FINAL

Field Sampling and Analysis Plan

Test Well Installation at RSA-10 (Unit 1) Redstone Arsenal, Alabama

EPA ID NO. AL2 210 020 742

Prepared for:

U.S. ARMY CORPS OF ENGINEERS
Savannah District

October 4, 1994

Draft
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for
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Prepared by

Enserch Environmental Corporation

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SYMBOLS AND ABBREVIATIONS

LIST OF ABBREVIATIONS

ADEM	Alabama Department of Environmental Management
ARARs	Applicable or Relevant and Appropriate Requirements
ASTM	American Standards for Testing of Materials
BNA	Base/Neutral/Acid Extractables
BOD	Biochemical Oxygen Demand
CESAS	Savannah District Corps of Engineers
CDAP	Chemical Data Acquisition Plan
CDQO	Chemical Data Quality Objectives
CFR	Code of Federal Regulations
C.I.H.	Certified Industrial Hygienist
COC	Chain of Custody
COD	Chemical Oxygen Demand
DERP	Defense Environmental Restoration Program
DQO	Data Quality Objective
EOD	Explosive Ordnance Disposal
EEC	Enserch Environmental Corporation
EPA	US Environmental Protection Agency
FOL	Field Operations Leader
FSAP	Field Sampling and Analysis Plan
HSM	Health and Safety Manager
HSO	Health and Safety Officer
HTW	Hazardous and Toxic Waste
ICM	Interim Corrective Measure
I.D.	Inside Diameter
IRA	Interim Remedial Action
MCL	Maximum Contaminant Level
mg/L	milligrams per liter
MICOM	U.S. Army Missile Command
MRD	USACE Missouri River Division
msl	mean sea level
N/A	Not Applicable
NPDES	National Pollutant Discharge Elimination System
OB/OD	Open Burn/Open Detonation
PARCC	Precision, Accuracy, Reproducibility, Completeness and Comparability
P.E.	Professional Engineer
P.G.	Professional Geologist
PM	Project Manager
PP	Priority Pollutant
ppb	parts per billion
QA/QC	Quality Assurance, Quality Control

LIST OF ABBREVIATIONS (Continued)

RCRA	Resource Conservation and Recovery Act
RPD	Relative Percent Difference
RSA	Redstone Arsenal
SS	Stainless Steel
SSHP	Site Safety and Health Plan
TCE	Trichloroethylene or Trichloroethene
TCLP	Toxicity Characteristic Leaching Procedure
TDS	Total Dissolved Solids
TOC	Top of Casing
TSS	Total Suspended Solids
USACE	United States Army Corps of Engineers
UXO	Unexploded Ordnance
UV	Ultraviolet
VOC	Volatile Organic Compound

1.0 INTRODUCTION

This Field Sampling and Analysis Plan (FSAP) combines the contents of a typical Chemical Data Acquisition Plan (CDAP) and Well Installation Plan. This FSAP describes the proposed Field Program at RSA-10 (Unit 1), Redstone Arsenal, involving the installation of up to 7 groundwater test wells. The purpose of the program is to further determine the design parameters for the Interim Corrective Measure (ICM) at RSA-10. Background information about the RSA-10 site and the proposed ICM is contained in the RSA-10 ICM Design Work Plan prepared by Enserch Environmental Corporation (EEC), formerly Ebasco. This FSAP describes the methodology to be used while installing the test/extraction wells and performing the aquifer and specific capacity tests. The physical data to be obtained during these activities is described in Section 1.3. Another purpose of this FSAP is to make certain that field work is performed in a manner which ensures that chemical analytical data acquired during the investigation are of sufficient quality to meet the intended usage. Data quality depends not only on how carefully an analytical method is carried out but also on the sample point selection, sampling procedures, sample integrity and analytical method selected.

This FSAP defines the project Data Quality Objectives (DQO). It describes the project organization and functional responsibilities and details the field activities and laboratory analytical procedures established to meet the DQO.

Development of this document was guided by a number of documents including the following:

- Chemical Data Management for Hazardous Waste Remedial Activities, USACE, 1 October, 1990.
- Minimum Chemistry Data Reporting Requirements for DERP and Superfund HTW Projects, USACE memorandum, August 1989.
- Guidance for Data Usability In Risk Assessment, US EPA, October 1990.
- Installation of Groundwater Monitor Wells and Exploratory Borings at Hazardous Waste Sites, USACE, Missouri River Division, May 1990.

1.1 Background

The U.S. Army Missile Command (MICOM) Environmental Management Office of Redstone Arsenal, Alabama, has tasked the U.S. Army Corps of Engineers (USACE), Savannah District (CESAS) to conduct an interim corrective measure (ICM) at RSA-10, the active construction/demolition landfill at Redstone Arsenal. The ICM for this project involves the design and construction of a pump and treat system to prevent the spread of the existing trichloroethylene (TCE) groundwater contamination found at the site.

The CESAS has tasked EEC under the Idenfinite Delivery Order Contracts DACA 21-91-D-0024 and DACA 21-94-D-0040 to prepare design documents for the ICM at RSA-10. In order to facilitate design of the ICM, EEC will perform a field sampling program to obtain additional field data at the RSA-10 site.

