - - - - - -          .000
     Friction angle - - - - -  32.000 degrees

     No (or zero) pore water pressures

DATA FOR MATERIAL TYPE  2
Upper crust

     Unit weight of material =   80.000

     CONVENTIONAL (ISOTROPIC) SHEAR STRENGTHS
     Cohesion - - - - - - - -      500.000
     Friction angle - - - - -     .000 degrees

     No (or zero) pore water pressures

DATA FOR MATERIAL TYPE  3
Middle crust of mud

     Unit weight of material =   80.000

     CONVENTIONAL (ISOTROPIC) SHEAR STRENGTHS
     Cohesion - - - - - - - -      115.000
     Friction angle - - - - -     .000 degrees

     No (or zero) pore water pressures

DATA FOR MATERIAL TYPE  4
Lower soft mud

     Unit weight of material =   80.000

     CONVENTIONAL (ISOTROPIC) SHEAR STRENGTHS
     Cohesion - - - - - - - -       72.000
     Friction angle - - - - -     .000 degrees
```

No (or zero) pore water pressures

DATA FOR MATERIAL TYPE 5
Foundation soils

Unit weight of material = 125.000

CONVENTIONAL (ISOTROPIC) SHEAR STRENGTHS
Cohesion - - - - - - - - 1000.000
Friction angle - - - - - 32.000 degrees

No (or zero) pore water pressures

All new material properties defined - No old data retained

TABLE NO. 10
```
*********************************************************************
* NEW SURFACE PRESSURE DATA - CONVENTIONAL/FIRST-STAGE COMPUTATIONS *
*********************************************************************
```

ALL NEW DATA INPUT - NO OLD DATA RETAINED

Surface Pressures -

Point	X	Y	Normal Pressure	Shear Stress
1	10.000	109.000	1250.000	.000
2	13.000	109.000	1250.000	.000

TABLE NO. 14
```
*************************************************************
*                NEW REINFORCEMENT LINE DATA                *
* (USED FOR FIRST-STAGE AND SECOND-STAGE OF COMPUTATIONS) *
*************************************************************
```

REINFORCEMENT LINE 1

Maximum rotation angle: 70.00
Option = 1 - Net reinforcement force on slice base
and boundaries applied

Point	X	Y	Longitudinal Force	Transverse Force
1	.000	105.000	.40000E+03	.00000E+00
2	22.000	105.000	.40000E+03	.00000E+00
3	24.000	105.000	.00000E+00	.00000E+00

All new reinforcement lines defined - No old lines retained

TABLE NO. 15
```
*********************************
* NEW ANALYSIS/COMPUTATION DATA *
*********************************
```

Circular Shear Surface(s)

Automatic Search Performed

Starting Center Coordinate for Search at -
X = 26.000
Y = 110.000

Required accuracy for critical center (= minimum
spacing between grid points) = .100

Critical shear surface not allowed to pass below Y = 90.000

For the initial mode of search
all circles are tangent to horizontal line at -
Y = 100.000

Initial trial estimate for the factor of safety = 1.500

Procedure used to compute the factor of safety: BISHOP

THE FOLLOWING REPRESENT EITHER DEFAULT OR PREVIOUSLY DEFINED VALUES:

Maximum number of iterations allowed for
calculating the factor of safety = 40

Allowed force imbalance for convergence = 100.000

Allowed moment imbalance for convergence = 100.000

Initial trial values for factor of safety (and side force inclination for Spencer's procedure) will be kept constant during search

Maximum subtended angle to be used for subdivision of the circle into slices = 3.00 degrees

Depth of crack = .000

Search will be continued to locate a more critical shear surface (if one exists) after the initial mode is complete

Depth of water in crack = .000

Unit weight of water in crack = 62.400

Seismic coefficient = .000

Conventional (single-stage) computations to be performed

TABLE NO. 18
INFORMATION FOR CURRENT MODE OF SEARCH - All Circles Are Tangent to a Horizontal Line at Y = 100.000

Center Coordinates X	Y	Radius	1-Stage Factor of Safety	Side Force Inclination (degrees)	Iterations
26.00	116.00	16.00	2.144	Horiz.	5
17.00	113.00	13.00	1.621	Horiz.	10
Message on the following line(s) applies to the above circle					
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR 2 SLICES					
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW - 49 50					
17.00	116.00	16.00	1.854	Horiz.	6
17.00	119.00	19.00	2.093	Horiz.	6
20.00	119.00	19.00	1.504	Horiz.	4
23.00	119.00	19.00	1.256	Horiz.	5
26.00	119.00	19.00	1.705	Horiz.	6
20.00	122.00	22.00	1.711	Horiz.	4
23.00	122.00	22.00	1.401	Horiz.	5
26.00	122.00	22.00	1.672	Horiz.	5
22.50	118.50	18.50	1.228	Horiz.	4

```
     23.00     118.50     18.50   1.265     Horiz.          4
     23.50     118.50     18.50   1.335     Horiz.          4
     22.50     119.00     19.00   1.258     Horiz.          5
     23.50     119.00     19.00   1.324     Horiz.          4
     22.50     119.50     19.50   1.287     Horiz.          6
     23.00     119.50     19.50   1.251     Horiz.          5
     23.50     119.50     19.50   1.314     Horiz.          4

     22.00     118.00     18.00   1.237     Horiz.          5
     22.50     118.00     18.00   1.210     Horiz.          6
     23.00     118.00     18.00   1.276     Horiz.          4
     22.00     118.50     18.50   1.267     Horiz.          6
     22.00     119.00     19.00   1.297     Horiz.          6

     22.00     117.50     17.50   1.208     Horiz.          7
     22.50     117.50     17.50   1.222     Horiz.          6
     23.00     117.50     17.50   1.287     Horiz.          4

     21.50     117.00     17.00   1.220     Horiz.          7
     22.00     117.00     17.00   1.181     Horiz.          7
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   1 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    45    45
     22.50     117.00     17.00   1.234     Horiz.          5
     21.50     117.50     17.50   1.249     Horiz.          6
     21.50     118.00     18.00   1.279     Horiz.          6

     21.50     116.50     16.50 See Message on Next Line(s)
Last Trial Values =                1.503     Horiz.         41
(Last Trial Values Shown Above Are Not Correct Final Values)
FATAL ERROR IN CALCULATING FACTOR OF SAFETY
SOLUTION DID NOT CONVERGE WITHIN  40 ITERATIONS
     22.00     116.50     16.50   1.192     Horiz.          7
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    46    47
     22.50     116.50     16.50   1.246     Horiz.          5
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    46    47

     21.70     116.70     16.70   1.188     Horiz.          8
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   1 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    45    45
     22.00     116.70     16.70   1.181     Horiz.          7
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   1 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    45    45
     22.30     116.70     16.70   1.217     Horiz.          6
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   1 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    45    45
     21.70     117.00     17.00   1.204     Horiz.          6
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   1 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    45    45
     22.30     117.00     17.00   1.209     Horiz.          6
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   1 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    45    45
     21.70     117.30     17.30   1.221     Horiz.          6
     22.00     117.30     17.30   1.197     Horiz.          7
     22.30     117.30     17.30   1.202     Horiz.          7

     21.70     116.40     16.40   1.172     Horiz.          8
Message on the following line(s) applies to the above circle
```

```
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    47    48
     22.00    116.40     16.40   1.189     Horiz.          9
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    46    47
     22.30    116.40     16.40   1.224     Horiz.          5
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    45    46

     21.40    116.10     16.10   1.180     Horiz.          7
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    45    46
     21.70    116.10     16.10   1.164     Horiz.          7
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    46    47
     22.00    116.10     16.10   1.197     Horiz.          6
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    46    47
     21.40    116.40     16.40 See Message on Next Line(s)
Last Trial Values =              1.507     Horiz.         41
(Last Trial Values Shown Above Are Not Correct Final Values)
FATAL ERROR IN CALCULATING FACTOR OF SAFETY
SOLUTION DID NOT CONVERGE WITHIN  40 ITERATIONS
     21.40    116.70     16.70   1.211     Horiz.          6
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   1 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    45    45

     21.40    115.80     15.80 Center of circle falls outside of
                                current grid - Grid re-initialized

     21.20    115.60     15.60   1.171     Horiz.          8
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    45    46
     21.70    115.60     15.60   1.179     Horiz.          7
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    47    48
     22.20    115.60     15.60   1.234     Horiz.          5
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    47    48
     21.20    116.10     16.10   1.196     Horiz.          7
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    45    46
     22.20    116.10     16.10   1.220     Horiz.          6
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    46    47
     21.20    116.60     16.60   1.222     Horiz.          8
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   1 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    45    45
     21.70    116.60     16.60 See Message on Next Line(s)
Last Trial Values =              1.500     Horiz.         41
(Last Trial Values Shown Above Are Not Correct Final Values)
FATAL ERROR IN CALCULATING FACTOR OF SAFETY
SOLUTION DID NOT CONVERGE WITHIN  40 ITERATIONS
     22.20    116.60     16.60 See Message on Next Line(s)
Last Trial Values =              1.566     Horiz.         41
```

```
(Last Trial Values Shown Above Are Not Correct Final Values)
FATAL ERROR IN CALCULATING FACTOR OF SAFETY
SOLUTION DID NOT CONVERGE WITHIN  40 ITERATIONS

     21.40    115.80     15.80   1.165     Horiz.          7
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    45    46
     21.70    115.80     15.80   1.173     Horiz.          7
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    47    48
     22.00    115.80     15.80   1.206     Horiz.          6
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    46    47
     21.40    116.10     16.10   1.180     Horiz.          7
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    45    46
     22.00    116.10     16.10   1.197     Horiz.          6
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    46    47
     21.40    116.40     16.40 See Message on Next Line(s)
Last Trial Values =              1.507     Horiz.         41
(Last Trial Values Shown Above Are Not Correct Final Values)
FATAL ERROR IN CALCULATING FACTOR OF SAFETY
SOLUTION DID NOT CONVERGE WITHIN  40 ITERATIONS
     21.70    116.40     16.40   1.172     Horiz.          8
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    47    48
     22.00    116.40     16.40   1.189     Horiz.          9
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    46    47

     21.60    116.00     16.00   1.160     Horiz.          7
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    47    48
     21.70    116.00     16.00   1.167     Horiz.          3
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    46    47
     21.80    116.00     16.00   1.178     Horiz.          6
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    47    48
     21.60    116.10     16.10   1.164     Horiz.          7
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    46    47
     21.80    116.10     16.10   1.175     Horiz.          5
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    47    48
     21.60    116.20     16.20   1.169     Horiz.          8
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    45    46
     21.70    116.20     16.20   1.162     Horiz.          8
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    46    47
     21.80    116.20     16.20   1.172     Horiz.          7
```

```
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    46    47

     21.50    115.90     15.90   1.162     Horiz.         5
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    46    47
     21.60    115.90     15.90   1.159     Horiz.         6
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    47    48
     21.70    115.90     15.90   1.170     Horiz.         7
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    47    48
     21.50    116.00     16.00   1.167     Horiz.         7
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    45    46
     21.50    116.10     16.10   1.172     Horiz.         7
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    45    46

     21.50    115.80     15.80   1.158     Horiz.         7
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    46    47
     21.60    115.80     15.80   1.162     Horiz.         7
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    46    47

     21.40    115.70     15.70   1.160     Horiz.         8
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    46    47
     21.50    115.70     15.70   1.155     Horiz.         7
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   3 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    45    47
     21.60    115.70     15.70   1.165     Horiz.         7
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    47    48
     21.40    115.90     15.90   1.170     Horiz.         6
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    45    46

     21.40    115.60     15.60   1.156     Horiz.         8
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   3 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    45    47
     21.50    115.60     15.60   1.160     Horiz.         8
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   3 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    46    48
     21.60    115.60     15.60   1.168     Horiz.         8
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    47    48

At the end of the current mode of search the most critical
circle which was found has the following values -
X-center =     21.50     Y-center =    115.70     Radius =     15.70
```

Factor of Safety = 1.155 Side Force Inclination = Horiz.

TABLE NO. 19
INFORMATION FOR CURRENT MODE OF SEARCH - All Circles Have the Same Radius - Radius = 15.700

Center Coordinates X	Y	Radius	1-Stage Factor of Safety	Side Force Inclination (degrees)	Iterations
18.50	112.70	15.70	13.665	Horiz.	29
21.50	112.70	15.70	9.800	Horiz.	21
24.50	112.70	15.70	8.214	Horiz.	18
18.50	115.70	15.70	1.493	Horiz.	5
24.50	115.70	15.70	1.646	Horiz.	6
18.50	118.70	15.70	2.311	Horiz.	4
21.50	118.70	15.70	2.268	Horiz.	6
24.50	118.70	15.70	3.748	Horiz.	8
21.00	115.20	15.70	4.691	Horiz.	10
21.50	115.20	15.70	4.486	Horiz.	9
22.00	115.20	15.70	4.320	Horiz.	9
21.00	115.70	15.70	1.192	Horiz.	8

Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR 2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW - 46 47

22.00	115.70	15.70	1.208	Horiz.	6

Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR 2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW - 45 46

21.00	116.20	15.70	1.191	Horiz.	7

Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR 1 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW - 47 47

21.50	116.20	15.70	1.249	Horiz.	5

Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR 1 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW - 45 45

22.00	116.20	15.70	1.311	Horiz.	4
21.20	115.40	15.70	3.837	Horiz.	8
21.50	115.40	15.70	3.733	Horiz.	6
21.80	115.40	15.70	3.647	Horiz.	8
21.20	115.70	15.70	1.176	Horiz.	8

Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR 2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW - 45 46

21.80	115.70	15.70	1.186	Horiz.	7

Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR 2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW - 47 48

21.20	116.00	15.70	1.173	Horiz.	7

Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR 2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW - 44 45

21.50	116.00	15.70	1.206	Horiz.	6

Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR 2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW - 45 46

21.80	116.00	15.70	1.241	Horiz.	5

Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR 2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW - 46 47

21.40	115.60	15.70	2.664	Horiz.	6

```
     21.50     115.60     15.70   2.640     Horiz.          6
     21.60     115.60     15.70   2.622     Horiz.          6
     21.40     115.70     15.70   1.160     Horiz.          8
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    46    47
     21.60     115.70     15.70   1.165     Horiz.          7
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    47    48
     21.40     115.80     15.70   1.160     Horiz.          6
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    46    47
     21.50     115.80     15.70   1.170     Horiz.          7
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    45    46
     21.60     115.80     15.70   1.181     Horiz.          7
Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR   2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW -    46    47

At the end of the current mode of search the most critical
circle which was found has the following values -
X-center =     21.50     Y-center =    115.70     Radius =     15.70
Factor of Safety =   1.155     Side Force Inclination = Horiz.

TABLE NO. 21
*****  1-STAGE FINAL CRITICAL CIRCLE INFORMATION  *****
X Coordinate of Center - - - - - - -    21.500
Y Coordinate of Center - - - - - - -   115.700
Radius - - - - - - - - - - - - - - -    15.700
Factor of Safety - - - - - - - - - -     1.155
Side Force Inclination - - - - - - -    Horiz.

Number of circles tried  - - - - - -  133
No. of circles F calc. for - - - - -  120

TABLE NO. 26
*************************************************************
*  Coordinate, Weight, Strength and Pore Water Pressure     *
*  Information for Individual Slices for Conventional       *
*  Computations or First Stage of Multi-Stage Computations. *
*  (Information is for the Critical Shear Surface in the    *
*  Case of an Automatic Search.)                            *
*************************************************************
```

Slice No.	X	Y	Slice Weight	Matl. Type	Cohesion	Friction Angle	Pore Pressure
	7.3	109.0					
1	7.5	108.6	15.6	1	.00	32.00	.0
	7.7	108.3					
2	7.9	107.9	51.2	1	.00	32.00	.0
	8.1	107.6					
3	8.3	107.2	91.7	1	.00	32.00	.0
	8.5	106.9					
4	8.8	106.5	136.6	1	.00	32.00	.0
	9.0	106.2					
5	9.3	105.9	185.0	1	.00	32.00	.0
	9.5	105.6					
6	9.8	105.3	205.5	1	.00	32.00	.0
	10.0	105.0					
7	10.0	105.0	5.0	1	.00	32.00	.0
	10.0	105.0					
8	10.3	104.7	278.4	2	500.00	.00	.0

	10.6	104.4					
9	10.6	104.4	60.6	2	500.00	.00	.0
	10.7	104.3					
10	11.0	104.0	328.9	3	115.00	.00	.0
	11.3	103.8					
11	11.6	103.5	371.2	3	115.00	.00	.0
	12.0	103.2					
12	12.1	103.1	191.6	3	115.00	.00	.0
	12.3	103.0					
13	12.6	102.8	432.6	4	72.00	.00	.0
	12.9	102.5					
14	13.0	102.5	35.0	4	72.00	.00	.0
	13.0	102.5					
15	13.4	102.3	475.6	4	72.00	.00	.0
	13.7	102.1					
16	14.1	101.9	513.7	4	72.00	.00	.0
	14.4	101.7					
17	14.8	101.5	549.5	4	72.00	.00	.0
	15.2	101.3					
18	15.5	101.2	582.5	4	72.00	.00	.0
	15.9	101.0					
19	16.3	100.9	612.3	4	72.00	.00	.0
	16.7	100.7					
20	17.1	100.6	638.5	4	72.00	.00	.0
	17.5	100.5					
21	17.9	100.4	660.8	4	72.00	.00	.0
	18.3	100.3					
22	18.7	100.3	678.9	4	72.00	.00	.0
	19.1	100.2					
23	19.5	100.1	692.6	4	72.00	.00	.0
	19.9	100.1					
24	20.3	100.0	701.7	4	72.00	.00	.0
	20.7	100.0					
25	21.1	100.0	654.1	4	72.00	.00	.0
	21.5	100.0					
26	21.8	100.0	429.8	4	72.00	.00	.0
	22.0	100.0					
27	22.4	100.0	664.9	4	72.00	.00	.0
	22.8	100.1					
28	23.2	100.1	580.5	4	72.00	.00	.0
	23.6	100.1					
29	23.8	100.2	230.9	4	72.00	.00	.0
	24.0	100.2					
30	24.4	100.3	491.0	4	72.00	.00	.0
	24.8	100.4					
31	25.2	100.4	474.5	4	72.00	.00	.0
	25.6	100.5					
32	26.0	100.7	454.2	4	72.00	.00	.0
	26.4	100.8					
33	26.8	100.9	430.6	4	72.00	.00	.0
	27.2	101.1					
34	27.5	101.2	404.0	4	72.00	.00	.0
	27.9	101.4					
35	28.3	101.6	374.7	4	72.00	.00	.0
	28.7	101.7					
36	29.0	101.9	343.1	4	72.00	.00	.0
	29.4	102.1					
37	29.7	102.3	309.7	4	72.00	.00	.0
	30.1	102.6					
38	30.4	102.8	261.8	4	72.00	.00	.0
	30.7	103.0					
39	31.1	103.3	241.2	3	115.00	.00	.0
	31.4	103.5					
40	31.7	103.8	205.4	3	115.00	.00	.0
	32.0	104.0					
41	32.2	104.2	85.3	3	115.00	.00	.0
	32.3	104.3					

42	32.6	104.6	152.9	2	500.00	.00	.0
	32.9	104.9					
43	32.9	104.9	26.4	2	500.00	.00	.0
	33.0	105.0					
44	33.3	105.3	105.9	1	.00	32.00	.0
	33.5	105.6					
45	33.8	105.9	62.5	1	.00	32.00	.0
	34.0	106.3					
46	34.3	106.6	22.2	1	.00	32.00	.0
	34.5	106.9					
47	34.5	107.0	.2	1	.00	32.00	.0
	34.6	107.0					

TABLE NO. 27

```
*************************************************************
*  Seismic Forces and Forces Due to Surface Pressures for   *
*  Individual Slices for Conventional  Computations or the  *
*  First Stage of Multi-Stage Computations.                 *
*  (Information is for the Critical Shear Surface in the    *
*  Case of an Automatic Search.)                            *
*************************************************************
```

				FORCES DUE TO SURFACE PRESSURES			
Slice No.	X	Seismic Force	Y for Seismic Force	Normal Force	Shear Force	X	Y
1	7.5	0.	108.8	0.	0.	7.5	109.0
2	7.9	0.	108.5	0.	0.	7.9	109.0
3	8.3	0.	108.1	0.	0.	8.3	109.0
4	8.8	0.	107.8	0.	0.	8.8	109.0
5	9.3	0.	107.4	0.	0.	9.3	109.0
6	9.8	0.	107.1	0.	0.	9.8	109.0
7	10.0	0.	107.0	14.	0.	10.0	109.0
8	10.3	0.	106.9	720.	0.	10.3	109.0
9	10.6	0.	106.8	148.	0.	10.6	109.0
10	11.0	0.	106.6	764.	0.	11.0	109.0
11	11.6	0.	106.4	799.	0.	11.6	109.0
12	12.1	0.	106.3	392.	0.	12.1	109.0
13	12.6	0.	106.1	847.	0.	12.6	109.0
14	13.0	0.	106.0	66.	0.	13.0	109.0
15	13.4	0.	105.9	0.	0.	13.4	109.0
16	14.1	0.	105.7	0.	0.	14.1	109.0
17	14.8	0.	105.6	0.	0.	14.8	109.0
18	15.5	0.	105.4	0.	0.	15.5	109.0
19	16.3	0.	105.3	0.	0.	16.3	109.0
20	17.1	0.	105.2	0.	0.	17.1	109.0
21	17.9	0.	105.1	0.	0.	17.9	109.0
22	18.7	0.	105.0	0.	0.	18.7	109.0
23	19.5	0.	105.0	0.	0.	19.5	109.0
24	20.3	0.	104.9	0.	0.	20.3	109.0
25	21.1	0.	104.9	0.	0.	21.1	109.0
26	21.8	0.	104.9	0.	0.	21.8	109.0
27	22.4	0.	104.7	0.	0.	22.4	108.6
28	23.2	0.	104.3	0.	0.	23.2	107.8
29	23.8	0.	104.0	0.	0.	23.8	107.2
30	24.4	0.	103.9	0.	0.	24.4	107.0
31	25.2	0.	104.0	0.	0.	25.2	107.0
32	26.0	0.	104.1	0.	0.	26.0	107.0
33	26.8	0.	104.2	0.	0.	26.8	107.0
34	27.5	0.	104.4	0.	0.	27.5	107.0
35	28.3	0.	104.5	0.	0.	28.3	107.0
36	29.0	0.	104.7	0.	0.	29.0	107.0
37	29.7	0.	104.9	0.	0.	29.7	107.0
38	30.4	0.	105.1	0.	0.	30.4	107.0
39	31.1	0.	105.3	0.	0.	31.1	107.0

40	31.7	0.	105.5	0.	0.	31.7	107.0
41	32.2	0.	105.7	0.	0.	32.2	107.0
42	32.6	0.	105.8	0.	0.	32.6	107.0
43	32.9	0.	106.0	0.	0.	32.9	107.0
44	33.3	0.	106.2	0.	0.	33.3	107.0
45	33.8	0.	106.5	0.	0.	33.8	107.0
46	34.3	0.	106.8	0.	0.	34.3	107.0
47	34.5	0.	107.0	0.	0.	34.5	107.0

TABLE NO. 28

```
*************************************************************
*  Forces Due to Internal Soil Reinforcement for Conventional  *
*  Computations or First Stage of Multi-Stage Computations.    *
*  (Information is for the Critical Shear Surface in the       *
*  Case of an Automatic Search.)                               *
*************************************************************
```

Slice No.	Horizontal Force	Vertical Force	Moment about Center of Slice Base	Resultant Force	Angle (degs.)	
1	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00	
2	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00	
3	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00	
4	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00	
5	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00	
6	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00	
7	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00	
8	.1198E+03	.2855E+03	-.1173E+03	.3096E+03	67.23	*REINFORCEMENT*
9	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00	
10	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00	
11	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00	
12	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00	
13	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00	
14	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00	
15	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00	
16	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00	
17	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00	
18	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00	
19	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00	
20	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00	
21	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00	
22	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00	
23	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00	
24	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00	
25	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00	
26	-.4000E+03	.0000E+00	.1998E+04	.4000E+03	180.00	*END OF*
27	.2359E+03	.0000E+00	-.1172E+04	.2359E+03	.00	*REINFORCEMENT*
28	-.1634E+03	.0000E+00	.8005E+03	.1634E+03	180.00	
29	-.7249E+02	.0000E+00	.3499E+03	.7249E+02	180.00	
30	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00	
31	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00	
32	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00	
33	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00	
34	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00	
35	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00	
36	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00	
37	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00	
38	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00	
39	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00	
40	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00	
41	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00	
42	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00	
43	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00	
44	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00	
45	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00	
46	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00	

47	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00

TABLE NO. 38

```
*************************************************************
*  Final Results for Stresses Along the Shear Surface       *
*  (Results for Critical Shear Surface in Case of a Search.) *
*************************************************************
```

SIMPLIFIED BISHOP PROCEDURE USED TO COMPUTE FACTOR OF SAFETY
Factor of Safety = 1.155

-------- VALUES AT CENTER OF BASE OF SLICE---------

Slice No.	X-center	Y-center	Total Normal Stress	Effective Normal Stress	Shear Stress
1	7.5	108.6	20.4	20.4	11.0
2	7.9	107.9	64.5	64.5	34.9
3	8.3	107.2	112.0	112.0	60.6
4	8.8	106.5	162.3	162.3	87.8
5	9.3	105.9	214.8	214.8	116.2
6	9.8	105.3	265.6	265.6	143.7
7	10.0	105.0	1080.9	1080.9	584.7
8	10.3	104.7	796.5	796.5	432.9
9	10.6	104.4	1347.3	1347.3	432.9
10	11.0	104.0	1698.5	1698.5	99.6
11	11.6	103.5	1750.2	1750.2	99.6
12	12.1	103.1	1786.4	1786.4	99.6
13	12.6	102.8	1845.8	1845.8	62.3
14	13.0	102.5	1868.3	1868.3	62.3
15	13.4	102.3	639.2	639.2	62.3
16	14.1	101.9	676.2	676.2	62.3
17	14.8	101.5	709.9	709.9	62.3
18	15.5	101.2	740.3	740.3	62.3
19	16.3	100.9	767.4	767.4	62.3
20	17.1	100.6	791.0	791.0	62.3
21	17.9	100.4	811.3	811.3	62.3
22	18.7	100.3	828.1	828.1	62.3
23	19.5	100.1	841.5	841.5	62.3
24	20.3	100.0	851.4	851.4	62.3
25	21.1	100.0	857.7	857.7	62.3
26	21.8	100.0	860.7	860.7	62.3
27	22.4	100.0	813.9	813.9	62.3
28	23.2	100.1	717.5	717.5	62.3
29	23.8	100.2	646.3	646.3	62.3
30	24.4	100.3	619.6	619.6	62.3
31	25.2	100.4	609.2	609.2	62.3
32	26.0	100.7	595.5	595.5	62.3
33	26.8	100.9	578.6	578.6	62.3
34	27.5	101.2	558.7	558.7	62.3
35	28.3	101.6	535.7	535.7	62.3
36	29.0	101.9	509.8	509.8	62.3
37	29.7	102.3	481.1	481.1	62.3
38	30.4	102.8	450.7	450.7	62.3
39	31.1	103.3	446.4	446.4	99.6
40	31.7	103.8	413.7	413.7	99.6
41	32.2	104.2	388.6	388.6	99.6
42	32.6	104.6	694.7	694.7	432.9
43	32.9	104.9	694.8	694.8	432.9
44	33.3	105.3	501.8	501.8	271.5
45	33.8	105.9	383.0	383.0	207.2
46	34.3	106.6	194.0	194.0	104.9
47	34.5	107.0	21.2	21.2	11.5

```
CHECK SUMS - (ALL SHOULD BE SMALL)
SUM OF FORCES IN VERTICAL DIRECTION     =          .00  (=  .438E-04)
     SHOULD NOT EXCEED      .100E+03
SUM OF MOMENTS ABOUT CENTER OF CIRCLE   =         1.19  (=  .119E+01)
     SHOULD NOT EXCEED      .100E+03
SHEAR STRENGTH/SHEAR FORCE CHECK-SUM    =          .00  (=  .220E-02)
     SHOULD NOT EXCEED      .100E+03

Sum of Forces in Horizontal Direction =     -.488E+02
NOTE: Simplified Bishop procedure does not satisfy equilibrium
      of forces in the horizontal direction


