#### **ERRATA SHEET**

The Following Corrections and Clarifications Apply to: Closure Report (CR) for Corrective Action Unit (CAU) 91: Area 3 U-3fi Injection Well

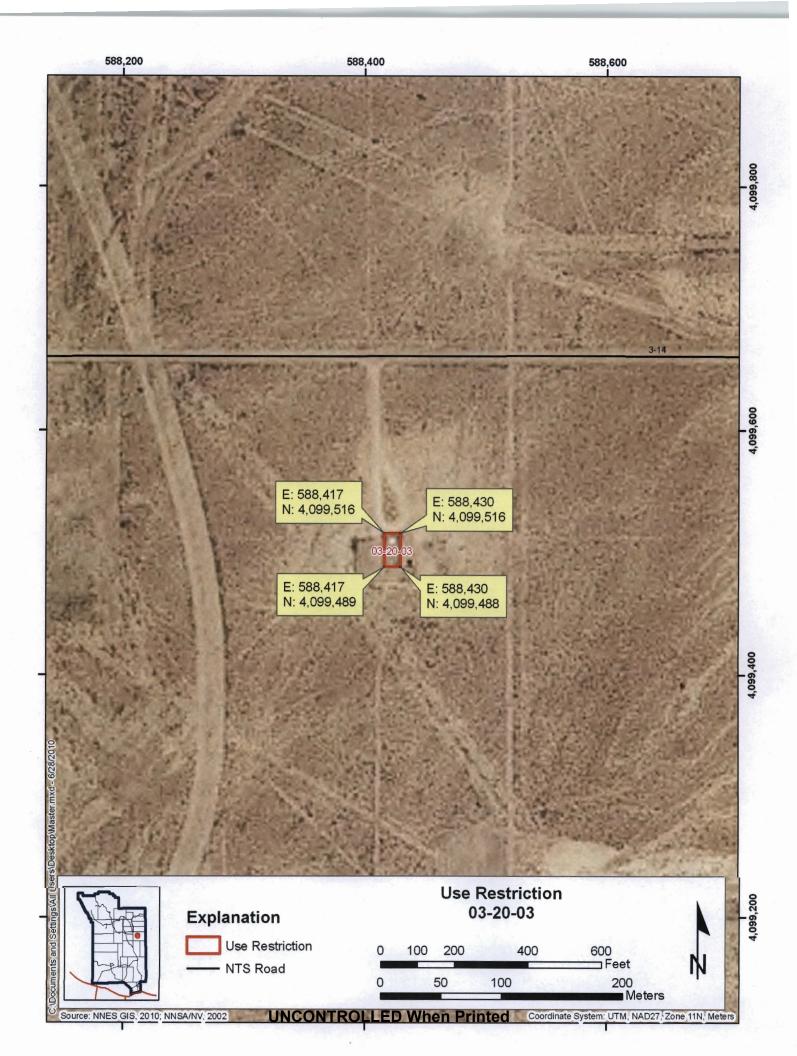
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The closure report for CAU 91 has no Use Restriction Form or drawing/map included in the document to describe the use restricted area, however, Section 3.3.3 states that the site will be fenced and signage placed indicating the area as a Resource Conservation and Recovery Act (RCRA) Unit. The drawing that was placed in the FFACO indicating the use restricted area lists the coordinates for the RCRA Unit in Nevada State Plan Coordinates – North American Datum of 1983. In the ensuing years the reporting of coordinates has been standardized so that all coordinates are reported in the same manner, which is: NAD 27 UTM Zone 11 N, meters. This Errata Sheet updates the coordinate reporting to the currently accepted method and includes an aerial photo showing the RCRA Unit with the coordinates listed showing the use restricted area.





#### Department of Energy

Nevada Operations Office P.O. Box 98518 Las Vegas, NV 89193-8518

NOV 22 1995

Paul J. Liebendorfer, P.E., Chief Bureau of Federal Facilities Division of Environmental Protection State of Nevada 333 W. Nye Lane Carson City, NV 89710

#### CERTIFICATION OF CLOSURE OF THE AREA 3 U-3FI WASTE UNIT

A copy of the Certification and Closure Report for the Area 3 U-3Fi Waste Unit, November 1995, is being sent by copy of this memorandum to your Las Vegas office. As required by 40 C.F.R. Part 265.115, the report contains a signed certification of closure by myself as owner/operator of the site and a signed certification of closure by an independent registered Professional Engineer.

Construction activities for the closure were completed on September 28, 1995, and the first neutron soil moisture logging of well 3-3 was completed.

Since the site is expected to remain in federal ownership, no notice of Resource Conservation and Recovery Act closure or survey plat is being provided to Nye County.

If you have any questions regarding the closure report, please contact Janet L. Appenzeller-Wing, Environmental Restoration Division, at (702) 295-0461.

Terry A. Vaeth
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ERD:JAW

Enclosures: As stated

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# AREA 3 U3fi WASTE UNIT RESOURCE CONSERVATION AND RECOVERY ACT CLOSURE REPORT

November 1995

Prepared for United States Department of Energy Environmental Restoration Division

Prepared by
Reynolds Electrical & Engineering Company
Environmental Restoration Projects Department
Environmental Remediation Section

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### ABBREVIATIONS AND ACRONYMS

ASTM American Society for Testing and Materials

bgs below ground surface

CFR Code of Federal Regulations

CX Categorical Exclusion

DOE United States Department of Energy

EPA United States Environmental Protection Agency

LANL Los Alamos National Laboratory

LLNL Lawrence Livermore National Laboratory

NAC Nevada Administrative Code

NDEP Nevada Division of Environmental Protection

NTS Nevada Test Site

RCRA Resource Conservation and Recovery Act

REECO Reynolds Electrical and Engineering Company, Inc.

RSN Raytheon Services Nevada

USGS United States Geological Survey

#### 1.0 INTRODUCTION

#### 1.1 INTRODUCTION

This report documents the closure of the U3fi Waste Unit (U3fi) located in Area 3 of the Nevada Test Site (NTS), Nye County, Nevada (Figure 1). The NTS, a United States Department of Energy (DOE) facility, is approximately 105 kilometers (65 miles) northwest of Las Vegas, Nevada. The unit was used for the disposal of wastes containing constituents regulated under the Atomic Energy Act and possibly the Resource Conservation and Recovery Act (RCRA).

Approval of the closure plan was granted by the Nevada Division of Environmental Protection (NDEP) on August 28, 1995. Mobilization efforts began September 5, 1995. Closure activities began on September 6, 1995. Closure was completed on September 28, 1995. Figure 2 provides the progress of the closure activities.

This section of the report provides the purpose and scope of the closure, a summary of the work performed leading to the closure, and background information about the U3fi Waste Unit. Section 2.0 provides information on the flood assessment prepared to determine engineering controls required to be designed into the closure. Section 3.0 provides details on the closure activity. Section 4.0 provides closure certifications signed by the DOE and by the Independent Professional Engineer.

Appendix A provides the design summary for the flood study. Appendix B contains the grout plug calculations. Daily reports and field notes are located in Appendix C. Appendix D contains the Independent Engineer's NTS Daily Rig Operations Forms. Material weight sheets and dry material batch weight certifications are found in Appendix E and the grout testing report in Appendix F.

Closure requirements are based on the following:

- Title 40 Code of Federal Regulations (CFR) §265.310 <u>Closure and Post-Closure Care</u>;
- Nevada Administrative Code (NAC) 534.421, <u>Plugging: Wells for Purposes</u> Other <u>Than Water Wells</u>;
- NDEP, 1995, <u>Hazardous Waste Management Facility Number NEV HW009</u>, <u>United States Department of Energy</u>, <u>Nevada Operations Office</u>, <u>Nevada Test Site I.D. Number NV3890090001</u>, Part B Hazardous Waste Permit; and
- Title 40, CFR §265.115 <u>Certification of Closure</u>.

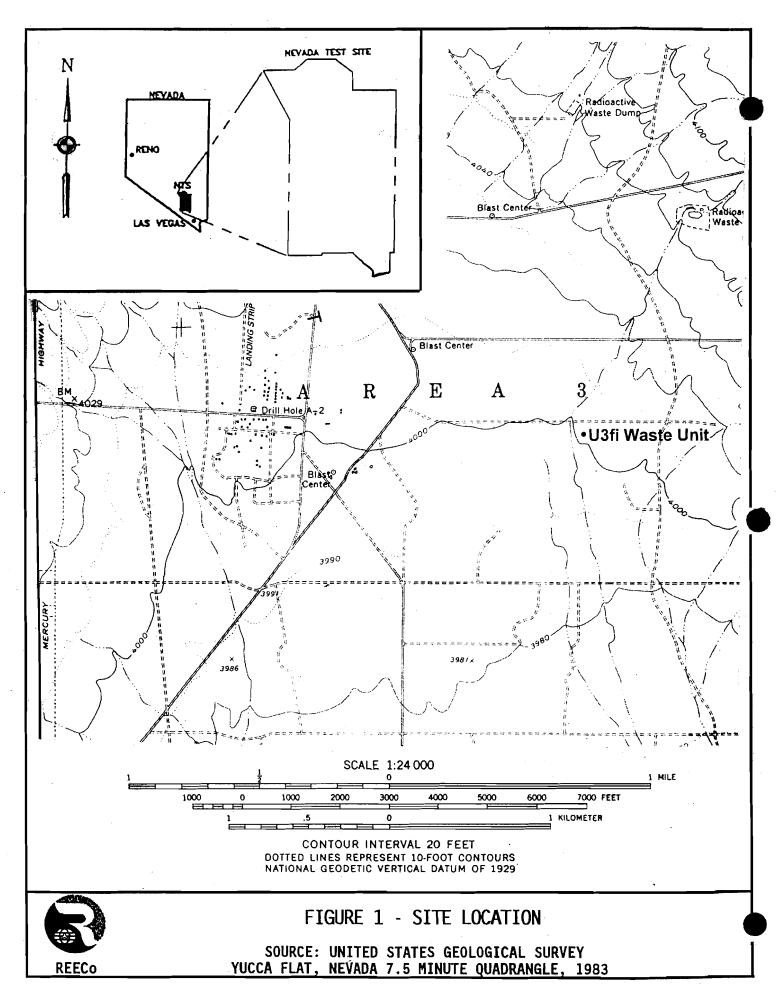


				FIGURE 2 - CLOSURE ACTIVITY PROGRESS CHART
Early Start		Early Finish	Activity At	
	***********	U3fi WAS	TEUNIT	
SEP 05 95	A S	EP 05 95 A	1010	■ MOBILIZE TO SITE
SEP 06 95	A S	EP 06 95 A	1020	# HEALTH & SAFETY BRIEFING
SEP 06 95	A S	EP 06 95 A	1030	# PLACE BASE SAND PLUG
SEP 06 95	A S	EP 06 95 A	1040	■ PLACE BASE EXPANDING CEMENT GROUT PLUG
SEP 07 95	A S	EP 07 95 A	1050	■ DESIGN EXPANDING GROUT PLUG
SEP 11 95	A S	EP 12 95 A	1060	PLACE INERT SAND PLUG
SEP 12 95	A S	EP 13 95 A	1070	PLACE UPPER CEMENT GROUT PLUG
SEP 13 95	A S	EP 14 95 A	1080	COMPLETE PAD AND PLACE MONUMENT
SEP 18 95	A S	EP 18 95 A	1090	<b>Æ</b> DEMOBILIZE
SEP 19 95	A S	EP 19 95 A	1100	■ COMPLETE SITE WORK
SEP 19 95	A S	EP 27 95 A	1110	INSTALL SECURITY FENCE AROUND UNIT
SEP 28 95	A S	EP 28 95 A	1120	ÆINSTALLATION OF SIGNS
SEP 28 95	A S	EP 28 95 A	1130	■UNIT CLOSED
OCT 02 95	A N	OV 13 95 A	1140	PREPARATION OF CLOSURE REPORT
NOV 30 95	AN	OV 30 95 A	1150	■ DELIVER CLOSURE REPORT TO NDEP

#### 1.2 PURPOSE AND SCOPE

Based upon the characterization drilling program, it was determined that the best course of action was to close the waste unit in place. Closure consisted of decommissioning the well by emplacing plugging materials, covering the unit with a concrete pad, and erecting a concrete monument equipped with a brass identification marker followed by site grading. Fencing and signs around the unit separate the unit from the surrounding area.

This report includes the following:

- U3fi Waste Unit description;
- Flood assessment and design;
- Closure and cap design;
- Closure details including as-built drawings;
- Survey plat of the locations and dimensions of the U3fi Waste Unit and ER-3-3 monitoring well; and
- Closure certificates signed by an authorized representative of DOE/Nevada and a independent registered professional engineer.

#### 1.3 SITE HISTORY

#### 1.3.1 DESCRIPTION

The U3fi Waste Unit was an abandoned emplacement hole located in Area 3 of the NTS (Figure 1). It was drilled by Reynolds Electrical & Engineering Company, Inc. (REECo), between March 27 and April 24, 1967, for emplacement of a nuclear testing device for the Los Alamos National Laboratory (LANL). A detailed history of the emplacement hole drilling program can be found in the U3fi Waste Unit Closure Plan (DOE, 1995a).

On April 11, 1967, the depth of the hole was 256 meters (841 feet) below the surface (bgs). Due to subsurface conditions, a thicker drilling foam was introduced to the hole. The foam did not work and the hole caved, trapping the drill bit at a depth of 254.8 meters (836 feet). Attempts to retrieve the drill bit failed. The top of the collapsed emplacement hole was located at 73.2 meters (240 feet) bgs. The hole was abandoned on April 24, 1967.

#### 1.3.2 WASTE DISPOSAL ACTIVITIES

The U3fi Waste Unit was established in 1970. A detailed presentation of waste disposal activities at the U3fi Waste Unit can be found in the U3fi Waste Unit Closure Plan (DOE, 1995a). The waste unit primarily received LANL solid

postshot drillback waste. The disposed waste was primarily postshot drillback "high-grading" wash water which was solidified with cement. Radioactive cores from drillback operations were also disposed into the unit (DOE, 1995a). Core samples consisted of mixed fission and activation products from the solidification of detonation debris/melt collected during postshot drilling activities (DOE, 1995a). The unit was under LANL control at the time (DOE, 1995a).

In 1977, control of the U3fi Waste Unit was assumed by the Atomic Energy Commission, renamed the Energy Research and Development Administration, now known as the DOE. Waste was generated from four additional sources; Lawrence Livermore National Laboratory (LLNL), the Area 6 Decontamination Pad, Area 12 Tunnels, and LRY3 which was an unspecified generator of weapons test program waste.

Documentation of waste disposal activities began in 1977. The database was established and maintained by the REECo Defense Waste Management Department, currently the REECo Waste Management Department. It had 102 entries between January 11, 1977 and November 28, 1988. Access to the U3fi Waste Unit from 1977 to 1989 was gained through both REECo Radiation Safety and Wackenhut Services, Inc. (DOE, 1995a). Copies of the waste disposal documents can be found in Appendix C of the Closure Plan (DOE, 1995a).

According to waste disposal records, an estimated 86.34 curies with a weight of 1.7 kilograms (3.7 pounds) of fission products from drilling activities were placed within the waste unit. In addition to the radioactive waste described in the waste disposal records, it is believed that chromium from drilling mud and lead from pipe-lubricant, stemming, and shielding materials may also have been disposed into the waste unit. Waste was placed from 55 meters (180 feet) bgs to approximately 73 meters (240 feet) bgs.

#### 1.4 SUMMARY OF PRELIMINARY ACTIVITIES

The U3fi Waste Unit Closure Plan (DOE, 1995a) summarizes the results of site characterization activities which included:

- Interviews with NTS employees familiar with the unit to identify details regarding construction, history, and waste inventory of the unit;
- Analytical results of soil samples taken from the soil surrounding the unit. Samples were taken at a shallow depth for radioactive and RCRA parameters;
- Sample results of the atmosphere of the unit for gamma emitting radionuclides and volatile organic compounds;
- Video logs of the inside of the unit to identify the form and condition of waste located on the top of the waste placed in the unit; and

• A slant borehole intersected the U3fi Waste Unit at approximately 400 feet. The borehole was used to describe soil conditions and to collect soil and soil gas samples. The borehole was converted into a monitoring well (ER-3-3) that will be used for monitoring soil moisture.

Since the U3fi Waste Unit was closed in place, the waste must be monitored to verify that well will not impact ground water. The U3fi Post-Closure Plan (DOE, 1995b) discusses the post-closure monitoring program, including the frequency and duration of monitoring.

#### 1.5 SUPPORT DOCUMENTS

Closure activities are based on the following documents:

- Resource Conservation and Recovery Act Industrial Site Environmental Restoration Closure Plan, Area 3 U3fi Waste Unit, (DOE, 1995a);
- Design Summary for U3fi Waste Unit Drainage, (RSN, 1995a);
- Nevada Test Site, Area 3, U3fi Waste Unit RCRA Closure, Drawing JS-003-133-C2 (RSN, 1995b);
- Resource Conservation and Recovery Act Industrial Site Environmental Restoration Post-Closure Plan, Area 3 U3fi Waste Unit (DOE, 1995b); and
- Standard Guide For Decommissioning of Ground Water Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices For Environmental Activities, Standard D5299-92, (American Society for Testing and Materials [ASTM], 1995).

The ASTM Decommissioning Guide (ASTM, 1995), while not required, is an industry standard for the decommissioning of wells containing hazardous waste. It supplements state regulations and provides general criteria for the selection of plugging materials. It defines characteristics such as a material's ability to remain structurally sound, the ability of materials to maintain sealing capabilities, and not react with the waste.

In addition to the previously described documents, several additional documents were prepared prior to the start of field activities to close the unit.

- An Environmental, Safety and Health (ES&H) Checklist for field projects
  was filled out. This checklist provides an overview of a broad range of
  ES&H issues typically observed at a site.
- A <u>Site Specific Health & Safety Plan</u> was prepared and approved by the DOE Project Manager and REECo Health Protection Department, Occupational Safety, Occupational Medicine, NTS Construction and Environmental Restoration Projects Departments.