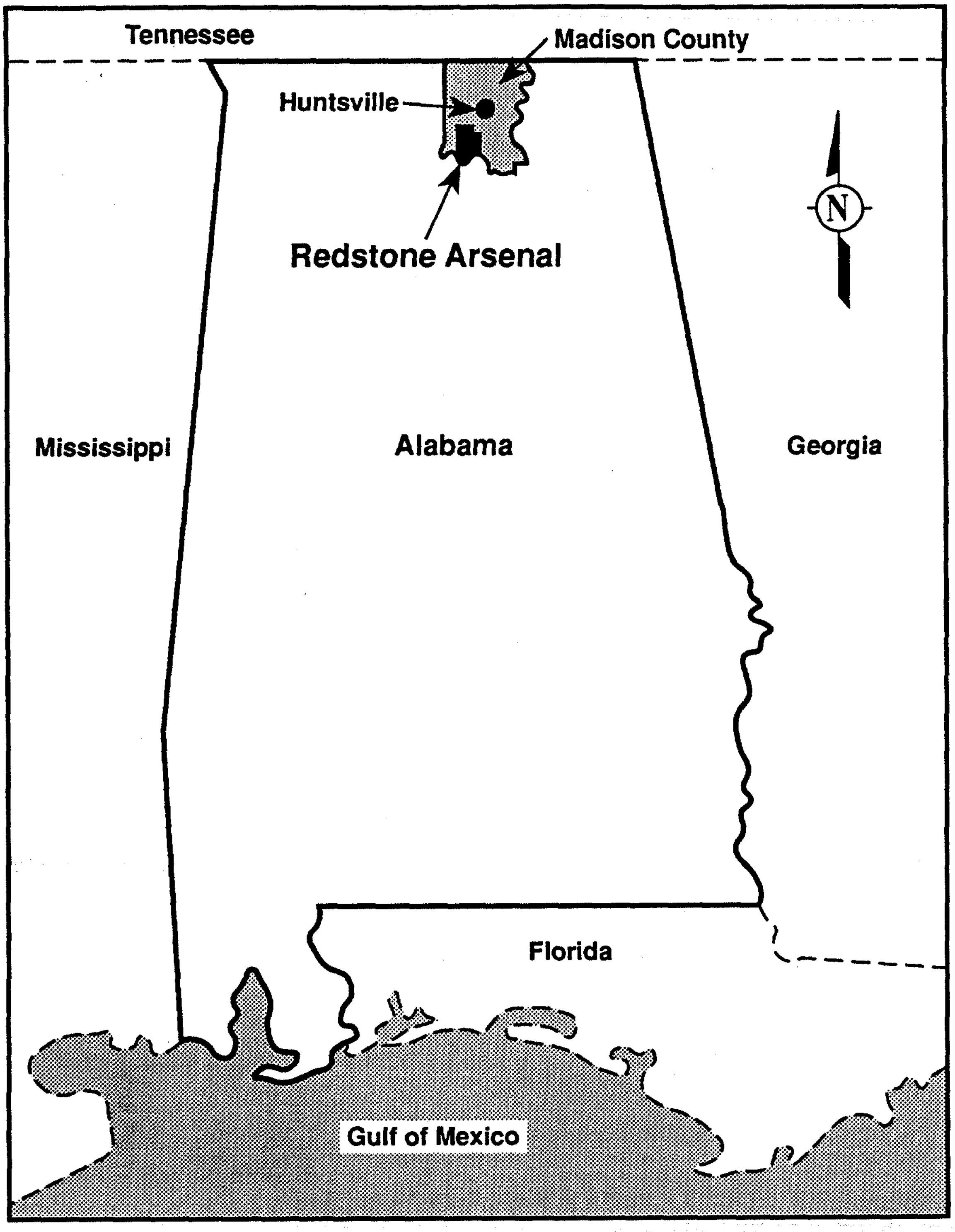
1.2 Location

Redstone Arsenal (RSA) is a U.S. Army facility located in Madison County, Alabama, as shown in Figure 1-1. It is bounded on the north and east by the City of Huntsville, on the south by Wheeler National Wildlife Refuge and the Tennessee River, and on the west by agricultural, residential and light industrial areas.

RSA-10 is located in the central portion of RSA and consists of approximately 68.5 acres (Figure 1-2). The area is bordered by Mills Road and woods to the north; wetlands, Wheeler National Wildlife Refuge and Wheeler Lake to the south; and NASA's East Test Area to the west. A 40-foot deep excavated drainage ditch borders RSA-10 on the east. RSA-10 is an unlined facility composed of two Solid Waste Management Units (SWMUs): the Construction/Demolition Landfill and the DDT Waste Soils Landfill (Figure 1-3). RSA-10 currently receives only construction/demolition wastes. In the past, the landfill was used for the disposal of household waste, sanitary waste, industrial waste, waste oil and construction debris. Previous investigations of this site indicate that both soil and groundwater contamination are present. TCE concentrations of approximately 390 parts per billion (ppb) and dichloroethylene (DCE) at 200 ppb have been encountered. Trace levels of other organic contaminants also are presents.

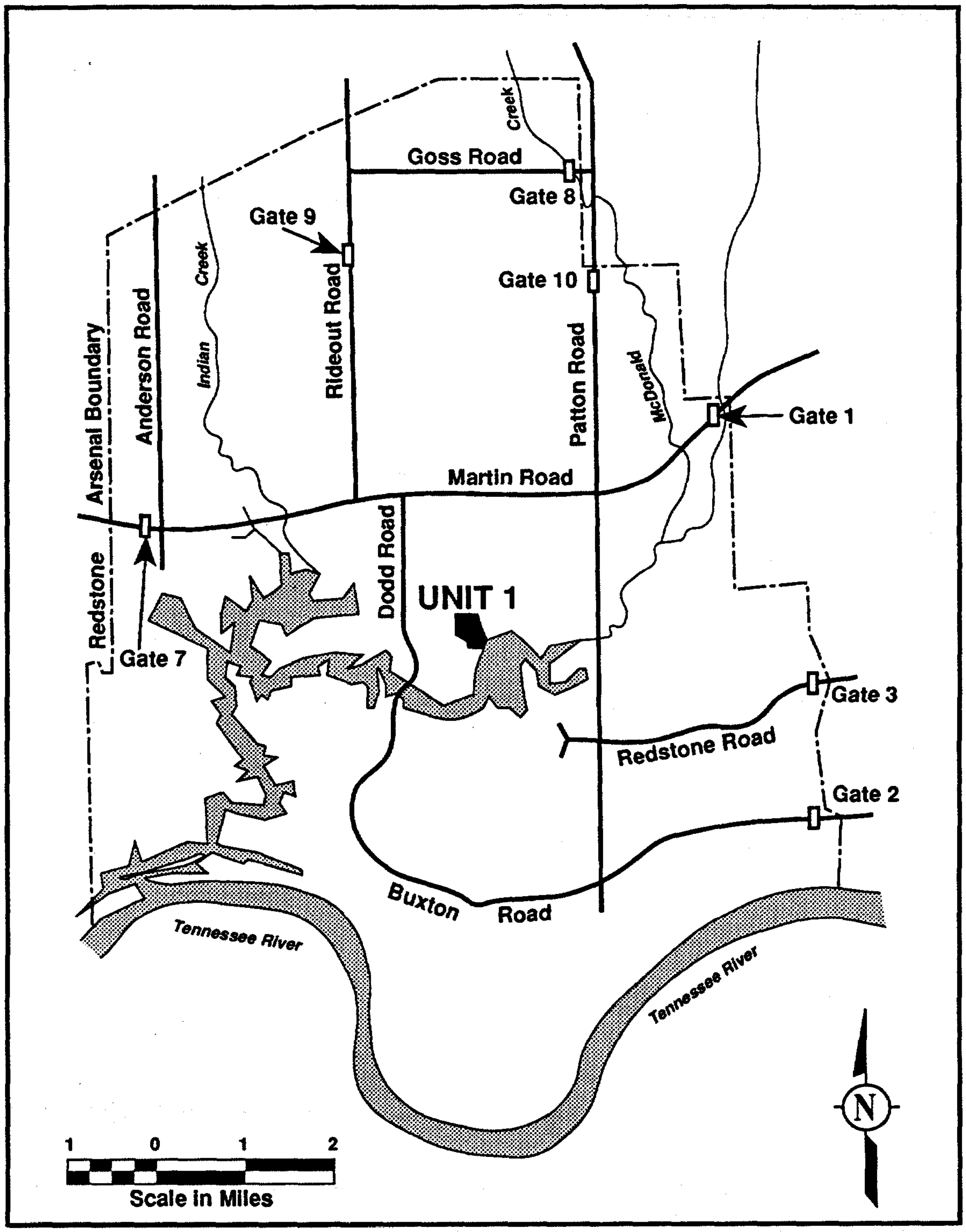
1.3 Field Program Objectives

EEC was tasked in 1992 by the USACE to design an Interim Corrective Measure to begin remediation of contaminated groundwater at the RSA-10 site. During preparation of the Draft ICM Design, it became apparent that the physical characteristics of the limestone aquifer, as well as the chemical characteristics of the groundwater, were not sufficiently defined. Hydrogeologic uncertainties, such as aquifer yield and location of fracture zones currently make it very difficult to predict if the proposed extraction wells will penetrate a productive zone, and if the aquifer will yield the predicted flows and contaminant concentrations. Additional information about the total suspended solids, iron and metals concentrations also is needed to determine the magnitude of pretreatment required for the ICM system.