END-OF-FILE ENCOUNTERED WHILE READING COMMAND
WORDS - END OF PROBLEM(S) ASSUMED
```

by Eric Strassburger

Settlement Analysis with Relative Over/Under Consolidation

Job Number: 23220 **Job Name:** CNTA UC-1 **Site Location:** around edge with 2 ' of mud

LAYER 1

Enter the following values: **C er =** 0.07 **C ec =** 0.53 **pc Relat. (psf)=** 300

Load Descriptions: 20 ft of fill

Depth Ft.	Average Depth Ft.	Gamma Eff. pcf.	Po psf.	** LOAD A ** Applied Elev. 0	dPa psf.	** LOAD B ** Applied Elev. 0	dPb psf.	** LOAD C ** Applied Elev. 0	dPc psf.	SUM dP (A+B+C)	Po + dP (Pf)	Recom-pression Strain	Virgin Strain	Layer Thickness in.	SETTLEMENT in.
0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
-	0.25	80	20	-	2200	-	0	-	0	2200	2220	0.084	0.446	6	3.181
0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
-	0.75	80	60	-	2200	-	0	-	0	2200	2260	0.054	0.423	6	2.864
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
-	1.25	80	100	-	2200	-	0	-	0	2200	2300	0.042	0.403	6	2.669
1.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
-	1.75	80	140	-	2200	-	0	-	0	2200	2340	0.035	0.385	6	2.517
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
-	0	80	1	-	0	-	0	-	0	0	1	0.000	0.000	-24	0.000
0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

Layer 1 Settlement (Inches) = 11.23

LAYER 2

Enter the following values: **C er =** ***** **C ec =** ***** **pc Relat. (psf)=** *****

Depth Ft.	Average Depth Ft.	Gamma Eff. pcf.	Po psf.	LOAD A (cont) dPa psf.	LOAD B (cont) dPb psf.	LOAD C (cont) dPc psf.	SUM dP	Po + dP (Pf)	Recom-pression Strain	Virgin Strain	Layer Thickness in.	SETTLEMENT in.
0	-	-	-	-	-	-	-	-	-	-	-	
-	0	0	1	-	0	-	0	0	1	0.000	0.000	0	0.000
0	-	-	-	-	-	-	-	-	-	-	-	
-	0	0	1	-	0	-	0	0	1	0.000	0.000	0	0.000
0	-	-	-	-	-	-	-	-	-	-	-	
-	0	0	1	-	0	-	0	0	1	0.000	0.000	0	0.000
0	-	-	-	-	-	-	-	-	-	-	-	
-	0	0	1	-	0	-	0	0	1	0.000	0.000	0	0.000
0	-	-	-	-	-	-	-	-	-	-	-	
-	0	0	1	-	0	-	0	0	1	0.000	0.000	0	0.000
0	-	-	-	-	-	-	-	-	-	-	-	

Layer 2 Settlement (Inches) = 0.00

LAYER 3

Enter the following values: **C er =** ***** **C ec =** ***** **pc Relat. (psf)=** *****

Depth Ft.	Average Depth Ft.	Gamma Eff. pcf.	Po psf.	LOAD A (cont) dPa psf.	LOAD B (cont) dPb psf.	LOAD C (cont) dPc psf.	SUM dP	Po + dP (Pf)	Recom-pression Strain	Virgin Strain	Layer Thickness in.	SETTLEMENT in.
0	-	-	-	-	-	-	-	-	-	-	-	
-	0	0	1	-	0	-	0	0	1	0.000	0.000	0	0.000
0	-	-	-	-	-	-	-	-	-	-	-	
-	0	0	1	-	0	-	0	0	1	0.000	0.000	0	0.000
0	-	-	-	-	-	-	-	-	-	-	-	
-	0	0	1	-	0	-	0	0	1	0.000	0.000	0	0.000
0	-	-	-	-	-	-	-	-	-	-	-	
-	0	0	1	-	0	-	0	0	1	0.000	0.000	0	0.000
0	-	-	-	-	-	-	-	-	-	-	-	
-	0	0	1	-	0	-	0	0	1	0.000	0.000	0	0.000
0	-	-	-	-	-	-	-	-	-	-	-	

Layer 3 Settlement (Inches) = 0.00

TOTAL SETTLEMENT IN SYSTEM (Inches) = 11.23

5

Settlement Analysis with Relative Over/Under Consolidation

by Eric Strassburger

Job Number: 23220 **Job Name:** CNTA UC-1 **Site Location:** center of pond with 5' of mud

LAYER 1

Enter the following values: **C er =** 0.07 **C ec =** 0.53 **pc Relat. (psf)=** 300

Load Descriptions: 20 ft of fill

Depth Ft.	Average Depth Ft.	Gamma Eff. pcf.	Po psf.	** LOAD A ** Applied Elev. 0	dPa psf.	** LOAD B ** Applied Elev. 0	dPb psf.	** LOAD C ** Applied Elev. 0	dPc psf.	SUM dP (A+B+C)	Po + dP (Pf)	Recom-pression Strain	Virgin Strain	Layer Thickness in.	SETTLEMENT in.
0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
-	0.5	80	40	-	2200	-	0	-	0	2200	2240	0.065	0.434	12	5.988
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
-	1.5	80	120	-	2200	-	0	-	0	2200	2320	0.038	0.393	12	5.178
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
-	2.5	80	200	-	2200	-	0	-	0	2200	2400	0.028	0.361	12	4.667
3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
-	3.5	80	280	-	2200	-	0	-	0	2200	2480	0.022	0.334	12	4.279
4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
-	4.5	80	360	-	2200	-	0	-	0	2200	2560	0.018	0.312	12	3.965
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

Layer 1 Settlement (Inches) = 24.08

LAYER 2

Enter the following values: **C er =** ***** **C ec =** ***** **pc Relat. (psf)=** *****

Depth Ft.	Average Depth Ft.	Gamma Eff. pcf.	Po psf.	LOAD A (cont)	dPa psf.	LOAD B (cont)	dPb psf.	LOAD C (cont)	dPc psf.	SUM dP	Po + dP (Pf)	Recom-pression Strain	Virgin Strain	Layer Thickness in.	SETTLEMENT in.
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
-	0	0	1	-	0	-	0	-	0	0	1	0.000	0.000	-60	0.000
0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
-	0	0	1	-	0	-	0	-	0	0	1	0.000	0.000	0	0.000
0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
-	0	0	1	-	0	-	0	-	0	0	1	0.000	0.000	0	0.000
0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
-	0	0	1	-	0	-	0	-	0	0	1	0.000	0.000	0	0.000
0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
-	0	0	1	-	0	-	0	-	0	0	1	0.000	0.000	0	0.000
0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

Layer 2 Settlement (Inches) = 0.00

LAYER 3

Enter the following values: **C er =** ***** **C ec =** ***** **pc Relat. (psf)=** *****

Depth Ft.	Average Depth Ft.	Gamma Eff. pcf.	Po psf.	LOAD A (cont)	dPa psf.	LOAD B (cont)	dPb psf.	LOAD C (cont)	dPc psf.	SUM dP	Po + dP (Pf)	Recom-pression Strain	Virgin Strain	Layer Thickness in.	SETTLEMENT in.
0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
-	0	0	1	-	0	-	0	-	0	0	1	0.000	0.000	0	0.000
0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
-	0	0	1	-	0	-	0	-	0	0	1	0.000	0.000	0	0.000
0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
-	0	0	1	-	0	-	0	-	0	0	1	0.000	0.000	0	0.000
0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
-	0	0	1	-	0	-	0	-	0	0	1	0.000	0.000	0	0.000
0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
-	0	0	1	-	0	-	0	-	0	0	1	0.000	0.000	0	0.000
0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

Layer 3 Settlement (Inches) = 0.00

TOTAL SETTLEMENT IN SYSTEM (Inches) = 24.08

52

Settlement Analysis with Relative Over/Under Consolidation

by Eric Strassburger

Job Number: 23220 **Job Name:** CNTA UC-1 **Site Location:** In trench, with 11' of mud

LAYER 1

Enter the following values: **C er =** 0.07 **C ec =** 0.53 **pc Relat. (psf)=** 300

Load Descriptions: 10 ft of fill

Depth Ft.	Average Depth Ft.	Gamma Eff. pcf.	Po psf.	** LOAD A ** Applied Elev. 0	dPa psf.	** LOAD B ** Applied Elev. 0	dPb psf.	** LOAD C ** Applied Elev. 0	dPc psf.	SUM dP (A+B+C)	Po + dP (Pf)	Recom-pression Strain	Virgin Strain	Layer Thickness in.	SETTLEMENT in.
0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
-	0.5	80	40	-	1100	-	0	-	0	1100	1140	0.065	0.278	12	4.122
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
-	1.5	80	120	-	1100	-	0	-	0	1100	1220	0.038	0.245	12	3.402
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
-	2.5	80	200	-	1100	-	0	-	0	1100	1300	0.028	0.220	12	2.974
3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
-	3.5	80	280	-	1100	-	0	-	0	1100	1380	0.022	0.200	12	2.660
4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
-	4.5	80	360	-	1100	-	0	-	0	1100	1460	0.018	0.183	12	2.414
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

Layer 1 Settlement (Inches) = 15.57

LAYER 2

Enter the following values: **C er =** 0.07 **C ec =** 0.53 **pc Relat. (psf)=** 300

Depth Ft.	Average Depth Ft.	Gamma Eff. pcf.	Po psf.	LOAD A (cont) dPa psf.	LOAD B (cont) dPb psf.	LOAD C (cont) dPc psf.	SUM dP	Po + dP (Pf)	Recom-pression Strain	Virgin Strain	Layer Thickness in.	SETTLEMENT in.
5	-	-	-	-	-	-	-	-	-	-	-	
-	5.5	80	440	-	1100	-	0	-	0	1100	1540	0.016	0.169	12	2.214
6	-	-	-	-	-	-	-	-	-	-	-	
-	6.5	80	520	-	1100	-	0	-	0	1100	1620	0.014	0.157	12	2.047
7	-	-	-	-	-	-	-	-	-	-	-	
-	7.5	80	600	-	1100	-	0	-	0	1100	1700	0.012	0.146	12	1.905
8	-	-	-	-	-	-	-	-	-	-	-	
-	8.5	80	680	-	1100	-	0	-	0	1100	1780	0.011	0.137	12	1.782
9	-	-	-	-	-	-	-	-	-	-	-	
-	10	80	800	-	1100	-	0	-	0	1100	1900	0.010	0.126	24	3.252
11	-	-	-	-	-	-	-	-	-	-	-	

Layer 2 Settlement (Inches) = 11.20

LAYER 3

Enter the following values: **C er =** ***** **C ec =** ***** **pc Relat. (psf)=** *****

Depth Ft.	Average Depth Ft.	Gamma Eff. pcf.	Po psf.	LOAD A (cont) dPa psf.	LOAD B (cont) dPb psf.	LOAD C (cont) dPc psf.	SUM dP	Po + dP (Pf)	Recom-pression Strain	Virgin Strain	Layer Thickness in.	SETTLEMENT in.
11	-	-	-	-	-	-	-	-	-	-	-	
-	0	0	1	-	0	-	0	-	0	0	1	0.000	0.000	-132	0.000
0	-	-	-	-	-	-	-	-	-	-	-	
-	0	0	1	-	0	-	0	-	0	0	1	0.000	0.000	0	0.000
0	-	-	-	-	-	-	-	-	-	-	-	
-	0	0	1	-	0	-	0	-	0	0	1	0.000	0.000	0	0.000
0	-	-	-	-	-	-	-	-	-	-	-	
-	0	0	1	-	0	-	0	-	0	0	1	0.000	0.000	0	0.000
0	-	-	-	-	-	-	-	-	-	-	-	
-	0	0	1	-	0	-	0	-	0	0	1	0.000	0.000	0	0.000
0	-	-	-	-	-	-	-	-	-	-	-	

Layer 3 Settlement (Inches) = 0.00

TOTAL SETTLEMENT IN SYSTEM (Inches) = 26.77

53

Bechtel Nevada

Engineering Department

ANALYSIS / CALCULATION (A/C) COVER SHEET

Project Title:	Project/Tracking No.:	Analysis/Calculation No.:
CAU 417 Remediation, UC1-CMP Closure	98228.A58	A/C-98228.A58-C-144

Subject:
West Drainage Channel Sizing

Analysis / Calculation Status Designation: ☐ Preliminary ☒ Final ☐ Superseded

Computer Program / Title	Mainframe / PC	Program No.	Version / Release No.
Flowmaster	PC	N/A	V5.13

Purpose:

The purpose of this calculation is to resize the west and north diversion channels, at the UC1-CMP, to intercept and convey the clear water flow from the 25 year, 6 hour storm event, away from the extents of the closure cap.

Conclusions:

A drainage channel with a bottom width of 20 feet (min), 3:1 side slopes, and a maximum bottom slope of 2 percent will convey the required flow of 68 cfs past the extents of the closure cap. The main breach through the fault scarp (North diversion channel) is based on the design of the west channel to facilitate drainage around the north edge of the pit into an existing swale to the east of the mud pit (ie. 20 feet wide w/3:1 side slopes).

Record of Revisions

Revision No.	Reason for Revision	Date	Originator	Checker	Approval
0	INITIAL ISSUE	2/28/00			

ANALYSIS / CALCULATION (A/C) SHEET

Project: CAU 417 Remediation, UC1-CMP Closure	Analysis/Calculation No.: A/C-98228.A58-C-144	
Subject: West Drainage Channel Sizing		
Date 2/28/00	Originator	Checker

Table of Contents

Section	Page Number
Purpose:	1
Conclusions:	1
Open Items:	3
References:	3
Assumptions:	3
Design Input:	3
Calculations:	4
Results:	4

ANALYSIS / CALCULATION (A/C) SHEET

Project: CAU 417 Remediation, UC1-CMP Closure	Analysis/Calculation No.: A/C-98228.A58-C-144	
Subject: West Drainage Channel Sizing		
Date 2/28/00	Originator AL	Checker gas

Open Items:

1. NONE

References:

1. Clark County Regional Flood Control District (CCRFCD) Hydrologic Criteria and Drainage Design Manual, 1990 Edition.
2. Flood Assessment for the Central Nevada Test Area, UC-1, UC-3, and UC-4 Sites, Nye County, Nevada, Bechtel Nevada, March 1999.
3. CNTA CAU 417 Flood Analysis for UC-1CMP Mud Pit Flood Protection, Calculation No: FD-DA-C-137, Rev 1, 2/23/99.
4. CAU 417 Remediation, UC1-CMP Closure, West Drainage Channel Sizing Calculation No: FD-DA-C-123, 11/4/99.
5. CAU 417 Remediation, Mud Pit UC-1, West Diversion Channel Plan & Profile Dwg. No.JS-058-98228 C34.
6. CAU 417 Remediation, Mud Pit UC-1, North Channel Grading Plan Dwg. No. JS-058-98228 C35.

Assumptions:

1. Mannings n value in the channel of .025 - Ref 4.
2. Due to location of the mud pit in a coalescing alluvial fan (REF 2), the full flow must be assumed to be able to occur at any point across the fan.

Design Input:

1. Topographic survey data.
2. Previously designed channel alignment (REF 4&5)
3. Revised peak design flow of 69 cfs (REF 3) for the 25 year, 6 hour precipitation event.
4. UC1-CMP lies in a coalescing alluvial fan (REF 2).

ANALYSIS / CALCULATION (A/C) SHEET

Project: CAU 417 Remediation, UC1-CMP Closure	Analysis/Calculation No.: A/C-98228.A58-C-144	
Subject: West Drainage Channel Sizing		
Date 2/28/00	Originator M.	Checker JAS

Calculations:

See attached revised Flowmaster (Haestad Methods Hydraulic Software) output plus hand calculations. Formulas can be found in REF 1 for subcritical/supercritical flows in open channels. The velocity head is added separately to account for flow instability that does not show up in the Flowmaster output sheets. Original design alignment/slopes (REF 4&5) were held due to topographic constraints (i.e. daylighting and associated lengths).

Results:

See Attached Calculations.

WEST3-South Section
Worksheet for Trapezoidal Channel

Project Description	
Project File	c:\haestad\fmw\project1.fm2
Worksheet	WEST3-Middle Section
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.025	
Channel Slope	0.005200	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	20.00	ft
Discharge	69.00	cfs

Results		
Depth	0.86	ft
Flow Area	19.32	ft²
Wetted Perimeter	25.42	ft
Top Width	25.14	ft
Critical Depth	0.69	ft
Critical Slope	0.010738	ft/ft
Velocity	3.57	ft/s
Velocity Head	0.20	ft
Specific Energy	1.05	ft
Froude Number	0.72	
Flow is subcritical.		

$d: .86 > 1.1 d_c$

$F_n: .72 < .86$

$\therefore$ Stable Flow

Superelevation

$Se = \frac{(3.57)^2\, 25.14}{32.2(200)}$

$= .05'$

Free board

$F_b = .5 + \frac{(3.57)^2}{2(32.2)}$

$= .70 < 1.0\,min \rightarrow 1.0'$

Req'd depth.

$d = .86 + .20 + 1.0 + .05'$

$= 2.11'$

$\doteq .64m$

69cfs

BN-0905 (08/99) **Bechtel Nevada**

Analysis Calc. #: A/C-98228ASS-C-144
Prepared By: AL
Checked By: Jas
Rev.#: 0 Page 6 of 7

WEST3-Middle Section
Worksheet for Trapezoidal Channel

Project Description	
Project File	c:\haestad\fmw\project1.fm2
Worksheet	WEST3-Middle Section
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.025	
Channel Slope	0.016800	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	20.00	ft
Discharge	69.00	cfs

Results		
Depth	0.61	ft
Flow Area	13.25	ft²
Wetted Perimeter	23.84	ft
Top Width	23.64	ft
Critical Depth	0.69	ft
Critical Slope	0.010739	ft/ft
Velocity	5.21	ft/s
Velocity Head	0.42	ft
Specific Energy	1.03	ft
Froude Number	1.23	
Flow is supercritical.		

$d: .61 < .9d_c$

$F_n: 1.23 > 1.13$

$\therefore$ stable Flow

Superelevation

$S_e = (5.21)^2 (23.64) / 32.2 (2.00)$

$= 642 / 6440$

$= .1$

Freeboard

$F_b = 1.0 + 0.025 (5.21)(.61)^{1/3}$

$= 1.11$

Req'd depth

$d = .61 + 1.11 + .1 + .42$

$= 2.24'$

$= .68$ m

WEST3-North Section
Worksheet for Trapezoidal Channel

Project Description	
Project File	c:\haestad\fmw\project1.fm2
Worksheet	WEST3-Middle Section
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.025	
Channel Slope	0.006200	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	20.00	ft
Discharge	69.00	cfs

Results		
Depth	0.81	ft
Flow Area	18.25	ft²
Wetted Perimeter	25.14	ft
Top Width	24.88	ft
Critical Depth	0.69	ft
Critical Slope	0.010739	ft/ft
Velocity	3.78	ft/s
Velocity Head	0.22	ft
Specific Energy	1.04	ft
Froude Number	0.78	
Flow is subcritical.		

d: .81 > 1.1dc

Fn: .78 < .86

∴ stable flow

superelevation

$Se = \frac{(3.78)^2 \, 24.88}{32.2(200)}$

$= .06'$

Freeboard

$F_b = 0.5 + \frac{(3.78)^2}{2(32.2)}$

$= .72' < 1.0 \text{ min} \rightarrow 1.0$

Req'd depth

$d = .81 + .06 + 1.0 + .22$

$= 2.09'$

$= .64 \text{ m}$

Bechtel Nevada Engineering Department

ANALYSIS / CALCULATION (A/C) COVER SHEET

Project Title:	Project/Tracking No.:	Analysis/Calculation No.:
CNTA, CAU 417 Remediation	98228.A58	A/C-98228.A58-C-145

Subject:

Erosion Calculations

Analysis / Calculation Status Designation: ☐ Preliminary ■ Final ☐ Superseded

Computer Program / Title	Mainframe / PC	Program No.	Version / Release No.
MathCad Standard	PC		8

Purpose:

Design criteria for the UC-1 Central Mud Pit Cover requires that the cover operate without exposing the contaminants for a period of at least 30 years. This calculation evaluates the cover design for wind and water erosion.

Conclusions:

Attached calculations show expected erosion of the cap in a 30 year period is approximately 0.26 inches. Cover design calls for a minimum of 4 feet of fill over the existing mud level. A cover of 4 feet is adequate to prevent exposure of relocated, hydrocarbon contaminated, granular soils and the existing mud pit. Revegetation of the cap surface will further reduce this erosion.

Open Items:

None

References:

1. U.S. Dept of Agriculture, Guide for Predicting Soil Loss by Wind Erosion, February 1983
2. U.S. Dept of Commerce, NTIS Document PB 80-100381, Design and Construction of Covers for Solid Waste Landfills

Assumptions:

- In-place density will be approximately 80% of maximum density of native soils determined by ASTM D1557.
- A windward direction of SSW was chosen to provide the longest unsheltered distance across the cap.

Record of Revisions

Revision No.	Reason for Revision	Date	Originator	Checker	Approval
0	Initial Issue	2/28/00			

ANALYSIS / CALCULATION (A/C) SHEET

Project: CNTA, CAU 417 Remediation	Analysis/Calculation No.: A/C-98228.A58-C-145	
Subject: Erosion Calculations		
Date 2/28/00	Originator	Checker

Assumptions (cont.):

- A ridge height of 2 inches was assumed in determination of the ridge roughness factor. A 2 inch ridge height is considered conservative as the entire surface will be tilled to a minimum depth of 1 foot and left fallow, prior to start of revegetation operations.

- No gradation information for this material was provided, therefore gradation information from testing location DT12 (west side of mud pit) was used because it was believed to be the most representative of the soils in these piles (see pages 10 - 11).The primary source for cover material is from the soil stockpiles north and south of the mud pit. This is material that was removed and stockpiled during construction of the mud pit.

Design Input:

Cover material density was obtained from an average of densities determined at various sampling locations around the mud pit (see page 12). All other variables were obtained from the referenced documents.

Calculations:

See attached MathCad calculations.

Results:

This cover will performed as required with regards to erodibility. Revegetation of this cover will increase its resistance to erosion.

Bechtel Nevada

Project: CNTA CAU 417 REMEDIATION

Project #: 98228.A58

Subject: EROSION CALCULATIONS

REFERENCES:

1) U.S. Dept of Agriculture, Guide for Predicting Soil Loss by Wind Erosion, February 1983

2) U.S. Dept of Commerce, NTIS Document PB 80-100381, Design and Construction of Covers for Solid Waste Landfills

Water Erosion

Universal Soil Loss Equation

$A := RKLSCP$ (Chapter 10, Ref 2)

Definition of Variables
R = Runoff Erosivity Factor
K = Erodibility Factor
LS = Slope Length Factor
C = Cover Factor
P = Practice Factor

$R := 40 \cdot ton \cdot acre^{-1} \cdot yr^{-1}$

Erodibility factor (K) determined by particle size distribution of native materials to be used for fill.
For distribution see attached sieve analysis and gradation curve.

% Silt/Fine Sand	%Sand	%Organics
15	32.5	0

Grain Sizes as defined in Ref. 2
Particle Size Distribution Curves Attached (See Pages 10-11)

$K := .13$ (Figure 60, Ref 2)

Cover slope = 2.49% Slope Length = 175.3 ft

$LS := .289$ (Interpolated from Table 28, Ref 2)

$C := 1$ $P := 1$

$A := R \cdot K \cdot LS \cdot C \cdot P$

$$A = 1.5 \cdot ton \cdot acre^{-1} \cdot yr^{-1}$$

Bechtel Nevada

Project: CNTA CAU 417 REMEDIATION Project #: 98228.A58

Subject: EROSION CALCULATIONS

Wind Erosion

$E := f(IKCLV)$ (Ref. 1, pg. 1)

Definition of Variables
I = Soil Erodibility
K = Ridge Roughness Factor
C = Climatic Factor