- A Categorical Exclusion (CX) was approved on December 22, 1992 that covers closure activities. It indicates that the proposed action will not affect any environmentally sensitive resources including cultural and historical resources, threatened or endangered species, critical habitats, floodplains or wetlands, special sources of water, or prime agricultural land. The CX also states that the proposed activity will not violate any statutory regulatory or permit requirements.
- A Mobilization Checklist was completed to facilitate mobilization activities to the site.

#### 2.0 FLOOD ASSESSMENT

#### 2.1 INTRODUCTION

RCRA regulations require that a flood assessment be prepared to determine if engineering controls need to be designed into the closure to protect the waste unit from erosion during flood events. The risk of flooding associated with the site can be established by assessing the drainage basin associated with a site. By using topographic maps and runoff models, the risk of flooding for a specified return frequency (for example, a flood that can be expected to occur on a statistical average of once every 25 years) and precipitation duration (the length of time of a precipitation event) can be developed.

Generally, surface runoff models are used to determine whether a site lies within a 100 year floodplain. The design requirement for the U3fi Waste Unit closure is that the cap is to withstand a 25 year, 24 hour storm event, i.e. a storm could statistically occur once every 25 years with a 24 hour duration.

#### 2.2 RESULTS OF THE FLOOD ASSESSMENT

A detailed flood assessment was prepared. The Design Summary for the U3fi Waste Unit Drainage (RSN, 1995a) can be found in Appendix A. The runoff was calculated using the TR-55 peak discharge method (Clark County, 1990). A drainage basin of 6 square kilometers (2.3 square miles) flows past the unit based on the United States Geological Survey (USGS) Yucca Flat and Paiute Ridge 7.5 minute topographic quadrangles.

A 25 year, 24-hour storm is calculated to generate 5.08 centimeters (2 inches) of precipitation discharged into the drainage basin. Using the TR-55 peak discharge method, a flow of 0.39 cubic meters per second (13.74 cubic feet per second) could pass through the U3fi Waste Unit. The estimated depth for this flow is 0.36 centimeters (0.14 inches) at a velocity of 0.15 meters per second (0.48 feet per second). Review of the native soil structure indicates that this velocity is insufficient to cause erosion. The U3fi Waste Unit cap was designed so that any water running across the waste unit will be directed away from the unit (USGS, 1983, a,b).

The flood assessment also considered the affects of a 100 year storm event. The analysis indicates that a 25 year, 24 hour storm event is larger than a 100 year, 6-hour storm event. Since the flow depth for the 25 year, 24-hour storm event is less than 0.31 meters (1 foot) it is unlikely that the U3fi Waste Unit is located within the 100 year floodplain.

#### 2.3 DESIGN CRITERIA SELECTED

Both the U3fi Waste Unit and the ER 3-3 Monitoring Well completion pads are elevated 7.62 centimeters (3 inches) above ground surface. The concrete pad is sloped away from each unit. This design prevents the possibility of any ponding in the vicinity of either the U3fi Waste Unit or Monitoring Well ER-3- 3.

#### 3.0 CLOSURE ACTIVITIES

#### 3.1 APPROACH

Results of the drilling program characterization indicated that soil surrounding the U3fi Waste Unit was not significantly impacted (DOE, 1995a). Analytical data indicated that soils around the well head and subsurface soil had concentrations below Regulatory Action Levels. Therefore, remediation of the surface or subsurface soil within the vicinity of the U3fi Waste Unit was not required.

#### 3.2 CLOSURE PLAN AND DESIGN

Based upon the findings of the drilling characterization program, a closure plan was prepared and submitted to the NDEP for concurrence and approval. The closure plan provided a design for plugging the waste unit by using expanding cement grout and sand. In addition, the plan included the installation of a well to monitor soil moisture (DOE, 1995a).

The closure design for the U3fi Waste Unit was developed based upon the conditions identified in the unit characterization and requirements found in the ASTM guidance document on the decommissioning of wells and boreholes (ASTM, 1995). The ASTM document provided a number of criteria on choosing plugging materials so that the material performed without adversely reacting with the waste, or caused a pathway to develop so that waste could move if mobilized by a liquid (such as water).

The methodology for unit closure as provided to the NDEP in the Closure Plan (DOE, 1995a) is summarized below:

- Provide equipment for decommissioning the well from the surface including a dust collection/control system for the placement of sand. This system is designed to reduce the volume of dust released from the unit during sand placement. Downhole equipment (such as a tremmie) is not required.
- Plugging of the well using a base sand plug of approximately five feet of stemming sand (a volume of 3.82 to 19.12 cubic meters [5 to 25 cubic yards]). The sand is placed on top of the waste. After sand placement, the depth of the hole is tagged in several locations using a wireline.
- The addition of a base cement grout plug that has a thickness of 0.91 meters (3 feet) of expanding cement grout (a volume of 2.4 cubic meters [3.14 cubic yards]) is placed on top of the sand. After placing the grout, the depth of the hole is to be tagged using a wireline.

A bottom grout cement plug is required to prevent the material placed into U3fi during the closure from compressing the underlying waste. The cement grout plug calculations are found in Appendix B.

- Wait a minimum of 24 hours for sufficient grout strength to be reached.
   The top of the cement grout is again tagged with the wireline. The 24 hour period allows the cement grout to properly set and therefore support the material to be placed above the grout.
- After the depth to the top of the expanding cement grout is measured, an additional plug of expanding cement grout is added. The thickness of this plug is between 2.13 to 3.05 meters (7 to 10 feet). This is a volume of 5.6 to 8.01 cubic meters [7.33 to 10.47 cubic yards]). The top of the second grout plug is then tagged with the wireline. This will bring the top of the material to a depth of 50.29 to 49.38 meters (165 to 162 feet) from the surface of the unit.
- Wait a minimum of 48 hours for the material to reach strength. Again tag the top of the cement plug with the wireline. Plug the well using stemming sand from the top of the cement plug to a depth of 15.85 meters (52 feet). This is an approximate volume of 88.073 cubic meters (115.19 cubic yards) of material. To verify that the fill is rising according to calculations, the top of the sand layer is to be tagged using the wireline after each truck load is discharged. The top of the final sand placement is also tagged.
- Place the upper expanding cement grout plug from 15.85 meters (52 feet) to grade.
- Prior to bringing the final pour of grout to the surface, build a form around the well for the pad. Pour the final plug and the pad.

The Area 3 U3fi Waste Unit Closure Plan was submitted to the NDEP in June 1995.

#### 3.3 CLOSURE ACTIVITIES

The Area 3 U3fi Waste Unit Closure Plan was approved by the NDEP on August 28, 1995. The DOE Subproject Task Manager authorized closure work to begin on August 28. Closure activities are summarized in Table 1.

A detailed description of the closure activity is provided below. A copy of the closure manager's daily field notes and daily reports are found in Appendix C. The Independent Engineer's Daily Rig Operating Reports can be found in Appendix D.

TABLE 1 - SUMMARY OF CLOSURE ACTIVITIES

ACTIVITY	DATE INITIATED	DATE COMPLETED	COMMENTS
Mobilize to site	9/5/95	9/5/95	Mobilized dust collection system, generator, installed security fencing, and cut holes in the U3fi cover for equipment access, safety, and environmental control.
Start closure activities	9/6/95_	9/6/95	Held pre-project Site Specific Health & Safety Meeting
Placement of base sand plug	9/6/95	9/6/95	Poured 4.25 cubic meters (5.56 cubic yards) of 20/40 sand. Created a 2.13 meter (7 foot) plug.
Placement of base cement grout plug	9/6/95	9/6/95	Poured 3.06 cubic meters (4 cubic yards) of expanding cement grout to form a 1.83 meter (6 foot) base plug.
Design of expanding cement grout plug and installation	9/7/95	9/7/95	Poured 9.17 cubic meters (12 cubic yards) of expanding cement grout to form a 3.05 meter (10 foot) plug.
Placement of inert sand plug	9/11/95	9/12/95	Poured 80.56 cubic meters (105.37 cubic yards) of NTS stemming sand to form a stemming sand column of 32.61 meters (107 feet).
Placement of upper cement grout plug	9/12/95	9/13/95	Poured 41.29 cubic meters (54 cubic yards) of expanding cement grout and 6.12 cubic meters (8 cubic yards) of concrete to form a final cement/concrete plug column of 15.54 meters (51 feet).
Placement of monument and completion of pad	9/13/95	9/14/95	Placed monument in center of the U3fi emplacement hole. Poured 6.88 cubic meters (9 cubic yards) of concrete for pad.
Demobilize	9/18/95	9/18/95	Demobilized dust collection system and generator from site

ACTIVITY	DATE INITIATED		COMMENTS
Completion of site work	9/19/95	9/19/95	Graded surface area surrounding U3fi and ER 3-3 with soil and crushed stone.
Installation of security fence around U3fi and ER 3-3	9/19/95	9/27/95	Installed a 18.29 meters (60 feet) by 12.19 meters (40 feet) fence that is 2.44 meters (8 feet) high.
Installation of RCRA signs	9/28/95	9/28/95	·
U3fi Waste Unit Closure	9/5/95	9/28/95	Site closed

#### 3.3.1 Mobilization Activities

The following activities were completed prior to the approval of the Closure Plan by the NDEP. The schedule allowed approximately 30 days to complete the closure (by September 30, 1995). This required that the following activities be done prior to approval of the plan.

- Preparing the expansive cement grout mixture and mixing the dry components;
- Drying the stemming sand;
- Ordering fencing material;
- Preparing dust abatement equipment for use at the unit; and
- Scheduling manpower for the activity.

Actual mobilization activities to the site began on September 5, 1995. This consisted of setting up the following:

- Establishing an exclusion zone around the well site;
- Erecting a fence for site control;
- Mobilizing the dust abatement system and a generator to the site;
- Modifying the existing U3fi cover plate to allow insertion of the dust control and wireline tagging equipment so that the cover did not have to be removed. Dust control was accomplished by cutting holes into the cover plate for insertion of the dust abatement equipment. This was done as the open 188 centimeters (74 inch) diameter hole is considered a safety hazard; and
- Removing of debris inside and around the exclusion zone.

#### 3.3.2 Plugging Activities

The initial plugging activities began on September 6, 1995 with the placement of approximately 4.20 cubic meters (5.5 cubic yards) of 20/40 stemming sand. The sand was placed into the well under pressure using a high pressure hose. The hose extended approximately three meters (10 feet) into the well. The large diameter of the well casing with a minimum diameter of 188 centimeters (74 inches) allowed for the use of this equipment (and later also for the free fall of the expanding cement grout). Free fall was used as bridging of discharged plugging materials within the large diameter casing had a very low probability of occurring.

The dust collection system which operated during the sand placement worked well. There were no releases of dust from the well.

Tagging indicated a rise of only 0.31 meters (1 foot) in the well. This was attributed to the sand filling interstitial spaces within the loosely packed waste before filling the well. An additional 4.20 cubic meters (5.5 cubic yards) of 20/40 sand was then placed into the hole. Tagging showed a depth to the top of the sand at 53.73 meters (173 feet). A total volume of 8.41 cubic meters (11 cubic yards) of sand were required to produce a sand bedding plug of 2.13 meters (7 feet). Dry materials batch weight certifications and material weight sheets are located in Appendix E.

Grouting operations to place the base cement grout plug began immediately following placement of the sand bedding plug with placement of 3.06 cubic meters (4 cubic yards) of expanding cement grout. The cement grout was placed into the well by backing up the cement truck to the edge of the well and allowing the cement to free fall to the base of the well. Tagging indicated the depth to the top of the grout was 51.21 meters (168 feet) equivalent to a grout thickness of 1.52 meters (5 feet). Samples of the expanding cement grout were taken for testing. Material testing results are found in Appendix F.

The grout was allowed to set for 24 hours before the addition of more grout. An additional 9.18 cubic meters (12 cubic yards) of grout was poured on September 7, 1995. The depth to the top of the grout was tagged at 48.16 meters (158 feet). This formed a plug of expanding cement grout containing 12.23 cubic meters (16 cubic yards) of grout, or a plug that is 4.57 meters (15 feet) in thickness.

The material was allowed to continue to set and any fallback was measured by tagging the top of the material again after 72 hours. The top of the grout was measured at 48.16 meters (158 feet) indicating that fallback had not occurred. Fallback is caused by a loss of material into the formation (unlikely in this situation), or into the waste, or from shrinkage of the grout. The latter could cause a preferential pathway for moisture to move into the waste.

NTS fine stemming sand was placed above the grout base plug. This activity began on September 11, 1995 and was completed on September 13, 1995. The sand was placed into the well in a similar manner as the initial sand pour. A volume of 82.28 cubic meters (105 cubic yards) of material was placed into the well. The top of the sand was tagged at 15.54 meters (51 feet). This resulted in a total sand thickness of 32.61 meters (107 feet).

The upper expanding cement grout plug was poured on September 13, 1995 with 41.29 cubic meters (54 cubic yards) of expanding grout placed into the well. The top of the grout was tagged at 1.83 meters (6 feet). The upper cement grout plug has a thickness of 13.72 meters (45 feet).

The closure design was modified on September 14, 1995 by a representative of the remediation project manager, the constructor, and inspection engineer. Instead of using the expanding cement grout mix, ready mix concrete was used to complete the well closure and construct the pad. This change reduced closure costs without reducing closure specifications. Concrete is a more durable material for pad construction than cement. Approximately 6.12 cubic meters (8 cubic yards) of ready mix concrete were poured into the well to a depth of 0.15 meters (0.5 feet) bgs.

A second small change was made to the size of the survey monument. Instead of constructing a monument, an available pre-cast monument was used. The change resulted in a larger monument than in the design. The survey monument was placed approximately in the center of the closed U3fi well.

A 4.57 meter (15 feet) square form was constructed around the well head. Once this activity was completed, 6.88 cubic meters (9 cubic yards) of concrete was poured into the well and the pre pad form to complete the final cap and pad.

#### 3.3.3 Site Cleanup, Grading and Fencing Activities

Between September 18, 1995 and September 27, 1995, the area around the pad was filled with clean fill material and road chips. This material was compacted and graded to a 4:1 slope. A 2.44 meter (8 feet) high chain link fence with a 6.10 meter (20 foot) wide double swing gate was installed around both the U3fi Waste Unit and Monitoring Well ER 3-3. The location of the U3fi monument was surveyed and a brass survey marker installed. Signs indicating that the facility is a RCRA Unit were placed on the fence on September 28, 1995.

All requirements for the closure of the unit were met on September 28, 1995 and the U3fi Waste Unit was closed.

The as-built drawings for the U3fi Waste Unit closure are provided as Figures 3 through 6. Figure 4 Site Plan/Survey Plat provides the survey locations for the U3fi monument and the ER 3-3 monitoring well.

#### 3.3.4 Changes Made To The Closure Design

Four minor changes were made between the closure design and the actual closure of the unit. These are indicated in Table 2. These changes do not negatively impact the closure and in a number of instances improve the performance of the material placed into the well.

TABLE 2 - MODIFICATIONS MADE TO THE CLOSURE DESIGN

MODIFICATION	ORIGINAL	ACTUAL	REASON & EFFECT ON CLOSURE
1. Thickness of the initial cement plug	3.05 meters (10 feet)	4.57 meters (15 feet)	To keep plug from moving.  Thicker plug increases the amount of
			weight the plug can support.
2. Top of the stemming sand	15.85 meters (52 feet)	15.54 meters (51 feet)	Within field accuracy of $\pm 1$ foot. No effect on closure.
3. The entire cement plug and cap.	Originally designed to use the expanding cement grout to grade	The top 1.83 meters (6 feet) of the well and the cap were completed with ready mix concrete	Costs were reduced by using a standard concrete mix rather than a specialized cement grout where the grout would not add any benefit to the closure.  Concrete is a more durable material than cement grout.
4. Height of the U3fi monument	0.61 meters (2 feet)	1.37 meters (4.5 feet)	Reduction in cost by using available pre-cast monument rather than construct monument.  No effect on the closure.

#### 4.1 CERTIFICATION BY THE DEPARTMENT OF ENERGY/NEVADA OPERATIONS OFFICE

I certify under penalty of law that the U3fi Waste Unit located in Area 3 at the Nevada Test Site has been closed in accordance with the approved Resource Conservation And Recovery Act, Industrial Site Environmental Restoration Closure Plan, Area 3 U3fi Waste Unit, dated June 1995 and the Permit for a Hazardous Waste Management Facility Number NEV HW009, United States Department of Energy, Nevada Operations Office, Nevada Test Site, I.D. Number NV3890090001, dated March 27, 1995. All measures required in the Closure Plan and the applicable Resource Conservation and Recovery Act 42 U.S.C. §6901-6991i and 40 CFR, Parts 260-268 have been fully implemented and that to the best of my knowledge, no violations exist.

Terry A: Vaeth, Acting Manager Nevada Operations Office

Nov 22, 1995

DOE Nevada Operations Office Post Office Box 98518 Las Vegas, NV 89193-8518

#### 4.2 CERTIFICATION OF CLOSURE BY THE INDEPENDENT PROFESSIONAL ENGINEER

I, Kenneth C. Beach, Jr., a registered Professional Engineer, hereby state that I have reviewed the Closure Plan for closure of the Area 3 U3fi Waste Unit located at the Nevada Test Site and am familiar with the rules and regulations of Title 40 CFR §265.310 pertaining to the closure of such a facility. The closure of this facility has been performed in compliance with the <u>Resource Conservation And Recovery Act</u>, <u>Industrial Site Environmental</u> Restoration Closure Plan, Area 3 U3fi Waste Unit dated June 1995 approved by the Nevada Division of Environmental Protection, and the Permit for a Hazardous Waste Management Facility Number NEV HW009, United States Department of Energy, Nevada Operations Office, Nevada Test Site, I.D. Number NV3890090001, dated March 27, 1995.

Kenneth C. Beach, Jr.

New Mexico Professional Engineer

License Number 8800

IT Corporation 4330 S. Valley View, #114 Las Vegas, NV 89103

#### 5.0 REFERENCES

ASTM, 1995, <u>Standard Guide For Decommissioning of Ground Water Wells, Vadose Zone Monitoring Devices, Boreholes, and Other devices For Environmental Activities</u>, Standard D5299-92

Clark County Nevada, 1990, <u>Regional Flood District Hydrologic Criteria and Drainage Design Manual</u>, Las Vegas, NV.