ICM DESIGN AT UNIT 1, REDSTONE ARSENAL	
LOCATION OF REDSTONE ARSENAL	
ENSERCH ENVIRONMENTAL CORPORATION	October 4, 1994

FIGURE 1-1 LOCATION OF REDSTONE ARSENAL



ICM DESIGN AT UNIT 1, REDSTONE ARSENAL	
LOCATION OF UNIT 1	
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FIGURE 1-2 LOCATION OF UNIT 1

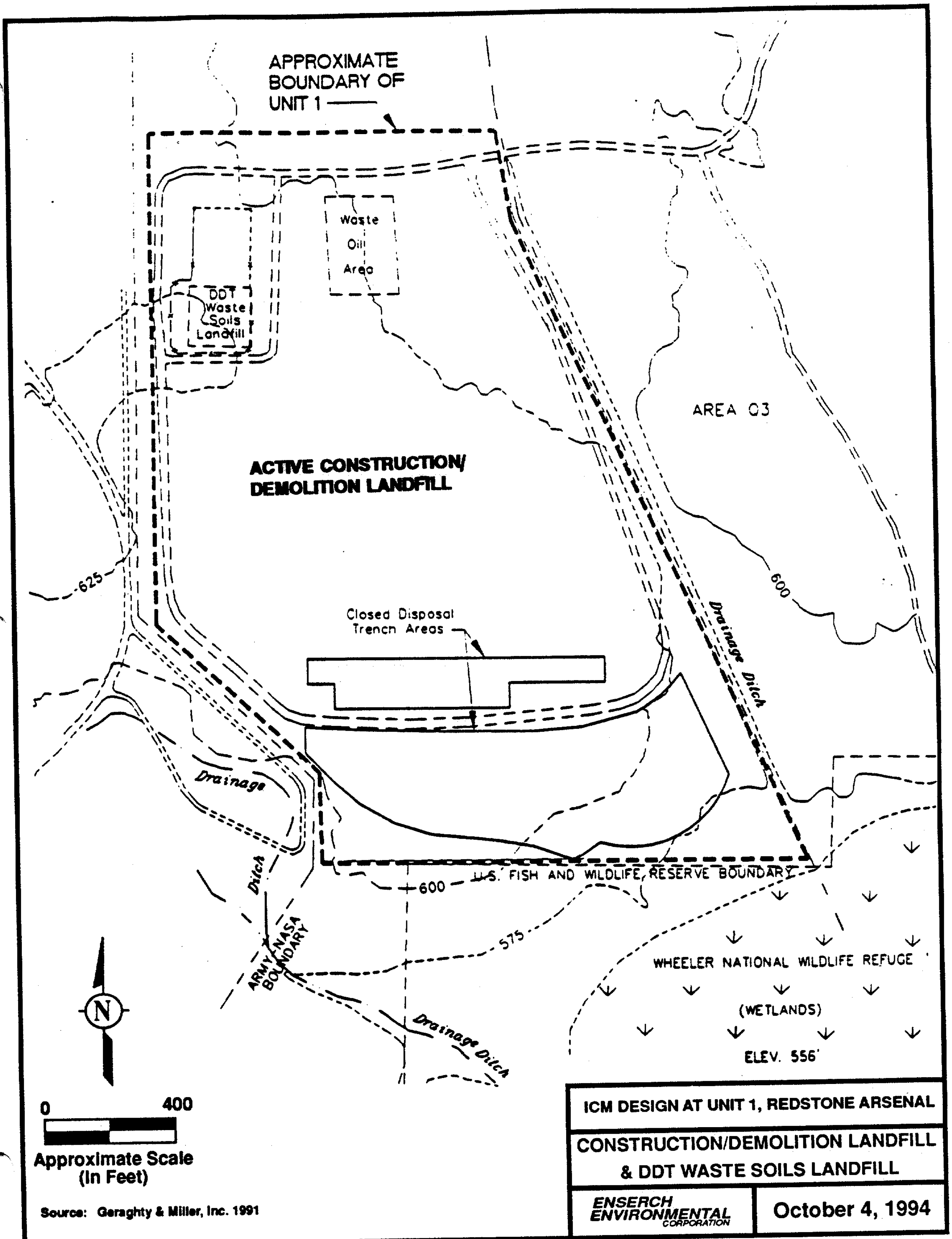


FIGURE 1-3 CONSTRUCTION/DEMOLITION LANDFILL & DDT WASTE SOILS LANDFILL

The purpose of this Field Program is to collect the additional data required to complete the design of the ICM. The scope of the proposed Field Program basically involves the installation of the extraction well network described in Section 2.0 of the RSA-10 ICM Design Work Plan [last revised October 1994], and the subsequent collection of chemical and physical data from those wells.

The physical data that will be obtained from this drilling and testing effort includes:

- Sediment and bedrock characteristics to allow for optimum well and well screen design.
- Aquifer hydraulics data to be used to project horizontal and vertical zones of capture and to project the quantity of water to be remediated.
- Groundwater quality data to be used to project future treatment requirements.
- Operational data from a temporary on-site carbon treatment system.

These data will be used to properly size the capacity and well field of the groundwater treatment system. As stated in the RSA-10 ICM Design Work Plan, it was necessary to use the Theis equation to estimate the potential radius of influence of an extraction well at the site. This information was essential in selecting the location, depth and screened interval of the test wells being installed during this field program. Once the raw data is obtained during this field program, it will not be necessary to use a model such as the Theis method to determine the aquifer characteristics at the site. The objective of this field program is to measure these characteristics directly. The direct measurements will be used to design the ICM.

Chemical analyses of extracted groundwater obtained during the Field Program will provide the data necessary to sufficiently characterize the groundwater contamination at the site. In particular, water quality parameters such as iron and total suspended solids are required to design any pretreatment system which may be required. Additional data to be collected will include analyses for metals and organics suspected of being present in the groundwater. These contaminants include all metals and organics detected during previous investigations.

At the conclusion of the Field Program, EEC will submit a Technical Report containing the results of the program and conclusions and recommendations for completion of the ICM Design.