L = Unsheltered Distance
V = Vegetative Cover Factor

Erodibility factor (I) is Equal to Product of Soil Erodibility Factor and Knoll Adjustment Factor (Ref 2, pg. 147).

Erodibility Factor : (Figure 69, Ref 2)
For Cover Material. %Coarser than 0.84 mm = 62

Erodibility Factor=20

Knoll Adjustment factor: (Figure 70, Ref 2)
Windward Slope = 2.0%

Knoll Adjustment factor= 112 *use b curve

$I := 19 \cdot 1.12$ $I = 21.28$

$K := .5$ (Table 2, Ref 1)

$C := 20$ (Attached SCS Figure)

Unsheltered Distance (L) is the Longest Distance Across Cover in Prevailing Wind Direction.

Prevailing Wind Direction is SSW

$L := 514$ ft

$V := 0$

Wind Erosion (cont.)

Wind Erosion (E) Determined by attached SCS Soil Loss Tables for Determined Variables.

$C = 20 \qquad I = 21.28 \qquad K = 0.5 \qquad L = 514\ \text{ft} \qquad V = 0$

Determine Erosion (E) by Linear Interpolation of Tabular Values (See Pages 8-9)

For I = 21 @ L = 514 ft

$$L := \begin{bmatrix} 400 \\ 600 \end{bmatrix} \text{ft} \qquad E := \begin{bmatrix} 0 \\ 0 \end{bmatrix} \text{ton}\cdot\text{acre}^{-1}\cdot\text{yr}^{-1}$$

$$\text{linterp}(L, E, 514\ \text{ft}) = 0 \cdot \text{ton}\cdot\text{acre}^{-1}\cdot\text{yr}^{-1}$$

For I = 38 @ L = 514 ft

$$L := \begin{bmatrix} 400 \\ 600 \end{bmatrix} \text{ft} \qquad E := \begin{bmatrix} .6 \\ .9 \end{bmatrix} \text{ton}\cdot\text{acre}^{-1}\cdot\text{yr}^{-1}$$

$$\text{linterp}(L, E, 514\ \text{ft}) = 0.77 \cdot \text{ton}\cdot\text{acre}^{-1}\cdot\text{yr}^{-1}$$

For L = 514 @ I = 21.28

$$I := \begin{bmatrix} 21 \\ 38 \end{bmatrix} \qquad E := \begin{bmatrix} 0 \\ .77 \end{bmatrix} \text{ton}\cdot\text{acre}^{-1}\cdot\text{yr}^{-1}$$

$$E := \text{linterp}(I, E, 24.7)$$

$$E = 0.17 \cdot \text{ton}\cdot\text{acre}^{-1}\cdot\text{yr}^{-1}$$

Bechtel Nevada

Project: CNTA CAU 417 REMEDIATION

Project #: 98228.A58

Subject: EROSION CALCULATIONS

Total Erosion

$$E_{rate} := A + E$$

$$E_{rate} = 1.67 \cdot ton \cdot acre^{-1} \cdot yr^{-1}$$

Cover Surface Area:

$$Area := 4.77\ acre$$

$$E_{tot} := E_{rate} \cdot Area$$

$$E_{tot} = 7.97 \cdot \frac{ton}{yr}$$

Depth of Erosion

Cover Material: Native Fill

Optimum Density = 134.8 pcf

80% Density = 107.84 pcf (See Page 12)

Cover weight /ft:

$$Wt := \left(107.84\ \frac{lb}{ft^3}\right) \cdot 207782\ ft^2$$

$$Wt = 11204 \cdot \frac{ton}{ft}$$

Bechtel Nevada

Project: CNTA CAU 417 REMEDIATION Project #: 98228.A58

Subject: EROSION CALCULATIONS

Depth of Erosion (cont.)

$$E_{tot} = 7.97 \cdot \frac{ton}{yr}$$

$$Depth := \frac{E_{tot}}{Wt} \qquad Depth = 7.1118 \cdot 10^{-4} \cdot \frac{ft}{yr}$$

Over 30 Years:

$$D_{30} := Depth \cdot 30\ yr$$

$$D_{30} = 0.02\ ft$$
$$D_{30} = 0.26 \cdot in$$

Erosion over 30 yr period (D_{30}) = 0.26 in.

(E)* SOIL LOSS FROM WIND EROSION IN TONS PER ACRE PER YEAR JANUARY,1981

C = 20
I = 21

SURFACE - K = 0.7

(V)** - FLAT SMALL GRAIN RESIDUE IN POUNDS PER ACRE

(L) UNSHELTERED DISTANCE IN FEET	0	250	500	750	1000	1250	1500	1750	2000	2250	2500	2750	3000
10000	2.9	2.3	1.4	0.7									
8000	2.8	2.1	1.3	0.6									
6000	2.5	1.9	1.1	0.5									
4000	2.2	1.7	1.0	0.5									
3000	1.9	1.4	0.8										
2000	1.5	1.1	0.6										
1000	0.9	0.5											
800	0.8	0.5											
600	0.6	0.3											
400													
300													
200													
150													
100													
80													
60													
50													
40													
30													
20													
10													

(E)* SOIL LOSS FROM WIND EROSION IN TONS PER ACRE PER YEAR JANUARY,1981

C = 20
I = 21

SURFACE - K = 0.6

(V)** - FLAT SMALL GRAIN RESIDUE IN POUNDS PER ACRE

(L) UNSHELTERED DISTANCE IN FEET	0	250	500	750	1000	1250	1500	1750	2000	2250	2500	2750	3000
10000	2.5	1.9	1.2	0.5									
8000	2.4	1.8	1.1	0.5									
6000	2.1	1.6	1.0	0.4									
4000	1.9	1.4	0.8										
3000	1.7	1.3	0.7										
2000	1.3	1.0	0.5										
1000	0.8	0.5											
800	0.7	0.4											
600													
400													
300													
200													
150													
100													
80													
60													
50													
40													
30													
20													
10													

(E)* SOIL LOSS FROM WIND EROSION IN TONS PER ACRE PER YEAR JANUARY,1981

C = 20
I = 21

SURFACE - K = 0.5

(V)** - FLAT SMALL GRAIN RESIDUE IN POUNDS PER ACRE

(L) UNSHELTERED DISTANCE IN FEET	0	250	500	750	1000	1250	1500	1750	2000	2250	2500	2750	3000
10000	2.1	1.6	1.0	0.4									
8000	2.0	1.5	0.8										
6000	1.9	1.4	0.8										
4000	1.6	1.2	0.7										
3000	1.5	1.1	0.6										
2000	1.2	0.9	0.5										
1000	0.7	0.4											
800	0.6	0.3											
600													
400													
300													
200													
150													
100													
80													
60													
50													
40													
30													
20													
10													

* NOTE: SOIL LOSS FOR VALUES WHERE 'E' IS LESS THAN 0.1 OR GREATER THAN 440.0 ARE NOT SHOWN: OTHER VALUES NOT SHOWN ARE INVALID

** NOTE: VALUES SHOWN ARE FLAT SMALL GRAIN EQUIVALENT, NOT 'V'

BN-0905 (08/99)
Bechtel Nevada
Analysis Calc. #: AK 5828 ASK-C-14
Prepared By: [illegible]
Checked By: [illegible]
Rev.#: 0 Page 18 of 12

(E)* SOIL LOSS FROM WIND EROSION IN TONS PER ACRE PER YEAR JANUARY,1981

C = 20
I = 38

SURFACE - K = 0.7
(V)** - FLAT SMALL GRAIN RESIDUE IN POUNDS PER ACRE

(L) UNSHELTERED DISTANCE IN FEET	0	250	500	750	1000	1250	1500	1750	2000	2250	2500	2750	3000
10000	5.3	4.2	2.7	1.4	0.6								
8000	5.3	4.2	2.7	1.4	0.6								
6000	4.9	3.9	2.5	1.3	0.5								
4000	4.5	3.5	2.2	1.2	0.5								
3000	4.1	3.2	2.0	1.0	0.4								
2000	3.6	2.8	1.7	0.8									
1000	2.4	1.8	1.1	0.5									
800	1.9	1.5	0.8										
600	1.6	1.2	0.6										
400	1.1	0.9	0.5										
300	0.8	0.5											
200	0.5	0.3											
150													
100													
80													
60													
50													
40													
30													
20													
10													

(E)* SOIL LOSS FROM WIND EROSION IN TONS PER ACRE PER YEAR JANUARY,1981

C = 20
I = 38

SURFACE - K = 0.6
(V)** - FLAT SMALL GRAIN RESIDUE IN POUNDS PER ACRE

(L) UNSHELTERED DISTANCE IN FEET	0	250	500	750	1000	1250	1500	1750	2000	2250	2500	2750	3000
10000	4.6	3.6	2.3	1.2	0.5								
8000	4.6	3.6	2.3	1.2	0.5								
6000	4.3	3.3	2.1	1.1	0.4								
4000	3.9	3.1	1.9	0.9									
3000	3.4	2.6	1.6	0.8									
2000	3.0	2.3	1.4	0.7									
1000	1.8	1.4	0.7										
800	1.6	1.2	0.6										
600	1.2	0.9	0.5										
400	0.9	0.5											
300	0.6	0.4											
200													
150													
100													
80													
60													
50													
40													
30													
20													
10													

(E)* SOIL LOSS FROM WIND EROSION IN TONS PER ACRE PER YEAR JANUARY,1981

C = 20
I = 38

SURFACE - K = 0.5
(V)** - FLAT SMALL GRAIN RESIDUE IN POUNDS PER ACRE

(L) UNSHELTERED DISTANCE IN FEET	0	250	500	750	1000	1250	1500	1750	2000	2250	2500	2750	3000
10000	3.8	3.0	1.8	0.9									
8000	3.8	2.9	1.8	0.9									
6000	3.4	2.7	1.7	0.8									
4000	3.1	2.4	1.5	0.7									
3000	2.6	2.0	1.2	0.6									
2000	2.1	1.6	1.0	0.4									
1000	1.4	1.0	0.5										
800	1.1	0.8	0.4										
600	0.9	0.5											
400	0.6	0.4											
300													
200													
150													
100													
80													
60													
50													
40													
30													
20													
10													

* NOTE: SOIL LOSS FOR VALUES WHERE 'E' IS LESS THAN 0.1 OR GREATER THAN 440.0 ARE NOT SHOWN; OTHER VALUES NOT SHOWN ARE INVALID

** NOTE: VALUES SHOWN ARE FLAT SMALL GRAIN EQUIVALENT, NOT 'V'

BN-0905 (08/99)
Bechtel Nevada
Analysis Calc. #: AC-58226-ASR-C-003
Prepared By:
Checked By:
Rev.#:
Page 9 of 12

Bechtel Nevada
MATERIALS TESTING LABORATORY
P. O. BOX 98521
LAS VEGAS, NV 89193-8521

Request / Test Report

Requested by: J. SOROLA — Charge #: C8W01H04
User/Agency: BECHTEL — Log # N/A — MTL Lab #: 1744

Project: CNTA UC1 — Material: DT12 7'
Sampled by: K. CAMPBELL — Date Sampled: 05/24/99
Tested By: D. HERRINGTON — Date tested: 06/07/99
Checked by: V. [signature] — Date checked: 6/9/99

LABORATORY TEST REQUIRED

- [ ] Sieve Analysis (ASTM C-136-96)
- [ ] (ASTM C-117-95)
- [X] (ASTM D-422-90)
- [X] (ASTM D-1140-97)
- [ ] Moisture Content (ASTM C-566-97)
- [X] (ASTM D-2216-92)
- [ ] Unit Weight (ASTM C-29-97)
- [ ] Soil Classification
- [ ] Percent Porosity
- [ ] Specific Gravity (ASTM C-127-93/128-97)
- [ ] (ASTM D-584-96)
- [ ] Other (as noted)

SIEVE ANALYSIS

U.S. Standard Sieve #	Cumulative Wt Retained	% Retained	% Passing	Spec % Passing
3"	0.0	0%	100%	N/A
1 1/2"	439.5	17%	83%	N/A
3/4"	769.0	30%	70%	N/A
3/8"	878.2	35%	65%	N/A
4	1064.3	42%	58%	N/A
10	1312.2	52%	48%	N/A
40	1804.5	71%	29%	N/A
100	2063.8	82%	18%	N/A
200	2189.5	86.6%	13.4%	N/A

Soil Class: SM — Sample Wt (g): DRY = 2528.4 — WET = N/A

MOISTURE CONTENT

	PAN # 27	N/A	Oversize PAN # 33
Wet Weight + Tare	3617.3	N/A	6175.1
Dry Weight + Tare	3507.3	N/A	6076.0
Water	110.0	N/A	99.1
Tare	978.9	N/A	939.9
Dry Weight	2528.4	N/A	5136.1
Moisture %	4.4%	N/A	1.9%

UNIT WEIGHT

	Loose	Rodded
Container Size(ft^3)	N/A	N/A
Total Weight (lb)	N/A	N/A
Tare Weight (lb)	N/A	N/A
Material Weight (lb)	N/A	N/A
Unit Weight (P.C.F.)	N/A	N/A
Percent Porosity	N/A	N/A

Oversize Specific Gravity: N/A — **Specific Gravity:** N/A

EQUIPMENT USED: PM 16, PTL #1256, Calibration Date: 05/04/99 — Calibration Due: 05/04/2000

Sieve 3"	PTL # 303221	Cal. Date: 03/30/99	Cal. Due: 03/30/00
Sieve 1 1/2"	PTL # 303222	Cal. Date: 03/30/99	Cal. Due: 03/30/00
Sieve 3/4"	PTL # 303276	Cal. Date: 03/30/99	Cal. Due: 03/30/00
Sieve 3/8	PTL # 302106	Cal. Date: 03/31/99	Cal. Due: 03/31/00
Sieve # 4	PTL # 302043	Cal. Date: 04/01/99	Cal. Due: 04/01/00
Sieve # 10	PTL # 311621	Cal. Date: 10/08/97	Cal. Due: 10/08/99
Sieve # 40	PTL # 300106	Cal. Date: 10/09/97	Cal. Due: 10/09/99
Sieve # 100	PTL # 300103	Cal. Date: 06/17/98	Cal. Due: 06/16/99
Sieve # 200	PTL # 311599	Cal. Date: 10/15/98	Cal. Due: 10/15/99

REMARKS: NATIVE SOIL

BN-0905 (08/99) Bechtel Nevada
Analysis Calc. #: AK-93228.A38-C-145
Prepared By: [signature]
Checked By: [signature]
Rev.#: 0 Page 10 of 12

JUN 0 . 99

Analysis Calc. #: [illegible]-98228 A58-C-145
Prepared By: [illegible]
Checked By: Jas
Rev.#: 0 Page 11 of 12

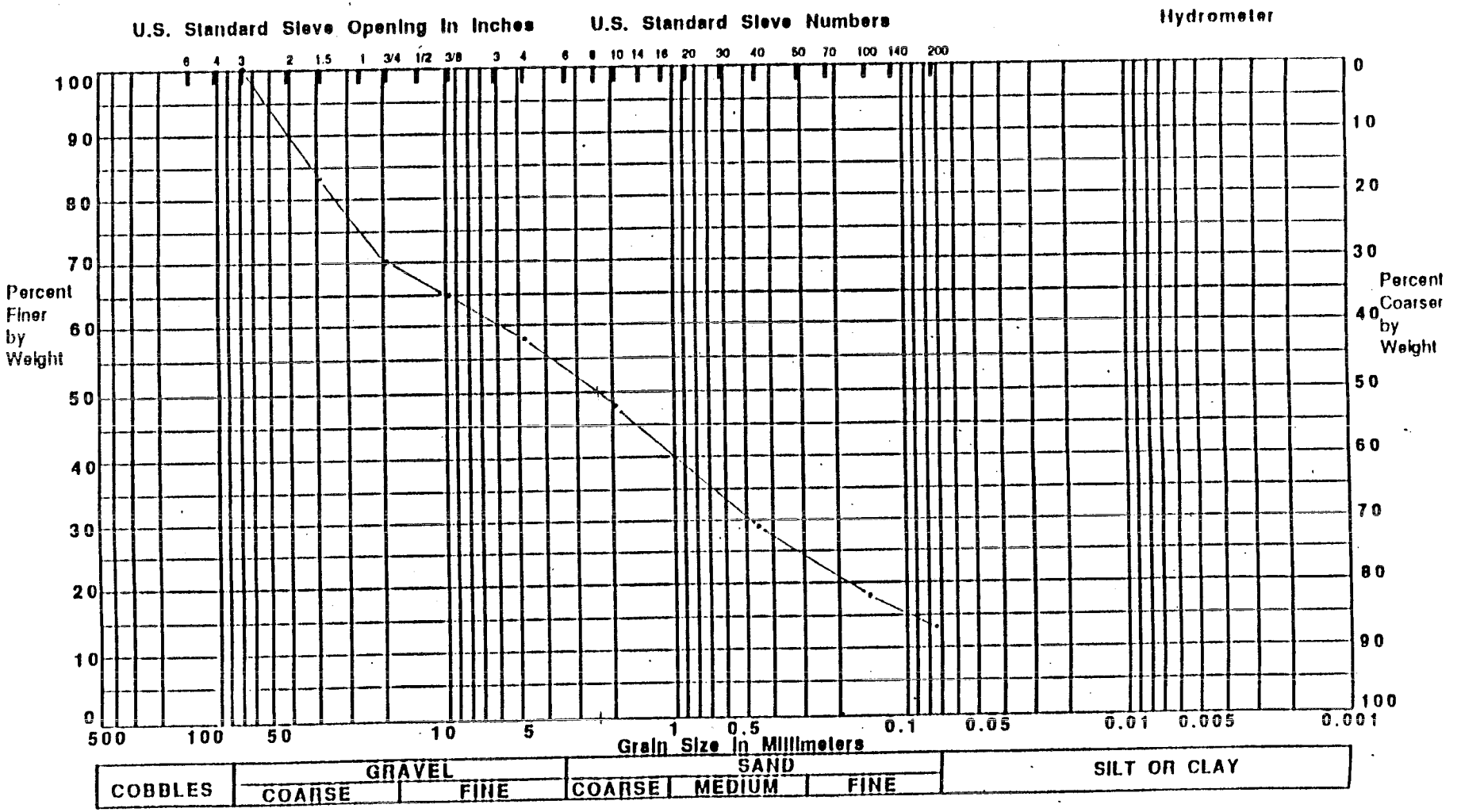
GRADATION CURVES

Bechtel Nevada
MATERIALS TESTING LABORATORY
P. O. BOX 98521
LAS VEGAS, NV 89193-8521

LAB NO.	1744
CHARGE #	C8WO1H04
DATE	06/07/99

PROJECT: CNTA UC1 LOG # N/A CLASSIFICATION: SM

CHECKED BY: D. HERRINGTON Del H. DATE CHECKED: 6-7-99 MATERIAL DT12 7'



Determination of Average Density

BN MTL Lab #	Corrected Max Density
1739	137.2
1740	133.0
1741	133.0
1742	134.8
1743	134.0
1744	136.5
Avg. Density	**134.8**

Bechtel Nevada

Engineering Department

Sheet 1 of 16

ANALYSIS / CALCULATION (A/C) COVER SHEET

Project Title: CAU 417 Closure	Project/Tracking No.: 98228.A58	Analysis/Calculation No.: A/C-98228.A58-C-159
Subject: UC1-CMP Cap Drainage Discharge Scour		
Analysis / Calculation Status Designation:	☐ Preliminary ☒ Final	☐ Superseded

Computer Program / Title	Mainframe / PC	Program No.	Version / Release No.
Haestad Methods FlowMaster	PC	N/A	V5.13
Microsoft Excel	PC	N/A	97 SR-1
Microstation/Inroads	PC	N/A	SE/v7.1

Purpose:

The purpose of this calculation is to determine the anticipated scour at the grade break (top of cap/side slope) on the east side of the cap. This location is the discharge point for drainage across the cap.

Conclusions:

Anticipated scour due to the 25 year, 6 hour storm event is 2 inches. Anticipated scour due to average annual precipitation is 1.43 inches over a 30-year design life. The total anticipated scour is 3.43 inches due to these events. The minimum fill over the drilling mud is 4.0 feet; therefore, no mitigation measures are required.

Record of Revisions

Revision No.	Reason for Revision	Date	Prepared	Checked	Approval
0	Initial Issue	4/10/00	Julie A. Sarola	Vefa Yucel	pep [signature]

ANALYSIS / CALCULATION (A/C) SHEET

Project: CAU 417 Closure	Analysis/Calculation No.: A/C-98228.A58-C-159	
Subject: UC1-CMP Cap Drainage Discharge Scour		
Date 4/10/00	Prepared gas	Checked cy

Table of Contents

Section	Page Number
Purpose:	*1*
Conclusions:	*1*
Open Items:	*3*
References:	*3*
Assumptions:	*3*
Design Input:	*3*
Calculations:	*3*
Results:	*4*

ANALYSIS / CALCULATION (A/C) SHEET

Project: CAU 417 Closure	Analysis/Calculation No.: A/C-98228.A58-C-159	
Subject: UC1-CMP Cap Drainage Discharge Scour		
Date 4/10/00	Prepared Gas	Checked UG

Open Items:

1. None

References:

1. *Hydrologic Criteria and Drainage Design Manual*, Clark County Regional Flood Control District, August 1999.
2. FD-DA-C-137 - *Flood Analysis for UC1-CMP Flood Protection, Rev 1*, February 2000.
3. A/C-98228.A58-C-145 – *Erosion Calculations, Rev 0*, February 2000.

Assumptions:

1. In-place density of the fill will be 80 percent of the maximum density of native soils determined by ASTM D1557.
2. Prevailing wind direction is SSW.
3. The line for cultivated, straight row (pg. 11) was used to determine the velocity for travel time computation for subbasin 1 to account for vegetation.
4. Mannings n value of .045 in FlowMaster runs to account for vegetation.
5. Only 1-25 year, 6 hour storm event will occur during the 30-year design life.

Design Input:

1. Soils properties from reference 3.
2. Basic USLE (Universal Soil Loss Equation) parameters/references from reference 3.
3. Rainfall parameters from reference 2.
4. Slope, length, and area values determined using Microstation/Inroads design tools (see page 16 for sketch of subbasins).

Calculations:

See Attached (pg. 5-8).

The Precipitation Depth vs. Return Period, and Time-Intensity Frequency Curves (pg. 9,10) were generated in Excel using parameters determined in reference 2. The Modified Rational Method, as outlined in section 600 of reference 1, was used to determine run-off from the 25 year, 6 hour storm event. Equation 604 was not used for time of concentration calculations as this equation was developed for urban areas. Average annual rainfall is accounted for in the USLE rainfall erosivity factor (R-value).

Scour in the discharge section (side slope) due to the 25 year, 6 hour storm event was determined using the formulas for contraction scour in section 704.2.1.5 of reference 1. The main drainage across the cap is constricted at the outlet by the existing berms on both sides. This depth of scour is added to the depth of erosion calculated using the USLE for the side slope (discharge section), to obtain the total anticipated depth of scour over the 30 year design life.

FlowMaster was used to determine the hydraulic parameters of the approach and constricted sections for the contraction scour calculations (pg. 14,15). FlowMaster was also used to determine the estimated velocity for travel time computations in subbasin 2 (pg. 13).

ANALYSIS / CALCULATION (A/C) SHEET

Project: CAU 417 Closure	Analysis/Calculation No.: A/C-98228.A58-C-159	
Subject: UC1-CMP Cap Drainage Discharge Scour		
Date 4/10/00	Prepared gas	Checked UY

Results:

Total anticipated scour over 30 years is 3.43 inches. This is less than the minimum thickness (4.0 feet) of fill required over the drilling mud. Therefore, the performance of the cap will not be adversely affected and mitigation measures are not required.

CCRFCD SEC 600 (REF 1)

MODIFIED
CNTA RATIONAL METHOD

SUBBASIN ① for t_i $L = 83.25\,m = 273\,Ft$
for t_t $L = 8.96\,m = 29.4\,Ft$

Avg Slope for Overland flow:

$(1839.4 - 1836.3) / 82.6 = 3.8\%$

Slope for channel Flow:

$(1836.3 - 1835.0) / 8.95 = 14.5\%$

$K = C_{10} = .25$ (PAGE 12)

INITIAL TIME

$t_i = 1.8(1.1-K)L^{1/2}/S^{1/3}$

$= 1.8(1.1-\overset{.85}{\cancel{.25}})(273)^{1/2}/\overset{1.56}{\cancel{(3.8)^{1/3}}}$

$t_i = 16.2\,min$

For Travel time use V for Cultivated Straight Row and Slope of 14.5% (Account for Vegetation)

$V = 3.5\,fps$ (PAGE 11)

$t_t = L/60V = 29.4/60(3.5)$
$= .14\,min$

time of Concentration

$T_c = t_i + t_t = 16.2 + .14 = 16.3\,min$

$I = 2.45\,in/hr$

$A = 8743\,m^2 = 2.16\,Acres$

$C = .29$ (INTERPOLATED between C_{10} & C_{100}) (PAGE 12)

$Q = CIA(.5)$

.5 IS LOCAL ADJUSTMENT FACTOR

$Q = .29(2.45)(2.16)(.5)$
$Q = .77\,CFS$

.77 CFS WILL BE USED TO ESTIMATE VELOCITY IN SUBBASIN 2 FOR T_t CALC. (SEE PAGE 13)

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

SUBBASIN (2)

For t_i $L = 54.85\,m = 180\,Ft$

t_t $L = 154.77\,m = 508\,Ft$

Avg Slope for overland Flow:

$\approx 2.0\%$

Slope for Channel Flow =

$(1835 - 1834.86)/154.77 = .09\%$

$K = C_{10} = .25$

$t_i = 1.8(1.1 - .25)\,180^{1/2}/(2)^{1/3}$

$t_i = 16.3\,min$

$t_t = \dfrac{508}{60(.25)} = 33.9\,min$ (See Page 13 for Velocity Calc)

$T_c = t_i + t_t = 16.3 + 33.9 = 50.2\,min$

$I = 1.5\,in/hr$

$A = 14965\,m^2 = 3.7\,ACRES$

$C = .29$

$Q = .29(1.5)(3.7)(.5)$

$Q = .80\,CFS$

OUTLET CHANNEL GEOMETRY:

Slope = 13.0%

LEFT SIDE SLOPE $\approx 4.5:1$
RIGHT SIDE SLOPE $\approx 4.9:1$

Total Q = .77 + .80 = 1.57 CFS

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

CONTRACTION SCOUR (REF 1 SEC 704.2.1.5)

$d_{50} = 2.5$ mm (REF 3 A/C-98228.A58-C-145)

$\delta_s = 134.8$ PCF (REF 3 " ")

$V_c = 10.95\, Y^{1/6}\, d_{50}^{1/3}$ $Y = .33$ Ft, $d_{50} = .0082$ Ft

$= 10.95(.33^{1/6})(.0082)^{1/3}$ (.83, .202)

$V_c = 1.84$ FPS

$V_{APPROACH} = .30$ FPS $< V_c$ ∴ CLEAR WATER CONTRACTION SCOUR

$$\therefore Y_2 = \left[\frac{Q_2^2}{120\, d_m^{2/3} W_2^2}\right]^{3/7}$$

$Q_2 = 3.0$ CFS *
$d_m = 1.25\, d_{50} = .0103$ Ft

$$= \left[\frac{3.0^2}{120(.0103)^{2/3}(2.94)^2}\right]^{3/7}$$

(.0473, 8.64, .1835)

$Y_o = .31$
$W_2 = 2.94'$

$= .48$ Ft

* Reduction in Flow Area ≈ 91%
∴ $Q_2 = 1.57(1.91) = 3.0$ CFS
(See Pages 14, 15 for flow areas for each section)

$Z_{cs} = Y_2 - Y_o$
$= .48 - .31$
$= .17$ Ft

∴ Scour of .17 Ft → 2.0 in

USLE:

$R = 40$ ton/Acre/YR (REF 3 A/C-98228.A58-C-145)

$K = .13$ $S = 13\%$ $L = 23.34$ m $= 76.6$ Ft

$LS = 1.8$ $C = 1$ $P = 1$ (CONSERVATIVE)
(Channel only)

$A = 40(.13)(1.8)(1)(1)$
$= 9.36$ Ton/Acre/YR

Area $= 111.3\ m^2$
$= .0275$ Acre
$= 1198\ Ft^2$

TOTAL EROSION $= 9.36(.0275)$
$= .257$ TON/YR

DRY DENSITY OF FILL $= (.8)\,134.2 \frac{\#}{CF}\left(\frac{TON}{2000\#}\right)$

$= .0539 \frac{TON}{CF}$

DEPTH OF EROSION:

$= .257 \frac{TON}{YR}\left(\frac{CF}{.0539 TON}\right)$

$= 4.77 \frac{CF}{YR}\left(\frac{1}{1198 SF}\right)$

$= .00398$ FT/YR
$= .048$ IN/YR (30 YR)
$= 1.43$ IN

SLOPE IS ASSUMED ON LEEWARD SIDE FOR WIND EROSION. BASED ON WIND ROSES / PREDOMINATE WIND DIRECTIONS AT NTS LOCATIONS WHICH ARE IN SAME CLIMATIC REGION OF NEVADA.

∴ WIND EROSION IS IGNORED.

∴ TOTAL EROSION AT CAP EDGE IS

$1.43 + 2.0 = 3.43'' \rightarrow 3.5$ IN

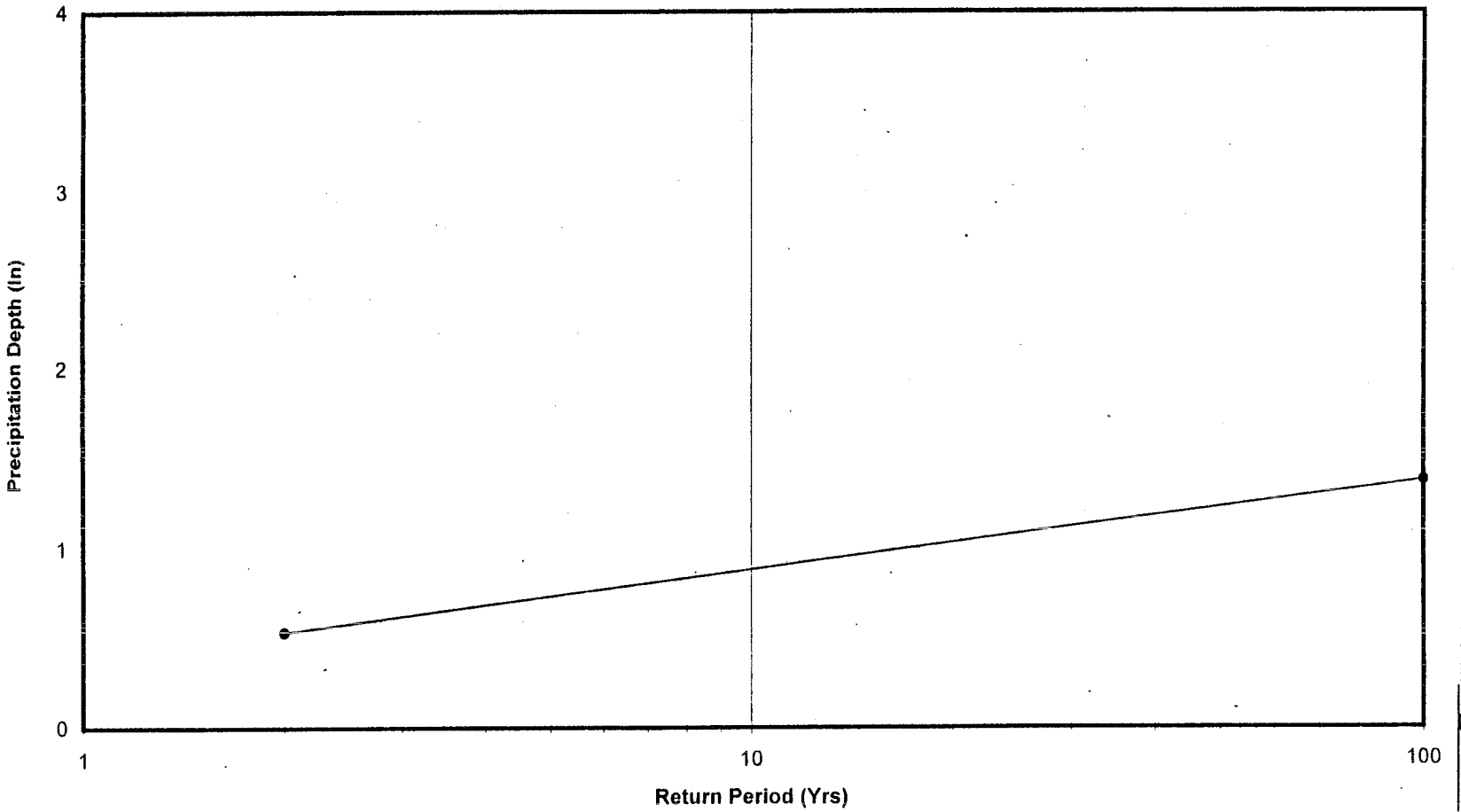
MIN FILL DEPTH $= 4.0' > 3.5''$ ∴ NO RIP-RAP REQ'D.

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

GENERATED USING VALUES
FROM FD-DA-C-137 REV 1
(REF 2)

Precipitaion Depth Vs. Return Period

Plot of 1-Hour Precipitation Values

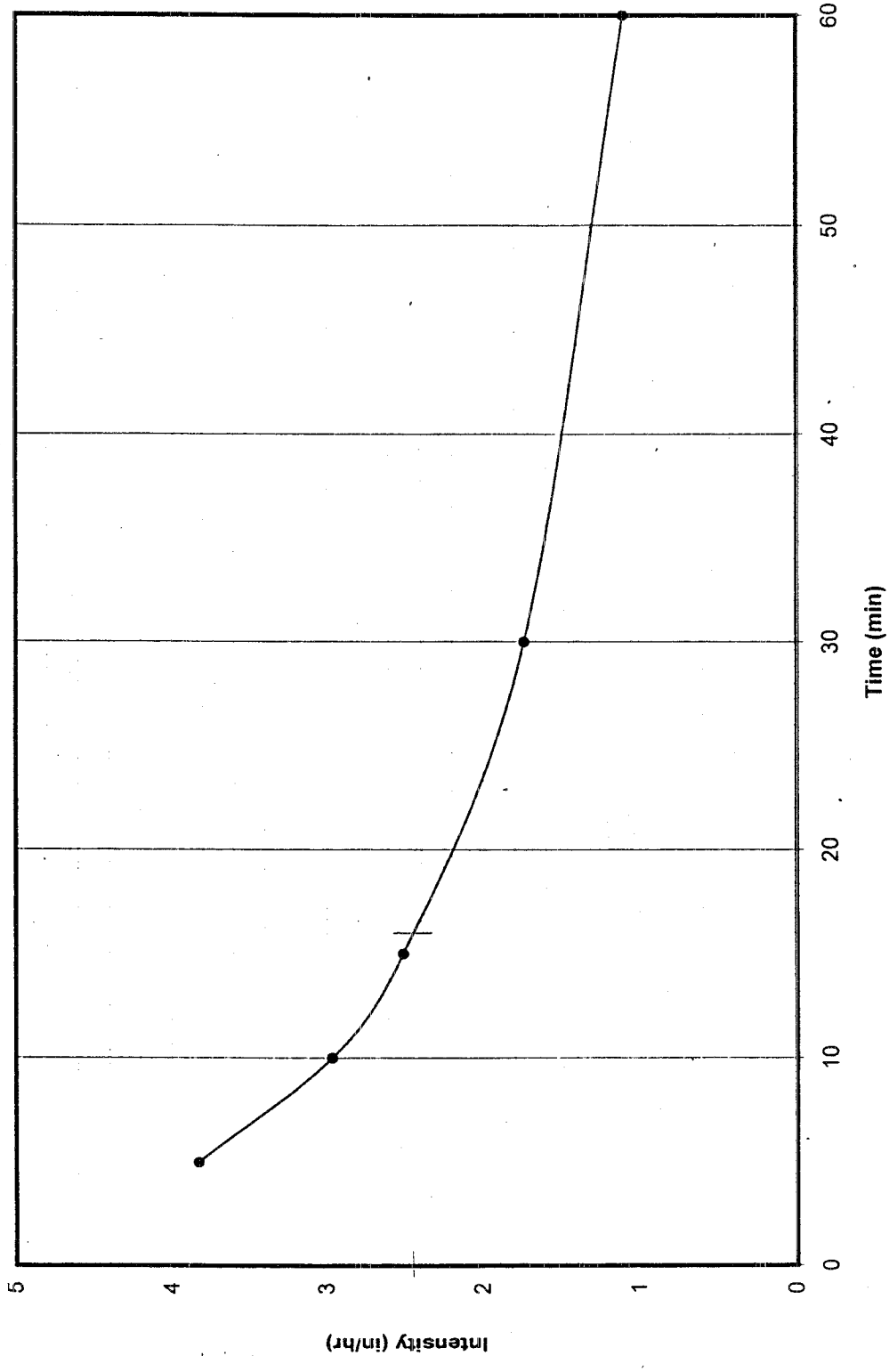


CCRFCD, Standard Form 3

Analysis Calc. #: AIC-98228A58-C-15
Prepared By: [illegible]
Checked By: [illegible]
Rev.#: 0 Page 9 of 16

GENERATED USING VALUES FROM FD-DA-C-137 REV 1 (REF 2)

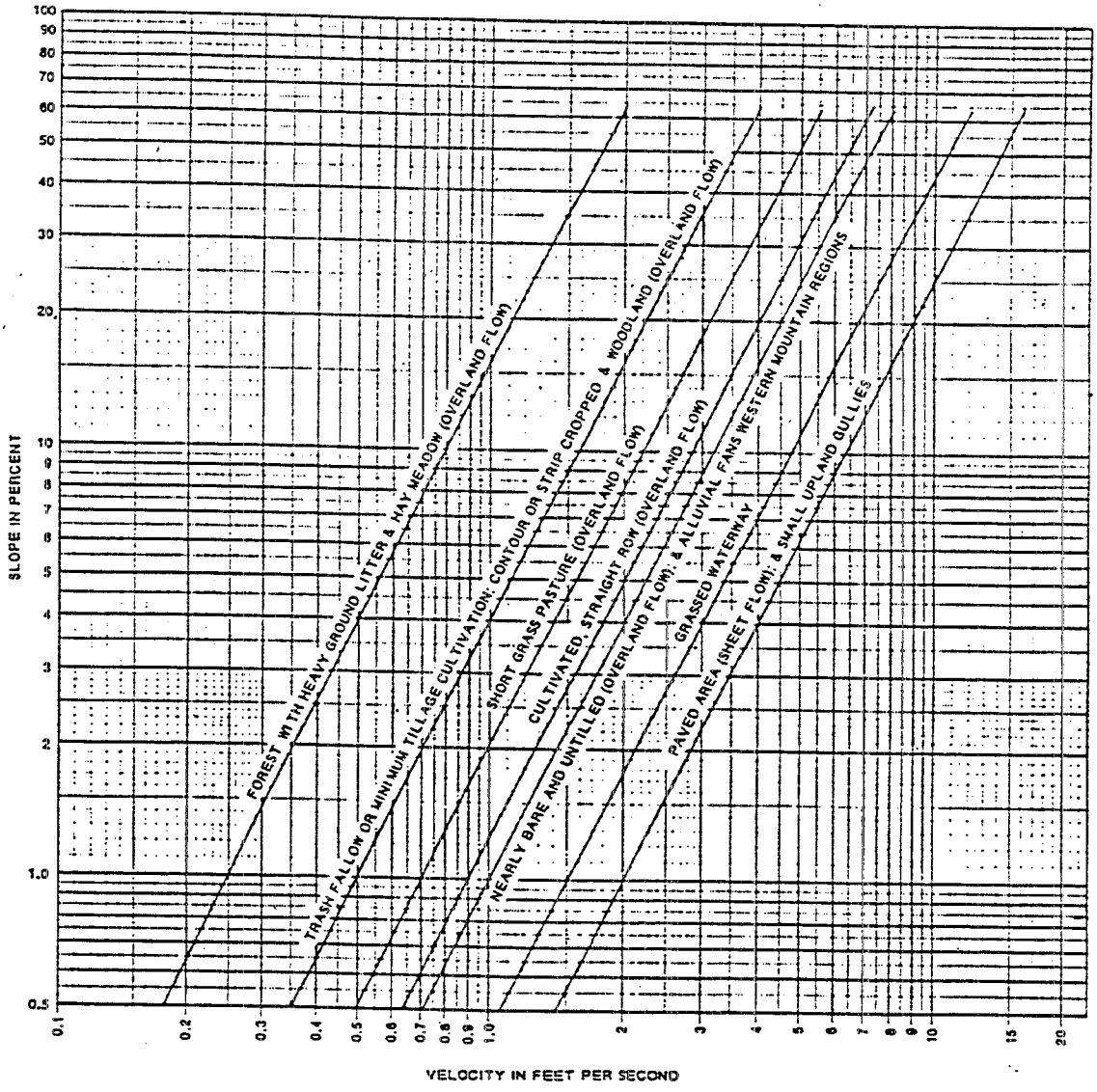
Time-Intensity Frequency Curves



HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL

(REF 1)

TRAVEL TIME VELOCITY