DOE, see U.S. Department of Energy

Nevada Administrative Code, 1995, <u>Plugging: Wells For Purposes Other Than Water Wells</u>, NAC 534.421

Nevada Division of Environmental Protection, 1995, <u>Permit for a Hazardous Waste Management Facility Number NEV HW009</u>, <u>United States Department of Energy</u>, <u>Nevada Operations Office</u>, <u>Nevada Test Site</u>, <u>I.D. Number NV3890090001</u>, Carson City, NV.

RSN, 1995a, Design Summary for U3fi Waste Unit Drainage

RSN, 1995b, <u>Nevada Test Site</u>, <u>Area 3, U3fi Waste Unit RCRA Closure</u>, Drawings JS-003-133-T1, C1, C2, and C3.

- U.S. Department of Energy, 1988, <u>Environmental Survey Preliminary Report</u>, <u>Nevada Test Site</u>, <u>Mercury</u>, <u>Nevada</u>, <u>DOE/EH/OEU-ISP</u>, <u>Washington</u>, <u>DC</u>.
- U. S. Department of Energy, 1995a, <u>Resource Conservation and Recovery Act Industrial Site Environmental Restoration Closure Plan, Area 3 U3fi Waste Unit</u>, DOE/NV, Las Vegas, NV.
- U. S. Department of Energy, 1995b, <u>Resource Conservation and Recovery Act Industrial Site Environmental Restoration Post-Closure Plan, Area 3 U3fi Waste Unit</u>, DOE/NV, Las Vegas, NV.
- U. S. EPA, 1995, Code of Federal Regulations, Title 40, Part 265, Subpart G Closure And Post-Closure
- U. S. Geological Survey, 1983a, Paiute Ridge, 7 ½ minute Topographic Map
- U. S. Geological Survey, 1983b, Yucca Flat, 7 ½ minute Topographic Map

# APPENDIX A

# DESIGN SUMMARY FOR U3fi WASTE UNIT DRAINAGE

# DESIGN SUMMARY for U3fi WASTE UNIT DRAINAGE

#### SCOPE

The scope of this document is to provide positive drainage of the area around the waste unit to prevent precipitation and runon from ponding at the waste unit and nearby monitoring well ER3-3.

#### **REFERENCES**

- 1. <u>Iternational Technologies Corporation</u>, Letter to J. L. Appenzeller-Wing (DOE), Dated June 19, 1995.
- 2. <u>Clark County Regional Flood Control District Hydrologic Criteria and Drainage</u> Design Manual, October 1990.
- 3. 40 CFR 264.

#### **CRITERIA**

The closure cap must prevent wash-out of the waste from a 25 year, 24 hour storm event.

#### DISCUSSION

The top of the waste zone is approximately 180 feet (54.86m) from the surface and the unit is planned to be closed by stemming to the surface with inert materials (expanding grout and sand) and a grout pad placed at the top that will be sloped to prevent ponding.

A visit to the site to investigate local drainage indicated that the surrounding grades are such that nuisance water from precipitation and runon will not pond at the waste unit or the monitoring well.

The drainage area impacting the unit was determined using USGS quadrangles, and divided into three subareas based on the pattern of intermittant streams within the drainage area. The TR-55 peak discharge method was then used to determine the discharge due to the 25 year, 24 hour storm event (see attached calcs).

#### **RESULTS**

The calculated peak discharge is 88.4 CFS in a measured flow width of 2707 feet. Using the modified mannings equation for shallow rectangular flow, the calculated depth of runon impacting the waste unit is less than 1 inch at a velocity of less than 1 foot per second.

As the discharge for the 25, 24 event is larger than the 100 year, 6 hour event, and the flow depth for the 25, 24 event is less than 1 foot, then it is reasonable to assume that the unit is not in a 100 year floodplain.

Also, since the velocity is less than the clear water scour for the native soils, erosion at the cap is unlikely, and providing a sloped cap to prevent ponding is adequate.

Contract of the second

# 1)3Fi LOCAL DRAIWAGE

USES QTR-55 IN ACCORDANCE WITH CCRFCD DESKIN MANUAL SEE ATTACHED EXCERPTFOR FORMULAS AND TABLES

#### SUBAREAS -

SEE ATTACHED DRAINAGE SUBAREAS OVERLAIW ON USGS 7.5 MINUTE QUAD.

TOTAL AREA = 2.33 Miz

FLOW LEWGTHS

Sullasin A:

SHEET FLOW (SF) - 2410'
OPEN CHAWNEL (OC) - 9303'
SHALLOW CONCENTRATED (SC) - 0

1077 10177 20 72 1120

SUBBASIN B:

SUBBASIN C:

BASED ON CONTOURS ON USGS QUADS - AREASOF O.C. FLOW (BLUE FLOW LINES) BASICALLY ARE AREAS OF S.C. FLOW.

CN = 63

$$T_{T_1} = \frac{.007(n_1).8}{(P_2)^{.5} 5.4}$$
  
= .272 HR

$$T_{T_2} = 2.14 \text{ HR}$$
  $T_{\overline{T}} = 2.41 \text{ HR}$ 

# SUBBASIN B:

$$5z - 4900 - 4198 = .0911$$

#### SUBBASINU C :

$$SF - S = \frac{4/48 - 4055}{4644} = .0200$$

$$5C - 5 = \frac{9055 - 9035}{934} = .0214$$

## PEAR DISCHARGE

AMC II

$$Q = \frac{(P - I_a)^2}{(P - I_a) + 5}$$

$$= \frac{(2 - 1.175)^2}{(2 - 1.175) + 5.87}$$

# DEPTH OF FLOW AT U392 WASTE UNIT

$$d = \frac{(Qn)^{3/5}}{(1.495VzW)^{3/5}}$$

$$W = 2707'$$
  $M = .025$ 

CHECK VELOCITY -

.. No Add tronal Drainage Structure 15 necessary to Protect UNECONTROLLED When Printed

# DRAINAGE SUBAREAS U3FI WASTE UNIT 20 FOOT CONTOUR INTERVAL GRAPHIC SCALE UNCONTROLLED When Printed 2000 6000 FEE 4000

# Chapter 2: Estimating runoff

#### SCS Runoff Curve Number method

The SCS Runoff Curve Number (CN) method is described in detail in NEH-4 (SCS 1985). The SCS runoff equation is

$$Q = \frac{(P - I_a)^2}{(P - I_a) + S}$$
 [Eq. 2-1]

where

Q = runoff (in),

P = rainfall (in),

S = potential maximum retention after runoff begins (in), and

 $I_a$  = initial abstraction (in).

Initial abstraction (I<sub>2</sub>) is all losses before runoff begins. It includes water retained in surface depressions, water intercepted by vegetation, evaporation, and infiltration. I<sub>2</sub> is highly variable but generally is correlated with soil and cover parameters. Through studies of many small agricultural watersheds, I<sub>2</sub> was found to be approximated by the following empirical equation:

$$l_a = 0.2S.$$
 [Eq. 2-2]

By removing  $l_a$  as an independent parameter, this approximation allows use of a combination of S and P to produce a unique runoff amount. Substituting equation 2-2 into equation 2-1 gives

$$Q = \frac{(P - 0.2S)^2}{(P + 0.8S)}.$$
 [Eq. 2-3]

S is related to the soil and cover conditions of the watershed through the CN. CN has a range of 0 to 100, and S is related to CN by

$$S = \frac{1000}{CN} - 10.$$
 [Eq. 2-4]

Figure 2-1 and table 2-1 solve equations 2-3 and 2-4 for a range of CN's and rainfall.

# Factors considered in determining runoff curve numbers

The major factors that determine CN are the hydrologic soil group (HSG), cover type, treatment, hydrologic condition, and antecedent runoff condition (ARC). Another factor considered is whether impervious areas outlet directly to the drainage system (connected) or whether the flow spreads over pervious areas before entering the drainage system (unconnected). Figure 2-2 is provided to aid in selecting the appropriate figure or table for determining curve numbers.

CN's in table 2-2 (a to d) represent average antecedent runoff condition for urban, cultivated agricultural, other agricultural, and arid and semiarid rangeland uses. Table 2-2 assumes impervious areas are directly connected. The following sections explain how to determine CN's and how to modify them for urban conditions.

#### Hydrologic soil groups

Infiltration rates of soils vary widely and are affected by subsurface permeability as well as surface intake rates. Soils are classified into four HSG's (A, B, C, and D) according to their minimum infiltration rate, which is obtained for bare soil after prolonged wetting. Appendix A defines the four groups and provides a list of most of the soils in the United States and their group classification. The soils in the area of interest may be identified from a soil survey report, which can be obtained from local SCS offices or soil and water conservation district offices.

Most urban areas are only partially covered by impervious surfaces: the soil remains an important factor in runoff estimates. Urbanization has a greater effect on runoff in watersheds with soils having high infiltration rates (sands and gravels) than in watersheds predominantly of silts and clays, which generally have low infiltration rates.

Any disturbance of a soil profile can significantly change its infiltration characteristics. With urbanization, native soil profiles may be mixed or removed or fill material from other areas may be introduced. Therefore, a method based on soil

#### **UNCONTROLLED When Printed**

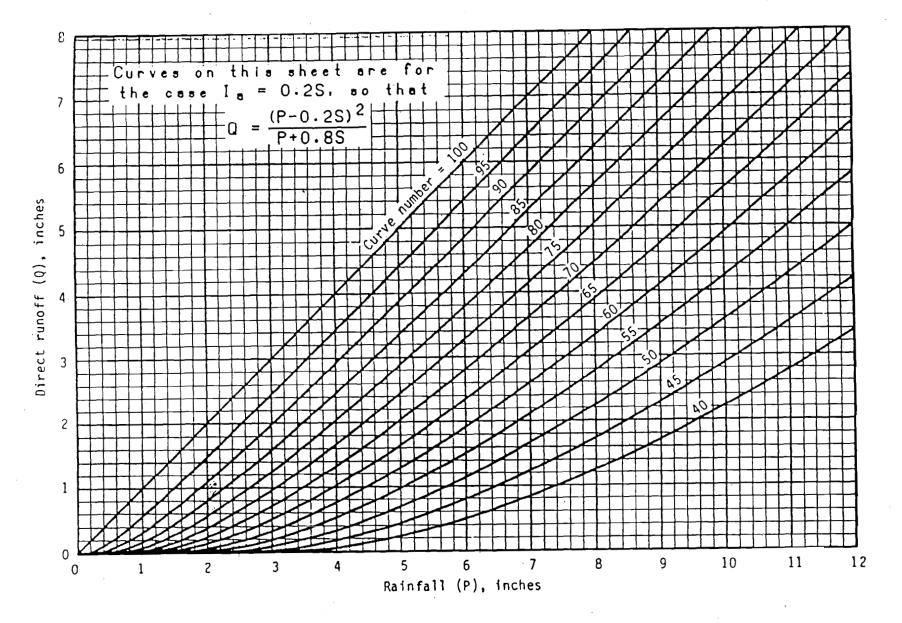


Figure 2-1.-Solution of runoff equation.

texture is given in appendix A for determining the HSG classification for disturbed soils.

#### Cover type

Table 2-2 addresses most cover types, such as vegetation, bare soil, and impervious surfaces. There are a number of methods for determining cover type. The most common are field reconnaissance, aerial photographs, and land use maps.

#### Treatment

Treatment is a cover type modifier (used only in table 2-2b) to describe the management of cultivated agricultural lands. It includes mechanical practices, such as contouring and terracing, and management practices, such as crop rotations and reduced or no tillage.

#### Hydrologic condition

Hydrologic condition indicates the effects of cover type and treatment on infiltration and runoff and is generally estimated from density of plant and residue cover on sample areas. Good hydrologic condition indicates that the soil usually has a low runoff potential for that specific hydrologic soil group, cover type, and treatment. Some factors to consider in estimating the effect of cover on infiltration and runoff are (a) canopy or density of lawns, crops, or other vegetative areas; (b) amount of year-round cover; (c) amount of grass or close-seeded legumes in rotations; (d) percent of residue cover; and (e) degree of surface roughness.

Table 2-1.—Runoff depth for selected CN's and rainfall amounts1.

	Runoff depth for curve number of-												
Rainfall	40	45	50	55	60	65	70	75	80 -	85	90	95	98
						inch	es						
1.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	80.0	0.17	0.32	0.56	0.79
1.2	.00	.00	.00	.00	.00	.00	.03	.07	.15	.27	.46	.74	.99
1.4	.00	.00	.00	.00	.00	.02	.06	.13	.24	.39	.61	.92	1.18
1.6	.00	.00	.00	.00	.01	.05	.11	.20	.34	.52	.76	1.11	1.38
1.8	.00	.00	.00	.00	.03	.09	.17	.29	.44	.65	.93	1.29	1.58
2.0	.00	.00	.00	.02	.06	.14	.24	.38	.56	.80	1.09	1.48	1.77
2.5	.00	.00	.02	.08	.17	.30	.46	.65	.89	1.18	1.53	1.96	2.27
3.0	.00	.02	.09	.19	.33	.51	.71	.96	1.25	1.59	1.98	2.45	2.77
3.5	.02	.08	.20	.35	.53	.75	1.01	1.30	1.64	2.02	2.45	2.94	3.27
4.0	.06	.18	.33	.53	.76	1.03	1.33	1.67	2.04	2.46	2.92	3.43	3.77
4.5	.14	.30	.50	.74	1.02	1.33	1.67	2.05	2.46	2.91	3.40	3.92	4.26
5.0	.24	.44	.69	.98	1.30	1.65	2.04	2.45	2.89	3.37	3.88	4.42	4.76
6.0	.50	.80	1.14	1.52	1.92	2.35	2.81	3.28	3.78	4.30	4.85	5.41	5.76
7.0	.84	1.24	1.68	2.12	2.60	3.10	3.62	4.15	4.69	5.25	5.82	6.41	6.76
8.0	1.25	1.74	2.25	2.78	3.33	3.89	4,46	5.04	5.63	6.21	6.81	7.40	7.76
9.0	1.71	2.29	2.88	3.49	4.10	4.72	5.33	5.95	6.57	7.18	7.79	8.40	8.76
10.0	2.23	2.89	3.56	4.23	4.90	5.56	6.22	6.88	7.52	8.16	8.78	9.40	9.76
11.0	2.78	3.52	4.26	5.00	5.72	6.43	7.13	7.81	8.48	9.13	9.77	10.39	10.76
12.0	3.38	4.19	5.00	5.79	6.56	7.32	8.05	8.76	9.45	10.11	10.76	11.39	11.76
13.0	4.00	4.89	5.76	6.61	7.42	8.21	8.98	9.71	10.42	11.10	11.76	12.39	12.76
14.0	4.65	5.62	6.55	7.44	8.30	9.12	9.91	10.67	11.39	12.08	12.75	13.39	13.76
15.0	5.33	6.36	7.35	8.29	9.19	10.04	10.85	11.63	12.37	13.07	13.74	14.39	14.76

Interpolate the values shown to obtain runoff depths for CN's or rainfall amounts not shown.

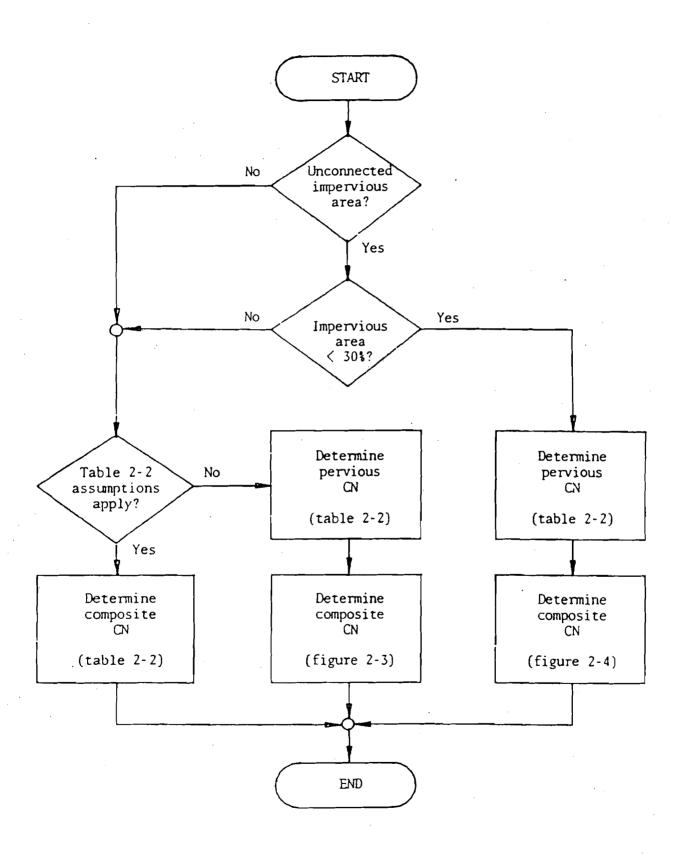


Figure 2-2.-Flow chart for selecting the appropriate figure or table for determining runoff curve numbers.

Table 2-2a.-Runoff curve numbers for urban areas1

Cover description			Curve numbers for hydrologic soil group—				
Cover type and hydrologic condition	Average percent impervious area <sup>2</sup>	A	В	C	D		
Fully developed urban areas (vegetation established)							
Open space (lawns, parks, golf courses, cemeteries, etc.):							
Poor condition (grass cover < 50%)		68	79	86	89		
Fair condition (grass cover 50% to 75%)		49	69	79	84		
Good condition (grass cover > 75%)		39	61	74	80		
Impervious areas:							
Paved parking lots, roofs, driveways, etc.							
(excluding right-of-way).		98	98	98	98		
Streets and roads:				•			
Paved; curbs and storm sewers (excluding	,						
right-of-way)		98	98	98	98		
Paved; open ditches (including right-of-way)		83	89	92	93		
Gravel (including right-of-way)		76	85	89	91		
Dirt (including right-of-way)		72	82	87	89		
Vestern desert urban areas:				,			
Natural desert landscaping (pervious areas only)		63	77	85	88		
Artificial desert landscaping (impervious weed							
barrier, desert shrub with 1- to 2-inch sand.		0.0	0.0				
or gravel mulch and basin borders)		96	96	96	96		
Urban districts:	or	on.	00	0.4	05		
Commercial and business	85 70	89	92	94	95		
Residential districts by average lot size:	72	81	88	91	93		
1/8 acre or less (town houses)	65	77	85	90	92		
1/4 acre	38	61	75	83	87		
1/3 acre	30	57	72	81			
1/2 acre	25	54	70	80	85		
1 acre	20	51	68	79	84		
2 acres	12	46	65	77	82		
		- 17	30	••	02		
Developing urban areas							
Newly graded areas (pervious areas only,							
no vegetation) <sup>5</sup>		77	86	91	94		
dle lands (CN's are determined using cover types							
similar to those in table 2-2c).							
·							

<sup>&</sup>lt;sup>4</sup>Average runoff condition, and  $I_a = 0.2S$ .