2.0 FIELD ACTIVITIES

2.1 Overview of Field Activities

Field activities to be performed at the RSA-10 ICM site consist of:

- Mobilization and location of utilities
- Installation of test/extraction wells
  - Drilling of Test Borings
  - Drilling of Pilot Holes
  - Blow Testing of Pilot Holes
  - Reaming and Setting Test Well
- Installation of piezometers
- Well Development
- Pump testing and Specific Capacity Testing
- Well abandonment
- Land survey and water level survey
- On-site Carbon Treatment
- Sampling and analysis
- Decontamination/Demobilization

Work will not be performed in active areas of the RSA-10 landfill, nor in areas previously used for disposal. Boring locations have been carefully selected to avoid buried waste. Any work involving contact with buried waste will be considered a changed condition, and EEC will contact CESAS immediately.

2.2 General Field Operations

2.2.1 Mobilization and Utilities Location

Upon approval of this plan, a field sampling crew and drilling contractor will be scheduled and equipment will be mobilized to the site. Site personnel will be thoroughly familiar with this FSAP, and the Site Safety and Health Plan (SSHP) prior to initiating field activities.

During field mobilization activities, EEC personnel will accompany RSA or other personnel qualified to locate underground utilities. Well locations will be repositioned if there is a conflict with underground utilities as identified by the utility locator and maps identifying underground utilities' locations. Allowances will also be made for drilling near overhead utilities, wherever applicable.

2.2.2 Test/Extraction Well Installation

The method of drilling will in large part be left to the discretion of the driller; however, the drilling will be done in such a manner that no mud or cuttings will be forced into the channels or pore space of the aquifer. The equipment selected for use on this project shall be intended specifically for this type of work, be capable of handling the site geologic materials, and assure proper execution of the well installation program described herein.

A specific sequence of construction, testing and evaluation tasks will be performed to ensure that the wells meet the objectives of this project and the Statement of Work. All of the possible scenarios cannot be described here since the work to be performed will depend upon local conditions at each well site. Figure 2-1 shows the logic/decision tree of events. It is anticipated that the following sequence will occur at each of the seven (7) well locations:

- Construct one test boring to determine the depth to bedrock while collecting continuous split-spoon samples from the surface to top of rock (approximately 65 feet).

- Construct a second test boring within approximately 30 feet of the first boring to again determine the top of rock. No split-spooning is required.

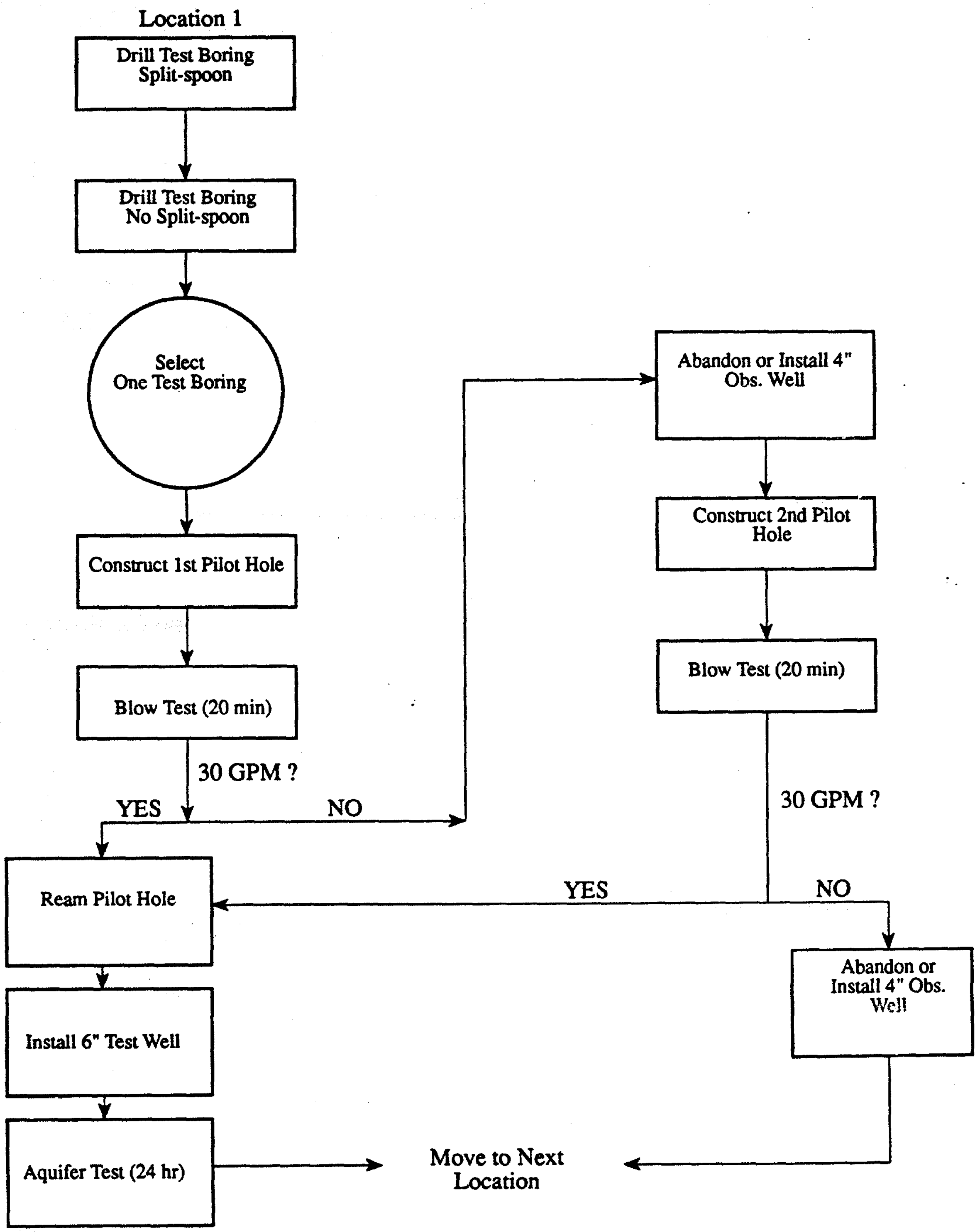
- Drilling through the unconsolidated soils for test borings above shall be accomplished via a hollow stem auger. Based on the elevations of top of rock, EEC will select one pilot hole for advance into the bedrock as follows.

- One test boring at each of the seven well sites will be selected by EEC for construction as a pilot hole and will be advanced 68 feet into bedrock. The pilot hole will be advanced into the bedrock using the air hammer method. The pilot hole will be temporarily cased one (1) foot into the top of rock; or the augers may be used instead of temporary casing.

- The pilot hole will be completed and a brief blow test performed as described in Section 2.2.2.3. If this first pilot hole shows that an adequate flow of groundwater exists, conversion of the second test boring into a second pilot hole will not be necessary at that test well location. If insufficient flow is determined during the blow test on the first pilot hole, the remaining test boring will be converted to a pilot hole and blow tested in the same manner as the first.