Revision	Date

WRC ENGINEERING	REFERENCE: SCS National Engineering Handbook Section 4, Hydrology, March, 1985	FIGURE 602

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL

(REF 1)

RATIONAL FORMULA METHOD RUNOFF COEFFICIENTS AND AVERAGE PERCENT IMPERVIOUS AREA

LAND USE OR SURFACE CHARACTERISTICS	AVERAGE PERCENT IMPERVIOUS AREA	RUNOFF COEFFICIENTS 10-YEAR GRASS[1]	10-YEAR DESERT[2]	100-YEAR GRASS[1]	100-YEAR DESERT[2]
Business and Commercial:					
Downtown Areas	95	.88	.88	.89	.89
Neighborhood Areas	70	.70	.75	.80	.83
Residential (Average Lot Size):					
1/8 Acre or less (Multi-Unit)	65	.68	.73	.78	.80
1/4 Acre	38	.55	.62	.65	.74
1/3 Acre	30	.50	.57	.60	.70
1/2 Acre	25	.45	.53	.55	.67
1 Acre	20	.40	.49	.50	.64
2 Acre	12	.35	.45	.40	.60
Industrial:	72	.72	.76	.82	.84
Open Space: (Lawns, Parks, Golf Courses)	5	.10	-	.30	-
Undeveloped Areas: (Natural Vegetation)	0	-	.25	-	.50
Streets and Roads:					
Paved	100	.90		.93	
Gravel	20	.40		.50	
Drives and Walks:	95	.88		.89	
Roofs:	90	.85		.87	

Notes:

1 Grass - Grassed Landscaping or Irrigated Vegetation
2 Desert - Desert Landscaping or Natural Vegetation

Revision	Date

WRC ENGINEERING

REFERENCE: USDCM, DRCOG, 1969 (with modifications)

TABLE 601

Subbasin 2 - Velocity for Conc Time Calc
Worksheet for Triangular Channel

Project Description	
Project File	g:\dgn\98228a58\uc1\option b\calcs\scour\capscour.fm2
Worksheet	UC1-CMP CAP CCHANNEL EROSION
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data			
Mannings Coefficient	0.045		← Accounts for Vegetation
Channel Slope	0.000900	ft/ft	SUBBASIN ② Avg Slopes ≈ 2.0%
Left Side Slope	50.000000	H : V	
Right Side Slope	50.000000	H : V	
Discharge	0.77	cfs	← Q AT SUBBASIN ①

Results			
Depth	0.25	ft	
Flow Area	3.11	ft²	
Wetted Perimeter	24.96	ft	
Top Width	24.95	ft	
Critical Depth	0.11	ft	
Critical Slope	0.078090	ft/ft	
Velocity	0.25	ft/s	← USED FOR V IN t_t Calc for Subbasin ②
Velocity Head	0.95e-3	ft	
Specific Energy	0.25	ft	
Froude Number	0.12		
Flow is subcritical.			

UC1-CMP Approach Section
Worksheet for Triangular Channel

Project Description	
Project File	g:\dgn\98228a58\uc1\option b\calcs\scour\capscour.fm2
Worksheet	UC1-CMP CAP Approach Section
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.045	
Channel Slope	0.000900	ft/ft
Left Side Slope	50.000000	H : V
Right Side Slope	50.000000	H : V
Discharge	1.57	cfs

Results		
Depth	0.33	ft
Flow Area	5.31	ft²
Wetted Perimeter	32.60	ft
Top Width	32.60	ft
Critical Depth	0.14	ft
Critical Slope	0.071010	ft/ft
Velocity	0.30	ft/s
Velocity Head	0.14e-2	ft
Specific Energy	0.33	ft
Froude Number	0.13	
Flow is subcritical.		

UC1-CMP Constricted Section
Worksheet for Triangular Channel

Project Description	
Project File	g:\dgn\98228a58\uc1\option b\calcs\scour\capscour.fm2
Worksheet	UC1-CMP Constricted Section
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.045	
Channel Slope	0.130000	ft/ft
Left Side Slope	4.500000	H : V
Right Side Slope	4.900000	H : V
Discharge	1.57	cfs

Results		
Depth	0.31	ft
Flow Area	0.46	ft^2
Wetted Perimeter	3.01	ft
Top Width	2.94	ft
Critical Depth	0.37	ft
Critical Slope	0.053339	ft/ft
Velocity	3.41	ft/s
Velocity Head	0.18	ft
Specific Energy	0.49	ft
Froude Number	1.52	
Flow is supercritical.		

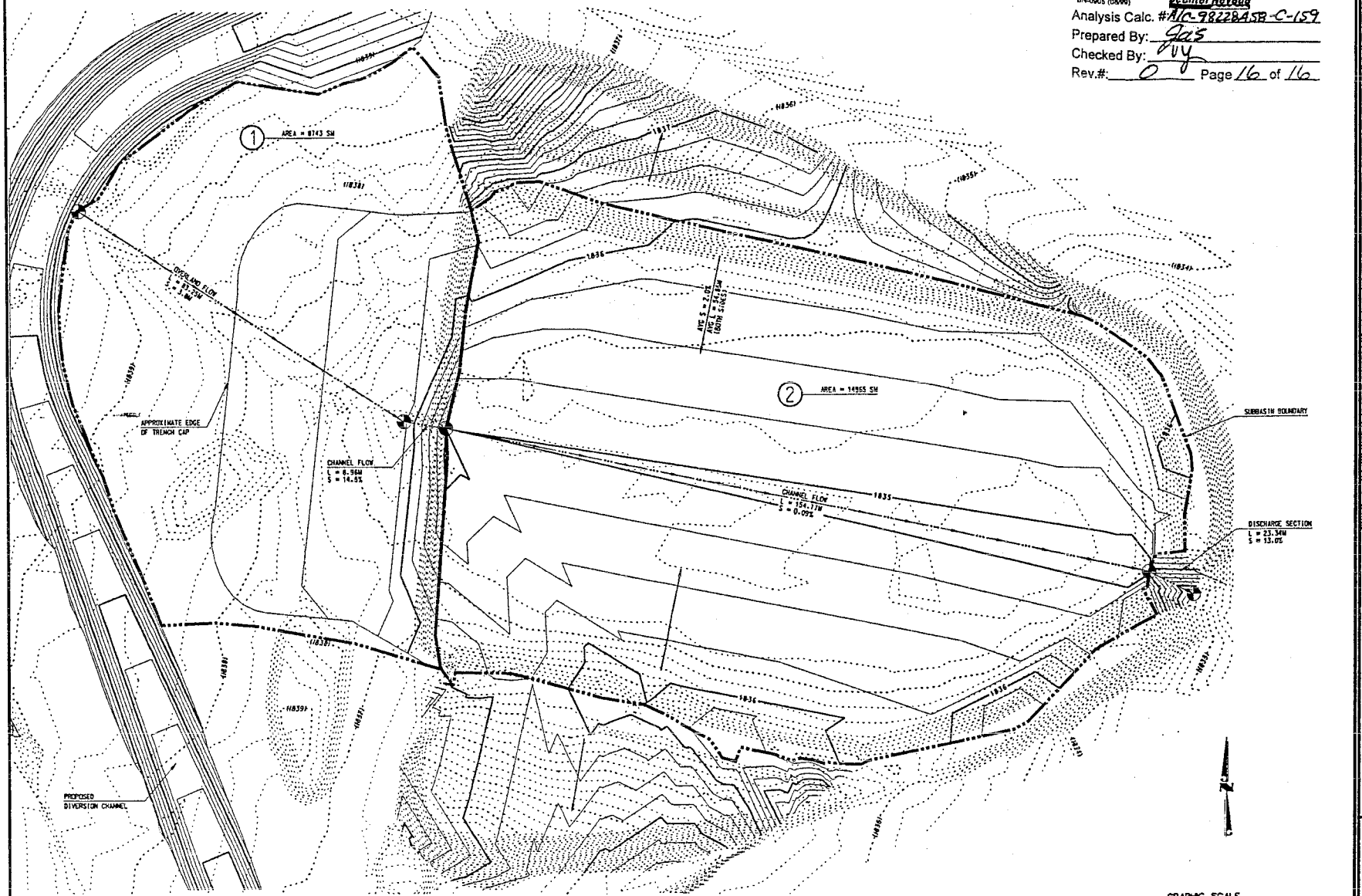
BN-0905 (08/99) **Bechtel Nevada**

Analysis Calc. #: A/C-98228A5B-C-159

Prepared By: Jas

Checked By: VY

Rev.#: 0 Page 16 of 16



GRAPHIC SCALE

0 10 20 30 40 50

SCALE: 1:400 METERS

DRAINAGE SUBBASIN PLAN

SCALE : 1:400
CONTOUR INTERVAL = 0.25M

CENTRAL NEVADA TEST AREA — AREA 5B
CAU 417 CLOSURE
UC1-CMP

DRAINAGE SUBBASIN PLAN

U.S. DEPARTMENT OF ENERGY
NEVADA OPERATIONS OFFICE
LAS VEGAS, NEVADA

Bechtel Nevada

SK-058-98228-C1

04/10/2000 10:12:23 AM g:\Dgn\98228a58\uc1\Option B\calcs\scour\subbasin.dgn

APPENDIX F

FAULT INVESTIGATIONS at the CENTRAL NEVADA TEST AREA UC-1 SITE, NYE COUNTY, NEVADA

FAULT INVESTIGATIONS AT THE CENTRAL NEVADA TEST AREA UC-1 SITE, NYE COUNTY, NEVADA

by

Stuart E. Rawlinson and Dennis L. Gustafson

Bechtel Nevada

Prepared for

U.S. Department of Energy
Nevada Operations Office
under Contract Number
DE-AC08-96NV11718

June 1999

CONTENTS

EXECUTIVE SUMMARY v

1.0 INTRODUCTION 1

1.1 Location 1
1.2 Purpose 1
1.3 Related Documents 1
1.4 Physiographic and Geologic Setting 3

2.0 PRE-TEST INDICATED AND INFERRED FAULTS 3
3.0 GEOLOGIC EFFECTS OF THE FAULTLESS TEST 6
4.0 FIELD INVESTIGATIONS 6
5.0 SEISMICITY 14
6.0 DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS 18
7.0 REFERENCES 19

Appendix A — Indicated and Inferred Faults in the Vicinity of UC-1, and Results of the Exploratory Trenching, Hot Creek Valley, Nevada

Appendix B — Preliminary Report on the Geologic Effects of the FAULTLESS Event

Appendix C — Seismicity of the Central Nevada Test Area, 26 September 1969 - 1 October 1970

Figures

Figure 1 — Map showing the Central Nevada Test Area and vicinity 2
Figure 2 — Map of the UC-1 area showing indicated and inferred faults and locations of exploratory trenches 5
Figure 3 — Photograph of Fault B showing eroded sediment redeposited at the angle of repose from the top to bottom of the scarp 8
Figure 4 — Photograph of Fault C near the northeast end showing little vertical displacement and a deep depression resulting from piping of water and sediment along the fault plane 9

Figures

Figure 5 Photograph of Fault C and the dike along the southeast side of the mud pit showing depressions 11
Figure 6 Photograph of Fault C at the intersection of the dike along the southeast side of the mud pit. The low terrace in front of the main Fault C scarp results from a secondary fracture 12
Figure 7 Photograph of Fault C southwest of the mud pit showing the nearly vertical fault scarp, and blocks of sediment calving from the scarp. Stakes at the top and bottom of the scarp are survey points FSI-1 and FSI-2, respectively 13
Figure 8 Photograph of Fault C southwest of the mud pit showing a deep depression and hole at the base of the scarp. 15
Figure 9 Photograph of Fault C near the southwest end showing fracture not visible on early post-test (1968) photographs 16
Figure 10 Photograph of Fault C near the southwest end showing fracture not visible on early post-test (1968) photographs 17

Plate

Plate 1 FAULTLESS Event – Explosion-Produced Fractures

ACRONYMS AND ABBREVIATIONS

CNTA	Central Nevada Test Area
DOE	U.S. Department of Energy
FFACO	Federal Facility Agreement and Consent Order
ft	Foot (feet)
GZ	Ground Zero
km	kilometer(s)
m	meter(s)
mi	mile(s)
USGS	U.S. Geological Survey

EXECUTIVE SUMMARY

The Central Nevada Test Area is located in the north-central part of Hot Creek Valley, approximately 96 kilometers (60 miles) northeast of Tonopah, in Nye County, Nevada. Project FAULTLESS was the only nuclear test conducted at the Central Nevada Test Area. Subsidence of the ground surface after detonation of the FAULTLESS test was atypical in that it was apparently significantly controlled by preexisting faults that generally trended along the valley. At least one of the preexisting faults (Fault A of Ekren, 1967) had been active during the Holocene. Opening of many radiating and concentric fractures, and displacement along the faults, occurred shortly after detonation of the FAULTLESS test. Evidence that displacement along the faults has occurred since initial displacement is lacking. However, the area is seismically active and the possibility of a moderate earthquake that could result in additional displacement cannot be discarded.

Hydrocarbon-based drilling mud from boring of emplacement holes associated with the FAULTLESS test was discharged to a mud pit built juxtaposed to a fault scarp that developed as a result of the test. The mud pit, which is approximately 460 meters (1,500 feet) southeast of the UC-1 ground zero (GZ), is now being remediated as a Corrective Action Unit 417 under the Federal Facility Agreement and Consent Order (FFACO) entered into by the state of Nevada, the U.S. Department of Energy (DOE), and the U.S. Department of Defense (FFACO, 1996). Evaluation of the potential for future regional seismicity and displacement along the juxtaposed fault and nearby faults is being conducted to help determine the best course of remediation and design of the closure cover and associated drainage structures.

Dropping of the approximate 0.9-square-kilometer (0.6-square-mile) area has resulted in much of the natural drainage to be diverted from natural courses. Water now runs along the fault scarp and eventually collects at the intersection of the mud pit dike and fault scarp. Water retained along the fault scarp and at the intersection of the dike and fault scarp pipes down the fault plane, generally resulting in a trench along the base of the scarp. This active process along the base of the scarp results in calving of blocks of sediment and regression of the fault scarp. Piping of water and sediment down the fault plane under the dike is responsible for depressions in the dike.

A flood diversion structure is required at the up-slope end of the mud pit to prevent run-on water from impinging on the closure cover. This structure should be designed to result in conveyance of water around the north and south sides of the dike where other structures (drainage channels cut through the fault scarp) would convey the water into existing channels east of the fault scarp. Such a design would eliminate piping of water and sediment down the fault plane. Injection of grout or mud into the

piping holes near and under the dike should first be conducted. Elimination of piping of sediment and water down the fault plane, especially under the dike, should also eliminate the need to excavate a trench at the west end of the mud pit for receipt of waste and soil excavated from the east end of the mud pit. In addition to flood control structures near the mud pit, the fault scarp should be breached by a channel in areas where active drainage intersects the scarp. One such area is located approximately where two indistinct roadbeds (one being the cable layout roadbed) trend perpendicular to the scarp. Here too, any piping holes should first be filled with grout or mud. An additional measure should be grading and compaction of sediments along the base of the scarp in areas where engineered channels are placed.

1.0 INTRODUCTION

1.1 Location

The Central Nevada Test Area (CNTA) is located in the north-central part of Hot Creek Valley, approximately 96 kilometers (km) (60 miles [mi]) northeast of Tonopah, in Nye County, Nevada (Figure 1). Project FAULTLESS was the only nuclear test conducted at CNTA. The test was conducted at the UC-1 site located at Nevada State coordinates, Central Zone; 1,414,340 N and 629,000 E. The FAULTLESS test was detonated at a depth of 975 meters (m) (3,200 feet [ft]) on January 19, 1968, and had an announced yield range of 200 to 1,000 kilotons (U.S. Department of Energy [DOE], 1994). The test was conducted primarily to acquire seismic data to predict responses from higher-yield tests in the same area (McKeown *et al.*, 1968).

1.2 Purpose

Hydrocarbon-based drilling mud from boring of emplacement holes associated with the FAULTLESS test was discharged to a mud pit juxtaposed to a fault scarp that developed as a result of the test. The mud pit, which is approximately 460 m (1,500 ft) southeast of the UC-1 GZ, is now being remediated as a Corrective Action Unit 417 under the Federal Facility Agreement and Consent Order (FFACO) entered into by the state of Nevada, the DOE, and the U.S. Department of Defense (FFACO, 1996). Evaluation of the potential for future regional seismicity and displacement along the juxtaposed fault and nearby faults is being conducted to help determine the best course of remediation and design of the closure cover and associated drainage structures.

1.3 Related Documents

The U.S. Geological Survey (USGS) conducted and reported on site characterization studies prior to and after the FAULTLESS test. These reports include, but are not limited to, detailed lithologic logs of exploratory boreholes, hydraulic testing of wells, acoustic properties of volcanic rocks, geologic maps, fault investigations, and geologic effects of the test.

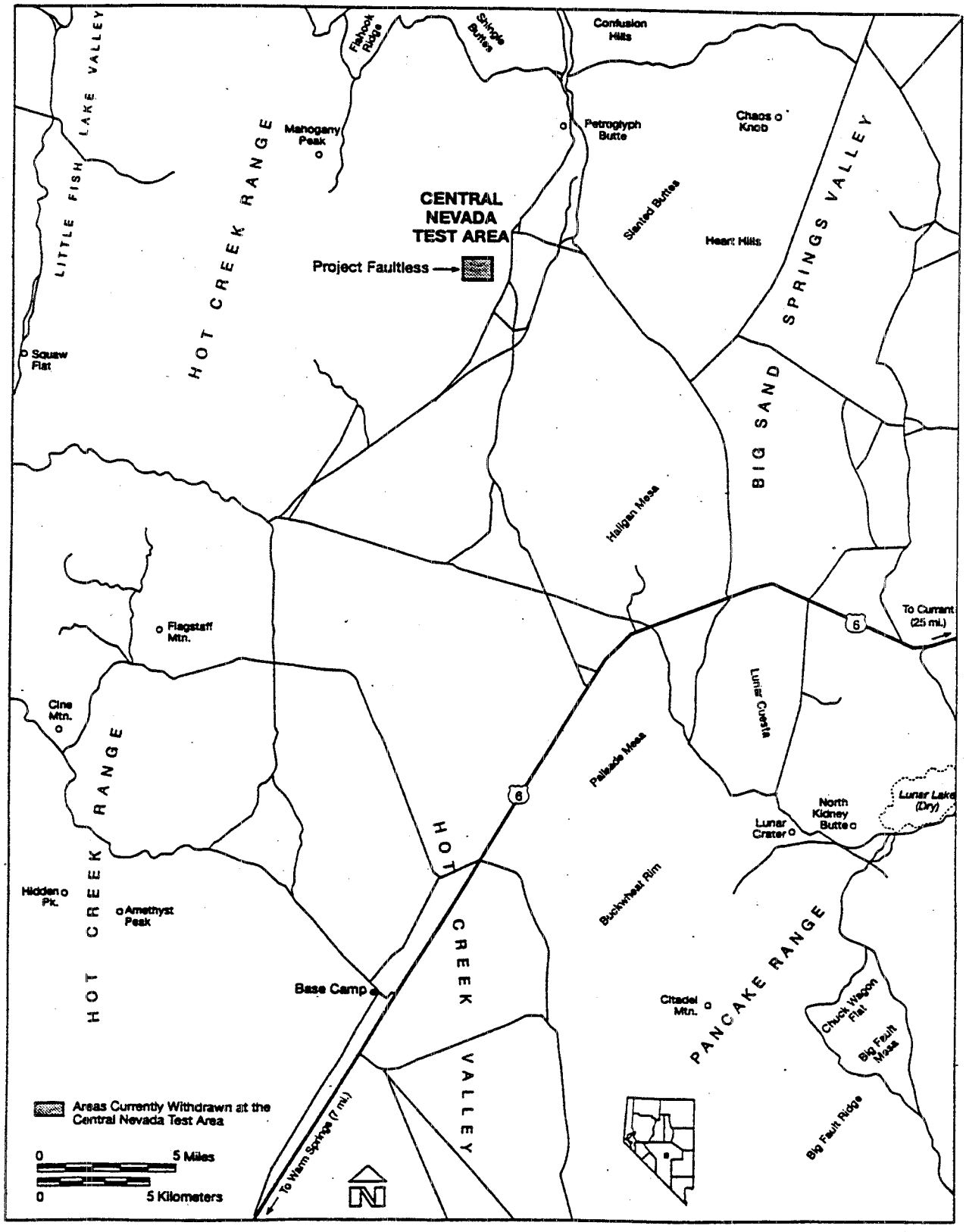


Figure 1 Map showing the Central Nevada Test Area and vicinity (from DOE, 1996).

Three USGS reports related to fault and seismic hazards at UC-1 are:

- *Indicated and Inferred Faults in the Vicinity of UC-1, and Results of Exploratory Trenching, Hot Creek Valley, Nevada* (Appendix A);
- *Preliminary Report on the Geologic Effects of the Faultless Event* (Appendix B); and
- *Seismicity of the Central Nevada Test Area* (Appendix C).

1.4 Physiographic and Geologic Setting

The Hot Creek Valley is within the Basin and Range Physiographic Province, which is characterized by regularly spaced, roughly north-south-trending mountain ranges separated by alluvial valleys that formed by faulting. Hot Creek Valley is approximately 112 km (70 mi) long north to south and 16 to 32 km (10 to 20 mi) wide. The ground surface elevation decreases to the south at approximately 9 m (30 ft) per mile; the approximate elevation at the UC-1 site is 1,860 m (6,100 ft) above mean sea level. The Hot Creek Range west of the UC-1 site rises 1,370 m (4,500 ft) above the valley floor. The Pancake Range east of the UC-1 site rises 550 m (1,800 ft) above the valley floor.

The geology of the Hot Creek Valley area has been summarized by Anderson *et al.* (1967), Ekren *et al.* (1968), and Hoover (1968). Paleozoic sedimentary rocks and Tertiary volcanic rocks compose the Hot Creek Range. The Paleozoic sedimentary rocks are comprised of sandstone, quartzite, limestone, and dolomite. The Tertiary volcanic rocks are comprised of welded tuff, nonwelded bedded tuff, argillized and zeolitized tuff, conglomeratic tuffaceous sandstone, carbonaceous siltstone, and rhyolite (Healey, 1968). Alluvium underlying the UC-1 site is approximately 730 m (2,400 ft) thick. The alluvium is underlain by tuffaceous sediments and zeolitized tuff from 730 m (2,400 ft) to at least 998 m (3,275 ft), which is the total depth of the UC-1 emplacement hole (Barnes, 1968). The northern part of Hot Creek Valley, including the UC-1 site, is thought to be underlain by the Morey Peak-Hot Creek caldera (Healey, 1968).

2.0 PRE-TEST INDICATED AND INFERRED FAULTS

Ekren (1967) described pre-test indicated and inferred faults in alluvium near the UC-1 site based on examination of aerial photographs and field study. Four faults, designated A, B, C, and D, and two zones of infrared anomaly ("low radiometric temperature") were mapped (Figure 2). All of these features trend northeastward,

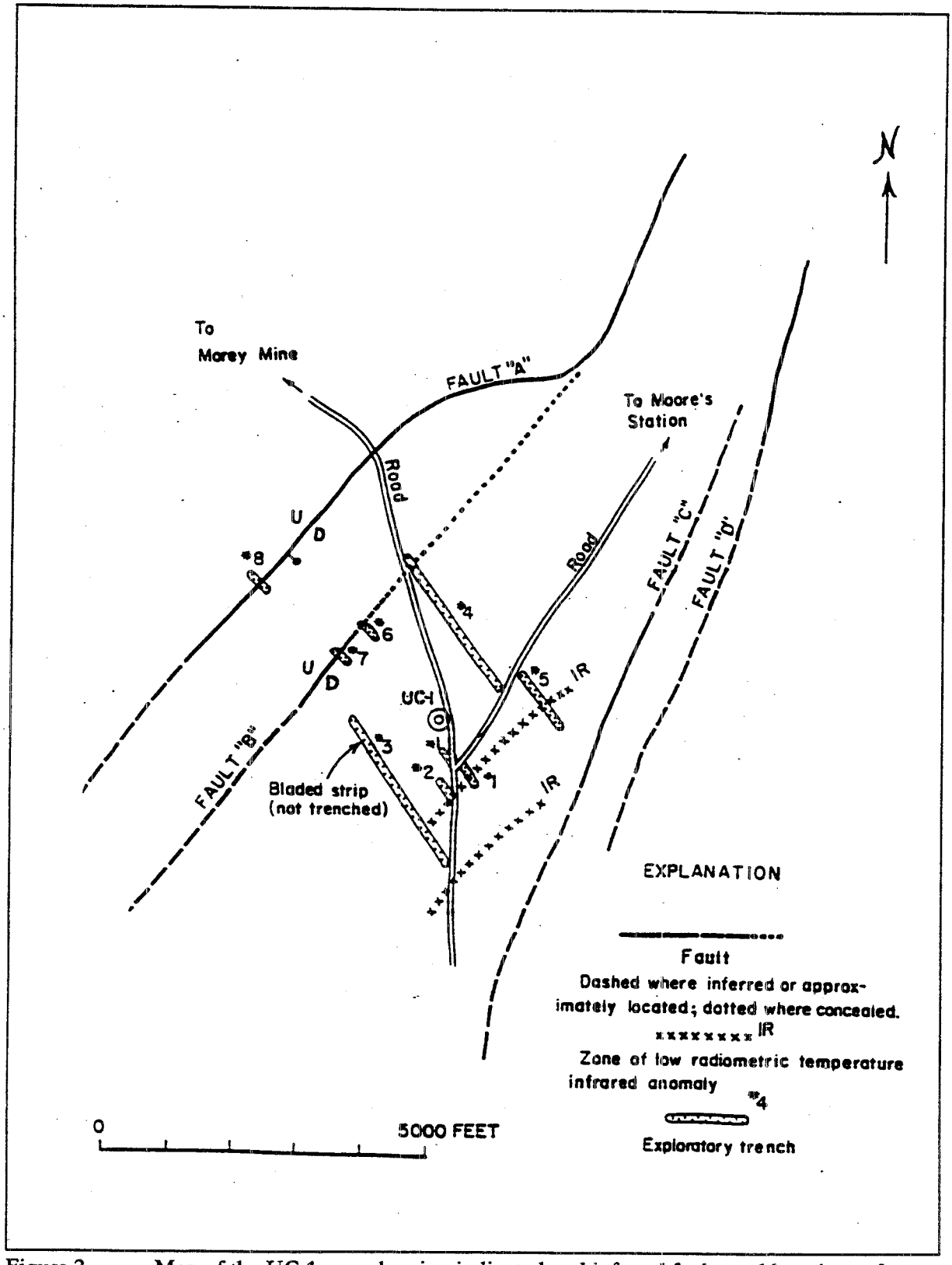


Figure 2 Map of the UC-1 area showing indicated and inferred faults and locations of exploratory trenches (from Ekren, 1967).

roughly along the Hot Creek Valley. Trenches were excavated by Ekren (1967) across Faults A and B, and across the zone of infrared anomaly nearest to the FAULTLESS test GZ. Prior to the FAULTLESS test, Fault A was marked by a well-defined scarp. Trenching indicated that the fault plane is nearly vertical and the uppermost strata are displaced, indicating relatively recent activity. Fault B was expressed as a poorly defined lineament on the aerial photographs and as a low scarp in a few locations on the ground. A trench across Fault B showed that only strata deeper than 0.9 to 1.2 m (3 to 4 ft) are displaced. Faults C and D were expressed as lineaments on the aerial photographs. No scarps were noted on the ground; however, Ekren (1967) indicated that these lineaments may reflect major bedrock faults. Three trenches across the zone of infrared anomaly nearest to the test GZ showed no evidence of fracturing or faulting prior to the FAULTLESS test.

Both pre-test and post-test lineaments, including Faults A, B, C, and D of Ekren (1967), were presented by McKeown *et al.* (1968) (*Appendix B, Figures 2 and 3*). The pre-test lineaments agree well with lineaments visible on high-altitude (approximately 1:36,000-scale), black-and-white, aerial photographs acquired on September 1, 1967 (GS-VBUE, Line 1, Frames 64 and 65). These photographs are apparently different from those examined by Ekren because his report was published in May 1967. The availability of the photographs examined by Ekren is unknown. A request to the USGS for pre-test photographs resulted only in the September 1967 photographs.

On the September 1967 photographs, Fault B appears as a low scarp northwest of UC-1 GZ. Three trenches are evident, presumably those excavated by Ekren. Fault B, if it extends northeastward from where the scarp is most prominent, may intersect Fault A, which appears as a prominent scarp that has a distinct eastward bend approximately 1.6 km (1 mi) north of GZ. Any southwestward extension of Fault B from where the scarp is most prominent is not obvious because drainage channels have cut the older surface where the scarp is best expressed.

On the September 1967 photographs, the surface expression of Fault C is clearly visible as a sharp, tonal difference east of the UC-1 GZ; a dark tone being present on the northwest side of the northeast-trending fault and a light tone being present on the southeast side of the fault. The tonal difference can be traced northeastward with certainty a short distance beyond a secondary road that trends roughly parallel with the main southeast-northwest access road to UC-1 (Plate 1). Here the fault becomes obscure where drainage channels have cut the older surface on which the tonal difference is best visible. The tonal difference continues northeastward; however, transversing drainage channels become increasingly common and the tonal difference becomes increasingly obscure. South of the main access road leading to UC-1, Fault C turns westward and becomes obscure where drainage channels have cut the

older surface on which the tonal difference is best visible. The trend of Fault C, if it continues through the area of more recent drainage, may intersect a fault that is expressed as a low, discontinuous scarp along the lower slopes of the west side of the valley (*Appendix B, Figure 2*). As with other pre-test faults in the area of UC-1, the downside of this fault is southeast.

3.0 GEOLOGIC EFFECTS OF THE FAULTLESS TEST

The FAULTLESS test resulted in the dropping of an irregularly shaped area bounded on the northwest and south-southeast by Faults B and C, respectively; and on the west-southwest and northeast by zones of concentric fractures (*Plate 1; Appendix B, Figures 2 and 3*). The approximate dimensions of the dropped area are 1,463 m (4,800 ft) by 1,189 m (3,900 ft), the long dimension being along the valley. McKeown *et al.* (1968) reported as much as 1.8 m (6 ft) of vertical displacement on Fault B (down on the southeast side) and 4.6 m (15 ft) of vertical displacement on Fault C (down on the northwest side). Additionally, within the dropped area, a fault opened approximately 76 m (250 ft) south of GZ. The fault trends roughly parallel to Fault C, and from GZ extends westward approximately 396 m (1,300 ft) and northeastward approximately 1,340 m (4,400 ft). Near GZ, the ground surface northwest of this fault dropped as much as 3 m (10 ft) according to McKeown *et al.* (1968). Away from GZ, the amount of displacement along this fault becomes substantially less. Both left and right lateral displacements were also mapped by McKeown *et al.* (1968), especially on the fault near GZ and on Fault C. Lateral displacement is generally less than 0.3 m (1 ft), but up to 0.9 m (3 ft) on Fault C south of GZ. The zone of fractures bounding the northeast side of the dropped area trends roughly parallel with long fractures that existed prior to the test (*Appendix B, Figure 2*), suggesting structural control. The test also resulted in fractures and pressure ridges that radiate outward from GZ for approximately 305 m (1,000 ft).