The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

<sup>&</sup>lt;sup>3</sup>CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type. 
<sup>4</sup>Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

<sup>\*</sup>Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4, based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Table 2-2b.-Runoff curve numbers for cultivated agricultural lands1

Cover description				Curve numbers for hydrologic soil group—					
Cover type	Treatment <sup>2</sup>	Hydrologic condition <sup>2</sup>	A	В	С	D			
Fallow	Bare soil	<u>-</u>	77	86	91	94			
	Crop residue cover (CR)	Poor Good	76 74	85 83	90 88	- 93 90			
Row crops	Straight row (SR)	Poor Good	72 67	81 78	88 85	91 89			
	SR + CR	Poor Good	71 64	80 75	87 82	90 85			
	Contoured (C)	Poor Good	70 65 .	79 75	82 84	88 86			
	C + CR	Poor Good	6H 69	78 74	83 81	87 85			
	Contoured & terraced (C&T)	Poor Good	66 62	74 71	80 78	82 81			
	C&T + CR	Poor Good	65 61	73 70	79 77	81 80			
Small grain	SR	Poor Good	65 13	76 75	84 83	88 87			
	SR + CR	Poor Good	64 60	75 72	83 80	84 86			
•	С	Poor Good	63 61	74 73	81 82	85 84			
	C + CR	Poor Good	62 60	73 72	81 80	84 83			
	C&T	Poor Good	61 59	72 70	79 78	82 81			
	C&T + CR	Poor Good	60 58	71 69	78 77 .	81 80			
Close-seeded or broadcast	SR	Poor Good	66 58	77 72	85 81	89 85			
legumes or rotation	C	Poor Good	64 55	75 69	83 78	85 83			
meadow	C&T	Poor Good	63 51	73 67	80 76	80 83			

Average runoff condition, and  $I_a = 0.28$ .

<sup>&</sup>lt;sup>2</sup>Crop resultae cover applies only if residue is on at least 5% of the surface throughout the year.

<sup>&</sup>lt;sup>3</sup>Hydrologic condition is based on combination of factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes in rotations, (d) percent of residue cover on the land surface (good  $\geqslant 20\%$ ), and (e) degree of surface roughness.

Poor: Factors impair infiltration and tend to increase runoff.

timal. Factors encourage average and better than average infiltration and tend to decrease runoff,

Table 2-2c.-Runoff curve numbers for other agricultural lands!

Cover description			Curve numbers for hydrologic soil group—				
Cover type	Hydrologic condition	A	В	С	D		
Pasture, grassland, or range—continuous	Poor	68	79	86	39		
forage for grazing. <sup>2</sup>	Fair	49	69	79	84		
	Good	39	61	74	80		
Meadow—continuous grass, protected from grazing and generally mowed for hay.	_	30	58	71	78		
Brush—brush-weed-grass mixture with brush	Poor	48	67	77	83		
the major element.3	Fair	35	56	70	77		
	Good	<b>4</b> 30	48	65	73		
Woods—grass combination (orchard	Poor	57	73	82	86		
or tree farm).5	Fair	43	65	76	82		
	Good	32	58	72	79		
Woods.6	Poor	45	66	77	<b>3</b> 23		
	Fair	36	60	73	79		
	Good	<b>4</b> 30	55	70	77		
Farmsteads—buildings, lanes, driveways, and surrounding lots.	-	59	74	82	86		

Average runoff condition, and  $I_a = 0.25$ .

<sup>\*</sup>Poor: <50% ground cover or heavily grazed with no mulch.

Fair: 50 to 75% ground cover and not heavily grazed.

Good: >75% ground cover and lightly or only occasionally grazed.

<sup>\*</sup>Poor: <50% ground cover. Fair: 50 to 75% ground cover. Good: >75% ground cover.

<sup>\*</sup>Actual curve number is less than 30; use CN  $\approx$  30 for runoff computations.

<sup>&</sup>lt;sup>5</sup>CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

<sup>\*</sup>Poor: Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.

Fair: Woods are grazed but not burned, and some forest litter covers the soil.

Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

Table 2-2d.-Runoff curve numbers for arid and semiarid rangelands'

Cover description			Curve numbers for hydrologic soil group—					
Cover type	Hydrologic condition <sup>2</sup>	A3	В	C	D			
Herbaceous-mixture of grass, weeds, and	Poor		80	87	93			
low-growing brush, with brush the	Fair		71	81	89			
minor element.	Good		62	74	85			
Dak-aspen-mountain brush mixture of oak brush,	Poor		66	74	79			
aspen, mountain mahogany, bitter brush, maple,	Fair		48	57	ផ			
and other brush.	Good		30	41	48			
Pinyon-juniper-pinyon, juniper, or both;	Poor		75	85	89			
grass understory.	Fair		58	73	80			
	Good		41	61	71			
Sagebrush with grass understory.	Poor		67	80	85			
	Fair		51	63	70			
	Good	·	35	47	55			
Pesert shrub—major plants include saltbush,	Poor	63	77	85	88			
greasewood, creosotebush, blackbrush, bursage,	Fair	55	72	81	86			
palo verde, mesquite, and cactus.	Good	49	68	79	84			

 $<sup>^{4}</sup>$ Average runoff condition, and  $I_{a}=0.25$ . For range in humid regions, use table 2.2c.

 <sup>\*</sup>Point <30% ground cover (litter, grass, and brush overstory).</li>
 Fair: 30 to 70% ground cover.
 Good: >70% ground cover.

<sup>\*</sup>Curve numbers for group A have been developed only for desert shrub.

#### Antecedent runoff condition

The index of runoff potential before a storm event is the antecedent runoff condition (ARC). ARC is an attempt to account for the variation in CN at a site from storm to storm. CN for the average ARC at a site is the median value as taken from sample rainfall and runoff data. The CN's in table 2-2 are for the average ARC, which is used primarily for design applications. See NEH-4 (SCS 1985) and Rallison and Miller (1981) for more detailed discussion of storm-to-storm variation and a demonstration of upper and lower enveloping curves.

#### Urban impervious area modifications

Several factors, such as the percentage of impervious area and the means of conveying runoff from impervious areas to the drainage system, should be considered in computing CN for urban areas (Rawls et al., 1981). For example, do the impervious areas connect directly to the drainage system, or do they outlet onto lawns or other pervious areas where infiltration can occur?

#### Connected impervious areas

An impervious area is considered connected if runoff from it flows directly into the drainage system. It is also considered connected if runoff from it occurs as concentrated shallow flow that runs over a pervious area and then into a drainage system.

Urban CN's (table 2-2a) were developed for typical land use relationships based on specific assumed percentages of impervious area. These CN values were developed on the assumptions that (a) pervious urban areas are equivalent to pasture in good hydrologic condition and (b) impervious areas have a CN of 98 and are directly connected to the drainage system. Some assumed percentages of impervious area are shown in table 2-2a.

If all of the impervious area is directly connected to the drainage system, but the impervious area percentages or the pervious land use assumptions in table 2-2a are not applicable, use figure 2-3 to compute a composite CN. For example, table 2-2a gives a CN of 70 for a ½-acre lot in HSG B, with an assumed impervious area of 25 percent. However, if the lot has 20 percent impervious area and a pervious area CN of 61, the composite CN obtained from figure 2-3 is 68. The CN difference between 70 and 68 reflects the difference in percent impervious area.

#### Unconnected impervious areas

Runoff from these areas is spread over a pervious area as sheet flow. To determine CN when all or part of the impervious area is not directly connected to the drainage system. (1) use figure 2-4 if total impervious area is less than 30 percent or (2) use figure 2-3 if the total impervious area is equal to or greater than 30 percent, because the absorptive capacity of the remaining pervious areas will not significantly affect runoff.

When impervious area is less than 30 percent, obtain the composite CN by entering the right half of figure 2-4 with the percentage of total impervious area and the ratio of total unconnected impervious area to total impervious area. Then move left to the appropriate pervious CN and read down to find the composite CN. For example, for a 1/2-acre lot with 20 percent total impervious area (75 percent of which is unconnected) and pervious CN of 61, the composite CN from figure 2-4 is 66. If all of the impervious area is connected, the resulting CN (from figure 2-3) would be 68.

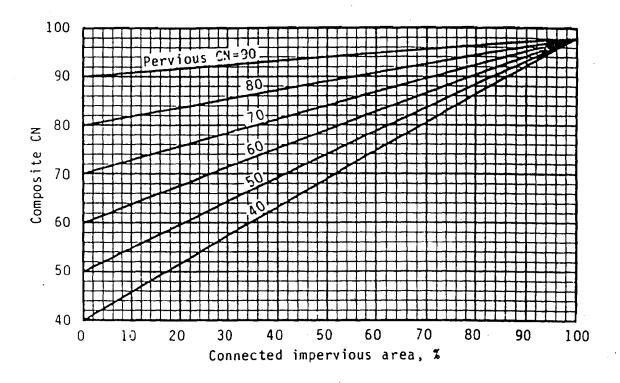


Figure 2-3.-Composite CN with connected impervious area.

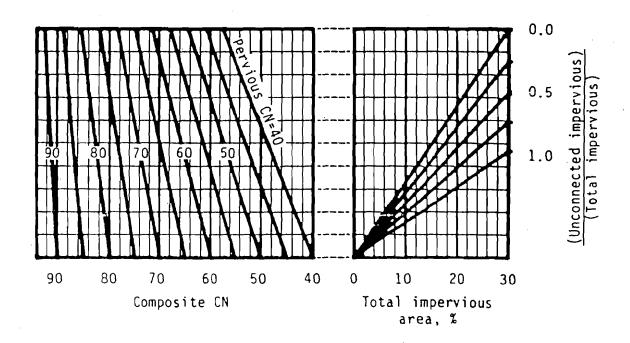


Figure 2-4.—Composite CN with unconnected impervious areas and total impervious area less than 30%.

#### Runoff

When CN and the amount of rainfall have been determined for the watershed, determine runoff by using figure 2-1, table 2-1, or equations 2-3 and 2-4. The runoff is usually rounded to the nearest hundredth of an inch.

### Limitations

- Curve numbers describe average conditions that are useful for design purposes. If the rainfall event used is a historical storm, the modeling accuracy decreases.
- Use the runoff curve number equation with caution when recreating specific features of an actual storm. The equation does not contain an expression for time and, therefore, does not account for rainfall duration or intensity.
- The user should understand the assumption reflected in the initial abstraction term (I<sub>a</sub>) and should ascertain that the assumption applies to the situation. Ia, which consists of interception, initial infiltration, surface depression storage, evapotranspiration, and other factors, was generalized as 0.2S based on data from agricultural watersheds (S is the potential maximum retention after runoff begins). This approximation can be especially important in an urban application because the combination of impervious areas with pervious areas can imply a significant initial loss that may not take place. The opposite effect, a greater initial loss, can occur if the impervious areas have surface depressions that store some runoff. To use a relationship other than  $I_a = 0.2S$ , one must redevelop equation 2-3, figure 2-1, table 2-1, and table 2-2 by using the original rainfall-runoff data to establish new S or CN relationships for each cover and hydrologic soil group.
- Runoff from snowmelt or rain on frozen ground cannot be estimated using these procedures.

- The CN procedure is less accurate when runoff is less than 0.5 inch. As a check, use another procedure to determine runoff.
- The SCS runoff procedures apply only to direct surface runoff: do not overlook large sources of subsurface flow or high ground water levels that contribute to runoff. These conditions are often related to HSG A soils and forest areas that have been assigned relatively low CN's in table 2-2. Good judgment and experience based on stream gage records are needed to adjust CN's as conditions warrant.
- When the weighted CN is less than 40, use another procedure to determine runoff.

## Examples:

Four examples illustrate the procedure for computing runoff curve number (CN) and runoff (Q) in inches. Worksheet 2 in appendix D is provided to assist TR-55 users. Figures 2-5 to 2-8 represent the use of worksheet 2 for each example. All four examples are based on the same watershed and the same storm event.

The watershed covers 250 acres in Dyer County, northwestern Tennessee. Seventy percent (175 acres) is a Loring soil, which is in hydrologic soil group C. Thirty percent (75 acres) is a Memphis soil, which is in group B. The event is a 25-year frequency, 24-hou storm with total rainfall of 6 inches.

Cover type and conditions in the watershed are different for each example. The examples, therefore, illustrate how to compute CN and Q for various situations of proposed, planned, or present development.

#### Example 2-1

The present cover type is pasture in good hydrologic condition. (See figure 2-5 for worksheet 2 information.)

#### Example 2-2

Seventy percent (175 acres) of the watershed, consisting of all the Memphis soil and 100 acres of the Loring soil, is 1/2-acre residential lots with lawns in good hydrologic condition. The rest of the watershed is scattered open space in good hydrologic condition. (See figure 2-6.)

#### Example 2-3

This example is the same as example 2-2, except that the 1/2-acre lots have a total impervious area of 35 percent. For these lots, the pervious area is lawns in good hydrologic condition. Since the impervious area percentage differs from the percentage assumed in table 2-2, use figure 2-3 to compute CN. (See figure 2-7.)

#### Example 2-4

This example is also based on example 2-2, except that 50 percent of the impervious area associated with the 1/2-acre lots on the Loring soil is "unconnected," that is, it is not directly connected to the drainage system. For these lots, the pervious area CN (lawn, good condition) is 74 and the impervious area is 25 percent. Use figure 2-4 to compute the CN for these lots. CN's for the 1/2-acre lots on Memphis soil and the open space on Loring soil are the same as those in example 2-2. (See figure 2-8.)

Project <u>Hea</u>	evenly Acres	Ву <u>У</u>	<u>JJ R</u>		Date 10	11185
Location Dye	- County, Tennessee	Chec	ked <u>7</u>	141	Date 1	0/3/85
Circle one: Pr	resent Developed			-		
l. Runoff_curv	ve number (CN)					· 
Soil name,	Cover description	CN 1/			Area	Product of
hydrologic group (appendix A)	(cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	Table 2-2	F1g. 2-3	F18. 2-4	Dacres Oni <sup>2</sup> M2	CN x area
Memphis, B	Pasture, good condition	61			30	1830
Loring, C	Pasture, good condition	74			70	5 180
		,				
1/ Use only o	ne CN source per line.	Tota	1s -		100	7010
CN (weighted)	total product 1010 70.1;	Vse	CN =		70	
2. Runoff		Store	/1	s	torm #2	Storm #3
Frequency	yr	2	5			
Rainfall, P (2	4-hour) in		.0	<u> </u>		
Runoff, Q (Use P and C	N with table 2-1, fig. 2-1,	۲.	в١		•	

Figure 2-5.-Worksheet 2 for example 2-1.

Project  -	avenly Acres	Ву <u>`г</u>	JZR		Date 10	11/82
Location Dy	er County, Tennessee	Chec	Checked WY Date 10 3 85			
Circle one: Pr	resent (Developed) 175	acr	es ·	<u> </u>	identia	<u> </u>
1. Runoff cur	re number (CN)					
Soil name and	Cover description		CN 1	·	Area	Product of
hydrologic group (appendix. A)	(cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	Table 2-2	F18. 2-3		Øacres □mi= □ t	CN x area
Memphis, B	Vz acre lots, good condition 259, impervious	70			75	S 2 S O
1 .	Vz are lots, good condition	80			100	8000
Loring, C	Open space, good condition	74			75	5550
				_		
						* <del>*****</del>
1/ Use only o	ne CN source per line.	Tota	ls -		250	18,800
CN (weighted)	total area 18,800 75.2	Use	CN -		75	
2. Runoff		Storm	b / 1	s	torm #2	Storm #3
Frequency	ут	2		<u>-</u>		
Rainfall, P (2	4-hour) in		0	+		
Runoff, Q (Use P and ( or eqs. 2-3	In with table 2-1, fig. 2-1, and 2-4.)	3.			·	

Figure 2-6.-Worksheet 2 for example 2-2.

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Project He	_ By <u>`</u>	By 11 R Date 1011185				
Location Dy	Chec	Checked MM Date 10/3/85				
Circle one: P	resent Developed				_	
1. Runoff cur	ve number (CN)	·				
Soil name	Cover description		CN 1/	,	Area	Product of
hydrologic group (appendix A)	(cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	Table 2-2	F18. 2-3	F18. 2-4	Macres Dmi <sup>2</sup> D <sup>2</sup>	CN x area
Memphis, B	1/2 acre lots, good condition 3590 imporvious		14		75	5550
	1/2 acre lots, good condition		82		1000	8200
Loring, C	Open space, good condition	74			75	5550
	<u> </u>					
$\frac{1}{}$ Use only or	ne CN source per line.	Tota	ls =		250	19,300
CN (weighted)	total area 250 77.2	Use	CN =		דר	
2. Runoff		Storm	#1	St	orm #2	Storm #3
Frequency	yr	2.5	5			
Rainfall, P (2	4-hour) 1n	6, 3.4		_		
Runoff, Q (Use P and CI		٠.,	TO.	<u> </u>		

Figure 2-7.-Worksheet 2 for example 2-3.

Project He	or-ly Acres	Ву <u>ч</u>	عتا		Date 12	11/8=		
Location Dy	er County, Termessee	Chec	ked _	111	Date 1	<u>ulelas</u>		
	resent (Developed)							
1. Runoff cur	ve number (CN)							
Soil name	Cover description		CN 1/		CN 1/		Area	Product of
hydrologic group (appendix A)	(cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	Table 2-2	F18. 2-3	F18. 2-4	Dacres	CN x area		
Menoinis, B	1/2 acre lots, good condition	70			75	5250		
Loring, C	1/2 acre lots, good condition			78	00	78∞		
	Open space, good condition	1			75	5350		
<u>-</u>								
					<u> </u>			
1/ Use only o	ne CN source per line.	Tota	ls =		250	18,600		
CN (veighted)	total area 250 74.4:	Use	CN -		74			
2. Runoff		Storm	*1	S	torm #2	Storm #3		
Frequency	yr	2	5					
Rainfall, P (2	4-hour)	6	.0					
Runoff, Q	Nuith table 2-1 fig. 2-1	3.	19					

Figure 2-8.—Worksheet 2 for example 2-4.