- A pilot hole that shows sufficient flow ($\geq$30 gpm) during the blow test will be reamed to a minimum of 12 inches (o.d.) to a total depth of approximately 133 feet.

Figure 2-1 Test Well Installation Logic Decision Tree



- Pilot holes which do not produce sufficient flow will either be completed as permanent observation wells or abandoned at the discretion of CESAS and EEC. Observation wells shall be developed as described in Section 2.2.4.

- A permanent 6-inch inner diameter test well will be installed in the reamed hole. This well will have a 60 foot long screen with a sand/gravel pack. The wells will be developed properly as described in Section 2.2.4 to yield sediment-free water.

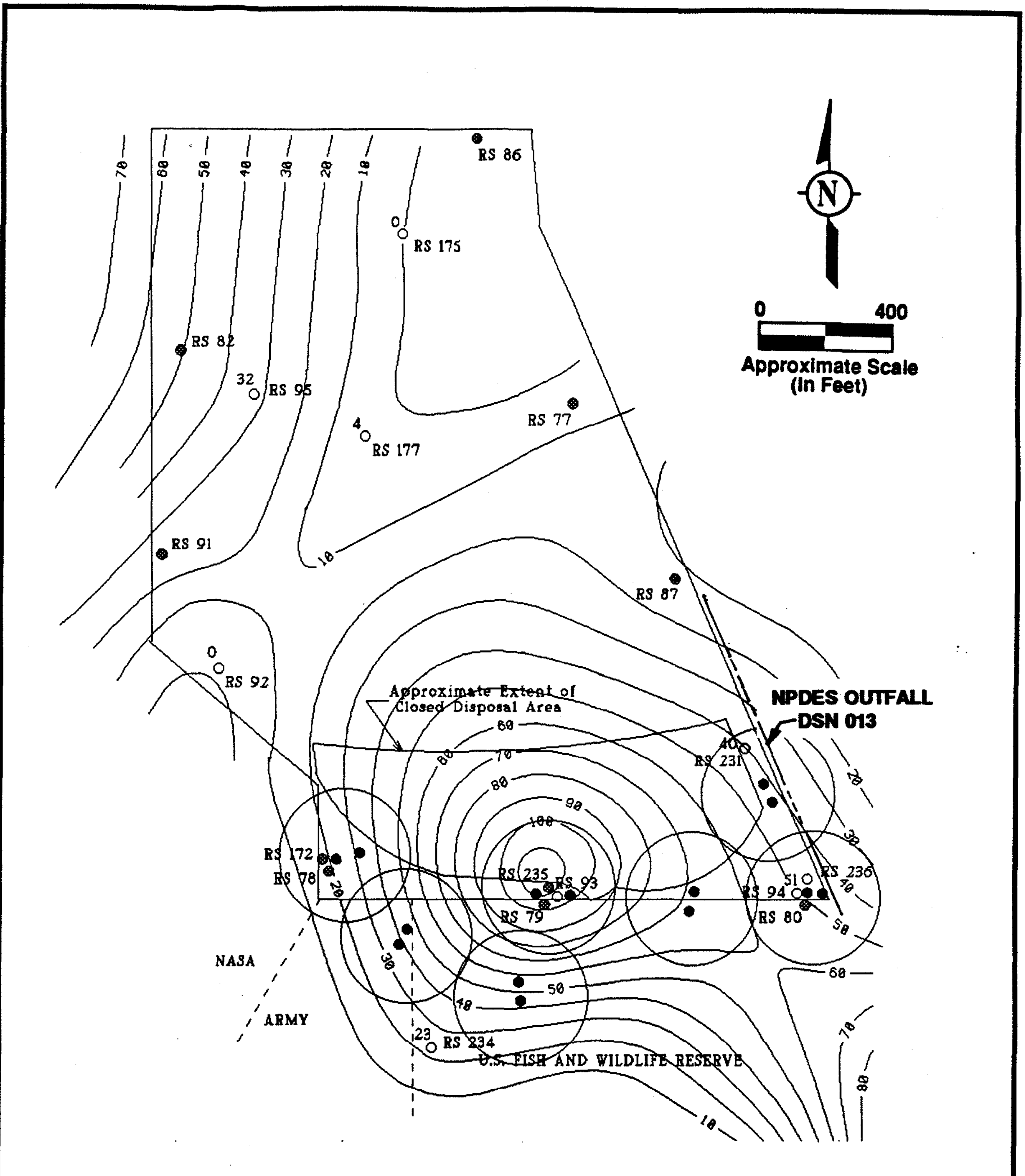
- Aquifer tests will be performed using three (3) of the test wells. Temporary piezometers will be installed as needed to record water levels during the tests. Specific capacity tests will be performed on the test wells not used for the aquifer test.

The locations of the seven proposed test wells are shown on Figure 2-2. After the borehole has been drilled, the well screen, attached end fittings and other appurtenances will be attached by an approved manner to the casing, lowered into the boring with the casing, and properly centered. It shall in no instance be driven or forced, and shall remain suspended from the surface until the gravel pack has been added. The string of casing and screen will be secured approximately 1 foot above the bottom of the borehole to allow the filter pack to form beneath the screen. Centralizers will be used to ensure plumbness and alignment of the wells, in addition to the performance of a deviation survey, described in Section 2.2.2.4.

The casing will be 6-inch minimum (I.D.), schedule 80 polyvinyl chloride (PVC) pipe with thread and couple joints. The screen shall be 6-inch (I.D.), continuous "V" slot, wire-wrapped design, Type 304 stainless steel and shall be 60 feet in length.

The screen slot size will be selected on the basis of the aquifer material (limestone rock and the presence or absence of fine material in the rock crevices) and the artificially introduced filter pack material as described below. Slot size shall be such that less than 10 percent of the sand filter pack can pass through (90% retention). Two different slot size screens will be provided on site at the time of mobilization. A pre-selected sand pack will be available for each slot size.

EEC will be prepared to install either a course (#6-10 sand) filter pack or a fine (#102 sand) filter pack depending upon conditions at each test well. The filter pack will be available in ratios corresponding to the screen sizes. If limestone containing crevices filled with fine grained sediment are encountered, a suitable fine grained sand pack material will be used to meet the well acceptance criteria. If no fine sediment is present, a coarse sand pack material will be used.