4.0 FIELD INVESTIGATIONS

Field investigations were conducted in April 1999 to determine whether displacement along faults (primarily Faults A, B, and C, and the undesignated fault near GZ) has occurred or is continuing, either from tectonic processes or some other process, since detonation of the FAULTLESS test. With the exception of these faults and a few associated fractures, all other fractures shown by McKeown *et al.* (1968) (*Appendix B, Figure 3*) have since healed and are no longer visible on aerial photographs or on the ground. No evidence was observed that suggests that Faults A and B have experienced any additional displacement since detonation of the FAULTLESS test. Sediment eroded from these scarps now lies at the angle of repose roughly from top to bottom of the scarps (Figure 3).

Particular attention was paid to Fault C because the mud pit subject to remediation is juxtaposed to this fault south of the main access road to GZ. Fault C, northeast of the main access road, is generally low and sediment eroded from the scarp lies at the angle of repose from top to bottom of the scarp. New survey points, FS4-1 and FS4-2, located respectively at the top and bottom of the scarp, and 50 m (163 ft) along the fault from the north side of the main access road, show about 2.1 m (7 ft) of vertical displacement (*Plate 1*). Few values of vertical displacement are shown by McKeown *et al.* (1968) (*Appendix B, Figure 3*) north of the main access road, making comparison of new data with old data difficult. The nearest value of vertical displacement shown by McKeown *et al.* (1968) (*Appendix B, Figure 3*), 1.2 m (4 ft), is approximately 76 m (250 ft) north of the main access road.

From the FS4-1 and FS4-2 survey points, the Fault C scarp continues approximately 460 m (1,500 ft) northeastward. Near the end of its observable northeastward extent, the fault crosses an unmaintained road at nearly a right angle. A benchmark is present on the north side of the roadbed near the fault. No fractures were observed in the roadbed. The fault has little vertical displacement over the last 61 m (200 ft) of its observable northeastward extent. Rather, an open fracture is present, primarily enlarged by piping of water and sediment down the fracture (Figure 4). Piping of water and sediment has enlarged the fracture to be as much as 1.8 m (6 ft) wide and 3.6 m (12 ft) deep. Over the last 30 m (100 ft) of the fault's observable northeastward extent, depressions resulting from piping are up to several feet deep. The fault bifurcates within this last interval. One splay continues along the same trend and the other splay continues northwestward for a short distance, where it becomes no longer discernable. The splay that continues along the initial trend can be traced as small, discontinuous depressions, approximately 6.1 m (20 ft) into a topographically lower area formed from incision of drainage paths.

The Fault C scarp south of the south side of the main access road to GZ is nearly vertical and fresh in that blocks of sediment have calved from the scarp leaving newly exposed sediment. Sediment calved from the scarp typically falls into depressions at the base of the scarp resulting from piping of water and sediment down the fault plane, or lies at the base of the scarp. Survey points at the top and bottom of the fault scarp, approximately 31 m (104 ft) south of the south side of the main access road (FS3-1 and FS3-2), show about 2.5 m (8 ft) of vertical offset. This offset is comparable with that shown by McKeown *et al.* (1968) for this part of the fault scarp. The fault scarp continues a short distance southwestward from these points, and is then covered by the southeastern part of a dike that has been constructed around the mud pit.

In 1998, an access road into the mud pit was cut through the dike near where it first covers the fault scarp. The road cut through the scarp exposes vertical fractures in the dike that may be indicative of minor displacement; however, these fractures probably

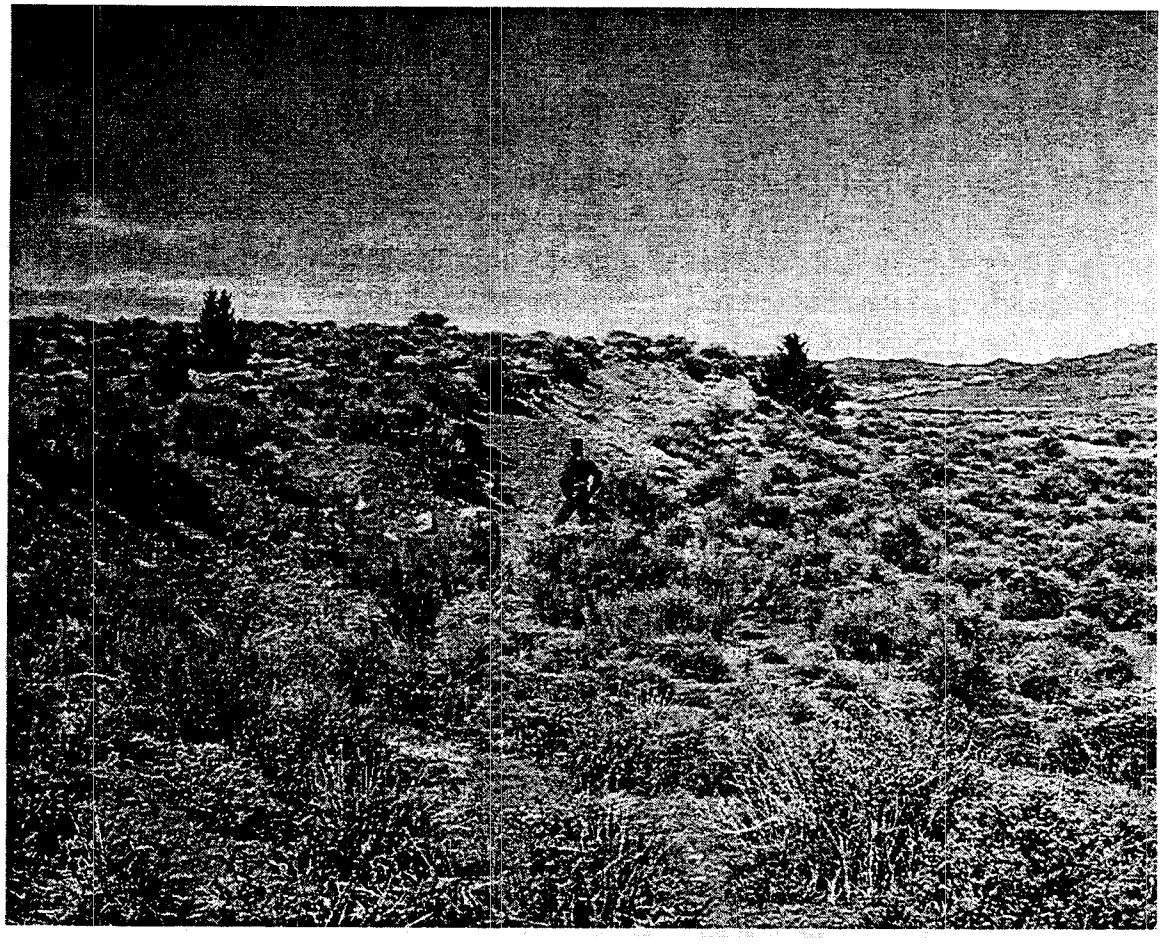


Figure 3 **Photograph of Fault B showing eroded sediment redeposited at the angle of repose from the top to bottom of the scarp. View is northeast.**

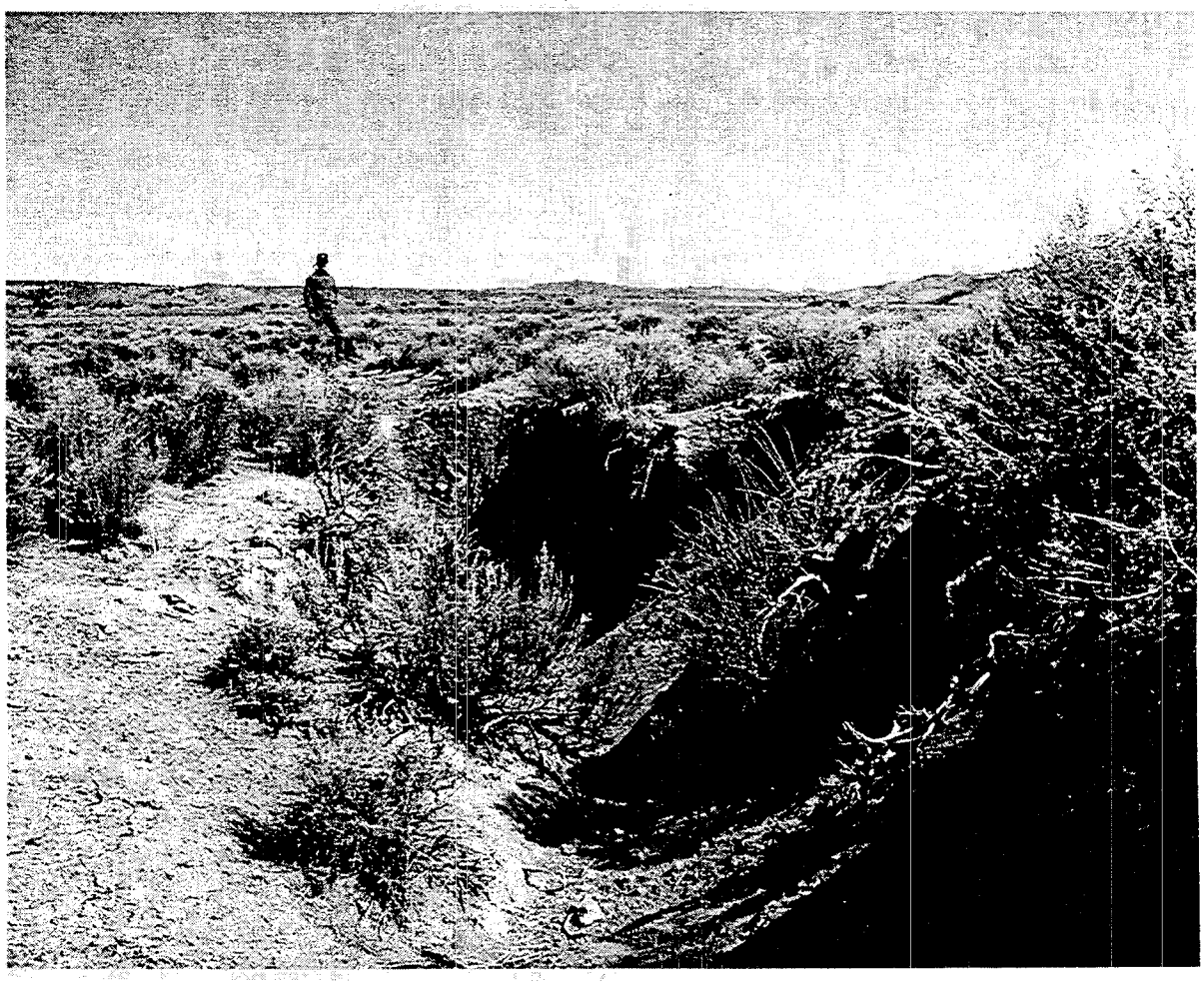


Figure 4 **Photograph of Fault C near the northeast end showing little vertical displacement and a deep depression resulting from piping of water and sediment along the fault plane. View is northeast.**

represent compaction of the sediment composing the dike. The dike covers the fault southwestward from the road cut. Depressions formed from piping of water and sediment along the fault plane are present inside the mud pit at the base of the dike; these depressions can be traced along and across the dike to a point where the dike turns westward, away from the fault scarp (Figures 5 and 6). At this intersection and continuing southwestward, the fault scarp is nearly vertical and fresh, again from blocks of sediment calving from the scarp (Figure 7). New survey points, FS2-1 and FS2-2, located respectively at the top and bottom of the scarp, and 20.5 m (66 ft) southwest of the intersection of the dike and fault scarp, show about 2.7 m (9 ft) of vertical displacement.

The well-defined Fault C scarp continues southwest to westward. New survey points, FS1-1 and FS1-2, located respectively at the top and bottom of the scarp, and 23.5 m (77 ft) northeast of the east side of the first indistinct road west of the intersection of the dike and fault scarp, show about 3 m (10 ft) of vertical displacement. The greatest apparent displacement on the fault is near the crossing of two parallel roadways that trend south from GZ. The wider of the two roadways is believed to be the area used to lay out cables that connected diagnostic equipment at the shot point with recording trailers. McKeown *et al.* (1968) noted probable maximum vertical displacement of 4.6 m (15 ft) in this general area, which is consistent with observations of this investigation. Also in this general area, and in a few locations elsewhere, the fault is manifested as a zone of several fractures, typically a less extensive fracture or fractures either in front or behind, or both, of the main fault plane. Where a fracture occurred in front of the main fault, the result is a block of sediment, lower than the top of the main scarp, and parallel to the main scarp (*Figure 6*). The block of sediment is typically separated from the main scarp by a depression resulting from piping of water and sediment down the main fault. Where a fracture occurred behind the main fault, the result is a depression along that fracture, again the result of piping of water and sediment down the fracture.

Continuing westward along the Fault C scarp from near the indistinct roadway where diagnostic cables for the FAULTLESS test were laid, the fault scarp becomes lower and sediment eroded from the scarp generally lies at the angle of repose from top to bottom of the scarp. One exception to the eroded sediment being at the angle of repose in this area is where piping of water and sediment down the main fault plane has resulted in a deep depression and hole at the base of the scarp, and sediment has calved from the scarp (Figure 8). The main scarp eventually intersects with drainage channels along the same trend and becomes indistinguishable from the drainage channels. Near the western end of the Fault C scarp, along the same trend but about 30 m (100 ft) south, a fracture not visible on early postshot (1968) (EG&G [Edgerton, Germeshausen, and Grier], Roll 1360, 08-29-68) photographs, and not mapped by McKeown *et al.* (1968), is present and extends for a length of approximately 152 m

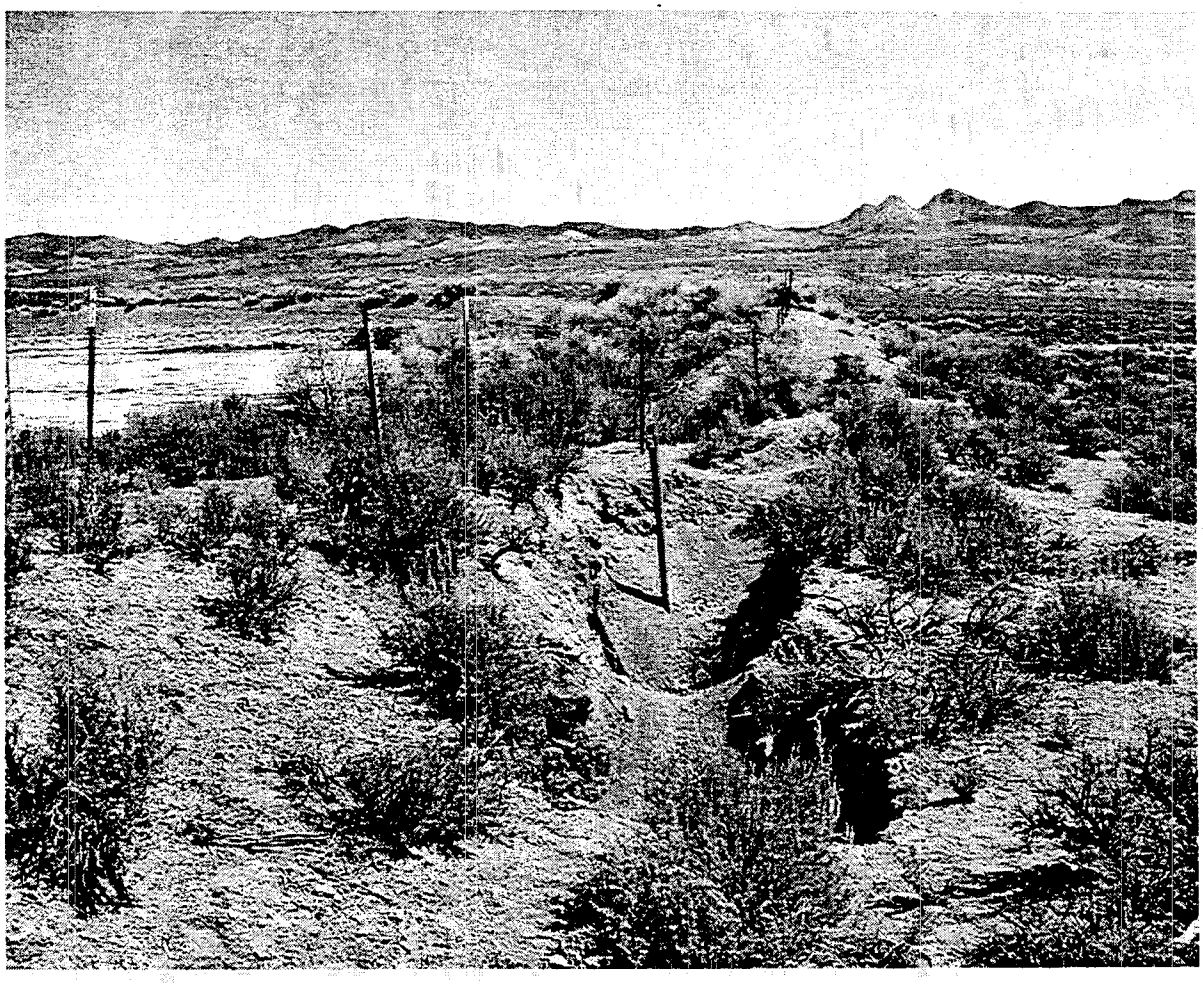


Figure 5 Photograph of Fault C and the dike along the southeast side of the mud pit showing depressions. View is northeast.

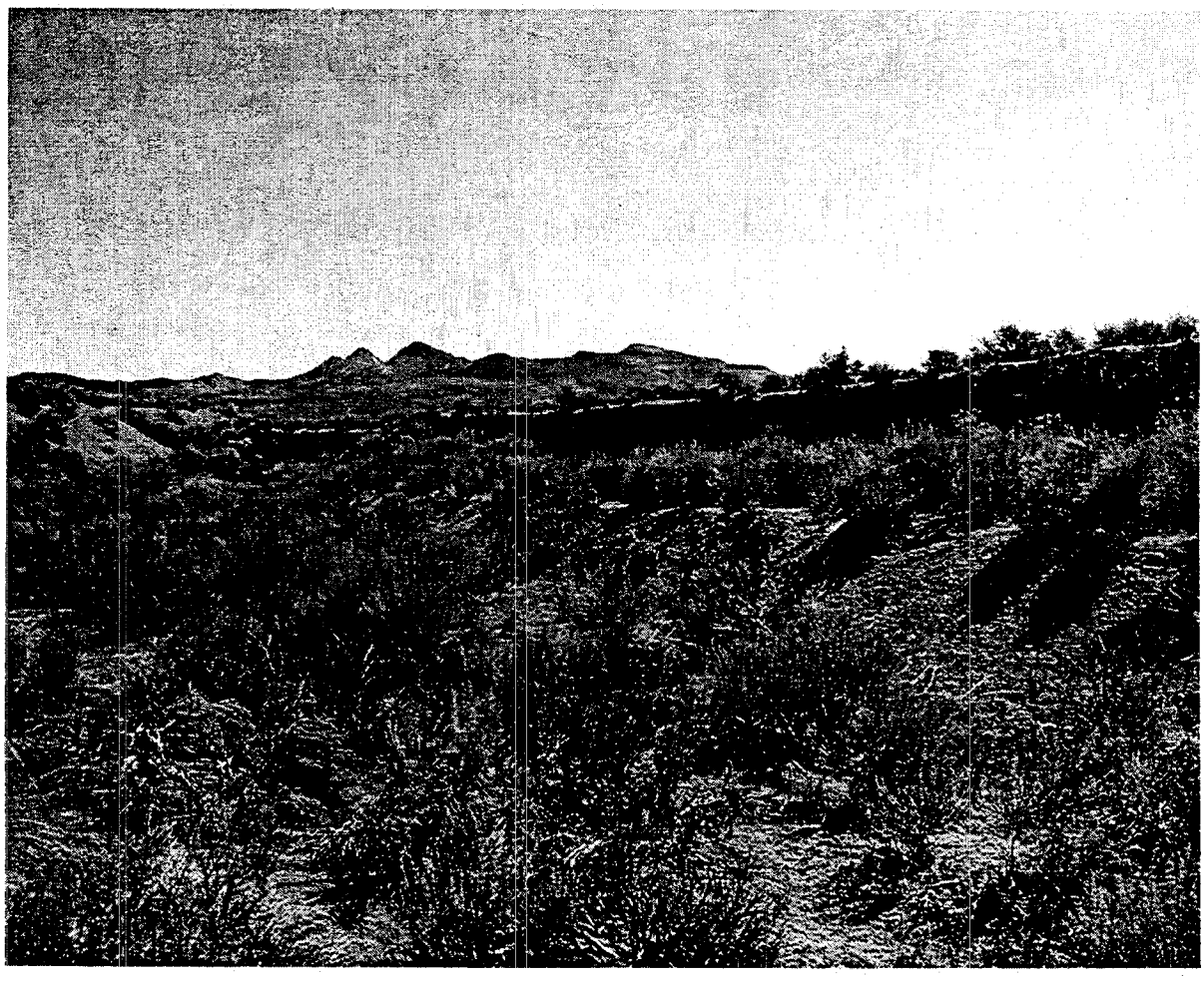


Figure 6 **Photograph of Fault C at the intersection of the dike along the southeast side of the mud pit. The low terrace in front of the main Fault C scarp results from a secondary fracture. View is northeast.**

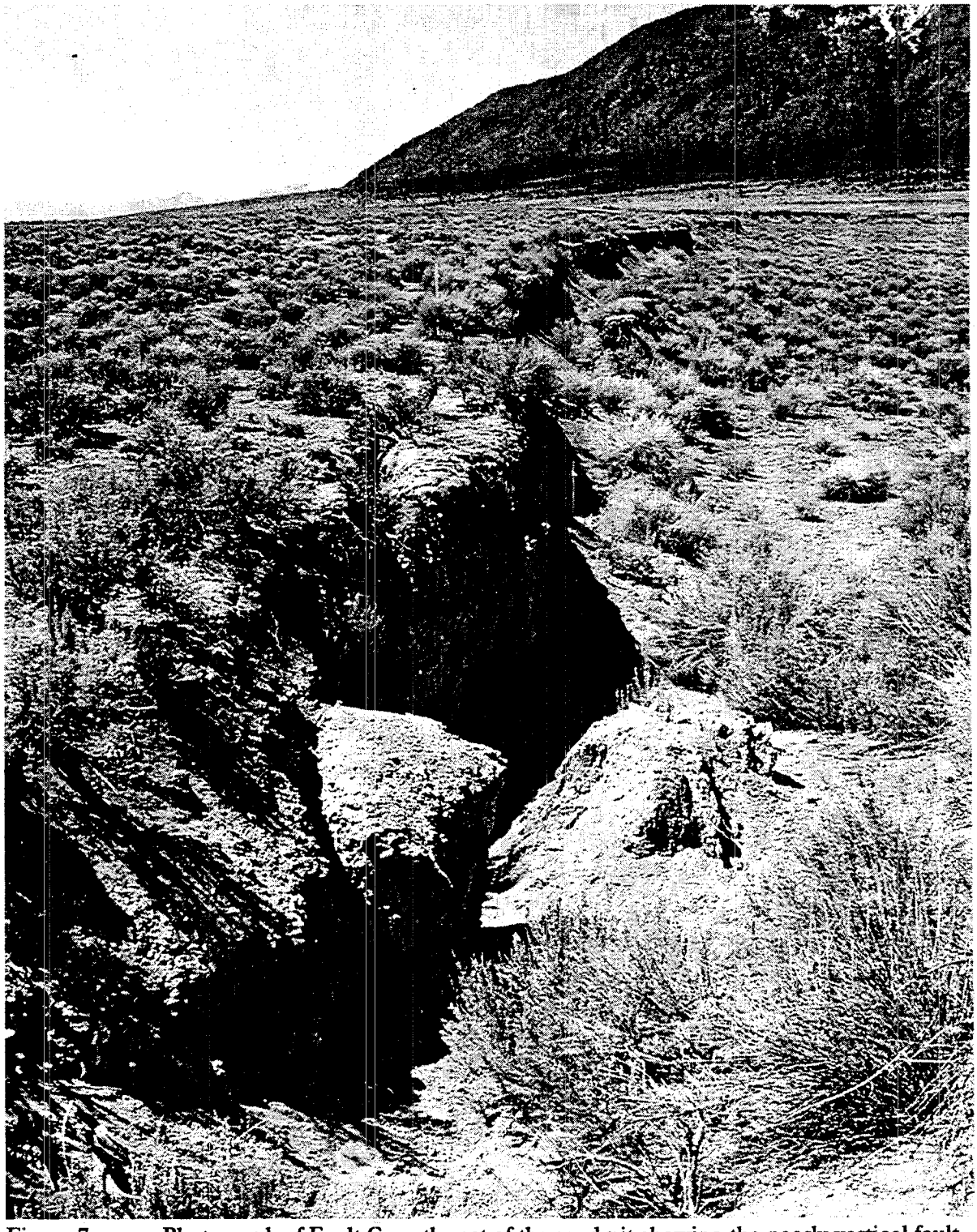


Figure 7 **Photograph of Fault C southwest of the mud pit showing the nearly vertical fault scarp, and blocks of sediment calving from the scarp. Stakes at the top and bottom of the scarp are survey points FSI-1 and FSI-2, respectively. View is southwest.**

(500 ft) beyond the end of the main fault (Figures 9 and 10). The fracture is visible on aerial photographs taken in 1995 (EG&G, 8046-4, 02-23-95). The fracture is likely contemporaneous with the main fault, but was not manifested, or observed, at the surface until it was widened by piping of water and sediment down the fracture. The fracture is generally between 0.6 and 1.5 m (2 and 5 ft) wide and about the same dimensions deep; however, at one location, the fracture is open to a depth of about 6.1 m (20 ft). Vertical displacement of between 0.3 and 0.6 m (1 and 2 ft), north side down, is also apparent along some parts of the fracture. As mentioned in Section 2.0, the trend of Fault C, if continued through the area of more recent drainage, may intersect a fault that is expressed as a low, discontinuous scarp along the lower slopes of the west side of the valley. The westernmost expression of Fault C is within 128 m (420 ft) of this older scarp.

A few fractures near GZ have also been widened by piping of water and sediment down the fractures. These fractures are not discernable on the 1968 post-test photographs, but may correspond to fractures mapped by McKeown *et al.* (1968).

5.0 SEISMICITY

Much of the Basin and Range Province has been seismically active in the historic past (Gawthrop and Carr, 1988; Rogers *et al.*, 1991). Seismicity in Nevada is partly caused by interaction of the Pacific and North American tectonic plates. Most of the slippage between these plates occurs in California, whereas about 20 percent of the total slippage is believed to occur in the Basin and Range Province, and may be concentrated in western Nevada (Anderson *et al.*, 1993).

The UC-1 site is outside the boundaries of two poorly defined seismic zones. The site is approximately 96 km (60 mi) north of the "East-West Seismic Zone" and 129 km (80 mi) east of the "Nevada-California Seismic Zone" (Gawthrop and Carr, 1988). Records show that two earthquakes were recorded in the Hot Creek Valley area; one in 1942 and the other in 1954, both with a Richter magnitude of 5 (Slemmons *et al.*, 1965). The USGS recorded only one earthquake within a 16-km (10-mi) radius of UC-1 site during the period January 1, 1973, to May 1, 1999 (USGS, 1999). This earthquake occurred on August 22, 1988, approximately 8 km (5 mi) northwest of the UC-1 site at a depth of 7 km (4.4 mi), with a reported magnitude of 3.1.

The USGS operated seven seismometer stations during the period September 26, 1969, to October 1, 1970, in the vicinity of the UC-1 site following the FAULTLESS test (Smith *et al.*, 1971, *Appendix C*). This postshot monitoring was initiated to establish the seismicity of the area prior to any further nuclear testing and to evaluate reports of earthquake activity following the FAULTLESS test. During this monitoring period, the locations of 36 earthquakes were determined. Magnitudes of these

Figure 8 **Photograph of Fault C southwest of the mud pit showing a deep depression and hole at the base of the scarp. View is west.**

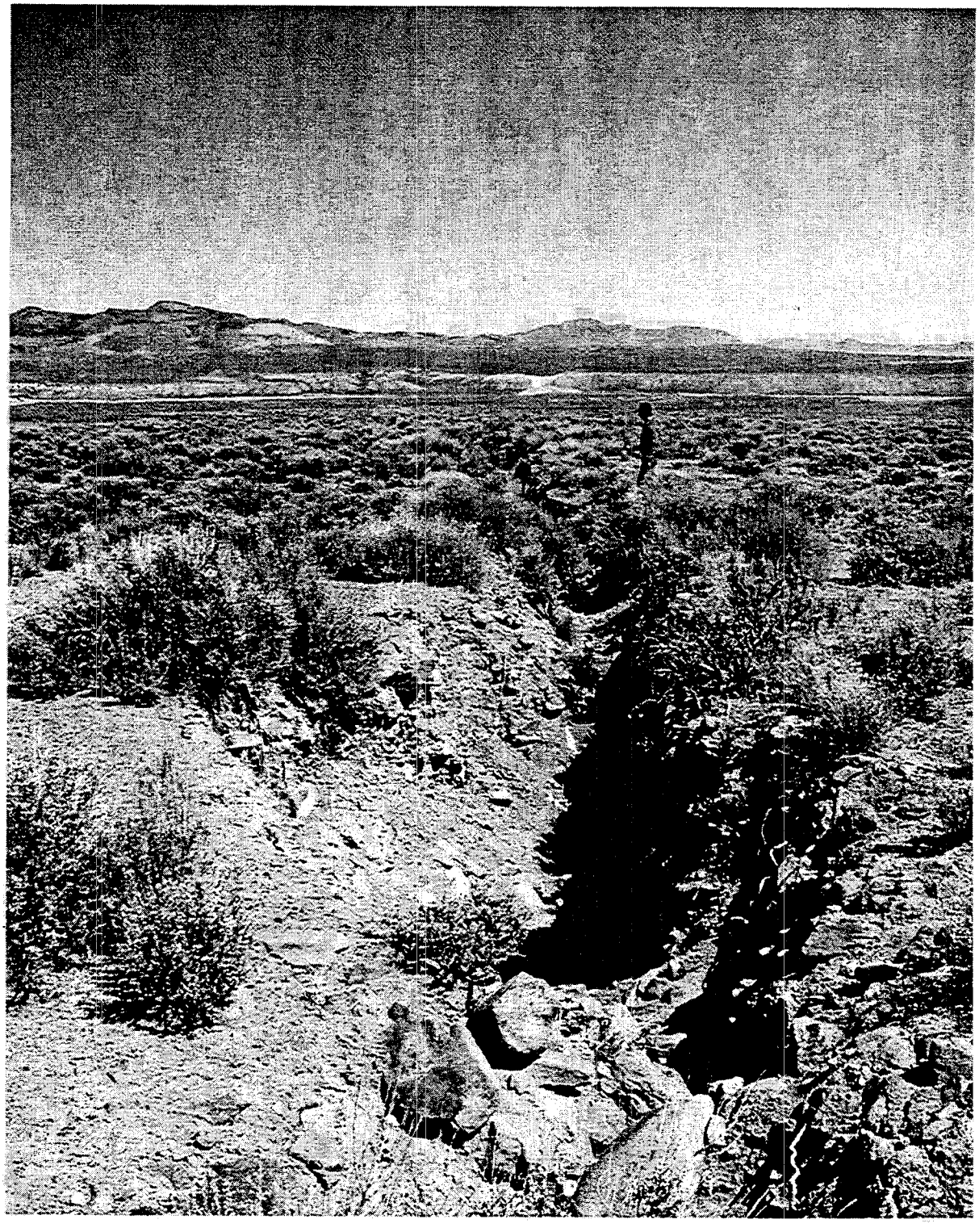


Figure 9 **Photograph of Fault C near the southwest end showing fracture not visible on early post-test (1968) photographs. View is east.**

Figure 10 **Photograph of Fault C near the southwest end showing fracture not visible on early post-test (1968) photographs. View is west.**

earthquakes ranged from -0.2 to 3.4 at depths ranging from 0.6 to 12 km (0.4 to 7.6 mi). The typically infrequent seismic activity at CNTA suggests that earthquakes closely following the test were probably initiated by that test.

6.0 DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

Subsidence of the ground surface after detonation of the FAULTLESS test was atypical in that it was apparently significantly controlled by preexisting faults that generally trended along the valley. At least one of the preexisting faults (Fault A of Ekren, 1967) had been active during the Holocene. Opening of many radiating and concentric fractures, and displacement along the faults, occurred shortly after detonation of the FAULTLESS test. Evidence that displacement along the faults has occurred since initial displacement is lacking. However, the area is seismically active and the possibility of a moderate earthquake that could result in additional displacement can not be discarded.

Dropping of the approximate 0.9-square kilometer (0.6-square-mile) area has resulted in much of the natural drainage to be diverted from natural courses. Water now runs along the fault scarp and eventually collects at the intersection of the dike and fault scarp. Water retained along the fault scarp and at the intersection of the dike and fault scarp pipes down the fault plane, generally resulting in a trench along the base of the scarp. This active process along the base of the scarp results in calving of blocks of sediment and regression of the fault scarp. Piping of water and sediment down the fault plane under the dike is responsible for depressions in the dike.

A flood diversion structure is required at the up-slope end of the mud pit to prevent run-on water from impinging on the closure cover. This structure should be designed to result in conveyance of water around the north and south sides of the dike where other structures, drainage channels cut through the fault scarp, would convey the water into existing channels east of the fault scarp. Such a design would eliminate piping of water and sediment down the fault plane. Injection of grout or mud into the piping holes near and under the dike should first be conducted. Elimination of piping of sediment and water down the fault plane, especially under the dike, should also eliminate the need to excavate a trench at the west end of the mud pit for receipt of waste and soil excavated from the east end of the mud pit. In addition to flood control structures near the mud pit, the fault scarp should be breached by a channel in areas where active drainage intersects the scarp. One such area is approximately located where the two indistinct roadbeds (one being the cable layout roadbed) trend perpendicular to the scarp. Here too, any piping holes should first be filled with grout

or mud. An additional measure should be grading and compaction of sediments along the base of the scarp in area where engineered channels are placed.

7.0 REFERENCES

Anderson, J. G., J. N. Brune, D. dePolo, J. Gomberg, S. C. Harmsen, M. K. Savage, A. F. Sheehan, and K. D. Smith, 1993. Preliminary report: "The Little Skull Mountain Earthquake, June 29, 1992." American Society of Civil Engineers, Proceedings of Symposium on Dynamic Analysis and Design Considerations for High-Level Nuclear Waste Repositories. San Francisco, California, August 19-20, 1992.

Anderson, R. E., F. M. Byers, Jr., G. L. Dixon, E. B. Ekren, D. C. Hedlund, E. N. Hinrichs, D. L. Hoover, F. N. Houser, F. J. Kleinhampl, P. P. Orkild, C. L. Rogers, K. A. Sargent, and R. P. Snyder, 1967. Preliminary Reconnaissance Geologic Map of Central Nevada. U. S. Geological Survey Technical Letter, Central Nevada-1.

Barnes, W., 1968. Report of Exploration Progress, Central Nevada, period August 1, 1967-December 31, 1967. U.S. Geological Survey Technical Letter, Central Nevada 3-2.

DOE, 1994. Environmental Restoration Sites Inventory, 1994 Annual Status Report, Draft, DOE/NV-UC700, Vols. I, II, III, and IV, Las Vegas, Nevada.

DOE, 1996. *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada.* DOE Nevada Operations Office, DOE EIS 0243.

Ekren, E. B., 1967. Indicated and Inferred Faults in the Vicinity of Uc-1, and Results of Exploratory Trenching, Hot Creek Valley, Nevada. U.S. Geological Survey Report, Central Nevada-5, 6 p.

Ekren, E. B., F. M. Byers, Jr., W. J. Car, G. L. Dixon, H. W. Dodge, D. C. Hedlund, E. N. Hinrichs, D. L. Hoover, W. D. Quinlivan, C. L. Rogers, and R. P. Snyder, 1968. Preliminary Geologic Map of the Hot Creek Valley Area, Nye County, Nevada. U. S. Geological Survey Interagency Report, Central Nevada-3.

FFACO, see Federal Facility Agreement and Consent Order

Federal Facility Agreement and Consent Order, 1996. Agreed to by the state of Nevada, the U.S. Department of Energy, and the U.S. Department of Defense.

Gawthrop, W. H., and W. J. Carr, 1988. *Location Refinement of Earthquakes in the Southwestern Great Basin, 1931-1974, and Seismotectonic Characteristics of Some of the Important Events.* U.S. Geological Survey Open File Report 88-560, 64 p.

Healy, D. L., 1968. Gravity Study of Northern Hot Creek Valley, Nye County, Nevada. U.S. Geological Survey Technical Letter, Central Nevada-18, 22 p.

Hoover, D. L., 1968. Lithologic Log of Drill Hole Uce-17 and Generalized Geology of the Uce-17 Area, Hot Creek Valley, Nevada. U. S. Geological Survey Technical Letter, Central Nevada-12.

McKeown, F. A., D. D. Dickey, and W. L. Ellis, 1968. *Preliminary Report on the Geologic Effects of the Faultless Event.* U.S. Geological Survey Report 474-65, 20 p.

Slemmons, D. B., A. E. Jones, and J. I. Gimlett, 1965. "Catalog of Nevada Earthquakes, 1852-1960. *Seismology Society of America Bulletin.*, V. 55, No. 2, p. 537-583.

Smith, B. E., R. M. Hamilton, and W. H. Jackson, 1971. *Seismicity of the Central Nevada Test Area.* U.S. Geological Survey Report 474-109, 27 p.

U.S. Geological Survey, 1999. Earthquake Data Base, Internet @ www.neic.cr.usgs.gov/cgi-bin/epic/epic.

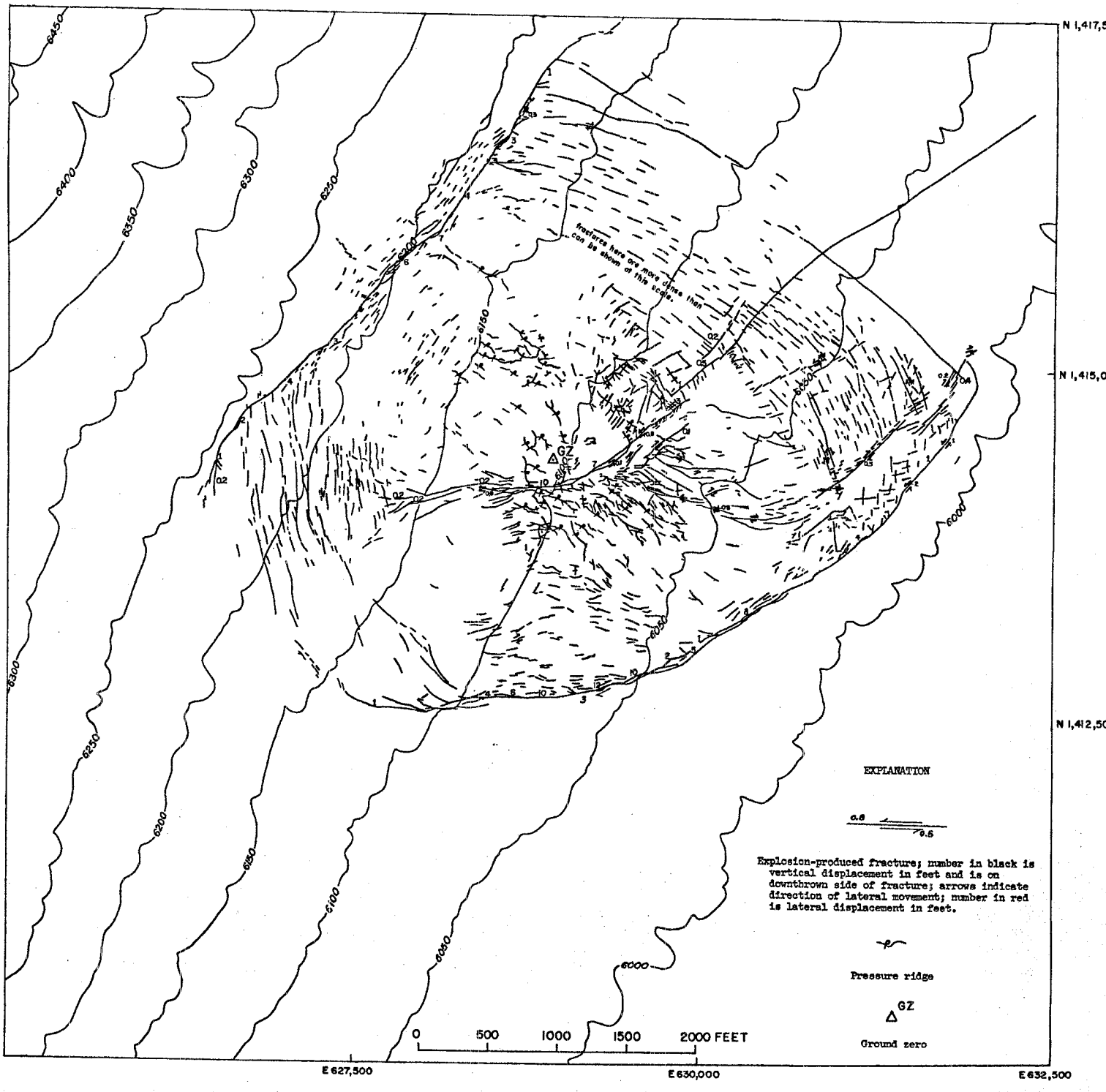


Figure 3.- Detailed fracture map of area around Faultless ground zero

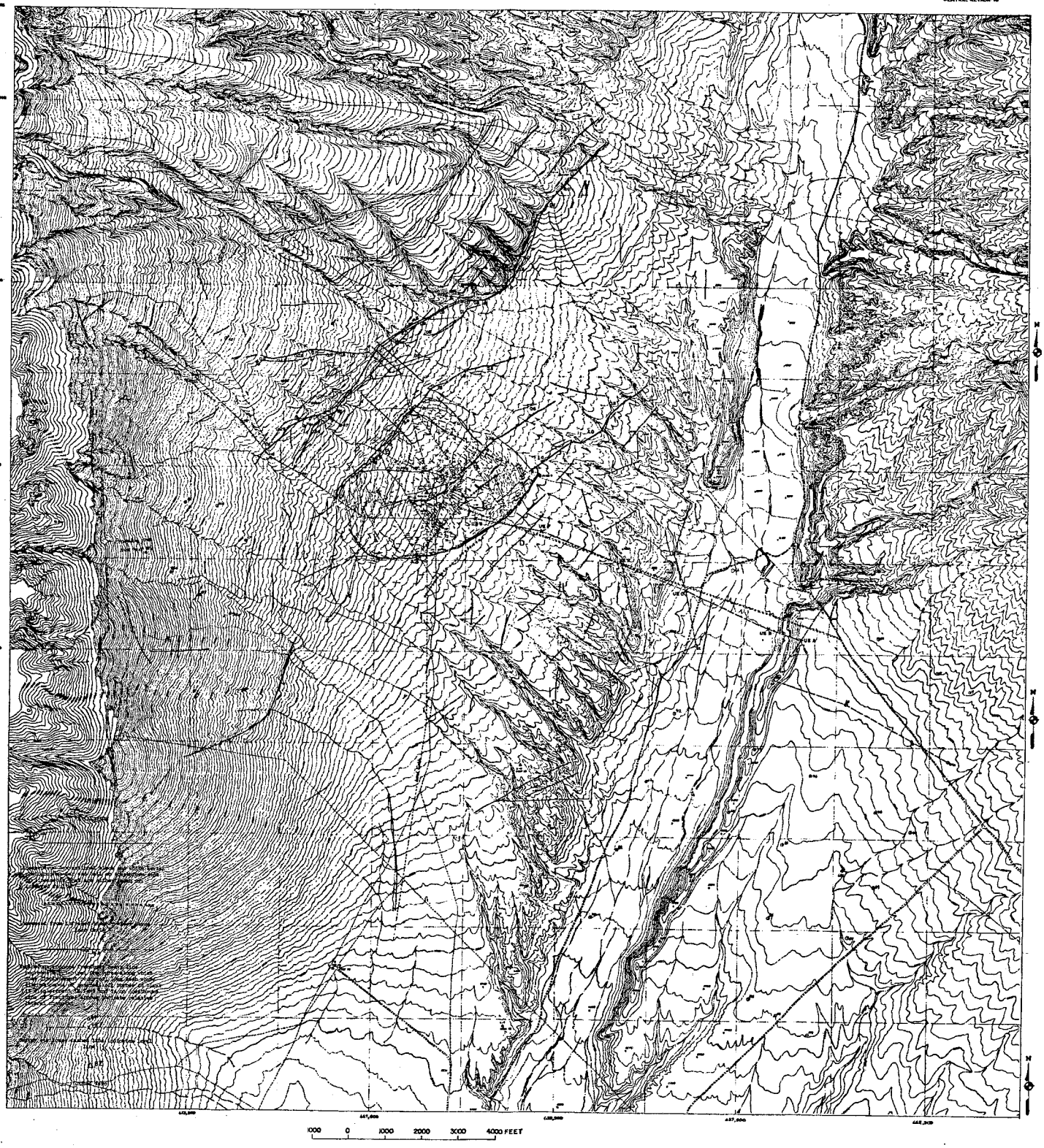


Figure 2.--Fractures produced by Faultless event and present lineaments in vicinity of Faultless ground zero.

APPENDIX A

TECHNICAL LETTER: CENTRAL NEVADA-5

INDICATED AND INFERRED FAULTS IN THE VICINITY OF UC-1, AND RESULTS OF EXPLORATORY TRENCHING, HOT CREEK VALLEY, NEVADA

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Federal Center, Denver, Colorado 80225

In reply refer to:

Technical Letter
Central Nevada-5
May 26, 1967

Mr. James E. Reeves, Manager