# Chapter 3: Time of concentration and travel time

Travel time  $(T_t)$  is the time it takes water to travel from one location to another in a watershed.  $T_t$  is a component of time of concentration  $(T_c)$ , which is the time for runoff to travel from the hydraulically most distant point of the watershed to a point of interest within the watershed.  $T_c$  is computed by summing all the travel times for consecutive components of the drainage conveyance system.

 $T_c$  influences the shape and peak of the runoff hydrograph. Urbanization usually decreases  $T_c$ , thereby increasing the peak discharge. But  $T_c$  can be increased as a result of (a) ponding behind small or inadequate drainage systems, including storm drain inlets and road culverts, or (b) reduction of land slope through grading.

# Factors affecting time of concentration and travel time

#### Surface roughness

One of the most significant effects of urban development on flow velocity is less retardance to flow. That is, undeveloped areas with very slow and shallow overland flow through vegetation become modified by urban development: the flow is then delivered to streets, gutters, and storm sewers that transport runoff downstream more rapidly. Travel time through the watershed is generally decreased.

#### Channel shape and flow patterns

In small non-urban watersheds, much of the travel time results from overland flow in upstream areas. Typically, urbanization reduces overland flow lengths by conveying storm runoff into a channel as soon as possible. Since channel designs have efficient hydraulic characteristics, runoff flow velocity increases and travel time decreases.

#### Slope

Slopes may be increased or decreased by urbanization, depending on the extent of site grading or the extent to which storm sewers and street ditches are used in the design of the water

management system. Slope will tend to increase when channels are straightened and decrease when overland flow is directed through storm sewers, street gutters, and diversions.

# Computation of travel time and time of concentration

Water moves through a watershed as sheet flow, shallow concentrated flow, open channel flow, or some combination of these. The type that occurs is a function of the conveyance system and is best determined by field inspection.

Travel time  $(T_t)$  is the ratio of flow length to flow velocity:

$$T_t = \frac{L}{3600 \text{ V}}$$
 [Eq. 3-1]

where

 $T_t = \text{travel time (hr)},$ 

L = flow length (ft).

V = average velocity (ft/s), and

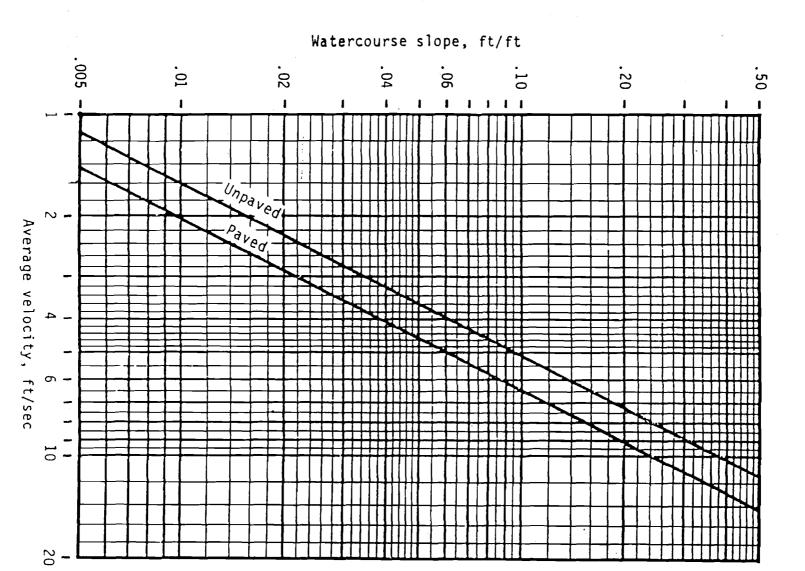
3600 = conversion factor from seconds to hours.

Time of concentration  $(T_c)$  is the sum of  $T_t$  values for the various consecutive flow segments:

$$T_e = T_{t_1} + T_{t_2} + ... T_{t_m}$$
 [Eq. 3-2]

where

T<sub>c</sub> = time of concentration (hr) and m = number of flow segments.



#### Sheet flow

Sheet flow is flow over plane surfaces. It usually occurs in the headwater of streams. With sheet flow, the friction value (Manning's n) is an effective roughness coefficient that includes the effect of raindrop impact; drag over the plane surface; obstacles such as litter, crop ridges, and rocks; and erosion and transportation of sediment. These n values are for very shallow flow depths of about 0.1 foot or so. Table 3-1 gives Manning's n values for sheet flow for various surface conditions.

For sheet flow of less than 300 feet, use Manning's kinematic solution (Overton and Meadows 1976) to compute  $T_t$ :

$$T_t = \frac{0.007 \text{ (nL)0.8}}{(P_2)0.5 \text{ s}^{0.4}}$$
 [Eq. 3-3]

Table 3-1.—Roughness coefficients (Manning's n) for sheet flow

Surface description	n¹
Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils:  Residue cover ≤20%  Residue cover >20%	0.06 0.17
Grass: Short grass prairie Dense grasses² Beimudagrass	0.15 0.24 0.41
Range (natural)	0.13
Woods:  Light underbrush  Dense underbrush	0.40 0.80

<sup>&</sup>lt;sup>3</sup>The n values are a composite of information compiled by Engman (1986).

#### where

 $T_t = \text{travel time (hr)},$ 

n = Manning's roughness coefficient (table 3-1),

L = flow length (ft),

 $P_2 = 2$ -year, 24-hour rainfall (in), and

s = slope of hydraulic grade line (land slope, ft/ft).

This simplified form of the Manning's kinematic solution is based on the following: (1) shallow steady uniform flow, (2) constant intensity of rainfall excess (that part of a rain available for runoff), (3) rainfall duration of 24 hours, and (4) minor effect of infiltration on travel time. Rainfall depth can be obtained from appendix B.

#### Shallow concentrated flow

After a maximum of 300 feet, sheet flow usually becomes shallow concentrated flow. The average velocity for this flow can be determined from figure 3-1, in which average velocity is a function of watercourse slope and type of channel. For slopes less than 0.005 ft/ft, use equations given in appendix F for figure 3-1. Tillage can affect the direction of shallow concentrated flow. Flow may not always be directly down the watershed slope if tillage runs across the slope.

After determining average velocity in figure 3-1, use equation 3-1 to estimate travel time for the shallow concentrated flow segment.

#### Open channels

Open channels are assumed to begin where surveyed cross section information has been obtained, where channels are visible on aerial photographs, or where blue lines (indicating streams) appear on United States Geological Survey (USGS) quadrangle sheets. Manning's equation or water surface profile information can be used to estimate average flow velocity. Average flow velocity is usually determined for bank-full elevation.

<sup>\*</sup>Includes species such as weeping lovegrass, bluegrass, buffalograss, blue grama grass, and native grass mixtures.

When selecting n, consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

Manning's equation is

$$V = \frac{1.49 \text{ r}^{2/3} \text{ s}^{1/2}}{\text{p}}$$
 [Eq. 3-4]

where

V = average velocity (ft/s),

r = hydraulic radius (ft) and is equal to a/pw,

a = cross sectional flow area (ft2),

 $p_{w}$  = wetted perimeter (ft),

s = slope of the hydraulic grade line (channel slope, ft/ft), and

n = Manning's roughness coefficient for open channel flow.

Manning's n values for open channel flow can be obtained from standard textbooks such as Chow (1959) or Linsley et al. (1982). After average velocity is computed using equation 3-4, T<sub>t</sub> for the channel segment can be estimated using equation 3-1.

#### Reservoirs or lakes

Sometimes it is necessary to estimate the velocity of flow through a reservoir or lake at the outlet of a watershed. This travel time is normally very small and can be assumed as zero.

#### Limitations

- Manning's kinematic solution should not be used for sheet flow longer than 300 feet. Equation 3-3 was developed for use with the four standard rainfall intensity-duration relationships.
- In watersheds with storm sewers, carefully identify the appropriate hydraulic flow path to estimate T<sub>c</sub>. Storm sewers generally handle only a small portion of a large event. The rest of the peak flow travels by streets, lawns, and so on, to the outlet. Consult a standard hydraulics textbook to determine average velocity in pipes for either pressure or nonpressure flow.
- The minimum T<sub>c</sub> used in TR-55 is 0.1 hour.

 A culvert or bridge can act as a reservoir outlet if there is significant storage behind it. The procedures in TR-55 can be used to determine the peak flow upstream of the culvert. Detailed storage routing procedures should be used to determine the outflow through the culvert.

#### Example 3-1

The sketch below shows a watershed in Dyer County, northwestern Tennessee. The problem is to compute  $T_c$  at the outlet of the watershed (point D). The 2-year 24-hour rainfall depth is 3.6 inches. All three types of flow occur from the hydraulically most distant point (A) to the point of interest (D). To compute  $T_c$ , first determine  $T_t$  for each segment from the following information:

Segment AB: Sheet flow; dense grass; slope (s) =

0.01 ft/ft; and length (L) = 100 ft.

Segment BC: Shallow concentrated flow, unpaved;

s = 0.01 ft/ft; and L = 1400 ft.

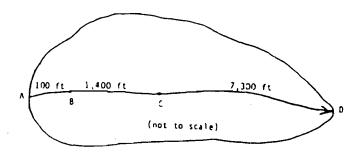
Segment CD: Channel flow; Manning's n = .05;

flow area (a) = 27 ft<sup>2</sup>; wetted perimeter ( $p_w$ ) = 28.2 ft; s = 0.005

fertheren  $(p_w) = 20.2$  (c, S = 0

ft/ft; and L = 7300 ft.

See figure 3-2 for the computations made on worksheet 3.



# Worksheet 3: Time of concentration $(T_c)$ or travel time $(T_t)$

Project Heavenly Acres	By <u>D</u>	<u>~</u>	Date 10161	85
Location Dyer County, Tennerse	Checke	d 72/	Date 1018	کھا
Circle one: Present Developed				<del></del>
Circle one: Tc Tt through subares				
NOTES: Space for as many as two segments per worksheet.	flow type o	an be use	d for each	
Include a map, schematic, or descript	ion of flow	segments.		
Sheet flow (Applicable to T <sub>c</sub> only) Sep	gment ID	AB		
1. Surface description (table 3-1)	· • • •	BENS E		
2. Manning's roughness coeff., n (table 3-1	·	0.24		
). Flow length, L (total L $\leq$ 300 ft)	ft	100	ļ	
4. Two-yr 24-hr rainfall, P <sub>2</sub>	in	3.6	<u> </u>	
5. Land slope, s	ft/ft	0.01	<u> </u>	
6. $T_t = \frac{0.007 \text{ (nL)}^{0.8}}{P_2^{0.5} \text{ s}^{0.4}}$ Compute $T_t$	br	0.30	+	0.30
Shallow concentrated flow Seg	gment ID	BC		]
7. Surface description (paved or unpaved) .	• • • •	Unpoved		
8. Flow length, L	ft	1400	ļ	[
9. Watercourse slope, s	ft/ft	0.01	<del> </del>	
10. Average velocity, V (figure 3-1)	ft/s	1.6	1,	
11. $T_t = \frac{L}{3600 \text{ V}}$ Compute $T_t$	hr	0.24	+ [	-0.24
Channel flow Ser	gment ID	- C D	I	Ì
12. Cross sectional flow area, a	ft <sup>2</sup>	27		
13. Wetted perimeter, p		28.2		
14. Hydraulic radius, $r = \frac{a}{P_{\perp}}$ Compute r	ft	0.957		
15. Channel slope, s		0.005	·  <del> </del>	
16. Hanning's roughness coeff., n		0.05		
17. $V = \frac{1.49 \text{ r}^{2/3} \text{ a}^{1/2}}{n}$ Compute V	ft/s	2.05	<u> </u>	
18. Flow length, L	ft	7300	<del> </del>	
19. $T_t = \frac{L}{3600 \text{ V}}$ Compute $T_t$		0.99	+	- 0.99
20. Watershed or subarea T or T (add T in	steps 6, 1	l, and 19)	h	, [1.53]

Figure 3-2.-Worksheet 3 for example 3-1.

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# Chapter 4: Graphical Peak Discharge method

This chapter presents the Graphical Peak Discharge method for computing peak discharge from rural and urban areas. The Graphical method was developed from hydrograph analyses using TR-20, "Computer Program for Project Formulation—Hydrology" (SCS 1983). The peak discharge equation used is

$$q_0 = q_0 A_m Q F_0 \qquad [Eq. 4-1]$$

where

q<sub>p</sub> = peak discharge (cfs);

qu = unit peak discharge (csm/in);

A<sub>m</sub> = drainage area (mi<sup>2</sup>);

Q = runoff (in); and

 $F_p$  = pond and swamp adjustment factor.

The input requirements for the Graphical method are as follows: (1)  $T_c$  (hr), (2) drainage area (mi²), (3) appropriate rainfall distribution (1, 1A, II, or III), (4) 24-hour rainfall (in), and (5) CN. If pond and swamp areas are spread throughout the watershed and are not considered in the  $T_c$  computation, an adjustment for pond and swamp areas is also needed.

## Peak discharge computation

For a selected rainfall frequency, the 24-hour rainfall (P) is obtained from appendix B or more detailed local precipitation maps. CN and total runoff (Q) for the watershed are computed according to the methods outlined in chapter 2. The CN is used to determine the initial abstraction  $(I_a)$  from table 4-1.  $I_a/P$  is then computed.

If the computed  $I_a/P$  ratio is outside the range shown in exhibit 4 (4-1, 4-1A, 4-1I, and 4-1II) for the rainfall distribution of interest, then the limiting value should be used. If the ratio falls between the limiting values, use linear interpolation. Figure 4-1 illustrates the sensitivity of  $I_a/P$  to CN and P.

Peak discharge per square mile per inch of runoff  $(q_0)$  is obtained from exhibit 4-1, 4-1A, 4-11, or 4-111 by using  $T_c$  (chapter 3), rainfall distribution type, and  $I_a/P$  ratio. The pond and swamp adjustment factor is obtained from table 4-2 (rounded to the nearest table value). Use worksheet 4 in appendix 1) to aid in computing the peak discharge using the Graphical method.

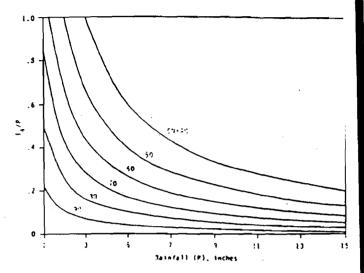


Figure 4-1.-Variation of L/P for P and CN.

Table 1-1.-1, values for runoff curve numbers

Curve	l <sub>a</sub>	Curve	I <sub>a</sub>
number 	(in)	number	(in)
40	3.000	70	0.857
41	2.878	71	0.817
45	2.762	72	0.778
43	2.651	73	0.740
44	2545	74	0.703
45	5.444	75	0.667
46	2.248	76	0.632
47	2.255	77	0.597
18	2.167	78	0.564
49	2.082	79	0.532
50	2,000	80	0.500
āl	1.922	81	0.469
52	1.846	82	0.439
53	1.774	X3	0.410
54	1.704	84	0.381
55	1.636	85	0.353
56	1.571	96	0.326
57	1.509	87	0.299
58	1.448	,	0.273
59	1.390	89	0.247
60	1.333	90)	0.222
61	1.279	91	0.198
62	1.226	92	0.174
63	1.175	93	0.151
64	1.125	94	0.128
65	1.077	95	0.105
66	1.030	96	0.083
67	0,985	97	0.062
68	0.941	98	0.041
69 .	0,899		
		·	

Table 4-2.—Adjustment factor (F<sub>p</sub>) for pond and swamp areas that are sprend throughout the watershed

Percentage of pond and swamp areas	$\overline{F}_{\mathfrak{p}}$ .
0	1.00
0.2	0.97
1.0	0.87
3.0	0.75
5.0	0.72

### Limitations

The Graphical method provides a determination of peak discharge only. If a hydrograph is needed or watershed subdivision is required, use the Tabular Hydrograph method (chapter 5). Use TR-20 if the watershed is very complex or a higher degree of accuracy is required.

- The watershed must be hydrologically homogeneous, that is, describable by one CN.
   Land use, soils, and cover are distributed uniformly throughout the watershed.
- The watershed may have only one main stream or, if more than one, the branches must have nearly equal  $T_{\rm c}$ 's.
- The method cannot perform valley or reservoir routing.
- The F<sub>p</sub> factor can be applied only for ponds or swamps that are not in the T<sub>c</sub> flow path.
- Accuracy of peak discharge estimated by this
  method will be reduced if I<sub>a</sub>/P values are used
  that are outside the range given in exhibit 4. The
  limiting I<sub>a</sub>/P values are recommended for use.
- This method should be used only if the weighted CN is greater than 40.
- When this method is used to develop estimates of peak discharge for both present and developed conditions of a watershed, use the same procedure for estimating T<sub>c</sub>.
- $T_c$  values with this method may range from 0.1 to 10 hours.

## Example 4-1

Compute the 25-year peak discharge for the 250-acre watershed described in examples 2-2 and 3-1. Figure 4-2 shows how worksheet 4 is used to compute  $q_{\rm p}$  as 345 cfs.