LEGEND

- EXISTING OVERBURDEN MONITOR WELL
- EXISTING BEDROCK MONITOR WELL
- 110 TOTAL TCH CONCENTRATION (ppb)
- PROPOSED PILOT HOLE LOCATION

CONTOUR INTERVAL = 10 ppb TCH

ICM DESIGN AT UNIT 1, REDSTONE ARSENAL	
PROPOSED TEST WELL LOCATIONS	
ENSERCH ENVIRONMENTAL CORPORATION	October 4, 1994

FIGURE 2-2 LOCATION OF PROPOSED TEST WELLS (PILOT HOLES)

2.2.2.1 Drilling of Test Borings

The USACE requires that all test wells installed during this project bottom out at the same approximate elevation (plus or minus 2 feet). In order to accomplish this, EEC will drill test borings at each of the 14 potential well locations (**Note:** There are only 7 potential wells, but there are 14 potential well locations). By drilling test borings, EEC will determine the range of bedrock elevations and can then plan for installation of test wells at equal elevations. The test boring with the deepest top of rock will govern the elevation of the bottom of screen for all wells.

Drilling through the unconsolidated soils for test borings will be accomplished using a 4-inch inner diameter (i.d.) and 6-inch maximum outer diameter (o.d.) hollow stem auger. EEC will collect continuous split-spoon samples at one of the two test borings for each of the seven potential wells. That is, 7 test borings will be split-spooned and seven will not. One and potentially both of these borings will be advanced into the bedrock as described in Section 2.2.2.2. Geotechnical analyses shall be performed on split-spoon samples as described in Section 2.2.11.

All 14 test borings will be drilled before proceeding with the remainder of work.

2.2.2.2 Drilling of Pilot Holes

Up to two test borings per location will be converted to pilot holes as follows. Pilot holes will be drilled into rock with a 4-inch i.d. and maximum 6-inch o.d. drill bit. Pilot holes will be temporarily cased 1 foot into the top of rock, approximately 66 feet below ground, to prevent cave in and allow for blow testing in the rock. Augers may be used as a substitute for temporary casing. An open hole in the bedrock will be advanced approximately 68 feet. Based on the demonstrated water flow rate produced during blow testing, described in Section 2.2.2.3, EEC will select one pilot hole at each site to be reamed for construction of a test well (See Section 2.2.2.4). If the first pilot hole is capable of producing a sustained flow of approximately 30 gpm (implying that a permanent test well in that location could produce approximately 15 gpm), the second pilot hole will not be drilled.

If two pilot holes are drilled, the pilot hole(s) not selected for use as a test well will either be finished as an observation well or abandoned, at the discretion of CESAS and EEC. A pilot hole to be completed as an observation well will be left as an open well in rock. Four (4) inch mild steel casing will be placed in the borehole and grouted in position 1 foot into the top of competent rock creating an observation well. The final casing will have a minimum annular space of 2 inches around the casing prior to grout placement. Abandonment of a pilot hole will be conducted as specified in Section 2.2.6. For planning purposes, it is estimated that up to 7 pilot holes will be completed as observation wells, and no pilot holes will be abandoned.

2.2.2.3 Blow Testing of Pilot Holes

A brief blow test will be performed by pumping each pilot hole using compressed air and measuring the duration of the test, flow rate, and total volume pumped. Each test will be run for a minimum of 20 minutes. The compressed air will be capable of producing a minimum of 30 gpm from the well for the duration of this test. The flow rate will be measured using either an established weir calculation or a flow meter. All water produced during the test will be containerized and moved to a central storage area to await on-site treatment as described in Section 6.0. The results of the blow tests will be used to select which wells will be converted to test wells. The criteria for accepting a bore hole as a potential well is discussed in section 2.2.6.

2.2.2.4 Reaming and Setting Test Wells

A pilot hole selected as a test well will be reamed to 12 inches using a two or three stage reamer with a stinger bit at the head of the drill string or a suitable hammer drill. A minimum twelve (12) inch o.d. hole shall be drilled into the bedrock. A minimum annular space of three (3) inches will be provided around the final well casing and screen for filter pack placement and grout. The hole will penetrate the Tuscumbia Limestone bedrock a minimum of sixty-eight (68) feet (total depth of approximately 133 feet below ground).

All test wells will bottom out at the same approximate elevation. Deviation from this standard will not exceed two (2) feet, plus or minus.

Temporary steel casing will be used to stabilize the borehole for setting all permanent components of the test wells. As an alternative, the driller may use hollow stem augers for protective casing.

Boreholes will be constructed and casing and screen installed plumb and true to line to within 3 inches per 100 feet of depth. EEC will perform a deviation survey for each well prior to installation of well materials. Any well bore exceeding the allowed deviation criteria will be straightened or grouted and a new bore hole drilled.

While the casing and screen remain suspended from the surface, the filter pack material and bentonite pellet seal will be placed by the use of a tremie pipe. The filter pack material will extend a minimum of 2 feet above the top of the screen. A graduated tape will be used to ensure proper depth. A five-foot bentonite pellet seal or bentonite slurry will be placed on top of the filter pack. The pellet seal (if used) shall be allowed to hydrate in accordance with the manufacturers specifications. The annular space above the bentonite will be filled with cement grout to ground surface.

Once the bentonite and grout have set for a period of at least 24 hours, each well will be developed to its maximum capacity as described in Section 2.2.4.

All test wells will be fitted with a vented protective cap which will be designed to prevent contaminants from entering the well. The well riser will be surrounded by a larger diameter steel protective casing rising 24" to 36" above ground level. The steel protective casing shall be provided with lock and cap. The cap for test wells shall be securely fastened to the well casing by means of the threaded connection.

Future plans at the RSA-10 site (for the ICM) include the installation of a vault around each well head. Therefore, no concrete pad or other structure will be installed around the well at this time. However, four 2-inch diameter bumper posts will be installed within a 3-foot radius around the well to protect the casing. The bumpers will extend a minimum of 2 feet into the ground and 3 feet above ground, be painted bright yellow, and be constructed of durable material.

2.2.3 Piezometer Installation

The drawdown at each installed well to be pump tested will be measured in two to three existing monitoring wells and/or new piezometers. If no or not enough monitoring wells exist nearby, new temporary piezometers will be installed. If new piezometers are required, they will be installed approximately 25 to 50 feet away from the pump test well. Piezometers will be drilled with an auger to refusal. Casing for temporary piezometers will be 2 inch I.D. thread and couple joint PVC or iron pipe. After the pump test is complete, the piezometer casing and screen will be removed, and the open hole will be grouted to the surface.

2.2.4 Well Development

EEC will develop each test well to its maximum capacity by surging, jetting and/or pumping. Development will continue for 4 hours (minimum) or until particle free water is produced. Particle free water is defined as follows:

Particle Size	Water Content
< #200 sieve (silt/clay)	< 10 ml/L
> #200 sieve (sand)	< 0.1 ml/L

EEC will determine the solids content using the Imhoff Cone Method. *The Imhoff Cone Method procedures are outlined in Appendix A.*

Permanent observation wells will be developed for a maximum of 4 hours, at the discretion of EEC. Temporary piezometers will not be developed.

All water produced by development will be containerized and moved to a central storage location awaiting on-site carbon treatment.