Nevada Operations Office
U.S. Atomic Energy Commission
Post Office Box 1676
Las Vegas, Nevada 89101

Dear Mr. Reeves:

Transmitted herewith is one copy of:

TECHNICAL LETTER: CENTRAL NEVADA-5

INDICATED AND INFERRED FAULTS IN THE VICINITY OF UC-1, AND RESULTS OF EXPLORATORY TRENCHING, HOT CREEK VALLEY, NEVADA

By

E. B. Ekren

Additional copies have been distributed as indicated on the attached sheet.

Sincerely yours,

W. S. Twenhofel

W. S. Twenhofel, Chief
Special Projects Branch

Enclosure

Attachment

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Federal Center, Denver, Colorado 80225

In reply refer to:

Technical Letter
Central Nevada-5
May 26, 1967

INDICATED AND INFERRED FAULTS IN THE VICINITY OF UC-1, AND RESULTS OF EXPLORATORY TRENCHING, HOT CREEK VALLEY, NEVADA

By

E. B. Ekren

INTRODUCTION

The proposed site of UC-1 (fig. 1) is about 3 miles south of UCE-17 and 3.7 miles northwest of UCE-18 along the northwest flank of Hot Creek Valley at the approximate coordinates 1,414,500 N. and 629,000 E. This report briefly describes the faults in the alluvium in the vicinity of the site and gives the results of the exploratory trenching in the area.

FAULTS

Fault "A"

The principal fault in the area, labeled "A" on the accompanying sketch map (fig. 2), is plainly visible on the high-altitude AMS aerial photographs and is outlined on the ground by a well-defined fault scarp. A bulldozer cut through this fault zone (trench no. 8) disclosed that the fault plane is nearly vertical and the uppermost layers of alluvium have been displaced by recent vertical movement along the fault.

Fault "B"

Fault "B" lies in the same zone of structural weakness as "A" and may connect with the latter fault north of the UC-1 site. Fault "B" is a very poorly defined lineament on the aerial photographs and forms a

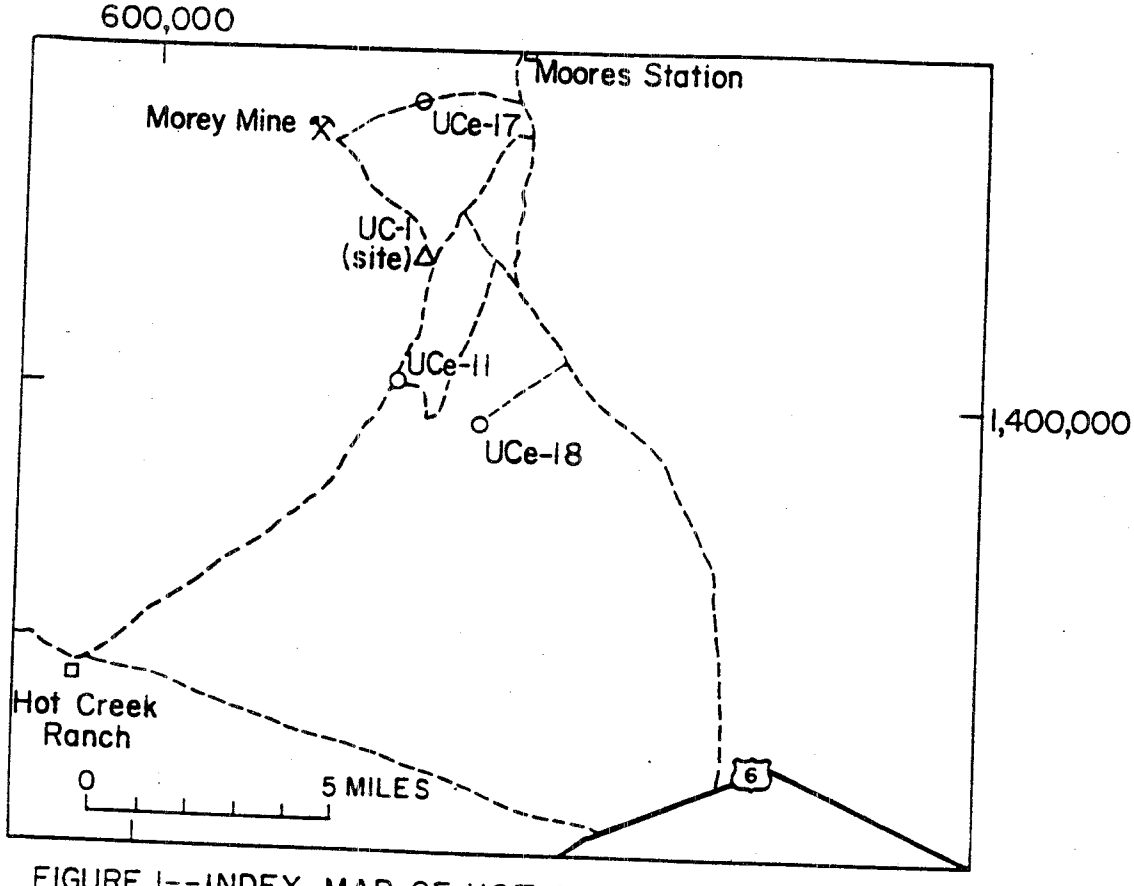


FIGURE 1.--INDEX MAP OF HOT CREEK VALLEY, NEVADA

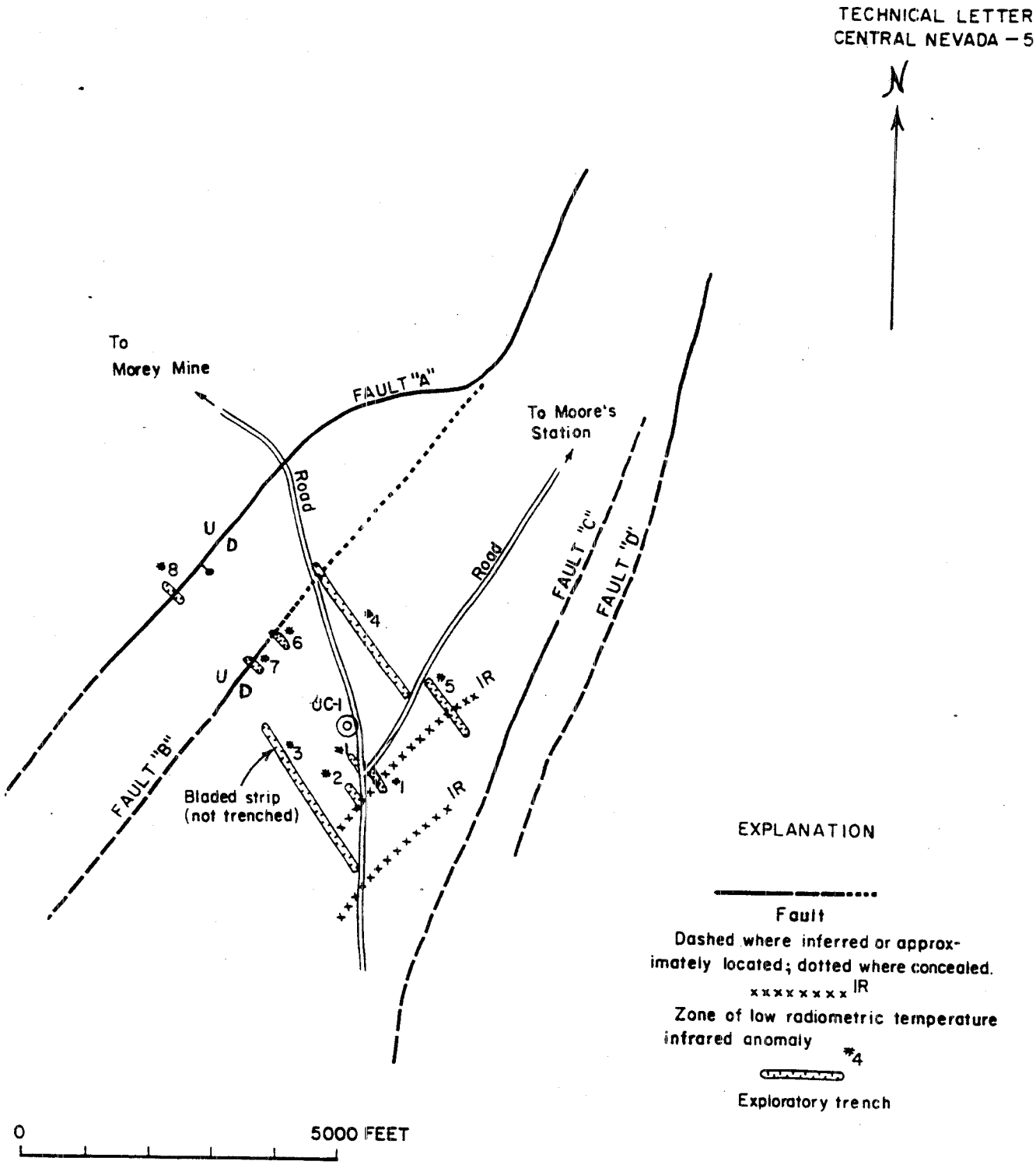


Figure 2.--Sketch map of UC-1 vicinity showing indicated and inferred faults and locations of exploratory trenches, Hot Creek Valley, Nye County, Nevada

Geology mapped by
E. B. Ekren and F. C. Currey

low scarp that is visible in a few localities on the ground. There has been no movement along this fault in recent times: this is indicated in bulldozer trench no. 7 which was cut to a depth of about 7 feet. Only the lower 3-4 feet of strata are faulted. The uppermost beds overlap the fault zone and are undisturbed. Neither trench no. 4 nor no. 6 disclosed faulted beds along the projection of Fault "B".

Faults "C" and "D"

These faults are both poorly defined. Their presence is suggested by feeble lineaments on the aerial photographs. No scarps are visible on the ground. Although poorly defined at the surface, the lineaments may reflect zones of major faulting in the bedrock at depth.

INFRARED ANOMALIES

Two zones of infrared anomalies that possibly reflect faulting at depth occur about 1,000 feet and 2,000 feet southeast of the UC-1 site. The nearest anomaly was trenched in three localities (trenches 1, 2, and 5). Trench no. 1 was cut to a depth of 10 feet; trenches 2 and 3 to depths of 5 feet. None of the trenches disclosed any evidence of fracturing or faulting. All three trenches encountered firmly cemented beds of boulder-sized gravel at depths of 4-6 feet.

CONCLUSIONS

None of the faults or infrared anomalies near UC-1 appear sufficiently near to the site to present safety problems. Careful scrutiny of the alluvium in other parts of the valley indicates that the

density of faults at UC-1 is not unique and few places exist where faults are sufficiently wide-spaced to allow shot points to be located at distances greater than 1,500 feet from all fault zones.

Technical Letter
Central Nevada-5

Distribution:

NVOO--W. Allaire
D. Edwards (2)
R. Emens, Mercury
R. Miller
W. Smith
SAN-- J. Philip
DTIE--Oak Ridge
DMA-- Director
DASA--Director, Attn: Blast and Shock Division
TC-DASA--Commander, Attn: TCDT
Attn: TCDP for B. Grote (2)
Attn: TCNB-TE, Mercury (2)
LASL--R. Blossom, Los Alamos
R. Blossom, Mercury
R. Campbell
R. Newman
W. Ogle
LRL-- R. Goeckermann
R. McArthur, Mercury
M. Nordyke
J. Skrove, Mercury
C. Williams
SC-- P. Schroeder, Mercury (2)
C. Selvage, Attn: R. Statler, 7263
W. Vollendorf (2)
W. Weart
ERC-- Las Vegas
Virginia (8)
F&S-- G. Bruesch, Mercury (3)
M. May, Las Vegas
H&N-- Engineering Mgr., Las Vegas
Advance Planning, Las Vegas
Resident Eng., Mercury
HNSC--Palo Alto (2)
WES-- W. Steinriede, Jr.
DRI-- G. Maxey
USGS--D. Lemmon
W. Pecora
Military Geology Branch
Chief Hydrologist, WRD, Attn: Radiohydrology Section
WRD, Las Vegas (5)
Geologic Data Center, Mercury (15)

APPENDIX B

TECHNICAL LETTER: CENTRAL NEVADA-16

PRELIMINARY REPORT ON THE GEOLOGIC EFFECTS OF THE FAULTLESS EVENT

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Federal Center, Denver, Colorado 80225

Special Projects Bran
Technical Letter
Central Nevada-16
March 25, 1968

PRELIMINARY REPORT ON THE GEOLOGIC EFFECTS OF THE FAULTLESS EVENT

By

F. A. McKeown, D. D. Dickey and W. L. Ellis

ABSTRACT

The Faultless event, an intermediate-yield nuclear explosion, produced fractures as much as thousands of feet in length, most of which are along preevent lineaments. Vertical displacements on the fractures are as much as about 15 feet and horizontal displacements are as much as 3 feet. The displacements, particularly vertical offsets on fractures that bound a quasi-sink area around ground zero, may have occurred hours after initial fracturing related to the explosion.

The quasi-sink is a graben bounded on the northwest, southeast, and south by faults; the greatest displacement occurred on a fault at the south margin. The northeast margin of the graben appears to be a hinge line zone characterized by many small tension fractures.

Preliminary study of data from pre- and postevent surveys indicates that definite strain patterns existed along principal fractures as well as within the quasi-sink. High-speed motion picture photographs taken from a helicopter during the event show clearly the development of two principal fractures about 1.1 second after the explosion.

The Faultless event was a contained intermediate-yield underground nuclear explosion at Nevada State coord., central zone; N. 1,414,340 ft, E. 628,921 ft, in Hot Creek Valley, Nevada (fig. 1). The explosion occurred at a depth of 3,200 feet on January 19, 1968 at 10:15 PST. The main purpose of the explosion was to acquire seismic data to predict responses from higher yield explosions in the same area.

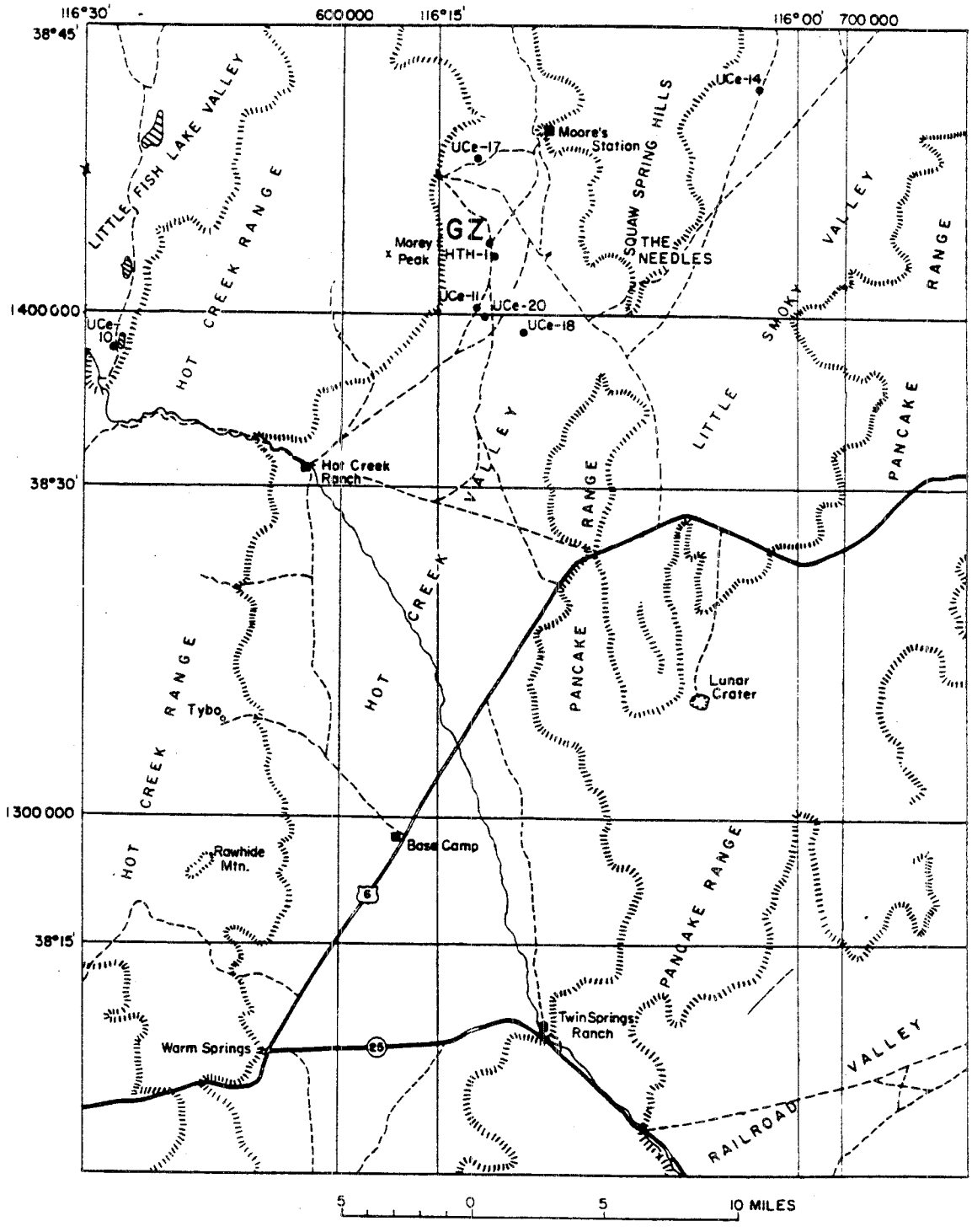


Figure 1- Index map of part of Central Nevada showing location of Faultless ground zero (GZ).

Effects of the explosion were mapped on aerial photographs at scales of 1:3,600 and 1:6,000. In general, only fractures more than 100 feet long were mapped. Ground elevations were measured using a Wild N3 level with a precision micrometer plate and invar rods. Horizontal distances were measured using a Model 6 geodimeter and angles were measured with a Kern DKM3 theodolite.

In order to obtain a maximum of information both fracture mapping and geodetic surveys had to be completed as quickly as possible after the explosion. A relatively large number of people were, therefore, required in the field immediately after the event. In addition to the authors, the following people made substantial contributions to the fracture mapping: G. S. Corchary, R. E. Davis, A. T. Fernald, D. L. Hoover, and W. S. Twenhofel. Level line and triangulation were done by: L. E. Bentley, R. C. Foley, L. R. Riebe, L. D. Shuler, J. E. Magner and D. R. Miller. Geodimeter surveying was done by: D. D. Dickey, W. L. Ellis, G. E. Brethauer, M. J. Cunningham and J. E. Magner.

GEOLOGY

Geologic mapping and study of Hot Creek Valley are still in progress; however, some of the data required to select and evaluate the emplacement hole (UC-1) and the results of a preevent lineament study that is pertinent to evaluation of geologic effects are summarized below.

The emplacement hole is reported by Barnes (1968, p. 18) to have penetrated alluvium from the surface to a depth of 2,400 feet and

tuffaceous sediments and zeolitized tuff from 2,400 to 3,275 feet (total depth). Ekren (1967) mapped some lineaments and faults within a few thousand feet of UC-1 that are nearly the same as A, B, C, and D, and infrared imagery lineaments shown in figure 2 of this report. After completion of the emplacement hole and shortly before the Faultless event another lineation map was prepared because the explosion was expected to cause fracturing for a distance of at least 10,000 feet from ground zero. This map (fig. 2) is a selected composite of lineations that were identified on three different sets of aerial photographs by G. S. Corchary, F. A. McKeown, and Paul P. Orkild. Most of these lineations are shown in black on figure 2. But many were eliminated because figure 2 is at a smaller scale than some of the photographs.

The thick alluvial fill of Hot Creek Valley displays little evidence of the structural framework of the valley. Only a few of the lineaments, could be demonstrated or inferred from scarps in the alluvium to have been faults before the Faultless event; these are shown with bar and ball on figure 2. The infrared imagery lineaments in particular were of dubious origin and location. No evidence of their origin could be found by trenching (Ekren, 1967, p. 4). Further, because of the distorted scale characteristics inherent in photographic prints of the infrared imagery, the location of the lineaments on figure 2 may be in error by as much as several hundred feet.

Inspection of the lineaments shown in figure 2 indicates that in order of length and abundance a first (strongest) set of lineaments trends about N. 25° E. to N. 45° E.; a second set trends from about N. 70° E. to due east; and a third very weak set trends nearly due north. The first set is in part subparallel to the trend of the local mountain ranges (fig. 1). As this set also contains more lineaments that are known or inferred faults than other sets, it presumably represents the principal structural grain of Hot Creek Valley. Furthermore, scarps in the alluvium along some faults in this set are evidence of recent movement and indicative of the principal direction of the current tectonic stress field.

GEOLOGIC EFFECTS

The principal geologic effect of the Faultless explosion was fracturing along preexplosion faults for distances of thousands of feet. Compared with fractures produced by intermediate-yield nuclear explosions at Nevada Test Site, however, fractures caused by the Faultless explosion were neither uncommon in displacement and geographic extent nor unexpected. Enough experience has been acquired from Nevada Test Site events and from the Long Shot explosion to predict that large explosions in tectonically active regions will initiate displacements on some preexplosion faults that are within several thousand feet of the explosions. The structure of the quasi-sink

around ground zero, however, was not anticipated and a satisfactory explanation for it has not been found. Furthermore, as all data were not available for incorporation into this report, detailed description and interpretation of the quasi-sink will be deferred to a subsequent report.

Three of the principal fractures produced by the explosion occurred on lineaments A, B, and C (fig. 2), which had been mapped prior to the explosion. Nearly all other fractures may be related spatially in various degrees of coincidence to lineaments.

Fractures within about 2,000 feet of ground zero

Figure 3 shows in considerable detail most of the fractures in a quasi-sink area within about 2,000 feet of ground zero. The principal fractures that bound the area on the northwest, south, and southeast are clearly evident, as is a prominent fracture that passes within 200 feet of ground zero on the south. Figure 2 shows most of the same fractures at a smaller scale as well as spatial relations of fractures to lineaments. The nearly exact coincidence of explosion-produced fractures to lineaments B and C leave little doubt that these lineaments were expressions of preexplosion faults. On the other hand, the fracture that passes near ground zero lies between and is subparallel to an infrared imagery lineament and a conventional photographic lineament but is coincident with neither. The plotting of lineaments

particularly infrared lineaments, is not always precise. Thus, these lineaments may or may not be expressions of a fault that controlled the location of the explosion-produced fracture.

Displacements on the northwest-bounding fracture range from about 7 feet vertically down on the southeast side nearest ground zero (fig. 3) to zero near the ends of the fracture. Right-lateral displacement of nearly a foot also occurred.

The southeast-bounding fracture has a maximum vertical displacement of about 15 feet nearly due south of ground zero (figs. 4A and 4B). Displacement decreases gradually and irregularly to the northeast and rapidly to the west from the locus of maximum displacement. Nearly 3 feet of right-lateral movement occurred on this fracture west of a point about S. 30° E. (fig. 5) from ground zero. About 2,500 feet northeast of this point about 2 feet of left-lateral displacement occurred; displacement decreases to less than an inch at the end of the fracture 6,500 feet to the northeast.

The northeast and southwest boundaries of the quasi-sink are unlike the other boundaries and unlike each other. About 1,500 feet northeast of ground zero is the inner margin of a multitude of northwest-trending fractures less than 50 feet in length that form a northwest-trending zone about 1,500 feet wide. Little or no displacement occurred on these fractures except for a fraction of an inch dilation. The zone appears to be bounded crudely on the north by several northwest-trending fractures 1,300-1,800 feet in length.

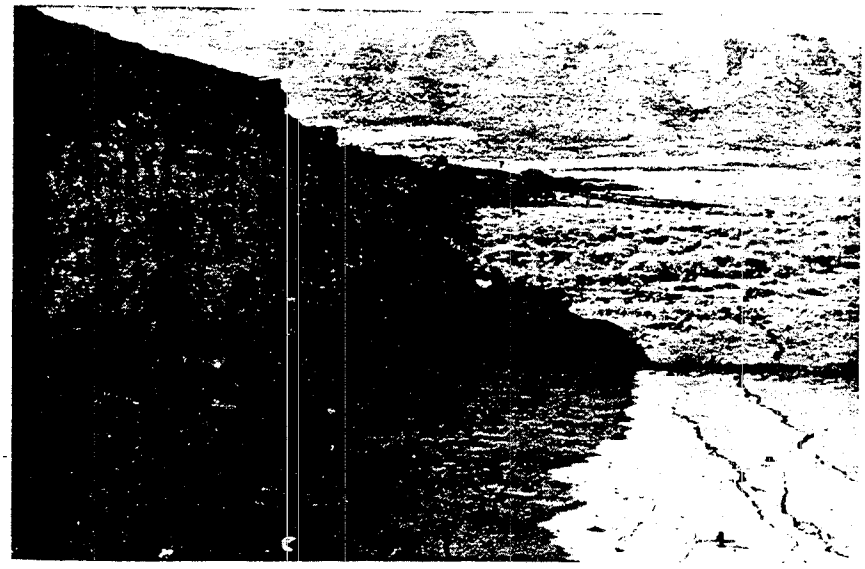


Figure 4A.--View looking west along southeast-bounding fracture. About 2,000 feet south of ground zero. Maximum height of scarp is about 15 feet.

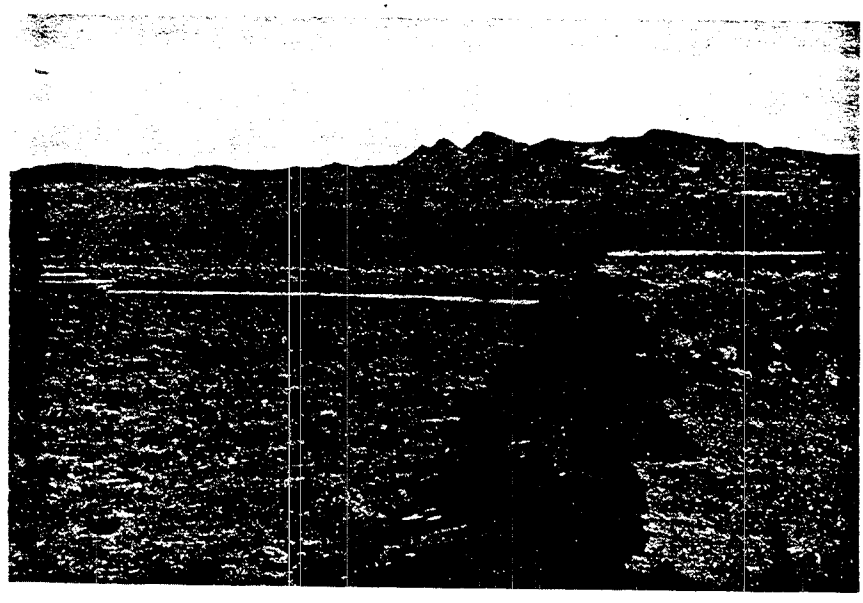


Figure 4B.--View looking northeast along southeast-bounding fracture from cable runway about 2,000 feet south of ground zero.

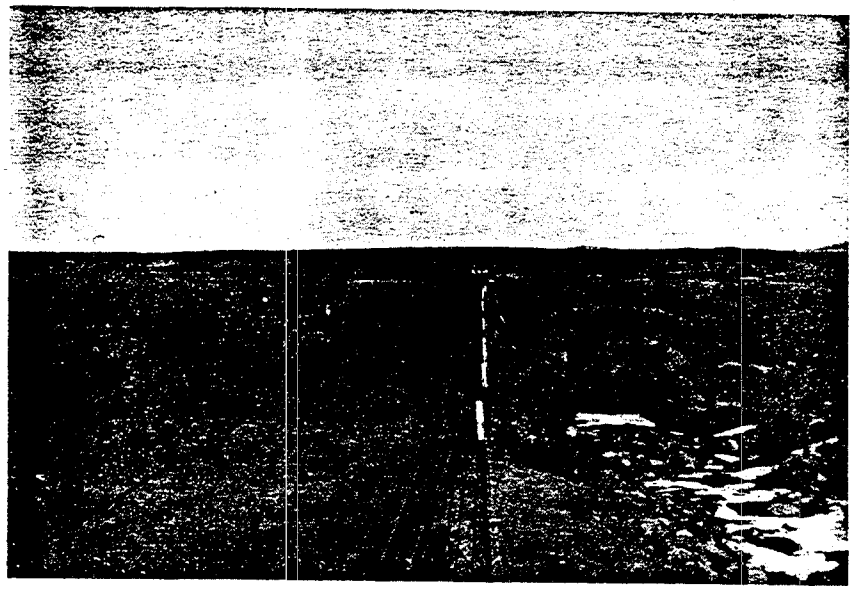


Figure 5.--View looking north along cable runway and showing right-lateral displacement of runway fence where it crosses the southeast-bounding fracture.

About 2,000 feet southwest of ground zero fractures as much as 600 feet in length form a northwest-trending zone that bounds the quasi-sink on the southwest side. Right-lateral movement (not shown on fig. 3) of a few inches is common on many of these fractures, but they have little or no vertical displacement.

Within 2,000 feet of ground zero the most conspicuous fracture is the one that passes 200 feet southeast of it. This fracture has as much as 10 feet vertical displacement on it at a point due south of ground zero and has left-lateral movement everywhere along it.

Another conspicuous structural feature within the quasi-sink area are the pressure ridges (fig. 3) within about 900 feet of ground zero. Presumably where these occur may be the most depressed part of the quasi-sink.

The remaining fractures within 2,000 feet of ground zero occur in crude concentric and radial patterns around ground zero. They are more abundant near large fractures and preevent lineaments.

Fractures beyond 2,000 feet from ground zero

Principal fractures that occur beyond 2,000 feet from ground zero are (1) the fractures that bound the quasi-sink on the northwest and southeast, (2) the fracture that passes 200 feet southeast of ground zero, (3) a very long fracture system on and associated with lineament A, (4) a fracture in a preexplosion lineament about 6,000 feet southwest of ground zero, (5) a range front fracture, and (6) a fracture 8,000 feet S. 70° E. of ground zero.

The fractures that bound the quasi-sink on the northwest and southeast extend total distances of 6,500 and 9,000 feet, respectively. The fracture that passes 200 feet southeast of ground zero has a total length of about 5,000 feet. That these fractures extend several thousand feet beyond the northeast margin of the quasi-sink is evidence of the control that preexplosion faults exercise on explosion-produced fractures.

The most significant fracture beyond 2,000 feet from ground zero is along lineament A. The Faultless explosion was expected to cause movement along this lineament because it is a scarp in the alluvium produced by faulting in Recent geologic time; explosions near this type of fault at Nevada Test Site always trigger movement on the fault. The Faultless explosion caused a total strike length of 12,000 feet of fracturing along the scarp. Most of the relative displacement was down on the southeast side; it ranges from indiscernable near the ends of the fracture to about 2 feet near the middle. Right-lateral movement was found at a few places and is confirmed by preliminary analysis of the geodetic surveys. Although most of the displacement occurs on one principal fracture, many other fractures with little or no displacement parallel the principal fracture or intersect it at oblique angles to form a zone as much as 1,000 feet wide.

In addition to lineament A and its associated fractures two other fractures that intersect it have vertical displacement on them and are

located on lineaments (fig. 2). One of these fractures strikes westerly from a point 4,000 feet N. 35° W. of ground zero; maximum displacement on this fracture is 1 foot down on the south side. The other fracture has nearly the same strike as lineament A and starts from a point about 3,500 feet N. 45° W. of ground zero. Unlike the displacement on the lineament A fracture, this fracture is vertically down on the northwest about 1 foot.

The fracture along the preexplosion lineament 6,000 feet southwest of ground zero has no discernable vertical displacement on it. Because of the trend of the well-developed scarp that defines the lineament, this lineament may reflect a preexplosion fault coextensive with that at lineament B. The area between the scarp and lineament B is underlain by modern alluvium and covered with thick brush at many places which very probably covers all surface evidence of this fault.

The most distant explosion-produced fracture is about 9,000 feet west of ground zero where it transects the uppermost parts of the alluvial fans that lap against the outcrops of bedrock of the Hot Creek Range. At a few places the fracture is within 300 feet of outcrop; at most places, however, it is 1,000 to 2,000 feet from outcrop. The northern end of the fracture is probably located about as shown on figure 3. However, it probably extends farther south than shown on figure 3 but no search was made in that area. Also, no search was made midway between the northern and southern parts,

though the fracture is very likely present there. The total length of this "range front" fracture is greater than 10,000 feet. The maximum displacement observed on it is 0.1 foot down on the west, but this is only local and may not be representative.