## Worksheet 4: Graphical Peak Discharge method

Pro	ject Heavenly Acres	_ Ву (	RHM	Date 10/15	185
Loc	acion Dyer Courty, Tennessee	Che	cked 2124	Date 10(17	185
Cir	cle one: Present Developed				<del>_</del>
1.	Data:			·	
	Drainage area $A_m = 0.39 \text{ mi}^2$	(acre	s/640)		
	Runoff curve number CN = 75 (Fro	om wor	ksheet 2)		
	Time of concentration T <sub>c</sub> = 1.53 hr	(From	worksheet 3	), Figure	3-2
	Rainfall distribution type = II (I,	IA, I	I, III)		
	Pond and swamp areas spread throughout watershed = percentage perc	cent o	f A <sub>m</sub> (	acres or mi	covered)
			Storm 1	Storm #2	Storm /3
				00018 12	3001# 13
2.	Frequency	yr	25		
3.	Rainfall, P (24-hour)	in	6.0		<u> </u>
4.	Initial abstraction, I	in	0.667	·	
5.	Compute I <sub>a</sub> /P		0.11		
				<del>                                     </del>	·
6.	Unit peak discharge, $q_u$	sm/in	270		
7.		in	3.28		
8.	Pond and swamp adjustment factor, F <sub>p</sub> (Use percent pond and swamp area with table 4-2. Factor is 1.0 for		1.0		
	zero percent pond and swamp area.)		· · · · · · · · · · · · · · · · · · ·		
9.	Peak discharge, qp	cfs	345		
	(Where q <sub>p</sub> = q <sub>u</sub> A <sub>m</sub> QF <sub>p</sub> )				

Figure 4-2.-Worksheet 1 for example 4-1.

## **UNCONTROLLED When Printed**

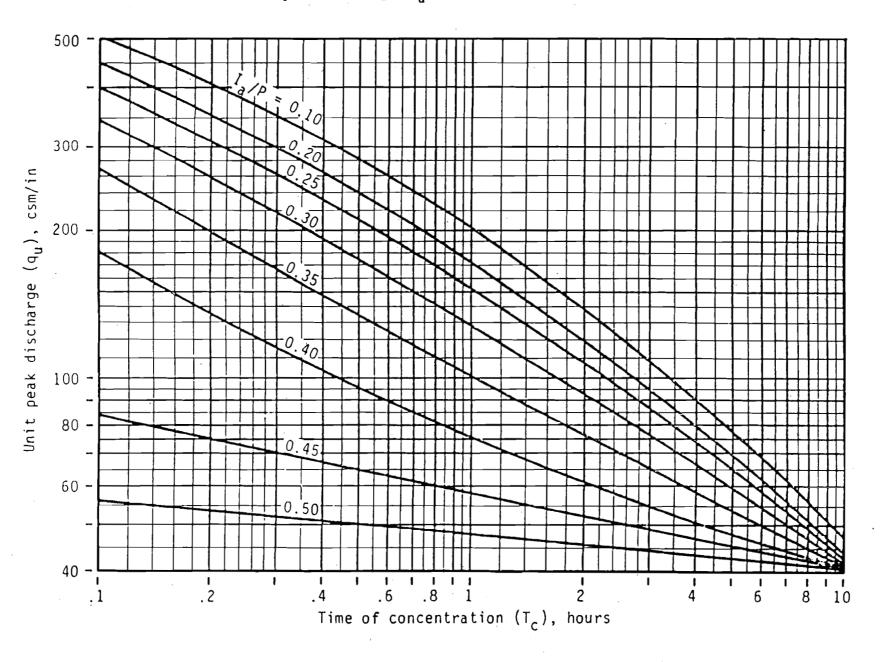


Exhibit 4-IA: Unit peak discharge  $(q_u)$  for SCS type IA rainfall distribution

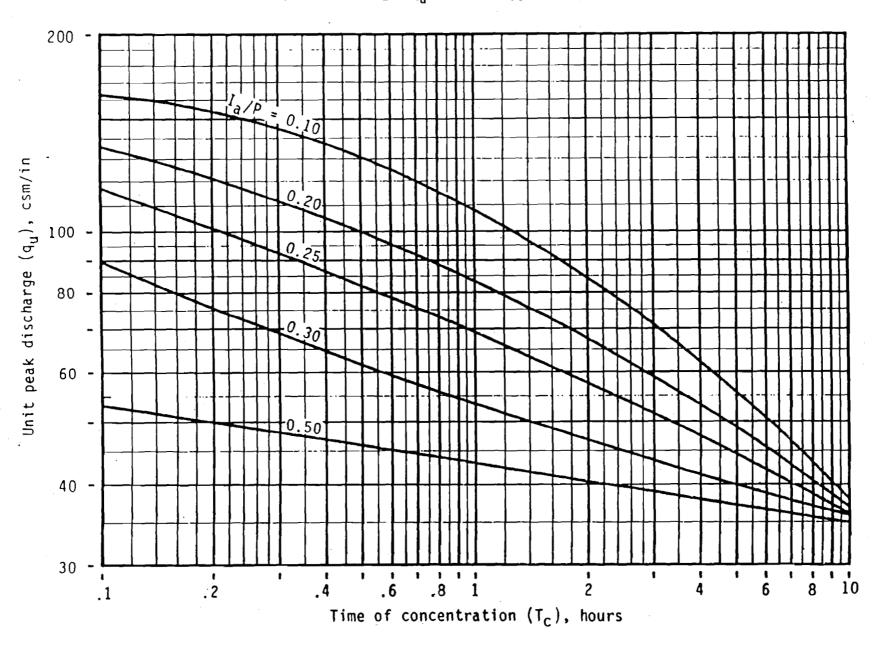


Exhibit 4-II: Unit peak discharge  $(q_u)$  for SCS type II rainfall distribution

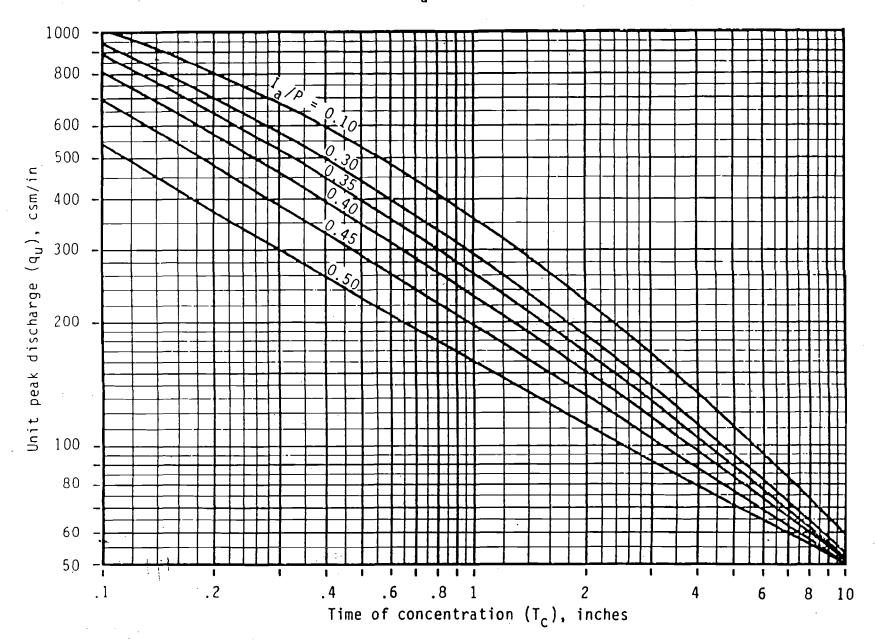
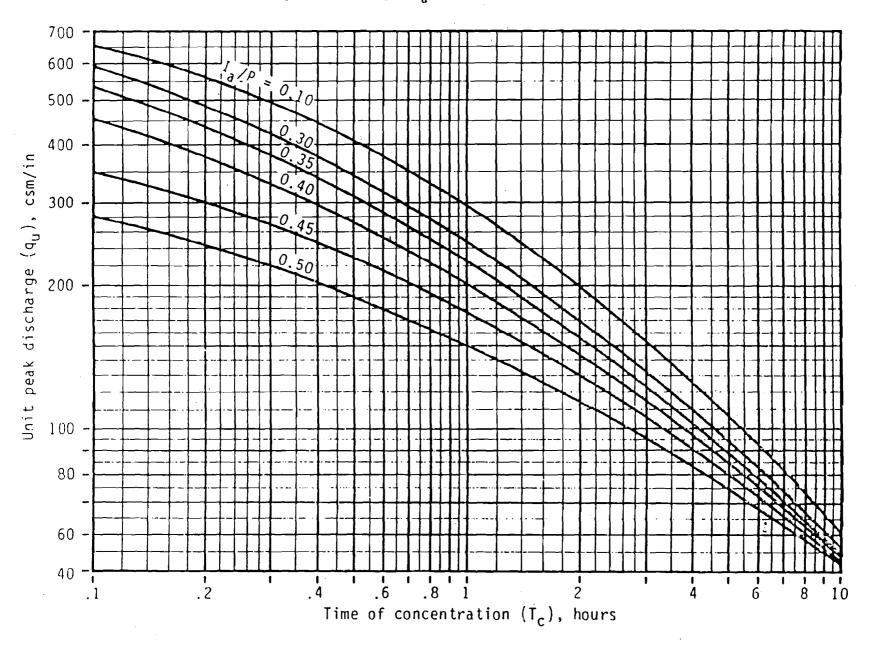
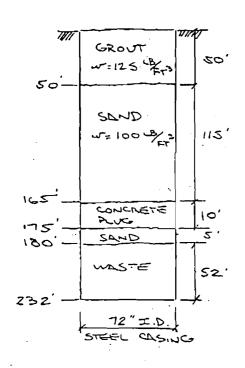


Exhibit 4-III: Unit peak discharge  $(q_u)$  for SCS type III rainfall distribution



# Raytheon Services Nevada Tille: U3FI PLUCBACK (REVISION 1) By For Date 7/24/95

## PROPOSED PLUCBACK



FROBLEM: DETERMINE IF 10' CONCRETE AUG CON SUPPORT THE WEIGHT FOR 115' OF SOND AND 50' OF CROUT. WORDT: 7/4 (72/12) (50) (125) = 176,715 LB

WORDT: T/4 (72/12)2 (115) (100) = 325,155 LB WORDT: T/4 (72/12)2 (115) (100) = 325,155 LB 501,870 LB

DETERMINE BOND FORCE BETWEEN CRUINCE

ASSUME SHEAR BOND PARSONE (M) = 80 PSI F = TT (M) DL WHERE D = 72, L = 10'x12 = 120' F = TT (80) (72) (120) = Z, 171, 469 LB

S.F. = 2171469 501870 = 4-33

CHECK BEARING PRESSURE

BEARING PRESSURE = 501670 = 124 PSI

FOR CONCRETE: ASSUME  $f'_{c}$ : 2500 PSI

MAXIMUM ALLOWABLE CONCRETE ISERRING

PRESSURE (NORKING STRESS)

= 0.25  $(f'_{c})$ : 0.25 (2500): 625 PSI

S.F. = 625/124 = 5.0

CONCLUSION: 10' THICK CONCRETE PLUC CAN SUPPORT THE

1/5' OF SAND PLUS SO' OF CROUT PLACED ON TOP

OF IT.

NOTE; TO ENSURE PLUC DOES NOT SLIDE, USE NON-SURINK GROUT AND HTHSG (CC)-1 IS CONSIDERED TO BE AN EXPONSION GROUT AND DEVELOPS 3000 PSI COMPRESSIVE STRENCTH AT 3 DAYS.

## DESIGN VERIFICATION

Project Title U3fe Wa	ste Unit Closure	P/N 9501. AO 3
	y and drainage	ID Number <u>5214 A 438A</u>
evaluation for	( )	EDS No. N/A
ESC Michels	Design Engineer J. Sokoo	C14 REVISION   8-20-95
METHOD OF VERIFICATI	ON	
Same Calculation Method	×	
Alternate Calculation		
Calculation Description	M RUNOFF TRAVEL TIME, PEAK DIS	CHARGE GORICTURAL PLUG
Manual (Y) N Fr		MINION MARIE LAND
		Vers
Computer Software Used Y	IVEV.	
Title	<del></del>	Date
Design Review (Y) N F	Performed by WILL MOOK	E
Qualification Test Y (N)		
-		
<b>^</b>	(Include Relative Importance/Risk)	
	TE CHECK AND CORRES	
KATIONALE AND MI	ETHOD USED BY THE	DESIGN ENGINEEIC.
<u>-</u>		<u> </u>
		·
Reference Documents Used	a demandado	<b>\</b>
UKBAN HYDROLOGY FOR	SMALL WATER SHEDS [TR 55]	/
	<u> </u>	
 		· · · · · · · · · · · · · · · · · · ·
		·
Verification Results ACCE	PTABLE	
	<u> </u>	
		<u> </u>
	·	

Project	Title U3 fi Waste Unit Closure				
Verifier WILL MOORE Date 8-8-95					
Evaluate	valuate the Following Items:				
1.	Were the design inputs correctly selected?	4			
2.	Are the assumptions adequately described and reasonable?	777			
3.	Where necessary, are the assumptions identified for subsequent reverification when the detailed design activities are completed?				
4.	Was an appropriate design method used?	7			
5.	Were the design inputs correctly incorporated into the design?				
6.	Is the design output correct?	4			
7.	Are the necessary design input, output, and verification requirements for interfacing organizations specified in the design documents, supporting procedures or instructions?	4			
8.					
9.	Were calculation results correct and complete?	4			
10.	9. Were calculation results correct and complete?  10. Were alternate design interpretations considered?  11. Are quality requirements and/or acceptance criteria				
11.	Are quality requirements and/or acceptance criteria adequately identified in the design package?	4			
12.	Does the design comply with quality requirements and acceptance criteria?	7			
Comments					
Comments					
	<del></del>				
Results A	Acceptable (Y) N Data Attached (Y) N Page 2 of	2			

# APPENDIX B GROUT PLUG CALCULATIONS

## Raytheon Services Nevada

Title:

PLUGBACK - "AS-BUILT"

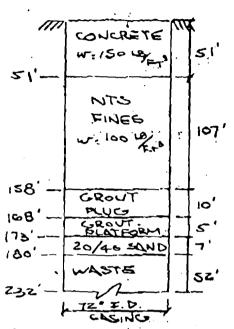
Job number COA4-3AAB Sheet \_\_\_ of \ By RC Date 10/20/95

## 'As built plugback schematic

## CENERAL REQUIREMENTS

- 1) GROUT PLATFORM (FLEV 168' TO 178') THIS PLUG REQUIRED ONLY TO INSURE THAT · ANY VOIDS BETWEEN THE WASTE, SAND, AND THE CASHO WALL ARE FILLED PRIOR TO PLACEMENT OF THE GROUT PLUC.
- 2) CROUT PUG (ELEV 168' TO 158) F' = 3000 PSI THIS PLUC WILL SUPPORT THE MOTERIAL PLACED ABOVE IT, SEE ANDLYSIS BELOW
- s) convicte aluc (ELEV SI TO 0') THIS PLUC REQUIRED BY THE STATE OF HEADA FOR ABMIDONED WELLS

MOTE: CROVI/CONCRETE CONRESSIVE STRENCTH VERIFICATION REQUIRED FOR THE GROUT PLUG ONLY,



re-check 10' crout pluc

WO-MONETE = 1/4 (75/2) = (51) (150) = ZIC 299 LB - 1/2 (12/2) (107) (104): 302535 LB 518B34 LB

DETERMINE BOND FORCE BETWEEN CASING AND GROUT PLUC SHELD BOND PRESSURE (M)= 1/2 (100) = 80 PSI F. T(L)(D)(L) WHERE D. 72", L:10'x12 = 120" F= 17 (80) (72) (120) = 2, 171, 469 LB S.F. = 2171469 518834 = 4.19 Q.K.

CHECK BEARING PRESSURE

BEDRING PRESSURE : 518834 = 128 PSI

FOR 3000' PSI CONCRETE! For 0,7.5 (3000) = 750 PSI S.F. = 750/128 = 5.80 O.K.

10' THICK CROUT PLUG (f': 3000 PSI) IS ADEPUATE

# APPENDIX C REECo ERS FIELD NOTES & DAILY REPORTS

UNCONTROLLED When Printed

Acrived on site at 1100

Crew on site placing generator

Jeff Smith acrived at 1/15

Forte 1184 - 1120 Removed spood, metal place, ad sign.

1300 Hrs

Crew Geturn +0 site (welders, Lubra)

Labor Began setting of control Fera

Neil Campbell arriver on site 1330

Jesus Monie (welding)

Paul Ketchell ( welding)

Storted Cutting holes in Cova at 1400

Moles Finished at 1445 Covers For cut holes installed at 1515

welled Fines onto EE Gake post for lifeline hook up

EF ferre Removed and replaced in square shape by lubar. This

done to make site less cluttered and to minimize Fencing meternal

welders Einisted and left site at 1530

Labor Finished entry gale a attacked sishs at 1630

Assorved on site

Dan Iphiason

Neil Campbell

Bob 6000 (Cubor)

Louis South (Cubor)

1410

Tassed at 168.5 ft.

Stopped operations for the day to allow growt

to set up Requires 24 hrs.