2.2.5 Pump Testing and Specific Capacity Testing

2.2.5.1 Aquifer testing will be performed in three (3) test wells as follows:

- Equipment will be installed prior to aquifer testing to begin background water level monitoring. A one hour duration trial test may be conducted, if necessary, to establish the target pump rate.
- Background water level monitoring will be conducted prior to aquifer testing for a period of approximately one hour.
- EEC will initiate pumping and adjust the pumping rate to attain a constant discharge rate.
- The pump will be shut-off after pumping a maximum of 20 hours, and recovery measurements will begin for up to 4 hours.

Detailed pump testing procedures are outlined in Appendix B.

The three wells to be pump tested will be selected in the field by EEC and submitted for approval to CESAS. Wells will be evaluated during development to determine if yields will be favorable for pump testing. Wells in the areas of highest contamination (based on previous investigations) which demonstrate favorable yield will be selected.

The pump tests are designed to determine the hydraulic characteristics of the contaminated aquifer and provide the data to predict the well yield necessary to intercept the contaminants. The duration of a test should be sufficient to identify delayed drainage or boundary effects. Decidedly, a 72 hour pump test would provide more data about late-time drawdown; however, three tests having a duration of 24 hours per test have been selected due to project time constraints and the necessity of treating all of the extracted water on site.

During each pumping test the well yield will be monitored with a flow meter. The initial pump settings will be guided by the results of the specific capacity tests conducted on other wells. The discharge valve will be pre-set, to the degree possible, to achieve a constant rate of 25 gpm or a rate sufficient to result in a maximum drawdown close to the top of the well screen. The rate will be adjusted only when absolutely necessary to keep the water level a safe distance above the pump intake. If necessary, a test will be disconnected and restarted after the water level has recovered to its original static position.

Water levels in the pumped well and 2 to 3 nearby monitoring wells or piezometers will be monitored with a pressure transducer and data recorder.

2.2.5.2 Specific capacity testing will be performed in test wells not being pump tested (up to 4 wells) as soon after each well is developed as practical. Specific capacity testing will proceed as follows:

- Equipment will be installed prior to specific capacity testing to begin background water level monitoring. Background water level monitoring will be conducted for a period of 5 minutes.

- EEC will start the pump and adjust the pumping rate to attain a constant discharge rate.

- After approximately 1000 gallons of water has been pumped, pumping will stop. EEC will then monitor well recovery for approximately 10 minutes.

All water produced during aquifer and specific capacity testing will be contained and transported to a central storage area awaiting on-site carbon treatment as described in Section 6.0.

2.2.6 Well Abandonment

As described in the RSA-10 ICM Design Work Plan, it is estimated from existing data that the aquifer underlying the site will yield an average of 25 gpm per well. Given the complex limestone hydrogeology, however, the actual flow from a well could vary from zero to 1,000 gpm, depending on whether or not the well intersects a productive fracture zone. For this design, it will be assumed that each well will produce from 15 to 35 gpm. Based on this assumption, and during installation of the extraction wells, a boring which does not appear capable of being converted to an extraction well having a pumping capacity of 15 gpm will be plugged and abandoned. Blow testing results will be evaluated to determine if a borehole will be completed as a well or abandoned as follows:

- During blow testing, air forced into the borehole displaces groundwater from the aquifer to the surface. The amount of water produced can be measured. Experience indicates that the flowrate of displaced water is roughly twice the potential yield of the completed well. Based on this, the criteria for accepting a borehole for completion as a well will be that the water produced during blow testing is at least 30 gpm.

The abandonment procedure shall restore, as closely as possible, the geohydrologic conditions that existed before construction began and shall conform to the State of Alabama regulations for well abandonment. Wells shall be grouted from the bottom of the borehole to the ground surface.

2.2.7 Land Survey and Water Level

This project will require surveying services within and adjacent to the site. These services entail the surveying of horizontal locations and vertical elevations of test wells, piezometers and abandoned boreholes. Survey data will be to 3rd order standards and will reference existing on-site monuments and/or permanent well disks which are tied to the Alabama State Plane Coordinate System and the North American Vertical Datum of 1929. Well designations will be obtained from the MICOM Environmental Office, Redstone Arsenal. Resulting coordinates and elevations will be submitted in hard copy, added to the existing RSA-10 topographic survey computer file, and plotted on the RSA-10 ICM Design Drawings.

Water levels in each of the test/extraction wells will be measured from the top of casing (TOC) and recorded in the field logbook. This activity will precede sampling and will provide information regarding groundwater flow direction.

2.2.8 Pretreatment Testing

EEC will test samples of groundwater obtained during the 3 pump tests to gather data for the design of the pretreatment portion of the ICM. The main objective will be to measure settling rates of the solids present in the groundwater. EEC will conduct a gravity sedimentation test using the methods outlined in Perry's Handbook of Chemical Engineering. *The procedures for the sedimentation test are contained in Appendix B.*

2.2.9 On-Site Groundwater Treatment

The contaminated groundwater resulting from development and testing of the extraction wells will be treated by temporary on-site treatment facilities. The treatment facilities will include the following components.

- One settling tank (3,000 gallons) with conical bottom to be used for settlable solids removal.
- Frac holding tanks (22,000 gallons each) for flow and contaminant equalization, and for holding treated effluent.
- Sand filters for TSS and iron removal.
- Carbon filters for organic removal.
- Pumps for transferring the water through the system, to the discharge point and for backwashing the sand filter.
- Holding tanks (300 gallons each) for holding process water.
- 55 Gallon Drums for storing spent carbon.
- An engine generator rated 15 KW, as a power source.

The treated effluent will be tested as described in Section 2.2.10.4 and discharged to a NPDES approved discharge point. Spent carbon will also be tested as described in Section 2.2.10.2 and properly disposed of.

2.2.10 Chemical Sampling and Analysis

Water samples collected for VOC analysis will be discharged directly into preserved 40 ml glass vials at a very low flow rate so that air will not be entrained in the sample. Sample bottles will be filled to the top to minimize aeration of the samples. The container will then be capped tightly, turned upside down and gently struck on the sampler's hand to check for bubbles. If air is present, that sample will be discarded and new samples will be collected until a sample is collected that is free of air bubbles. The remaining, pre-preserved sample bottles will then be filled. Samples will be handled and shipped according to procedures described in Section 5.0.

QA/QC requirements for sampling will include one split sample sent to the USACE QA laboratory and one blind duplicate sample sent to the contractor laboratory for every 10 samples taken. One VOC trip blank, prepared by the laboratory, will be included in each cooler for shipment containing VOC samples. Sufficient quantity for matrix spike/matrix spike duplicates will be collected approximately every 20 samples. A pre- and post-preservative blank sample, as well as equipment rinseate blank samples will be collected.

2.2.10.1 Soil Sampling and Analysis

Auger cuttings generated during test well construction will be stored in roll-off boxes provided at the site. In order to determine proper disposal procedures, one composite soil sample will be collected from each roll-off box and sent to a designated laboratory for analysis. The methods of analysis and the parameters to be analyzed are summarized in Table 2-1.