One fracture, 2,500 feet in length and located 8,000 feet S. 70° E. of ground zero, is the only evidence of movement on an inferred major fault, which may be one of the largest structures in Hot Creek Valley. This fault, as determined from seismic survey data, has more vertical displacement than any other fault in the valley (Hazlewood, 1968, oral commun.).

RESULTS OF GEODETIC SURVEYS

In order to estimate the depth of fracturing produced by the Faultless event, horizontal displacements of stations in two grids (fig. 2) were determined by geodimeter and angulation surveys before and after the event. In addition, pre- and postevent elevations were determined for stations along a line extending from about 3 miles east-southeast of ground zero to a point about 2 miles northwest of ground zero. Parts of the survey nets were surveyed twice before and twice after the event. The data from the surveys has not yet been analyzed. A few of the initial conclusions are summarized below.

Probable maximum downward displacement of about 15 feet is at station UEH about 800 feet south of ground zero. Greater vertical displacements may have occurred elsewhere in the quasi-sink but data are not yet available to confirm this probability.

The fracture along lineament A has a right-lateral displacement of about 7 inches northwest of ground zero.

Nearly all stations in the survey net west of ground zero appear to have moved towards ground zero; stations closest to ground zero moved the greatest distance. A maximum decrease in horizontal distance of more than 8 feet occurred between stations 9A and 49A on opposite sides of 62. Each station probably moved towards ground zero.

Horizontal movements of stations in the eastern survey grid show a definite strain pattern indicative of downward displacements on the east side of the major north-trending fault that lies near the west side of the grid. The level-line data are also indicative of this strain pattern. The only surface expression of the fault in this area is the fracture 8,000 feet S. 70° E. of ground zero.

RESULTS OF MOTION PICTURE PHOTOGRAPHY

As part of the documentation on the Faultless event the U.S. Geological Survey requested high-speed motion picture photography of the event. The pictures were taken by J. Popovitch and R. Poole under the direction of L. Donovan of Edgerton, Germeshausen & Grier, Inc. Two 16-millimeter cameras were operated in a helicopter at a radial distance of 10,000 feet from ground zero at an altitude of about 6,000 feet above ground elevation. One camera was fitted with a 10-millimeter focal length lens; the other camera had a 75-millimeter lens. Both cameras operated at about 400 frames per second. A third

camera operating at about 48 frames per second also was used, but no pictures were obtained because of a malfunction.

The most significant information obtained from preliminary study of the pictures shows clearly that both the fracture that passes near ground zero and the fracture that bounds the quasi-sink on the southeast side developed about 1.1 seconds after the explosion. The resolution of the pictures is not sharp enough, however, to determine whether the fractures had much, if any, vertical displacement on them at this time. The southern part of the southeast boundary fracture, where the largest vertical displacement occurred, is not evident in the pictures. This large vertical displacement probably formed minutes or hours later than the 40-second time interval that was documented on film. None of the fractures west of ground zero can be found in the pictures, probably because these fractures were about 3 miles from the cameras and the film and lens systems were inadequate to resolve minute images at great distances.

Also recorded on film is the movement at the ground surface of the pressure pulse that was induced by the explosion. This pulse first appears about 3,000 feet around ground zero as a dark zone moving in towards ground zero about 1 second after the explosion. The pictures show that the shape of this zone is strongly controlled by the southeast bounding fault and the fault that lies near ground zero. This control further confirms the existence of these faults before the explosion.

CONCLUSIONS

The Faultless event caused fractures along lineaments that were expressions of preevent faults. The fractures are similar to fault-controlled fractures that were produced by explosions at Yucca Flat and Pahute Mesa, Nevada Test Site. Two of the principal fractures are known from motion picture photography taken during the Faultless event to have formed about 1 second after the event. All other principal fractures are at greater distances from the explosion. They are presumably more sensitive to seismic wave energy than the fractures nearest the explosions if they too formed when the seismic wave train reached them. The amount of displacement that occurred at this time, however, is unknown. Certainly much of the vertical displacement on the fractures that bound the quasi-sink occurred minutes to hours after the passage of seismic waves.

The quasi-sink lacks many of the internal structural characteristics of most sinks in Yucca Flat. Though some concentric fractures and a depression around ground zero are present, no rotation of blocks of ground towards ground zero is apparent. Further, the apparent ratio of depth to radius of the sunken area is anomalously large. Both horizontal and vertical displacement measurements confirm that the quasi-sink is at least 4,000 feet wide. It is a part of a graben bounded on the northwest, southeast, and south by faults. The northeastern part of the graben seems to be a hinge zone for downward

displacement which, at the edges of the graben, is greatest along the southern fault boundary. The hinge zone is characterized by many small tension fractures. Right-lateral movement of the northwest-bounding fault and left-lateral movement on the southeast-bounding fault support the tension concept, except that the lateral movements extend far northeast of the zone of tension fractures.

Even though a depressed area with some structural characteristics of sinks can be delimited around ground zero, the available data do not permit synthesis of a mechanical model that can satisfactorily account for such a large area being affected by the filling of what is probably a relatively small cavity. Further speculation is not warranted without additional data and study.

References cited

Barnes, William, 1968, Report of exploration progress, Central Nevada Period August 1, 1967-December 31, 1967: U.S. Geological Survey Technical Letter Central Nevada-3-2.

Ekren, E. B., 1967, Indicated and inferred faults in the vicinity of UC-1, and results of exploratory trenching, Hot Creek Valley, Nevada: U.S. Geological Survey Technical Letter Central Nevada-5.

ADDENDUM

Since this report was prepared and just before it was to be sent to the printer, a few photographs were received that provide significant information on the northeast-trending fault that passes near ground zero. As mentioned in the text, the EG&G high-speed movie film shows clearly the period of development of this fault. Figure 6 is a print of frame 520 from one of the films and shows the fault as it appears at about 1.1 seconds after shot time. More important, however, is that by viewing stereoscopicall frames 520 and 450 (which shows the fault in a slightly earlier stage of development) a large vertical displacement is evident along the fault. The displacement is down on the northwest as shown in figure 3.

F. N. Houser (1968, oral commun.) points out that this evidence make volume calculations of the quasi-sink of questionable value, because obviously a significant fraction of the total volume would be the result of faulting that occurred so soon after shot time as to preclude it as a phenomenon of cavity collapse.

Tentatively the authors and Houser believe that this fault is the surface evidence of a small earthquake induced by the explosion. A volume of $2.85 \times 10^6 yds^3$ is computed for the subsided region around the Faultless site when the volummetric effect of this fault and the southeast-bounding fault of the quasi-sink, which was formed at the same time, is discounted. Houser observes from preliminary studies of the area around sinks in Yucca Flat that this adjusted volume for the Faultless subsidence is comparable in terms of yield to the subsidence of the surface around the Yucca Flat sinks. Extrapolating on the basis

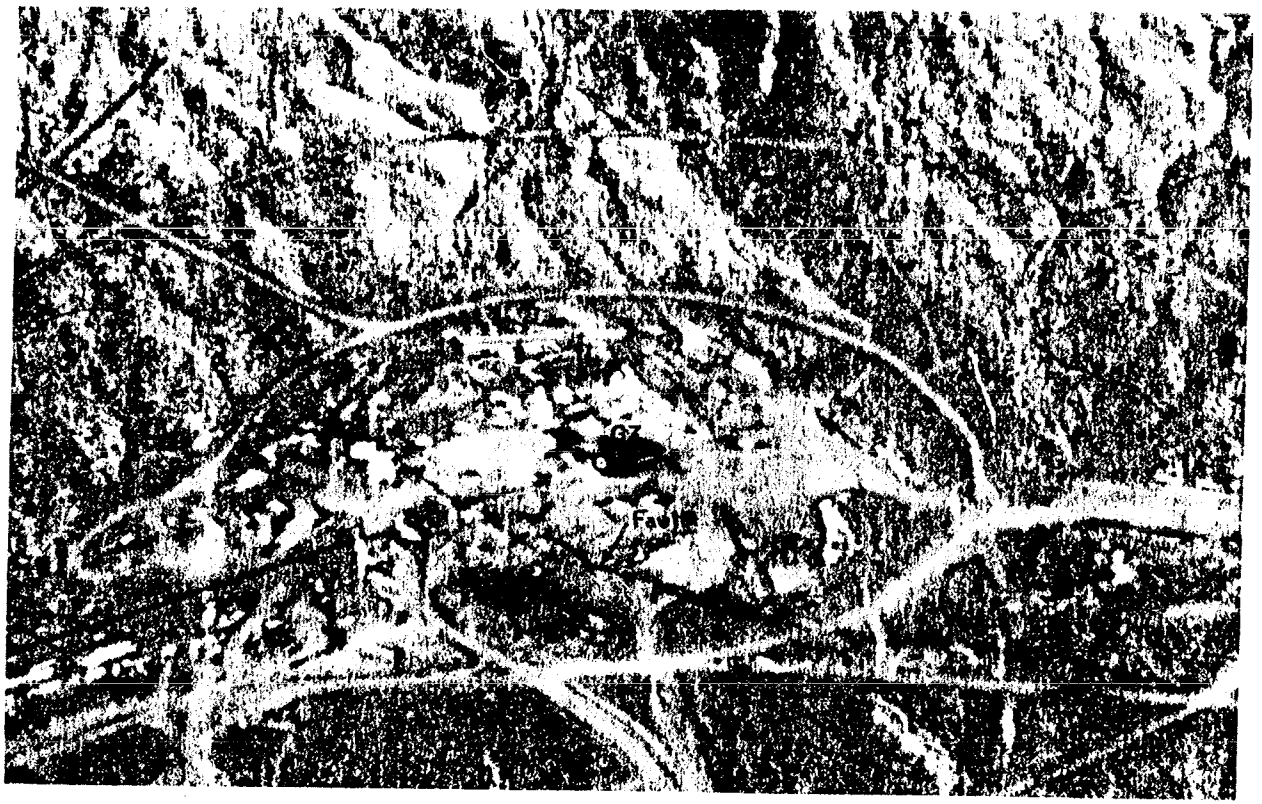


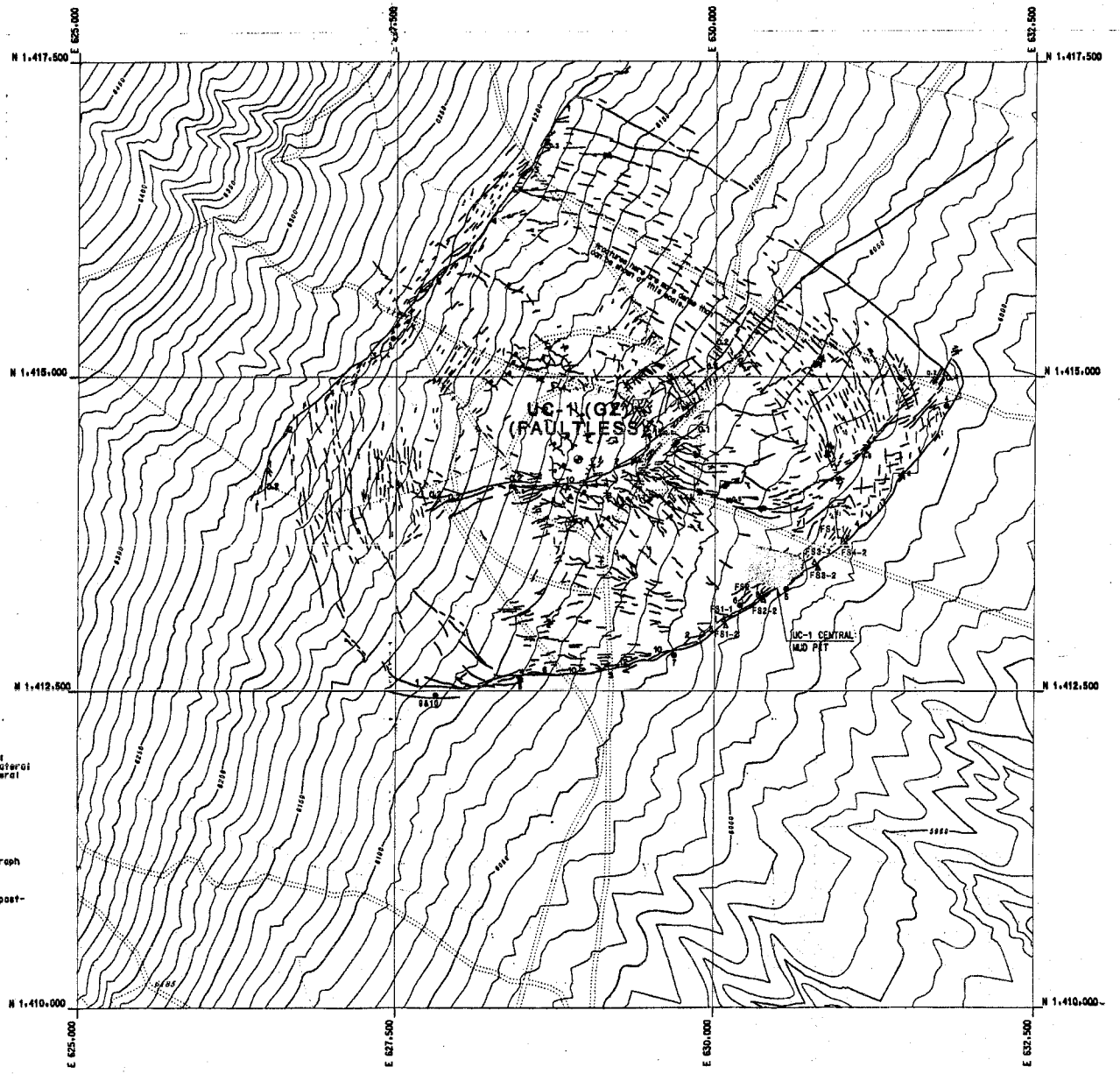
Figure 6.--Print from movie film frame 520 showing fault near ground zero at about 1.1 seconds after the Faultless event. View is to the northwest.

of the volumes of the subsided areas over the following Yucca tests and some classified tests, a volume of about 4.0 X 10^6 yds^3 would have been estimated for the area around the Faultless site for the design yield.

Site	Subsidence volume (yds^3 X 10^6) (exclusive of sink)
U2ab	.018
U3ai	.017
U3cn	.59
U3das	.039
U3dd	.018
U9bn	.062
U10c	.22
U2am	1.75
U9al	.006

Distribution:

NVOO--Technical Library
W. Allaire
D. Edwards (2)
R. Emens, Mercury
R. Miller
W. Smith
SAN-- J. Philip
DTIE--Oak Ridge
DMA-- Director
DASA--Director, Attn: SPSS
TC-DASA--Commander, Attn: TCDT
Attn: TCDP (Grote) (2)
Attn: TCNB-TE, Mercury (2)
LASL--R. Blossom, Los Alamos
R. Blossom, Mercury
R. Campbell
R. Newman
W. Ogle
R. R. Sharp, Jr.
LRL-- C. S. Barnett (2)
C. Boardman (2)
H. Reynolds
R. McArthur, Mercury
SC-- J. Banister
B. G. Edwards, Mercury (2)
M. L. Merritt
C. Selvage, Attn: R. Statler, 7263
W. Vollendorf
W. Weart
ERC-- Las Vegas
Virginia (8)
F&S-- G. Bruesch, Mercury
W. B. Palmer, Jr., Las Vegas (3)
H&N-- Advance Planning, Las Vegas (R. H. Jacobson)
Engineering Manager, Las Vegas
Resident Engineer, Mercury
II-- Palo Alto Lab. (2)
WES-- W. Steinriede, Jr.
DRI-- G. Maxey
USGS--D. Lemmon
W. Pecora
T. B. Nolan
Military Geology Branch
Chief Hydrologist, WRD, Attn: Radiohydrology Section
WRD, Las Vegas (5)
Geologic Data Center, Mercury (15)



GRAPHIC SCALE

0 500 1000 1500 FEET

1" = 500'

CONTOUR INTERVAL 10 FEET

LEGEND

Pressure ridge

Explosion produced fracture; number in black is vertical displacement in feet and is on downthrown side of fracture; arrows indicate direction of lateral movement; number in red is lateral displacement in feet

GZ — Ground Zero

Approximate location of photograph (Figures 3-10)

Fracture not visible on early post-event aerial photography

FS1-1 — Top of fault scarp location 1

FS1-2 — Toe of fault scarp location 1

PLATE 1

U.S. DEPARTMENT OF ENERGY

NEVADA OPERATIONS OFFICE
LAS VEGAS, NEVADA

Bechtel Nevada

P.O. BOX 98521 LAS VEGAS, NV 89193-8521

CENTRAL NEVADA TEST SITE—AREA 58

UC-1

FAULTLESS EVENT

EXPLOSION PRODUCED FRACTURES

DETAILED MAP

DRAWING NUMBER: JS-98228-GT2

REV

FILE LOCATION: g:/dgn/98228a58/geotech

DATE	REVISION DESCRIPTION	DRAWN	CHECK	MD PE	SCE

22 NOV 1999 6:48:51 g:\dgn\98228a58\geotech\skgeotc2.dgn

APPENDIX C

TECHNICAL LETTER: CENTRAL NEVADA-42

SEISMICITY OF THE CENTRAL NEVADA TEST AREA

26 September 1969 - 1 October 1970

Seismicity of the Central Nevada Test Area

26 September 1969 - 1 October 1970

by

B. E. Smith, R. M. Hamilton, and W. H. Jackson

Abstract

The U.S. Geological Survey operated seven seismograph stations in the vicinity of the Central Nevada Test Area (CNTA), Hot Creek Valley, for a period of about one year. Locations were determined for 36 earthquakes. A few of the larger shocks were located with additional recordings from stations elsewhere in Nevada. Earthquake activity was observed in Hot Creek Valley, Little Fish Lake Valley, and northern Stone Cabin Valley. Magnitudes ranged from -0.2 to 3.4. Depths of focus ranged from 0.6 to 12.2 km. A composite first-motion plot for 21 earthquakes yielded a fault-plane solution consistent with a strike-slip pattern striking approximately N40°E (right-lateral) or N50°W (left-lateral). Large underground nuclear explosions at NTS did not stimulate earthquake activity at CNTA. The infrequent seismic activity at CNTA suggests that any earthquakes closely following a future explosion probably have been initiated by that explosion.

Introduction

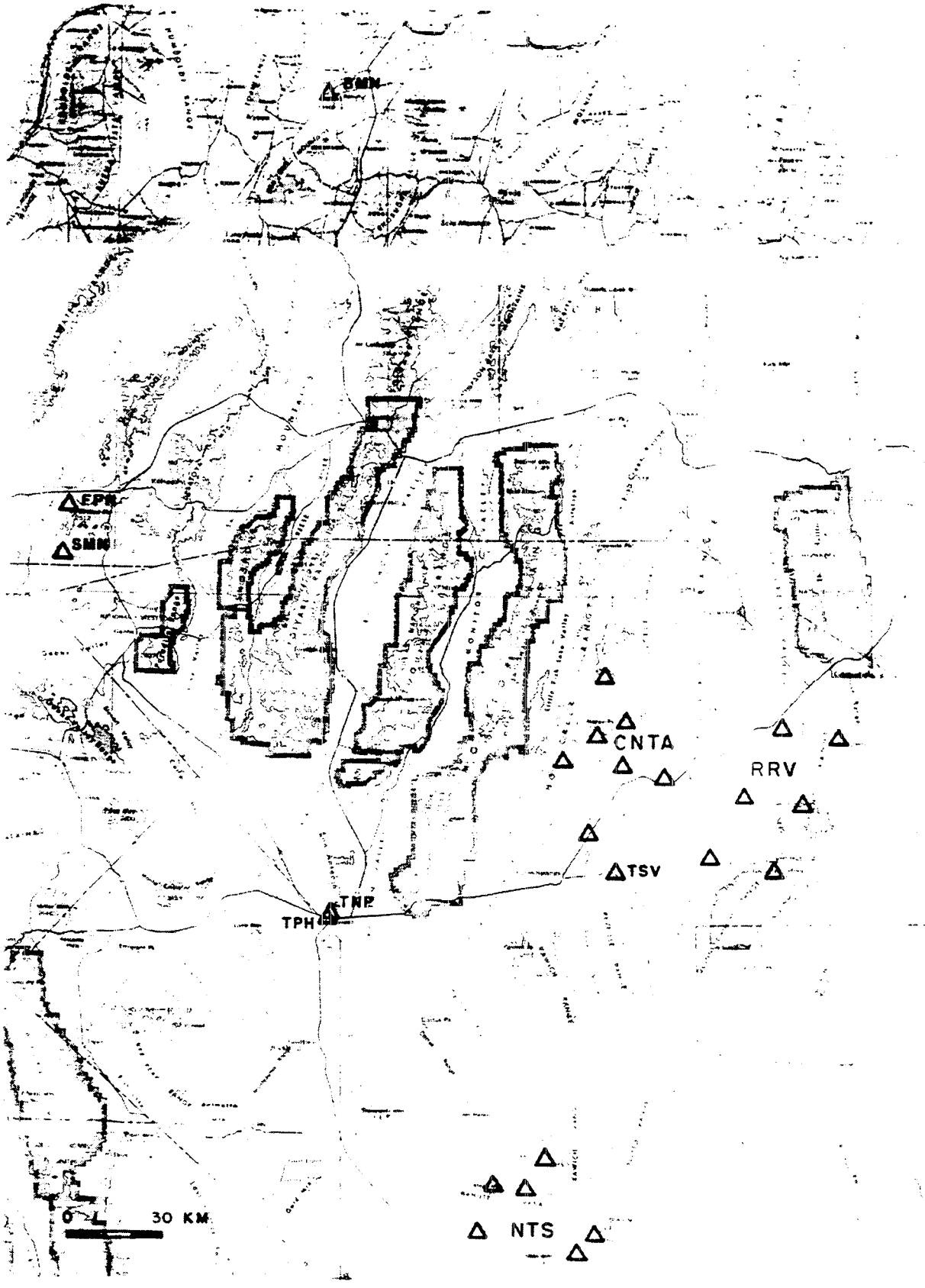
A program to monitor seismic activity in the vicinity of the Central Nevada Test Area (CNTA), located in Hot Creek Valley (fig. 1), was conducted by the National Center for Earthquake Research (NCER), U.S. Geological Survey, for a period of about one year starting 26 September 1969. The purpose of the program was to establish the seismicity of the area prior to any future underground nuclear explosions at CNTA. The monitoring of seismic activity was discontinued on 1 October 1970, after the Atomic Energy Commission decided to postpone indefinitely testing at CNTA. This report contains the results obtained during the period of monitoring.

Interest in seismicity at CNTA had been stimulated by reports of earthquake activity following the Faultless underground nuclear explosion in Hot Creek Valley on 19 January 1968. Faultless, one of the largest nuclear tests conducted in Nevada (m_b = 6.5), was followed by both surficial faulting (fig. 6) and at least several dozen earthquakes, one of which was reported to have a magnitude of 4.5 (Boucher and others, 1969). Twenty seven of the reported earthquakes were located with a tripartite array which was installed in Hot Creek Valley seven weeks after Faultless, and operated for one week. Most of the earthquakes were located within about 5 km of Faultless ground zero, although six were located in the Monitor Range (fig. 1) about 40 km to the west.

The largest earthquakes recorded during the period 1852-1960 in the Hot Creek Valley area were of Richter magnitude 5 and occurred in 1942 and 1954 (Slemmons and others, 1965).

Figure 1

Location of all seismograph stations (triangles) used in locating earthquakes. Stations BMN, TPH, and TSV are operated by the National Ocean Survey. Stations FPN, SMN, BMN, and TNP are operated by the University of Nevada, Reno. NTS, RRV and CNTA are seismic arrays operated by the U.S. Geological Survey.


BMN
EPN
SMN
CNTA
RRV
TSV
TNP
TPH
NTS
0
30 KM

Instrumentation

Seven seismograph stations were operated in the vicinity of Hot Creek Valley for the duration of the program. In addition, seismograph stations outside the Hot Creek Valley area operated by the National Ocean Survey (formerly the U.S. Coast and Geodetic Survey), University of Nevada, Reno, and the U.S. Geological Survey (fig. 1) were used to help locate some of the larger events. The locations of the U.S. Geological Survey CNTA stations are listed in table 1 and plotted in figure 2.

The seismograph system can be explained by block diagrams (fig. 3 and 4). The equipment at each of five outlying stations (CNHR, CNHC, CNPS, CNSB, and CNEC) included: a vertical-component 1 Hz seismometer (Mark Products, L-4C); a combined preamplifier and voltage-controlled oscillator (Develco, Model 6202); a VHF FM, 100-milliwatt, transmitter (Develco, Model 3401); a yagi antenna; and batteries. The frequency-modulated signal produced at each of the above five stations was transmitted by radio to five separate receivers at station CNHM. Station CNHM was equipped with a full complement of the above-mentioned components plus a multiplexer to combine the six seismic signals before their transmission by radio to station CNBC. Station CNBC was equipped with the full complement of components except for the transmitter. From station CNBC the combined seismic signals were transmitted by telephone lines to the NCER office in Menlo Park, California, where they were separated and demodulated by discriminators (Develco, Model 6203), and recorded on 16-mm film (Geotech Division, Teledyne Industries, Develocorder). Readings from the film yielded locations and magnitude determinations of the earthquakes.

Table 1

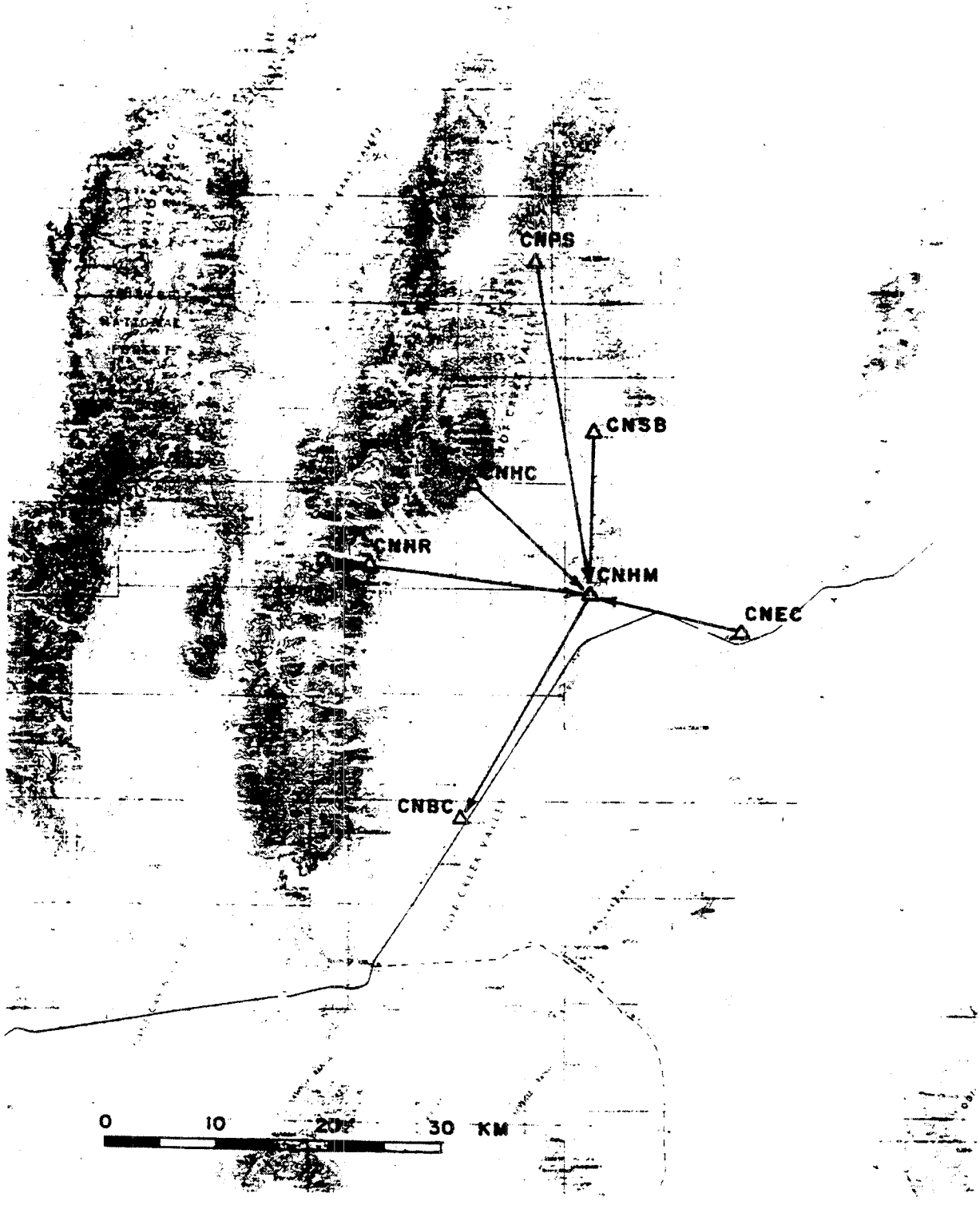
U.S. Geological Survey Seismograph Station Data

Geographic Coordinates

Station Code	Latitude, N. deg.	min.	Longitude, W. deg.	min.	Elevation, meters
CNHR	38	31.39	116	22.38	1786
CNBC	38	18.68	116	16.64	1591
CNHC	38	35.44	116	14.73	1811
CNPS	38	45.96	116	12.22	1942
CNSB	38	37.68	116	8.88	1960
CNEC	38	28.13	115	59.90	1682
CNHM	38	30.28	116	8.79	2210

Figure 2

Locations of CNTA seismograph stations (triangles). Arrows indicate direction of radio transmission.


CNPS
CNSB
CNHC
CNNR
CNHM
CNEC
CNBC
0
10
20
30
KM

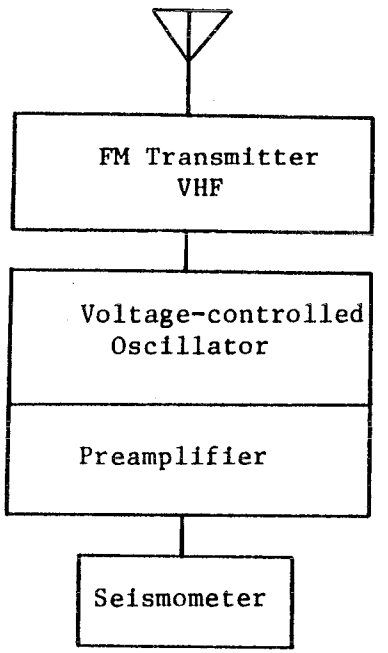


Figure 3a. Basic equipment used at remote locations such as Stations CNHR, CNHC, CNPS, CNSB, and CNEC.

Center frequencies:

Channel	1	680 Hz
	2	1020 Hz
	3	1360 Hz
	4	1700 Hz
	5	2040 Hz
	6	2380 Hz
	7	2720 Hz

Maximum deviation: ±125 Hz

Guard band: 90 Hz

Signal frequency: 0.5 to 25 Hz

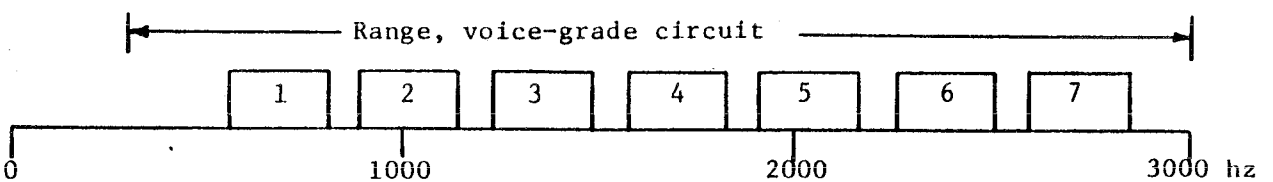


Figure 3. Constant bandwidth channels used for telemetry of seismograph data via telephone and radio.

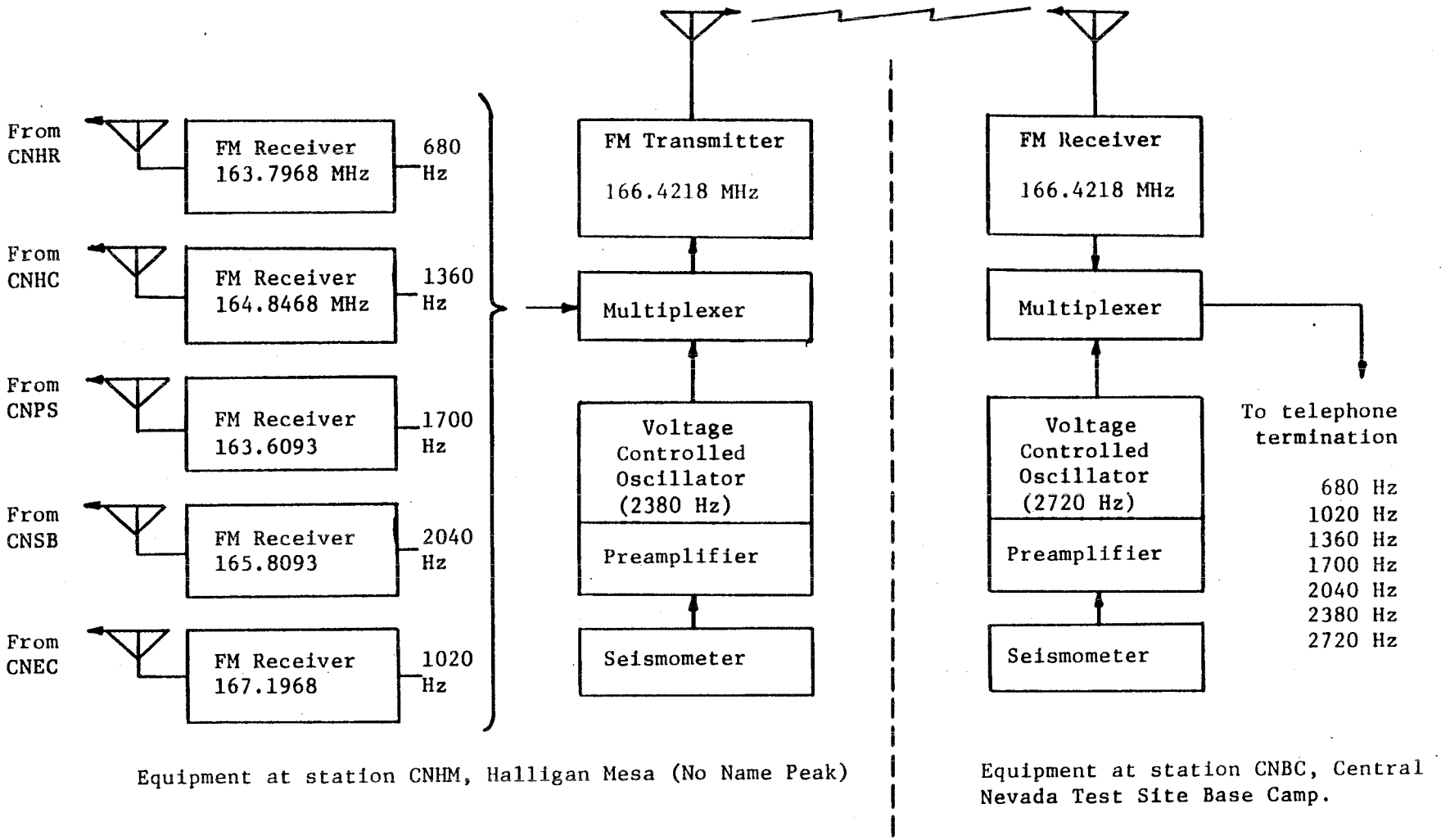


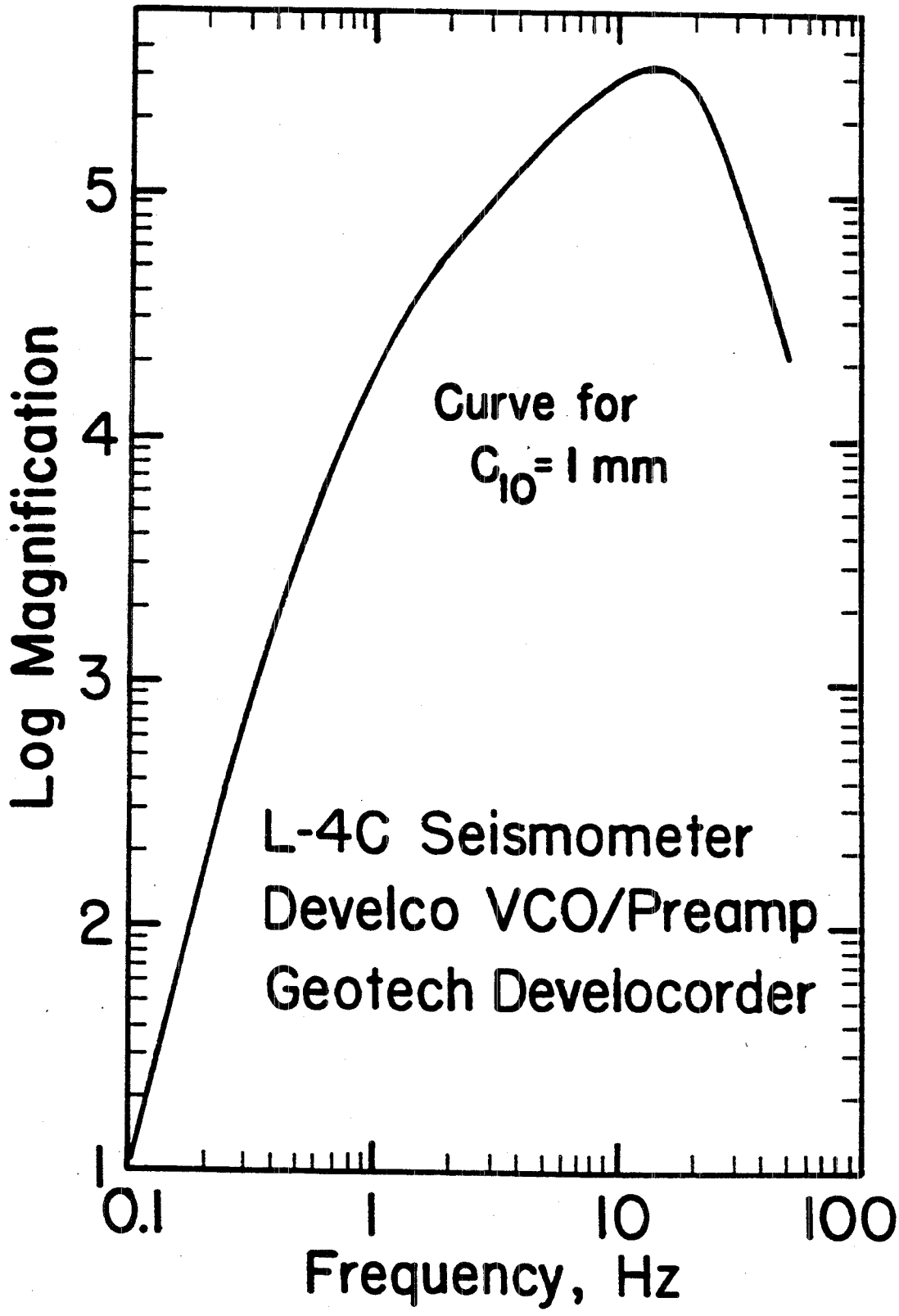
Figure 4. Equipment located at stations CNHM and CNBC. A total of 7 seismograph data channels are transferred to telephone line 8GD-7022 at the Base Camp station for transmission to the NCER office, Menlo Park, California.

The overall response of the seismic system is shown in figure 5. The peak-to-trough record amplitude for a 10 μv rms, 5 Hz, calibration signal, input in parallel with the seismometer is defined as C_{10}. Values of C_{10} for CNTA stations range from 9 to 22 mm.

The CNTA seismic network experienced technical difficulties that caused some of the stations to be inoperative for several periods lasting as long as two weeks. The most serious problem arose when lightning struck station CNHM and damaged the transmitter and most of the receivers. CNBC was the only station that remained operative. Other operational problems were mostly connected with telephone transmission.

Figure 5

Overall magnification of the seismic system that includes a Mark Products, Model L-4C, vertical-component seismometer; a Develco, Model 6202, VCO/Preamplifier; and a Geotech Division, Teledyne Industries, Develocorder. Curve shown is for settings yielding a 1-mm peak-to-trough record amplitude for an input signal of 10 μv rms at 5 Hz. The true magnification for each station can be obtained by multiplying the curve value by C_{10}, which ranged from 9 to 22 mm for the CNTA stations.


Log Magnification
5
4
3
2
1
0.1
1
10
100
Frequency, Hz
Curve for
C_{10}= 1 mm
L-4C Seismometer
Develco VCO/Preamp
Geotech Develocorder

Hypocenter Determination

The earthquake locations were derived from arrival times of P seismic waves using a Fortran program written by Eaton (1969) for the IBM 360/65 computer. Locations were determined for all earthquakes yielding sufficient data.