Site closed and secured at 1450

7-7-95

130 Tassed 6-owt at 168 re
1310 Return to site Clear, windy, 100s

DISSORAL

DISCORDED JOR August & Supply

N. Campbell Dove Clark

J. Holley

L. Sonth

S. Egreia J. Smith

Don Cox

1490. Tailsake Safety Briefing
1450 Beom Powering Growt

isod Soe Ringer, Dane Clark Teme Sire. Informed as

that sike looks soud

isto 6 cm gd growt powered har con left sike

1515 Desin powers next 6 cm gd of growt

1540 Finish powering last 6 cm gd of growt

1545 Tagged at 158 Feet in 2 15 Ft of Growt

Shirt down operation for the day

Neil Campbells Office.
_0900 Arrivel on s. Le Clear 90's
De Tobiaso Neil Comptell  Jim Holly Joe Ceeming
Bol Garcin Lon, s South
Some poble with the sail dryer. Duly of
wit method plussing the pipes in Fin #3
1035 Finished pouring NTS Fines who have 1040 Tassed at 143 ft.
#2 12520 Began pouring NTS Fined into Hole 1305 Finished pouring '485 cuft fines (48560 165) '300 Tassed at 125 Ft
1345 Finished pouring 510 ouft fines (51040 16s)  Tassed at 105 ft

1425 Finished	porcing 468 cust fill	(s (41,8401b2)	·
Shut down	operations for the	dy	
			9-12-95
0750 Suf	cty Eriefing con	ducted it re	211 Campbel
	e. All attend	in parionel sise	d form.
personul			
Da Tobiason Jim Holley	traik & ak Mike Powers		
Bob bacin	· · · · · · · · · · · · · · · · · · ·		
Louis South			
Jose Avila			
	sed at 97 ft.		1 .
Truck #1	gy70/	10 3/2-1 gens	nator
		13 fre into H	ble
0905 Fin	sted pouring 5.	ig calt fines (5	2960/65)
	l at 67 FE		

**UNCONTROLLED When Printed** 

1915 Bega Couring Nts Free , to Able

(Ron-)
0922 Finished pouring FIRST THE OF WS Finis
10930 Finished pourin 2 second tier of Nis Fines
Sanding aperation computed Total said usual today 95828/65 98762
0945 Sabire Curtis arrived on site - 6.1en Sifety Briting
NIEP
1030 Jest Smith, Bruce Wilcox, John Taylor, Clen Goerth
arrival on site
1035 Water track orrived on site for dust control.
115 Storted pouring 1 Truck load of growt
1120 Solvie Curtis Cept site
112 C MARCHAIL C)
1725. Finished pouring 1st Good of Grout 127 cuft (6 insl)
130 Stated Pouring 2nd Truck Lord of Growt
1140 Formsled Porcis 2 Lord of Cont 162 cuft (benyd
1140 Finished Pouris 2 Lord of Good 162 cuft (benyd) Tassed at 42 H.
1205 Started pouring 319 Truck laid of Growt
1210 finished poring 3th Truck land of Growt 182 cuto (6 ciny)

1235 Begin pouring 4th wad of growt 1240 Finish pouring 4th Load of Grost 162 cn Ft (6 cm gd) Tagsed it 32 feet 1255 Begin pouring 5th Coul of Grout
1300 Finish pouring 5th bond & grout 164 cuts (6 cmgd) 1335 Gegin pouring 6th Lord of growt 182 cafe (6 cryd) 1900 Finish pouring 7th Load of growt Tagged at i7 feet 1420 Gegn pour 8th Coul of yout 162 cute (6 cm yl) 1515 Seson pouring 9th al last bond of Grout
1530 Finish pumping 9th bod of grout 162 cuft (bongs)
Tagsed at 7 feet to cover. 6 feet below ground level Finished operations for the day.

9-13.95
0945 Satety Driefing Conducted in Neil Carpbelli
office. All parsonal signal sofety Form
persond
Da Tobian. Gab-jul/clie
Sim William Bubb, with
Merle Cramwell
John Donahad
Neil Campbell
Willie Chessr
Mila Powers
1040 Begin pouring concrete into hole
1000 Finished pouring concrete into Lok
1100 yed forklift to pott Tover from hole
1/10 F Certining pouris concrete into hole.
1115 Completed porring concrete 8 cm yd. Concrete  about 6' below rin of cover.
1115 Gabriel Klin, Bobby with (conside Formers) are.
on sike Given Celeti S-rel
1120 Best Renoving Francis Francis Cover Asoposts
1125 Kline, Witt left site to gather materials.
130 Bega Sacia morumet
1145 Placed manual - held in place with Fort, or
until set.

UNCONTROLLED When Printed

'305 Remard forklift from monunet. Revoved fora got? 1345 Finished removing gate posts and policing site 1405 Formers arrived on site 1440 fromworken arrived a site to cit off lid and cover on after cutting 525 Over at post removed. 1530 Begin setting forms for concrete pad. Form centered around casing and squarel

0930 RSN Survey on sike to /oxite Fence boundaries
and place Survey Marken in monument Cut Citing eye from top of morement 1030 Concrete Armel on site 1040 formers arrived on site 1045 Besin Buring concrete 1100 tinish Pouring a cubic yerds of concrete 1100 RSN Surey left Site For Part of power and for Just ·230 Pad Finished - 1310 Donworken on six +1 /ay out fence lines, 1325 Concrete Finisher back on site to apply sealest to 1335 Finisher left site. Pad is complete except for Siliane seder in jointe. '400 Ionworken 1914 sike UNCONTROLLED When Printed

## U-3fi WASTE UNIT CLOSURE DAILY REPORT - DAN TOBIASON

DATE: September 5, 1995

### PERSONNEL ON SITE:

Dan Tobiason
Jeff Smith
Neil Campbell
Bob Garcia
Louis South
Jesus Monje
Paul Ketchell

### MILESTONES/PROGRESS:

- Initial site mobilization. Removed all debris from in and around exclusion zone. Site control fencing and signs, and exclusion zone fence were installed. Construction vehicle parking area was roped off.
- Holes were cut into well head cover. These holes allow for insertion of sand, grout, and dust suppression hoses.

#### PROBLEMS:

## U-3fi WASTE UNIT CLOSURE DAILY REPORT - DAN TOBIASON

DATE: September 6, 1995

#### PERSONNEL ON SITE:

Dan Tobiason
Jeff Smith
Neil Campbell
Bob Garcia
Louis South
Jim Holley
Joe Leeming
William Hodges

Frank Eck Willie Chesser

#### MILESTONES/PROGRESS:

- Health and Safety Plan briefing was held at Neil Campbell's office. All personnel signed Declaration of Understanding.
- Approximately 150 cubic feet of 20/40 sand was poured into the well. The sand was tagged at 179 feet at the center of the hole and 178.5 feet at the edge of the hole. These depths indicate that the sand only lifted 1 foot. It was determined that since the material at the bottom of the hole was not uniform, the sand worked its way into the interstitial spaces before filling the bore hole. Discussion with REECo project manager, ERS section chief, RSN inspector, and REECo construction superintendent approved the addition of more sand. An additional 150 cubic feet of 20/40 sand was poured into the hole. The sand was then tagged at 173 feet at the center and 173.5 feet at the edge. This indicated approximately 6 feet of sand in the hole.
- Grouting operations commenced with the emplacement of approximately 4 cubic yards of grout. The grout was tagged at 168.5 feet. This indicates a grout thickness of approximately 6 feet. Operations were concluded for the day to allow grout set up time of 24 hours.

#### **PROBLEMS:**

# U-3fi WASTE UNIT CLOSURE DAILY REPORT - DAN TOBIASON

DATE: September 7, 1995

#### PERSONNEL ON SITE:

Dan Tobiason
Jeff Smith
Neil Campbell
Bob Garcia
Louis South
Jim Holley
Don Cox

Frank Eck Herb Stewart Joe Auyer David Clark

#### MILESTONES/PROGRESS:

- Tailgate Safety Briefing was conducted on site. All attendees signed briefing form.
- Grout was tagged at 168 feet prior to pouring additional grout. A total
  of 12 cubic yards of grout was then poured into the hole. After
  pouring, the grout was tagged at 158 feet. Including the grout poured
  on September 6, 1995, this gives a total grout plug thickness of 15
  feet.

#### PROBLEMS:

### U-3fi WASTE UNIT CLOSURE DAILY REPORT - DAN TOBIASON

DATE: September 11, 1995

#### PERSONNEL ON SITE:

Dan Tobiason
Neil Campbell
Bob Garcia
Louis South
Jim Holley

Frank Eck Joe Leeming Mike Powers

#### MILESTONES/PROGRESS:

- Tailgate Safety Briefing was conducted at Neil Campbell's office. All attendees signed briefing form.
- Hole was tagged at 158 feet. Approximately 1863 cubic feet (4 truck loads) of NTS fines sand was poured into the hole. The hole was then tagged at 87 feet. This gives a total sand column of 71 feet.

### **PROBLEMS:**

• There was a problem with getting sand loaded onto the trucks. This resulted in a total delay of 2 hours. The trouble was attributed to the Area 1 Shaker Plant where the trucks were loaded. Since the plant had been unused for some time, excess material was plugging the pipes. Otherwise there were no problems.

## U-3fi WASTE UNIT CLOSURE DAILY REPORT - DAN TOBIASON

DATE: September 12, 1995

#### PERSONNEL ON SITE:

Dan Tobiason
Neil Campbell
Bob Garcia
Louis South
Jim Holley

Frank Eck Joe Leeming Mike Powers Jose Avila

### MILESTONES/PROGRESS:

- Tailgate Safety Briefing was conducted at Neil Campbell's office. All attendees signed briefing form.
- Hole was tagged at 87 feet. Approximately 982 cubic feet (1 1/2 truck loads) of NTS fines sand was poured into the hole. The hole was then tagged at 51 feet. This gives a total sand column of 107 feet.
- A total of 54 cubic yards (9 truck loads) of grout was poured into the hole. The hole was tagged at 6 feet below ground surface. This gives a total grout column of 45 feet.

#### PROBLEMS:

# U-3fi WASTE UNIT CLOSURE DAILY REPORT - DAN TOBIASON

DATE: September 13, 1995

### PERSONNEL ON SITE:

Dan Tobiason Neil Campbell Jim Holley Merle Cromwell Mike Powers Gabriel Kline John Donahue Bobby Witt

D.G. Miller

Willie Chesser

### MILESTONES/PROGRESS:

- Tailgate Safety Briefing was conducted at Neil Campbell's office. All attendees signed briefing form.
- The hole was filled with 8 cubic yards of concrete to approximately 6 inches below rim of casing. Survey monument was placed and centered on casing.
- Fencing, gate, posts, and cover were removed.
- Concrete forms were set and centered around hole and squared to North.

### PROBLEMS:

### U-3fi WASTE UNIT CLOSURE DAILY REPORT - DAN TOBIASON

DATE: September 14, 1995

#### PERSONNEL ON SITE:

Dan Tobiason Neil Campbell Jim Holley Bobby Witt D.G. Miller Bill Neal

Arlen Rogers
Gabriel Kline
Lure James
Louis South
Charlie Smith
Fred Benabise

Louis Washington Scott Woolsey Gary Olson Robert Rogers Richard Olson

### MILESTONES/PROGRESS:

- Tailgate Safety Briefing was conducted at the job site. All attendees signed briefing form.
- RSN Survey located fence boundaries and placed brass survey marker in top of monument.
- Wire mesh was placed inside forms prior to pouring concrete.
- Approximately 9 cubic yards of concrete was poured for the pad. The pad was leveled, finished, and sealant was applied.
- Fence lines were laid out and post locations were marked for installation of fencing.

### **PROBLEMS:**

## APPENDIX D

## INDEPENDENT ENGINEER'S NTS DAILY RIG OPERATIONS REPORTS

Page \_\_3\_\_of \_\_3\_

Day:	Thur	sday	Date:	9/0	7/95	Time:	07	00 Hrs.	Init	lais:	JCH
Station:	U-3f1				Rig:		,		,	User:	DOE
Present a	ctivity:	No Activ	rity		Bit size:		Tota	depth:	ROP: (fi	/hr)	RPM:
Drilled:			From	•	<b></b> _	Weight	on blt	к	<u> </u>	ČGV.	<u> </u>
Surveys:	H1 		rion		No. of comp. on loc:	Using:		Type fluid:		- OTM E	Nt P8
GPM in:		GPM of	ıt:	La	et oasing size:	De	opth:	2'	Hole P	rogram	total depth:
Time Log	<u> </u>										
1.0 H	rs	Health a	ind safety	me	eting.			<u> </u>			
1.0 H	rs	Rig up R	RCS.		_						
0.5 H	rs	RCS blow	ring 150 f	t³	of 20/40	sand d	own	hole: to	p of w	aste	at 180',
		top of s	and at 17	9' <i>,</i>	with tag	line	at	1010 hou	rs.		
2.5 H	rs	Wait on	20/40 san	d f	rom RCS.					· 	
0.5 H	rs	RCS blow	ving 150 f	t³	of 20/40	sand d	own	hole fro	om 179'	to 1	173°. Tag
		with tag	line at	132	O hours.						
0.5 H	rs	RCS ceme	enting wit	h 1	08 ft <sup>3</sup> of	HTHSG	(c	:-1) from	n 173'	to 16	69'. Cement
		in place	e at 1400	hou	rs. Tag	with t	ag	line.	·		
18.0	Hrs	No activ	/ity.								
											· · · · · · · · · · · · · · · · · · ·
								<u> </u>			
											_
											·
											· ·
	. —										·

## **Raytheon Services Nevada**

Page \_ 2 \_ of \_ 6

Day:			Date:		. 4	Time:			Init	als:			
	Mond	lay	09	09/11/95			0700 Hrs.				JCH		
Station:	U-3fi				Rig:					User:	DOE		
Present a	-	Waiting	on Cement		Bit size:		Tota	depth:	ROP: (ft	/hr)	RPM:	-	
Drilled:	in	Hre	From	 to		Weight		: K		CEM at	<del> </del>	PSI	
Surveys:				-	No. of comp. on loc:	Using:		Type fluid:					
GPM in:		GPM or	ut:	Las	t casing size:	1	epth:	2 ·	Hole Pi	rogram tot	al depth:		
Time Log					,,,			<u></u>			*****		
	<u> </u>	FRIDAY	Y - 09/08	/95	5 - 0700	Hrs.							
7.5 H	rs	Waiting	on cement		Run tag 1	ine to	to	p of ceme	nt at	168'.			
1.5 H	rs	Safety m	meeting. F	RCS	cementin	g with	32	4 ft <sup>3</sup> of	HTHSG	(cc-1)	from	,	
	· 	168' to	158'; ceme	ent	in place	at 15	40	hours. T	ag wit	h tag			
		line: to	op of cemer	nt a	it 158				_				
15.0	Hrs	Wait on	cement.				•			·			
	·		· 								<u>_</u>		
							_						
	·												
		· <u>-</u>	<u> </u>				_	<u></u>		<u> </u>			
						- <del>-</del>	_			<u> </u>		· <u> </u>	
		<u></u>											
_	· 												
					<u> </u>								
					<del></del>		<u>-</u>						
			UNCON	ITR	OLLED V	Vhen F	Print	ted					

## **Raytheon Services Nevada**

Page \_ 3 \_ of \_ 4

Station: U-3fi			<u> </u>	2/95		07	00 Hrs.			JCH ————
	Station: U-3fi			Rig:					User:	DOE
Present activity:	No Activ	ity		Bit size:		Tota	l depth:	ROP	: (ft/hr)	RPM;
Drilled:	Hrs.	From	to				K		CFM •	ıt
Surveys:				No. of comp. on loc:	Usin	g:	Type fluid:			
GPM in:	GPM ox	rt:	Las	nt casing size:		Depth:		Hole	e Program t	otal depth:
Time Log:										
3.0 Hrs	Safety m	eeting. V	<b>l</b> ai	t on NTS	fine	es ste	mming mat	teria	1. Ru	n tag
	line to	top of cer	nen	t at 158'						
0.5 Hrs	Stemming	with NTS	fi	nes - 40.	000	lbs;	run tag	line	to top	of sand
	at 143'.									
1.5 Hrs	Wait on	stemming s	san	d.				_		
2.5 Hrs	Stemming	with NTS	fi	nes - 146	.44(	) lbs;	run tag	line	to to	o of
	sand at	87°.								
3.0 Hrs	Wait on	stemming s	an	 d.			<del>.</del>			
13.5 Hrs	No activ	ity.			_			_		
	Total NT	S fines us	sed	09/11/95	: 18	36.440	lbs.			

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## Raytheon Services Revada

Page 3 of 5

Day: Wed	Wednesday Date: 09/13/95			Tim		700 Hrs.	init	iais:	 JCH	
Station:	<u> </u>		Rig:					User:		_
U-3f	i 				<del></del> ,		·		DOE	
Present activity:	No Activ	ity	Sit size	:	Tota	depth:	ROP: (ff	t/hr)	RPM:	
Orilled:			l	W	ight on bi	t			·	-
	Hrs.	From						CFM a	t	P
Surveys:			No. of on loc:	comp. Usi	ng:	Type fluid:				
GPM In:	GPM ou	rt:	Last casing	size:	Depth:		Hole P	rogram t	otal depth:	
			72"	- 74"	23	<u> </u>				
Time Log:						<u>.                                    </u>				
1.5 Hrs	Safety m	eeting.	Run tag	line to	top c	of sand a	at 87'.			
1.0 Hrs	Stemming	72" casi	ng with I	NTS fin	es (sa	ınd). Fr	om 87'	to 51	l'used	
		bs. of sa	<u>-</u>		_		<del>'</del>	-		
1 5 11		<del></del> -							·	•
1.5 Hrs		grout fro				<del></del>				
4.5 Hrs	Grout in	side of 7	4" casing	ng from 51' to 6' with 1458 ft <sup>3</sup> of					: 	
	HTHSG (c	c-1). Ce	ment in p	place a	t 1525	hours.				_
15.5' Hrs	No activ	ity.	•••							
<del></del>							<del></del>			
										_
· · · · · · · · · · · · · · · · · · ·										
_			_				_			
:			<u> </u>			<del>.</del>				
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				<u>.</u>				<u> </u>		
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# Raytheon Services Nevada

RSN 240 (2/92)

Page \_ 2 \_ of \_ 2

Day: Thursday		Date: 09/14/95			7700 Hrs.			Initials: JCH		
Station: U-3fi		·		Rig:				User:	DOE	
Present activity:	No Activ	ity	<del></del>	Bit size:		Total depth:	ROP: (	t/hr)	RPM:	
Orilled:	Hrs.	From	t	0	Weight			_ CFM #	nt	 _ PSI
Surveys:			- <del></del>	No. of comp. on loc:	Using:	Type flui				
GPM in:	GPM ou	rt:	La	st casing size:72" 74		232 ·	Hole F	rogram 1	total depth:	
Time Log:										
0.5 Hrs	Safety m	eeting.					•			
0.5 Hrs	Grout in	side of	74"	casing wi	th REE	Co red mi	x - used	179	ft³ from	
	6' to G.	L. Ceme	ent i	n place a	t 1050	hours.	NOTE: P	er Mr	. Kudak,	
	it is ac	ceptable	e to	use REECo	red m	nix.				
1.0 Hrs	Set in m	arker pe	edest	al.						
22.0 Hrs	No activ	ity.								
<del></del>	<del></del>									
			,							
	<u> </u>		-						٠.	
						<del></del>				
				-				<del></del>		
<u> </u>										
			<del>`</del>					. <del></del>		
				<u> </u>	•					
	<del>-</del>									
		,	<del></del>		<del></del>	<del></del>		<del></del>		
<u> </u>	<del> </del>	UNC	ONTE	ROLLED V	Vhen	Printed				

## Raytheon Services \ \_vada Page \_\_1\_\_ of \_\_2\_ Nevada Test Site Daily Rig Operations Day: Date: Time: Initials: 09/18/95 Monday 0700 Hrs. JCH Station: Rig: User: DOE U-3fi Total depth: ROP: (ft/hr) RPM: Present activity: Bit size: No Activity Weight on bit: Drilled: CFM at Using: Type fluid: No. of comp. Surveys: on loc: Depth: Last casing size: Hole Program total depth: GPM in: GPM out: 72" - 74" 232' Time Log: FRIDAY - 09/15/95 - 0700 Hrs. 5.0 Hrs. - Build form around well and pour cap over well. Used REECo 9 $cy^3$ of REECo Redi-Mix. Marker pedestal 4' 1-1/2" above cement pad. 19.0 Hrs. - No activity.

## APPENDIX E

# DRY MATERIALS BATCH WEIGHT CERTIFICATIONS AND MATERIAL WEIGHT SHEETS

BATCH SIZE (FT	'): <u>/62</u>	
	CHEM COMP	POUNDS
	TYPE II	POUNDS
	W-60	POUNDS
	FLY ASH	POUNDS
	A1 CONCRETE SAND	POUNDS
	D-19	POUNDS
·	PLASTIMENT	S POUNDS
	MIX TIME //O	HOUR / DATE
	WEIGHT/GAL 12.	POUND8
	GROUT TEMP 37	°F
	WATER	BARRELS
	ICE	POUNDS

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USAE Waterways Experiment Station, CE Concrete Laboratory • Grouting Branch P. O. Box 700 Mercury, Novada 89023

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HOLE: 03/ I		DATE: 9/2/95
MIXTURE DESIGN: 117190	& C(ec) 1	TRUCK NO.:
BATCH SIZE (FT³):		TEAR
CHEM COMP		POUNDS
TYPE II		POUNDS
W-60		POUND8
FLY ASH		POUNDS
A1 CONCRETE SANI	D	POUNDS
D-19		POUNDS
PLASTIMENT		ROUNDS GE
		***************************************
MIX TIME	2:15	HOUR / DATE
WEIGHT/GAL	12.2	POUNDS
GROUT TEMP	50	°F
WATER		BARRELS
ICE		POUNDS

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HOLE: UBFI		DATE:	9/12/25
MIXTURE DESIGN:	GC (CC) 1	TRUCK NO.	:
BATCH SIZE (FT3):			TEAR
CHEM COMP		POUNDS	
TYPE II		POUNDS	
W-60		POUND8	
FLY ASH		POUNDS	
A1 CONCRETE SAND		POUNDS	,
D-19		POUNDS	•
PLASTIMENT		POUND8	
·			
MIX TIME	10:35	HOUR / DAT	<b>E</b>
WEIGHT/GAL	12.2	POUNDS	
GROUT TEMP	50	°F .	
WATER	<u> </u>	BARRELS	
ICE	600	POUNDS	

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HOLE: U3	FI		DATE: 9/12/55
MIXTURE DESIGN	: HTH36	- C(cc) /	TRUCK NO.:
BATCH SIZE (FT'):	162		T E A R
	CHEM COMP		POUNDS
	TYPE II		POUNDS
	W-60		POUNDS
	FLY ASH		POUNDS
	A1 CONCRETE SAND		POUNDS
	D-19		POUNDS
	PLASTIMENT		POUNDS GY
	MIX TIME	(/:07)	HOUR / DATE
•	WEIGHT/GAL	17.2	POUND8
	GROUT TEMP	50	°F
	WATER	3	BARRELS
	ICE	EOO	POUNDS
		PEN	

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HOLE: (3)			DATE:	95
MIXTURE DESIGN:	471456	-Cd1	TRUCK NO.:	· · · · · · · · · · · · · · · · · · ·
BATCH SIZE (FT3):	162			TEAR
	CHEM COMP		POUNDS	
•	TYPE II		POUNDS	·
	W-60		POUND8	
	FLY ASH		POUNDS	
	A1 CONCRETE SAND		POUNDS	
	D-19	· · · · · · · · · · · · · · · · · · ·	POUNDS	
	PLASTIMENT		POUNDS ST	•
· · · · · · · · · · · · · · · · · · ·		<i>2.</i> /		
	MIX TIME	1/125	HOUR / DATE	
	WEIGHT/GAL	17.2	POUNDS	
	GROUT TEMP	50	۰۶	
	WATER	3.2	BARRELS	
	ICE		POUNDS	n - The Robbs

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HOLE:	=		DATE: 9/12/95
MIXTURE DESIGN:	HTHSE	5 C(Cc) /	TRUCK NO.:
BATCH SIZE (FT3):	162		T E A R
,	CHEM COMP		POUNDS
	TYPE II		POUNDS
	W-60	×	POUNDS
	FLY ASH	<del></del>	POUNDS
	A1 CONCRETE SAND		POUNDS
	D-19		POUNDS
	PLASTIMENT		POUNDS ST
•	MIX TIME	12:05	HOUR / DATE
	WEIGHT/GAL	12:05	POUNDS
•	GROUT TEMP	50	°F
<u>.</u>	WATER	10.3	BARRELS Total
	ICE	600	POUNDS

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Mall Stop 605

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HOLE:	FI		DATE: 9/3/95	<del>-</del> -
MIXTURE DESIGN	47/13	6 C (ce)	/ TRUCK NO.:	• .
BATCH SIZE (FT'):	162		`_T £ A	R
	CHEM COMP		POUNDS	
	TYPE II		POUNDS	
	W-60		POUND8	
	FLY ASH		POUNDS	
	A1 CONCRETE SAND		POUNDS	
	D-19		POUNDS	
	PLASTIMENT		POUNDS GE	
		/	the strength of the strength o	
	MIX TIME	12:25	HOUR / DATE	
•	WEIGHT/GAL	-17,2	POUND8	•
	GROUT TEMP	50	°F	
	WATER	10.3	BARRELS	
	ICE	600	POUNDS	1-10-1

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HOLE:	EZ	<del></del> ;	DATE: 9/12/55
MIXTURE DESIGN:	HTH56	sc(sc)	TRUCK NO.:
BATCH SIZE (FT3):	162		TEAR
	CHEM COMP		POUNDS
	TYPE II		POUNDS
	W-60		POUNDS
	FLY ASH		POUNDS
	A1 CONCRETE SAND	<del></del>	POUNDS
·	D-19		POUNDS
	PLASTIMENT	1/4	POUNDS G
		,	
	MIX TIME	1:00	HOUR / DATE
	WEIGHT/GAL	122	POUNDS
	GROUT TEMP	50	°F
	WATER		BARRELS
,	ICE	600	POUNDS

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HOLE:	FI		DATE:	2/95
MIXTURE DESIGN: _	HTH5G	c (cd)	TRUCK NO.:	
BATCH SIZE (FT'): _	162			TEAR
(	CHEM COMP		POUNDS	
7	TYPE II		POUNDS	
	W-80		POUND8	
F	FLY ASH		POUNDS	
· ·	A1 CONCRETE SAND		POUNDS	
Γ	D-19		POUNDS	
F	PLASTIMENT	1 1/4	POUNDS 676	
1. H				
<del>.</del>	MIX TIME	1.25	HOUR / DATE	,
v	VEIGHT/GAL	12.2	POUNDS	•
. G	ROUT TEMP	50	°F	
٧	VATER		BARRELS	
;	CE	600	POUNDS	*

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HOLE:	3-1		DATE: 9/12/95
MIXTURE DESIGN	: HTH56	C(Cc) 1	TRUCK NO.:
BATCH SIZE (FT3)	:_167_		TEAR
	CHEM COMP		POUNDS
· · ·	TYPE II		POUNDS
•	W-80		POUNDS
	FLY ASH		POUNDS
	A1 CONCRETE SAND		POUNDS
	D-19		POUNDS
	PLASTIMENT		POUNDS GU
;		···	
: -	MIX TIME	1:50	HOUR / DATE
	WEIGHT/GAL	-17.7	POUND8
	GROUT TEMP	50	°F
	WATER		BARRELS
	ICE	•	POUNDS

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HOLE:	FI	· ·	DATE: 9/2/	95
MIXTURE DESIGN:	HT#56	<u>(cy 1</u>	TRUCK NO.:	
BATCH SIZE (FT'):	162	. *	·	TEAR
	CHEM COMP		POUNDS	•
	TYPE II		POUNDS	
	W-60		POUNDS	
	FLY ASH		POUNDS	
	A1 CONCRETE SAND		POUNDS	
	D-19		POUNDS	
•	PLASTIMENT		POUNDS OF	
				15.
	MIX TIME	2:00	HOUR / DATE	·
	WEIGHT/GAL		POUNDS	`
	GROUT TEMP	50	۰¢	
	WATER	17	BARRELS	
	ICE	600	POUNDS	

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HOLE:	FI		DATE: 9/12/25
MIXTURE DESIGN	HTHSG	(6)	TRUCK NO.:
BATCH SIZE (FT3):	162		TEAI
	CHEM COMP		POUNDS
8	TYPE II		POUNDS
	W-60	•	POUNDS
	FLY ASH	· .	POUNDS
	A1 CONCRETE SAND	<del></del>	POUNDS
	D-19	·	POUNDS
	PLASTIMENT		POUNDS GE
		,	
•	MIX TIME	2:40	HOUR / DATE
	WEIGHT/GAL	122	POUND8
	GROUT TEMP	50	°F
<b>}</b>	WATER	10.3	BARRELS Total
	ICE	600	POUNDS

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CONTROL NO.	<del></del>		
DATE 6.9.95	LOCAT	ION_U3FT	USER
UNIT NO. <u>21919</u>	DRIVE	R	-
·	•	FRONT TIER	
SLURRY TYPE	Fines		
PRODUCT #2 SILO I PRODUCT #3 SILO I PRODUCT #4 SILO I PRODUCT #5 SILO I	NO.	TYPE TYPE TYPE TYPE TYPE TYPE TYPE TYPE	WEIGHT WEIGHT WEIGHT WEIGHT WEIGHT WEIGHT WEIGHT WEIGHT
TOTALS	CU. FT.	SLURRY 700	WEIGHT 2 Coc
SLURRY TYPE 25/4	10 Sene	REAR TIER	
PRODUCT #2 SILO I PRODUCT #3 SILO I PRODUCT #4 SILO I PRODUCT #5 SILO I	NO. 77 NO NO NO NO	TYPE TYPE TYPE TYPE TYPE TYPE TYPE TYPE	WEIGHT WEIGHT WEIGHT WEIGHT WEIGHT WEIGHT WEIGHT
TOTALS	CU. FT.	<b>SLURRY</b> /50	WEIGHT/ 5, 00 C
		TIME STARTED	
		BATCH NO'S.	//2
		BULK PLANT OPERA	TOR
	UNCONTRO	DLINSDEWIGH Printe	



					•			
CON	ITROL NO			in the second				•
DAT	E 8-31-	95	LOCATIO	N U3FI	US	SER	<b>事</b> 6	
	T NO. 57	V	DRIVER	Tom			THE STATE OF THE S	
			F	RONT TIER				
&LU	RRY TYPE	4TH50	(	/			42	
PRO PRO PRO PRO ADD ADD ADD	DDUCT #1 DDUCT #2 DDUCT #3 DDUCT #4 DDUCT #5 DDUCT #5 DTIVE #1 DTIVE #2 DTIVE #4	SILO NO SILO NO SILO NO	17 27 33 21	TYPE	Flour	WEIGHT _ WEIGHT _ WEIGHT _ WEIGHT _ WEIGHT _ WEIGHT _ WEIGHT _ WEIGHT _	4860 1620 4835 3765 225	
ТОТ	ALS	10000000000000000000000000000000000000	ÇU. FT. SI	URRY	21	WEIGHT ()	15405	1
SLU	RRY TYPE _	HTHSO			,			
PRO PRO PRO PRO ADD ADD ADD	DDUCT #1 DDUCT #2 DDUCT #3 DDUCT #4 DDUCT #5 DDUCT #5 DITIVE #1 DITIVE #2 DITIVE #4	SILO NO.	11 27 33 21	TYPE	Ash Y	WEIGHT _ WEIGHT _ WEIGHT _ WEIGHT _ WEIGHT _ WEIGHT _ WEIGHT _ WEIGHT _	4860 1626 4835 3765 225	
TOT	ALS	Charles	CU. FT. S	LURRY _/ 6	<u>Z</u>	WEIGHT _	15 405	1
		er en	~	TIME STARTED		, <u>a demograph</u> de la comp		
				TIME ENDED		·	· 	
				BATCH NO'S	9.10			
		•		BULK PLANT C	PERATOR 4	123		
			0.I.T.D.O.I	INSPECTOR				,



CONTROL NO.			
DATE 9/5/85	LOCATION 43FT	USER	·
UNIT NO. <u>タケケケ</u>	DRIVER	•	
	FRONT TIER		
SLURRY TYPE			
PRODUCT #2 SILO I PRODUCT #3 SILO I PRODUCT #4 SILO I PRODUCT #5 SILO I	NO TYPE		
ADDITIVE #4 TOTALS	CU. FT. SLURRY	WEIGHT _	
SLURRY TYPE 20/40	REAR TIER		
PRODUCT #2 SILO   PRODUCT #3 SILO   PRODUCT #4 SILO   PRODUCT #5 SILO	NO. 27  TYPE 26/9C  NO. TYPE	WEIGHT	
TOTALS	CU. FT. SLURRY	WEIGHT _	15,000
	TIME STARTED		
	TIME ENDED		
	BATCH NO'S/ BULK PLANT OPERAT	TOR CONTRACTOR	and the same of th
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CONTROL NO.		
•		
DATE <u>9-11-9</u>		USER
UNIT NO. 8/949	DRIVER Jon	
		·
	FRONT TIER	•
SLURRY TYPE		
	_O NO TYPE _O NO TYPE	
	O NO TYPE	
	O NO. TYPE	
	O NO TYPE	WEIGHT
	O NO TYPE	
ADDITIVE #1		
ADDITIVE #1	TYPE TYPE	WEIGHT
ADDITIVE #2	TYPE	
ADDITIVE #4	TYPE	
ADDITIVE #4		
TOTALS	CU. FT. SLURRY	WEIGHT
	REAR TIER	
SLURRY TYPE	175 Fines	·
OLORITA TITL		
PRODUCT #1 SII	O NO. 13 TYPE Fine 5	WEIGHT 2000
	_O NO TYPE	
	_O NO TYPE	WEIGHT
	_O NO TYPE	
	_O NO TYPE	WEIGHT
	O NO TYPE	
ADDITIVE #1	TYPE	WEIGHT
ADDITIVE #2	TYPE	
ADDITIVE #3	TYPE	WEIGHT
ADDITIVE #4	TYPE	
TOTALS	CU. FT. SLURRY 200	WEIGHT
		,
	TIME STARTED	
TIME ENDED		
BATCH NO'S. 2		
BULK PLANT OPERATOR		
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# APPENDIX F CONCRETE TESTING REPORT

**CONCRETE CYLINDER COMPRESSION TESTS** AS PER ASTM C 39-86

## Raytheon Services Nevada MATERIA CONCENTRATION OF CONTRACTOR (2) (6) (3; (8) (X) (2).

JOB #: 5214A 4BBB SUB # DATE: 09/15/95

1

MERCHINAN COID Time Molded: 1510,1540/1115,1235,1525 Date Molded: 9/7 & 12/95 **BREAK DAY** Time Stripped: Date Received: 09/13/95 АЗ U3FI Area Project: Quantity Represented (cu yds): N/A AREA 3 Loc of Placement: N/A Batch Plant Inspector: Specimen Made by: J. HOLLEY 3000 HTHSG (CC-1) Required Strength (psi): @ 3 DAYS Mix #: **ADJUSTED MIX MATERIALS** ORIGINAL MIX DESIGN N/A **CHEM COMP** 30.00 **PCF** N/A 10.00 **PCF FLY ASH** N/A **PCF SAND 20/40** 29.83 SILICA FLOUR 23.25 **PCF** N/A **PCF** N/A **GEL** 1.40 PSP 0.62 **PCF** N/A **PLASTIMENT** 0.96 FL OZ N/A WATER 28.00 PCF N/A Weather: N/A Concrete Temp.(F): % Air: Ambient Temp. (F): N/A N/A Slump: N/A N/A Dial Caliper, PTL # Y4480 Calibration Date: Calibration Due: 04/03/96 Equipment Used: 04/03/95 Calibration Due: Calibration Date: 02/22/95 02/22/96 Tested on Machine: Tinius Olsen, DOE 171442 3 Day Strength 4010 psi 7 Day Strength 3255 psi Average Average N/A 56 Day Strength Average 8 Day Strength N/A psi Average psi Cylinder Total Truck Test X-Sect Comp. Type Load Diameter (in) Area Load St. Tested Lab at Date of Frac. Tested 2 Avg (sq in) (lbs) (psi) Bv Days 1.2 3.00 25200 8291 09/14/95 3.00 3.00 7.07 3570 Shear V. Thummala 2.2 3.00 21200 8292 7 09/14/95 3.00 3.00 7.07 3000 Columnar V. Thummala 3.2 8293 7 09/14/95 3.00 3.00 3.00 7.07 23000 3250 Shear V. Thummala 4.2 8294 7 3.00 3.00 3.00 22600 3200 09/14/95 7.07 Shear V. Thummala 3.00 3.00 3.00 27500 3890 1.3 8295 3 09/15/95 7,07 Shear J. Aamodt 29000 4100 2.3 8296 3 09/15/95 3.00 3.00 3.00 7.07 Shear J. Aamodt 3.3 3.00 3.00 3.00 7.07 28200 3990 8297 3 09/15/95 Shear J. Aamodt 3.00 3.00 29200 4130 4.3 8298 3 09/15/95 3.00 7.07 Shear J. Aamodt 5.3 8299 3 09/15/95 3.00 3.00 3.00 7.07 27800 3930 Shear J. Aamodt 6.3 3930 8300 3 09/15/95 3.00 3.00 3.00 7.07 27800 Shear J. Aamodt CC: **REMARKS:** A/6 LOG # 1716 J. PEDALINO R.S.N. R. HUNTER R.S.N. SPECIFICATION REQUIRED STRENGTH R.S.N. G. HUDAK PROJECT FILES MTL GPP FILES Checked by: Del 24

Date: 16-31-95

Page