There was insufficient information available to determine an accurate velocity model for the Hot Creek Valley area. Further, the geology changed considerably from station to station. Therefore, the velocity model used in the earthquake location program was that previously used for Pahute Mesa at the Nevada Test Site (Hamilton and Healy, 1969), with the addition of station corrections to allow for variations from the model. The station corrections were derived by observing the delay in expected P arrival times from earthquakes at teleseismic distances and underground nuclear explosions at NTS. These delays probably reflect variations in the crustal thickness as well as variations in the upper crust. However, it is felt that the latter is more significant, and the delays used have been found to be consistent with station residuals calculated by the location program. The velocity model and station corrections, expressed as a delay, are listed in table 2.

Locations were determined for earthquakes inside the network that had sharp arrivals at three or more stations. Earthquakes outside the network were located with six or more stations. Only a few of the located earthquakes had station distributions adequate to calculate reliable depths. Other earthquakes were restricted to a depth of 5 km in the location program.

Table 2

Velocity model used in locating seismic events

Depth to layer, km	Layer velocity, km/sec
0.0	2.7
0.94	3.4
1.33	3.8
2.14	4.4
2.50	5.1
5.00	6.1
25.00	7.0
35.00	8.0

Station corrections

Station code	P-delay, seconds
CNHR	-0.26
CNBC	0.61
CNHC	0.00
CNPS	0.29
CNSB	0.13
CNEC	0.18
CNHM	0.19

Magnitudes were calculated for all located earthquakes from signal duration, i.e., the elapsed time from the first arrival to the point that the peak-to-trough amplitude falls below 1 cm for the last time. The duration was measured for all stations on which first arrivals could be timed. The average duration for each earthquake was then converted to M_L (Richter local magnitude) using a curve that was derived empirically from seismic data collected at the U.S. Geological Survey seismograph network near Rangely, Colorado (J. H. Healy, 1971, written communication). This curve has been found to be consistent with several dozen magnitudes calculated from the maximum peak-to-trough amplitude of earthquakes at both CNTA and NTS. The duration magnitudes were the only ones that could be uniformly computed for all of the CNTA earthquakes because reliable calibrations were not obtained for the whole recording period.

A chronological listing of all located earthquakes is given in table 3 along with the data discussed above. The readings of CNTA seismic stations for all located earthquakes with $M_L \geq 1.5$ are listed in table 4.

Table 3.

Chronological List of Located Earthquakes

		Day	Origin Time Hr	Mn	Sec	Lat N Deg	Min	Long W Deg	Min	Depth Km	MD+ Sec	No Stns	M_L
1969	Nov	02	03	35	50.45	38	19.75	116	13.26	5.0*	0.06	7	1.5
		08	04	35	2.28	38	42.73	116	9.09	5.0*	0.01	4	0.6
1970	Jan	25	01	41	57.16	38	34.08	116	12.28	8.9	0.05	7	1.6
	Feb	06	20	02	48.63	38	28.57	116	4.42	12.2	0.02	4	0.4
		10	20	28	31.02	38	29.24	116	37.18	5.0*	0.08	7	1.0
		11	02	53	42.74	38	38.24	116	11.08	6.2	0.03	6	1.0
		15	15	14	23.61	38	28.70	116	13.71	5.0*	0.00	3	0.7
		18	16	42	19.27	38	34.41	116	4.67	1.5	0.04	4	0.9
	Mar	06	20	28	6.07	38	41.60	116	10.02	1.0	0.10	7	2.3
		06	20	29	21.97	38	42.11	116	10.65	5.0*	0.06	4	1.7
		06	20	43	8.22	38	42.11	116	10.42	5.0*	0.03	5	2.4
		06	21	57	19.82	38	42.06	116	11.51	5.0*	0.01	4	0.6
		07	00	07	45.29	38	42.12	116	11.13	5.0*	0.04	4	1.0
		07	01	04	37.18	38	42.16	116	11.05	5.0*	0.05	4	1.1
		08	10	23	36.68	38	41.98	116	8.54	5.0*	0.00	3	1.4
		08	17	38	30.43	38	42.19	116	11.53	5.0*	0.00	4	0.8
		09	05	05	45.91	38	41.97	116	10.48	5.0*	0.04	4	1.6
		11	22	15	45.70	38	37.99	116	3.88	5.0*	0.00	3	1.0
		26	17	04	16.08	38	51.59	116	21.34	5.0*	0.14	6	2.4
		28	09	38	42.95	38	52.69	116	22.05	5.0*	0.09	11	3.4
		28	10	53	39.05	38	52.47	116	22.21	5.0*	0.16	9	2.6
		28	15	45	34.31	38	52.46	116	20.67	5.0*	0.21	7	2.2
		29	21	23	57.41	38	42.75	116	9.26	5.0*	0.02	4	1.0
		31	03	18	4.33	38	29.15	115	52.21	0.6	0.16	8	1.0
	Apr	09	11	55	3.47	38	38.45	116	9.17	5.0*	0.0	3	1.0
		09	12	28	36.09	38	38.24	116	9.00	5.0*	0.00	3	0.6
		19	11	09	1.12	38	36.53	116	3.29	5.0*	0.09	4	1.0
		19	11	57	15.06	38	36.64	116	3.07	5.0*	0.09	4	0.4
		19	13	06	8.41	38	36.49	116	3.25	5.0*	0.09	4	-0.9
		30	11	57	28.68	38	46.14	115	55.39	1.5	0.08	4	2.4
	May	17	17	23	8.82	38	28.89	116	6.21	12.0	0.04	6	1.1
		19	13	59	22.92	38	31.94	116	30.47	5.0*	0.07	7	1.2
	Jun	17	06	05	24.75	38	36.83	116	13.34	7.4	0.06	5	1.4
	Sep	11	13	39	41.44	38	10.43	116	23.98	5.0*	0.09	7	0.6
		20	13	01	25.66	38	26.18	116	1.98	5.0*	0.00	3	-0.2
		28	10	46	9.62	38	13.04	116	23.58	5.0*	0.10	11	1.4

+Mean deviation of arrival-time residuals.

*Depth restricted to 5.0 km in location program.

Table 4

CNTA Seismic Station Readings for Earthquakes with $M_L \geq 1.5$

(1) First motion (C - compression, D - Dilation).

(2) Weighting factor for arrival time (0 - excellent, 1 - good, 2 - fair, 4 - not used in location routine).

(3) Arrival time in seconds.

Origin Time	CNHR	CNBC	CNHC	CNPS	CNSB	CNEC	CNHM
	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
Nov 2 0335	2 55.25	C 0 52.83	2 56.25	2 59.55	2 57.10	D 0 55.65	D 0 54.80
Jan 25 0141	C 0 60.52	1 63.48	C 0 59.19	C 0 61.97	C 0 59.89	C 0 61.78	0 59.88
Mar 6 2028	C 0 11.48	2 15.10	C 0 09.53	C 0 08.87		C 0 12.52	
Mar 6 2029	1 27.00		1 25.00	1 24.38		1 28.03	
Mar 6 2043	C 0 13.23	0 17.00	C 0 11.32	0 10.65		C 0 14.23	
Mar 9 0505	C 0 50.90		D 0 48.95	C 0 48.37		C 0 51.90	
Mar 26 1704		C 0 27.41		C 0 19.92	C 0 22.43		C 0 24.30
Mar 28 0938		C 0 54.60		C 0 47.17	C 0 49.72	C 0 53.14	C 0 51.60
Mar 28 1053	4 43.50	C 0 50.74		C 0 43.24	C 0 45.78		C 0 47.62
Mar 28 1543		0 45.78		C 0 38.24	C 0 40.77		C 0 42.65
Apr 30 1157	4 34.70			C 0 34.30	D 0 34.39	D 0 34.83	D 0 35.85

Discussion

Thirty six earthquakes were located by the CNTA network during the one-year period of its operation. Excluding the intermittent periods during which the network was not operating, we believe that all earthquakes above magnitude 1.0 that occurred inside the network, were located (fig. 6). Figure 7 shows the relationships between these same earthquakes, Cenozoic faulting, and bedrock (F.J. Kleinhampl and J.I. Ziony, written communication, January, 1971).

Four earthquakes are considered to have good computed depths, i.e., the first arrival could be read from at least one station with an epicentral distance less than the focal depth and other readings were from stations with a good azimuthal distribution. These depths were: 6.2 km, 7.4 km. 8.9 km, and 12.0 km. Other depths ranged from 0.6 to 12.2 km. This depth range is greater than that found at NTS, where earthquakes occur from near surface to about 6 km, but about the same as was found in a study conducted by NCER in December, 1968, of earthquakes near Fairview Peak, Nevada.

The four earthquakes to the northwest of the network occurred from 26 to 28 March 1970. These events were located with the help of the National Ocean Survey stations BMN and TPH, and the University of Nevada stations TNP, BMN, FPN and SMN (fig. 1). Several dozen smaller earthquakes, mostly aftershocks of the four larger events, appeared to come from this same area but could not be located. The largest of these earthquakes had a magnitude of 3.4 and was the largest earthquake located.

The two earthquakes to the south of the network were located with additional readings from the NTS seismograph network operated by the U.S. Geological Survey, and the National Ocean Survey station TSV.

Figure 6

Epicenter map. Stations shown as triangles. Surficial faulting from the Faultless explosion is indicated by the lines in the upper center (McKeown and Dickey, 1969).

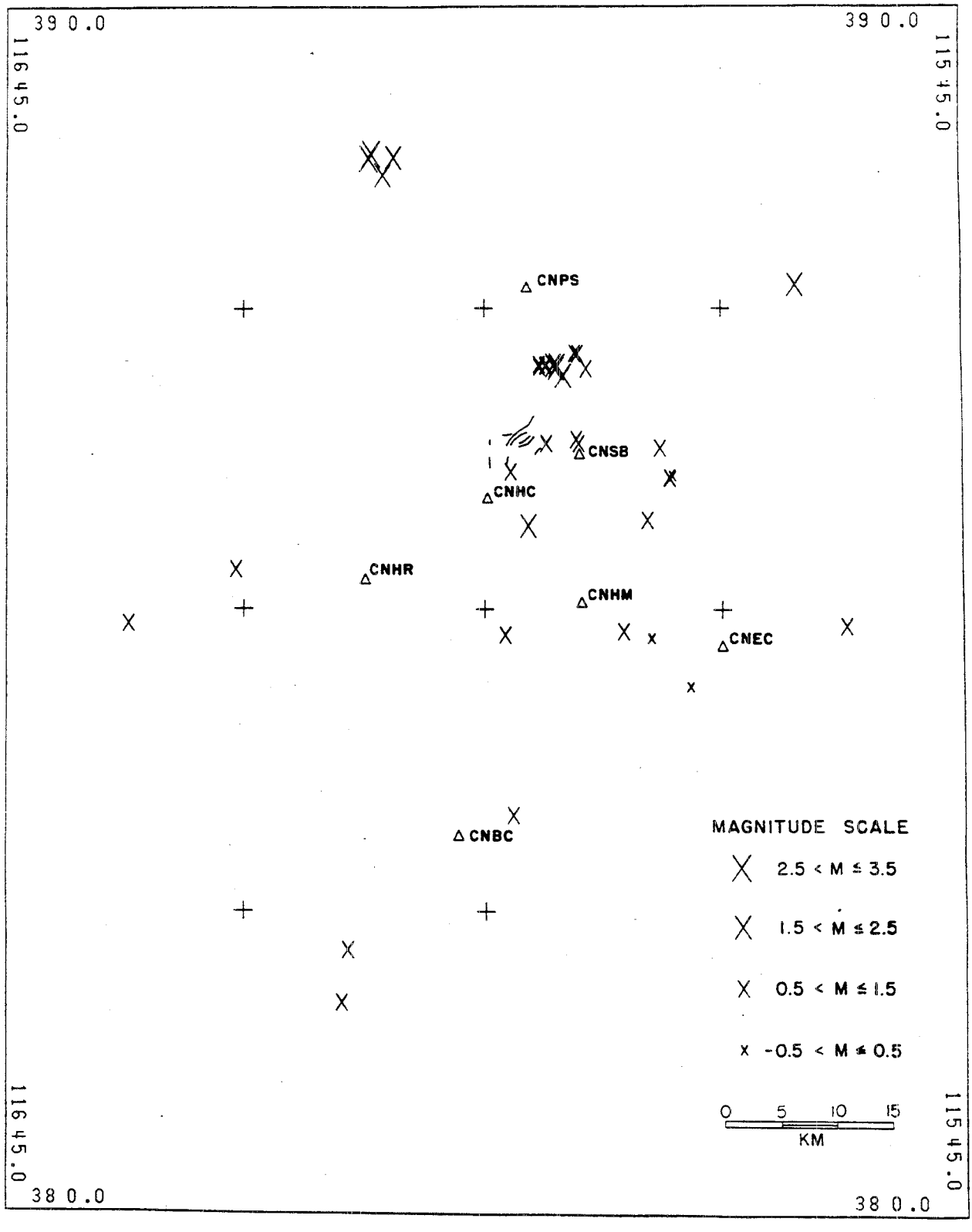
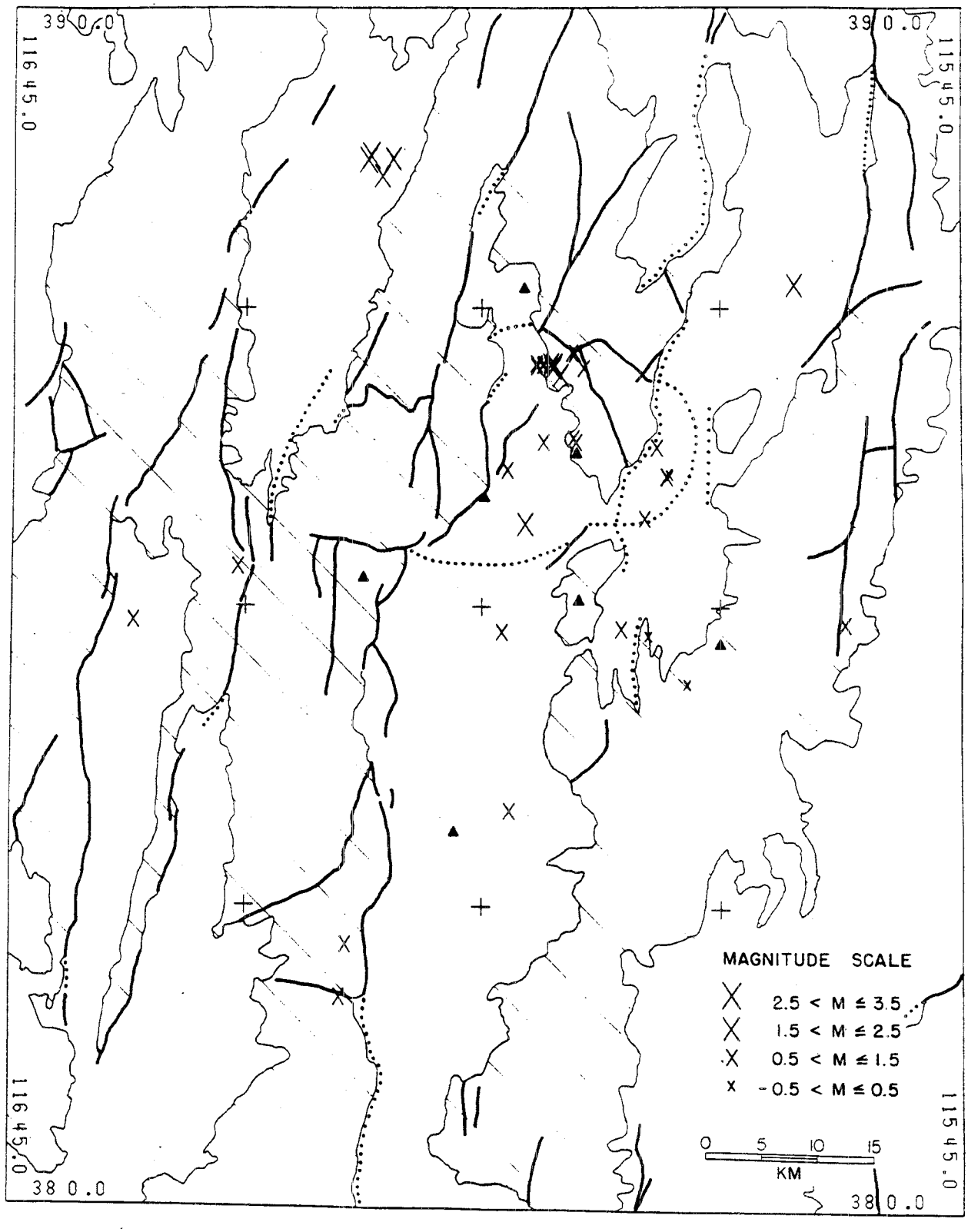

39 0.0
116 45.0
39 0.0
115 45.0
CNPS
CNSB
CNHC
CNHR
CNHM
CNEC
CNBC
MAGNITUDE SCALE
2.5 < M ≤ 3.5
1.5 < M ≤ 2.5
0.5 < M ≤ 1.5
-0.5 < M ≤ 0.5
0 5 10 15
KM
116 45.0
38 0.0
115 45.0
38 0.0

Figure 7.

Relationship of epicenters to major geologic features. Mapped faults are shown by solid lines, probable faults by dotted lines. Circular faults bound calderas. Areas of bedrock are cross-hachured to distinguish them from alluviated areas (F. J. Kleinhampl, and J. I. Ziony, U.S. Geological Survey, 1971, written communication).


39 0.0
116 45.0
39 0.0
115 45.0
116 45.0
38 0.0
115 45.0
38 0.0
MAGNITUDE SCALE
2.5 < M ≤ 3.5
1.5 < M ≤ 2.5
0.5 < M ≤ 1.5
-0.5 < M ≤ 0.5
0 5 10 15
KM

The most easterly earthquake was located with the help of six portable seismograph stations in Railroad Valley which were operated by the U.S. Geological Survey during the time of the Handley underground nuclear explosion.

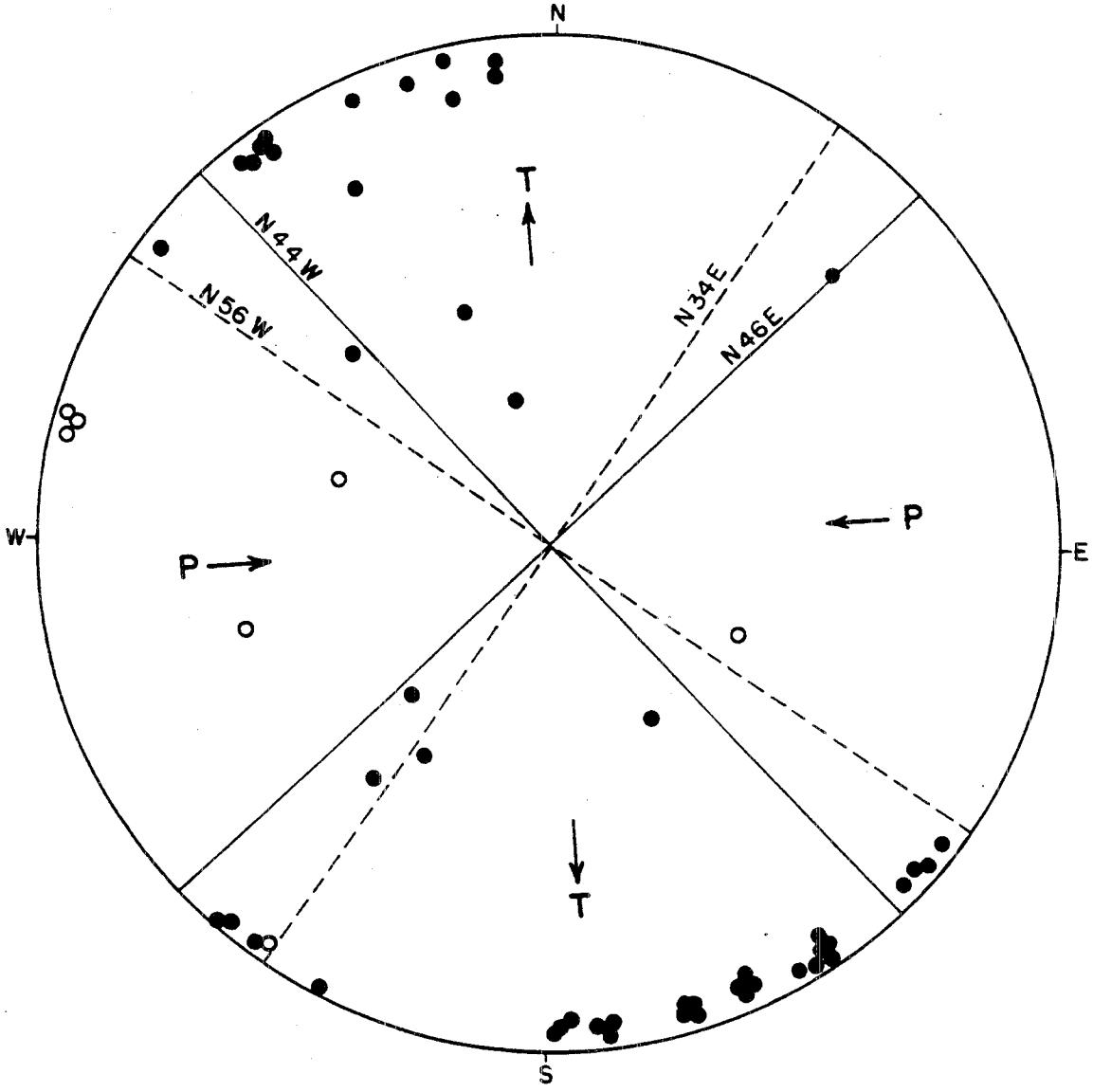
The eleven earthquakes in the area midway between stations CNSB and CNPS (fig. 6) occurred from 6 to 9 March 1970, with two exceptions: one on 8 November 1969, and the other on 29 March 1970. The magnitudes of these eleven events ranged from 0.6 to 2.4. These earthquakes fell to the northeast of the faulting produced by Faultless and may possibly represent a continuation of those northeasterly-trending faults (fig. 6).

The two earthquakes to the west of the CNTA network are near those located in the Monitor Range following Faultless (Boucher and others, 1969). These shocks had magnitudes of 1.0 and 1.2.

Fault-plane solutions for the located earthquakes were in general ambiguous due to insufficient data. However, 21 of the 36 earthquakes were consistent with the fault-plane solution shown in figure 8. We do not believe that this composite fault-plane solution is definitive for earthquakes in this area. More data might yield solutions showing dip-slip movement, especially considering that many of the earthquake solutions had poor depth control. Nevertheless, it is interesting to compare the range of possible solutions (fig. 8) with the faulting observed following Faultless (fig 6). Most of the relative displacement was down toward the southeast. However, some right-lateral movement was observed and confirmed by preliminary analysis of geodetic surveys (McKeown and Dickey, 1969). The observed right-lateral movement has a strike which falls within the range of possible fault-plane solutions (fig. 8).

Figure 8

Composite plot of first motions from 21 CNTA earthquakes. The figure is an equal-area projection of the lower focal hemisphere. Symbols are: compressional first motion - solid circle, dilatational first motion - open circle. Solid and dashed lines represent range of possible strike-slip solutions. The arrows bisect the angles formed by the nodal planes. The bisector of the dilatational quadrant is labeled as the pressure axis and the bisector of the compressional quadrant is labeled as the tension axis.


N
E
S
W
T
T
P
P
N44W
N56W
N34E
N46E

Large underground nuclear explosions from NTS did not trigger any activity at CNTA. The first of the earthquakes in late March, to the northwest of the network, occurred two hours prior to the Handley test (m_b = 6.5) at NTS. If this earthquake had occurred two hours later, it would have been tempting to incorrectly correlate these two events. Two low-yield NTS tests (Cyathus, m_b = 4.5, and Arabis, m_b = 4.3) occurred about five hours before the first of the series of earthquakes starting on 6 March. However, the small size of these tests makes it unlikely that they are related to the earthquakes at CNTA.

During the monitoring period at CNTA, there were only two areas of concentrated activity: midway between stations CNSB and CNPS, and northwest of the network. The activity in these areas occurred primarily during earthquake sequences lasting for less than one week. The small number and limited duration of the earthquake sequences suggests that if any earthquakes closely follow a future underground nuclear explosion at CNTA, the activity would probably have been stimulated by that explosion.

If underground nuclear testing is resumed in Hot Creek Valley, likely areas for stimulated earthquake activity would be northern Hot Creek Valley, Little Fish Lake Valley, and northern Stone Cabin Valley.

Acknowledgment

We wish to thank Professor Alan Ryall for providing the readings from the University of Nevada, Reno, seismograph stations.

References

Boucher, Gary, Ryall, Alan, and Jones, Austin E., 1969, Earthquakes associated with underground nuclear explosions: Jour. Geophys. Research, v. 74, no. 15, p. 3808-3820.

Eaton, J. P., 1969, Hypolayr, a computer program for determining hypocenters of local earthquakes in an earth consisting of uniform flat layers over a half space: U.S. Geol. Survey open-file report, 106 p.

Hamilton, R. M., and Healy, J. H., 1969, Aftershocks of the Benham nuclear explosion: Seismol. Soc. America Bull., v. 59, no. 6, p. 2271-2281.

McKeown, F. A., and Dickey, D. D., 1969, Fault displacement and motion related to nuclear explosions: Seismol. Soc. America Bull., v. 59, no. 6, p. 2253-2269.

Slemmons, D. B., Jones, A. E., and Gimlett, J. I., 1965, Catalog of Nevada earthquakes, 1852-1960: Seismol. Soc. America Bull., v. 55, no. 2, p. 537-583.

Distribution

Nevada Operations Office, U.S. Atomic Energy Commission, Las Vegas, Nevada:

W. W. Allaire
E. M. Douthett (3)
D. M. Hamel, NVOO Technical Library (2)
R. R. Loux (3)
R. E. Miller/C. E. Williams
W. D. Smith, Jr.
H. G. Vermillion

U.S. Atomic Energy Commission, Mercury, Nevada:

D. T. Schueler, NTSSO
CETO Library (Attn: E. A. Schultz) (2)

U.S. Atomic Energy Commission, Washington, D. C.:

M. B. Biles, DOS
Maj. Gen. E. B. Giller, AGMMA (2)
Richard Hamburger, DPNE

Division of Technical Information, U.S. Atomic Energy Commission, Oak Ridge, Tenn.: (2)

Defense Atomic Support Agency:

Chief, Nevada Branch, Test Commnad, Mercury, Nevada (2)
Director (Attn: SPSS), Washington, D. C.
Test Command (Attn: Dr. Benjamin Grote), Albuquerque, New Mexico

Los Alamos Scientific Laboratory, Los Alamos, New Mexico:

Robert Bradshaw
R. H. Campbell
R. W. Newman
W. E. Ogle
R. R. Sharp, Jr.

Los Alamos Scientific Laboratory, Mercury, Nevada:

Robert Bradshaw

Lawrence Radiation Laboratory, Livermore, California:

J. E. Carothers
P. E. Coyle
D. O. Emerson
J. W. Hadley
G. H. Higgins
D. L. Springer
Geoscience Group (Attn: A. E. Lewis)
Technical Information Department (3)

Lawrence Radiation Laboratory, Mercury, Nevada:

R. D. McArthur

Sandia Laboratories, Albuquerque, New Mexico:

J. R. Banister
M. L. Merritt
B. F. Murphey
W. C. Vollendorf
W. D. Weart

Sandia Laboratories, Mercury, Nevada:

B. G. Edwards

NVOO Panel of Consultants:

L. K. Bustad, University of California, Davis, California
D. U. Deere, University of Illinois, Urbana, Illinois
L. S. Jacobsen, 267 Belgreen Place, Oakmont, Santa Rosa, California
Carl Kisslinger, St. Louis University, St. Louis, Missouri
G. M. Maxey, DRI, Reno, Nevada
N. M. Newmark, University of Illinois, Urbana, Illinois
L. A. Sagan, Palo Alto Medican Clinic, Palo Alto, California
Vincent Schultz, Washington State University, Pullman, Washington
T. F. Thompson, 2360 Fireside Circle, Reno, Nevada
W. G. VanDorn, Scripps Institute of Oceanography, La Jolla, California
L. G. von Lossberg, Sheppart T. Powell & Assoc., Baltimore, Maryland
J. T. Wilson, University of Michigan, Ann Arbor, Michigan
S. D. Wilson, Shannon & Wilson, Inc., Seattle, Washington

Advanced Research Projects Agency, Washington, D. C.:

V. C. Fryklund

Battelle Memorial Institute:

J. B. Kirkwood, Columbus, Ohio
R. G. Fuller, Las Vegas, Nevada

Colorado School of Mines, Golden, Colorado:

Maurice Major

Desert Research Institute, Las Vegas, Nevada:

A. E. Peckham

Eberline Instrument Corporation, Santa Fe, New Mexico:

W. S. Johnson

Environmental Research Corporation:

O. A. Israelsen, Alexandria, Virginia (2)
J. A. Lahoud, Las Vegas, Nevada

Environmental Sciences and Services Administration, Research Laboratories, San Francisco, California:

Don Tocher

Environmental Sciences and Services Administration, U.S. Coast & Geodetic Survey, Las Vegas, Nevada:

K. W. King

Fenix & Scisson, Inc.:

Grant Bruesch, Mercury, Nevada
M. H. May, Las Vegas, Nevada

Holmes & Narver, Inc.:

P. D. Pack, Las Vegas, Nevada
Resident Engineer, Mercury, Nevada

Teledyne Isotopes:

M. M. Bell, Las Vegas, Nevada
P. R. Fenske, Palo Alto, California
L. B. Werner, Palo Alto, California

Ken O'Brien and Associates, Albuquerque, New Mexico:

Dallas Donegon

U.S. Army Corps of Engineers, Anchorage, Alaska:

District Engineer

U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, Mississippi:

J. M. Polatty
William Steinriede, Jr.
Library

U.S. Bureau of Mines, Denver, Colorado:

P. L. Russell

U.S. Public Health Service, Las Vegas, Nevada:

M. W. Carter (2)

U.S. Geological Survey, Washington, D. C.:

J. T. Hack
W. T. Pecora
Military Geology Branch
Chief Hydrologist, WRD, (Attn: Radiohydrology Section)

U.S. Geological Survey, Mercury, Nevada:

Geologic Data Center (15)

DISTRIBUTION LIST

Nevada Division of Environmental Protection

Paul Liebendorfer — 2 (Controlled)
Bureau of Federal Facilities
Division of Environmental Protection
333 W. Nye Lane, Room 13B
Carson City, NV 89706-0866

Mike McKinnon — 1 (Controlled)
Bureau of Federal Facilities
Division of Environmental Protection
Sawyer State Building
555 E. Washington, Suite 4300
Las Vegas, NV 89101-1049

U.S. Department of Energy

Sabrina Lawrence — 1 (Controlled)
Environmental Restoration Division
U.S. Department of Energy, Nevada Operations Office
P.O. Box 98518 M/S 505
Las Vegas, NV 89193-8518

Monica Sanchez — 1 (Uncontrolled)
Environmental Restoration Division
U.S. Department of Energy, Nevada Operations Office
P.O. Box 98518 M/S 505
Las Vegas, NV 89193-8518

Peter Sanders — 2 (Uncontrolled)
Environmental Restoration Division
U.S. Department of Energy, Nevada Operations Office
P.O. Box 98518 M/S 505
Las Vegas, NV 89193-8518

DISTRIBUTION LIST (Continued)

Bechtel Nevada

Correspondence Control — 1 (Uncontrolled)
Bechtel Nevada
P.O. Box 98521 M/S NLV008
Las Vegas, NV 89193-8521

Environmental Management Library — 1 (Uncontrolled)
Bechtel Nevada
P.O. Box 98521 M/S NLV080
Las Vegas, NV 89193-8521

Kevin Campbell — 1 (Uncontrolled)
Bechtel Nevada
P.O. Box 98521 M/S NTS306
Las Vegas, NV 89193-8521

David Cowser — 1 (Uncontrolled)
Bechtel Nevada
P.O. Box 98521 M/S NLV082
Las Vegas, NV 89193-8521

Ronald Hunter — 1 (Uncontrolled)
Bechtel Nevada
P.O. Box 98521 M/S NLV082
Las Vegas, NV 89193-8521

Wayne Johnson — 1 (Uncontrolled)
Bechtel Nevada
P.O. Box 98521 M/S NTS306
Las Vegas, NV 89193-8521

David Madsen — 1 (Uncontrolled)
Bechtel Nevada
P.O. Box 98521 M/S NTS306
Las Vegas, NV 89193-8521

DISTRIBUTION LIST (Continued)

Paul Brown
Bechtel Nevada
P.O. Box 98521 M/S NTS306
Las Vegas, NV 89193-8521
3 (Uncontrolled)

Michael Shotton
Bechtel Nevada
P.O. Box 98521 M/S NLV082
Las Vegas, NV 89193-8521
1 (Uncontrolled)

Julie Sorola
Bechtel Nevada
P.O. Box 98521 M/S NLV085
Las Vegas, NV 89193-8521
1 (Uncontrolled)

IT Corporation

IT FFACO Support Office
IT Corporation
P.O. Box 93838
Las Vegas, NV 89193-3838
2 (Controlled)

PEER Consultants

Gary Hudak
PEER Consultants
P.O. Box 98521 M/S NLV082
Las Vegas, NV 89193-8521
1 (Uncontrolled)

U.S. Bureau of Lan Management

William S. Fisher
P.O Box 911
Tonopah, NV 89049-0911
1 (Uncontrolled)

DISTRIBUTION LIST (Continued)

U.S. Forest Service

John Haney Tonopah Ranger District P.O. Box 3940 Tonopah, NV 89049-6286	1 (Uncontrolled)