2.2.10.2 Spent Carbon Sampling and Analysis

The onsite carbon treatment system will include tanks to remove particles in the groundwater. The resulting spent carbon and filtered particles will be sampled and analyzed for the parameters shown in Table 2-1 and disposed according to the analytical results. The carbon was selected to last the duration of the field program; therefore, it is anticipated that only one composite sample of carbon will be required at the end of the project.

2.2.10.3 Groundwater Sampling and Analysis

Groundwater from each test well will be collected for sampling from each pilot hole, and during the pump test or specific capacity test, as applicable. All samples will be sent to a designated laboratory for analysis. Table 2-2 summarizes the method of analysis, parameters to be analyzed and the number of samples to be analyzed.

Pilot Hole Sampling

One sample will be collected from each installed pilot hole (up to 14 maximum) and will be analyzed for VOCs.

TABLE 2-1
IDW SOIL AND SPENT CARBON SAMPLING

Matrix	Duplicate Samples	SAD-Lab QA Samples	Trip Blanks	Parameter	EPA Method No.	DQO Level	Turn-Around Time	Est. No. of Samples*	Preservative	Sample Container
Soil or Spent Carbon	1/10	1/10	1/Cooler	TCLP-VOCs	1311	III	1 week maximum	3	Ice to 4°C	8 oz. wide mouth glass jar
	1/10	1/10	0	TCLP-Metals	1311	III	1 week maximum	3	Ice to 4°C	Can go with TCLP-VOCs
	*Excludes duplicate, QA and trip blank samples.									

TABLE 2-2
PILOT HOLE/PUMP TEST/SPECIFIC CAPACITY TEST SAMPLING

Matrix	Duplicate Samples	SAD-Lab QA Samples	Trip Blanks	Parameter	EPA Method No.	DQO Level	Turn-Around Time	Est. No. of Samples*	Preservative	Sample Container
Water	1/10	1/10	1/Cooler	VOCs	8240	III	14 Days	27	Ice to 4°C, 4 drops conc. HCl or $NaHSO_4$ to pH<2	3x40 mL glass septa vial
	1/10	1/10	0	PP Metals	6010/7470 7740/7421 7060/7471	III	14 Days	13	Ice to 4°C, HNO_3 to pH<2	2x500 mL P
	1/10	1/10	0	Manganese (Mn)	7460	III	14 Days	13	Ice to 4°C, HNO_3 to pH<2	1x500 mL P
	1/10	1/10	0	Iron (Fe)	7380	III	14 Days	13	Ice to 4°C, HNO_3 to pH<2	Can go with Mn
	1/10	1/10	0	Carbonate (CO_3)	2320	III	14 Days	13	Ice to 4°C	1x500 mL P
	1/10	1/10	0	TSS	160.2	III	14 Days	13	Ice to 4°C	Can go with TSS
	N/A	N/A	N/A	pH	150.1	III	N/A	13	N/A	On-site Analyses
	N/A	N/A	N/A	Turbidity	180.1	III	N/A	13	N/A	On-site Analyses

*Excludes duplicate, QA and trip blank samples.

Pump Test Sampling

Three samples per well will be collected during each pump test. One sample will be collected at the end of the first hour of pumping. A second sample will be collected at the mid-point of the pumping cycle. The third sample will be collected 30 minutes prior to the end of the pump test. Samples will be analyzed for all parameters shown on Table 2-2.

Specific Capacity Test Sampling

One sample per well will be collected during each specific capacity test. The sample will be collected at the approximate mid-point of pumping. Samples will be analyzed for all parameters shown on Table 2-2.

2.2.10.4 Treated Groundwater/NPDES Samples

It is estimated that approximately 150,000 gallons of groundwater will be generated by drilling, blow testing, development, pump testing and specific capacity testing. All of this water will be treated on-site as described in Section 2.2.9. All treated water will be discharged on-site in accordance with Redstone Arsenal's existing NPDES permit, as described in Section 6.0

In order for treated water to be discharged, its constituents must meet the requirements of the NPDES permit. Table 2-3 summarizes the parameters which must be analyzed in accordance with the NPDES permit. During the treatment system startup and shakedown period, treated water samples will be collected and the system modified as necessary until treated water proves to be in compliance with the NPDES permit requirements described in Section 6.0. Treated water will be recirculated through the system until lab analyses indicate compliance.

It is expected that the treatment system will be operated intermittently, as water is generated. The number of samples collected will depend on the number of batches discharged. One sample will be collected per discharge. During system startup/shakedown, samples will be collected from a treatment system effluent sampling port. Once the system is in compliance, samples will be collected at the point of discharge (end of pipe) at the stream.

During sampling at the treatment system port, water will be allowed to run for 10 seconds into a 5-gallon bucket before filling the appropriate sample bottle. This will ensure that the water collected represents flowing water within the system and not stagnant water within the sampling port. The water discharged into the bucket will be recycled back into the treatment system.

2.2.11 Geotechnical Sampling and Analysis

During drilling of the test borings, split-spoon samples will be collected from seven borings as described in Section 2.2.2.1. Geotechnical analyses will be performed on each sample as described below.

- Sampling will be done with a split-spoon sampler (ASTM-D 1586-667) or thin wall sampler (ASTM 1587-74) using standard sampling techniques. A CME 5 foot split sampler may be used provided 90% recovery is maintained throughout each drive or run of the tools.
- Samples will be stored in labeled, air-tight plastic or glass containers.
- All samples will be visually classified by the Unified Soil Classification System. Classification will be verified by laboratory analyses. Lab analyses will consist of the following:

Test Description	No. Required/Well
Grain Size Distribution (ASTM-D 421 & 422)	1
Atterburg Limits (ASTM-D 423 & 424)	1
Moisture Content (ASTM-D 2216)	1

2.2.12 Decontamination

All drilling and sampling equipment will arrive at the site clean and in good working condition. Drilling and sampling equipment, including appropriate portions of the drill rig, augers, drill casing, rods, tools, etc. will be decontaminated between each drilling event to prevent potential cross-contamination of soil and groundwater.

Decontamination will be conducted on a decon pad constructed in the field. The pad will be designed so that all water and soils resulting from the decontamination process can be captured and transferred to storage containers. The disposition of contained decon water and solids is discussed in Section 6.0.

Tools and equipment will be decontaminated using the following procedures:

- Steam clean equipment;
- Rinse with potable water;
- Air dry all equipment;
- Wrap in aluminum foil or plastic (if equipment is not to be used immediately).

TABLE 2-3
TREATED GROUNDWATER/NPDES SAMPLING

Matrix	DuplicateS amples	SAD-Lab QA Samples	Trip Blanks	Parameter	Method No.	DQO Level	Turn-Around Time**	Est. No. of Samples*	Preservative	Sample Container
Water	1/10	1/10	1/Cooler	VOCs	8240	III	24 hr/ 14 Days	5	Ice to 4°C, 4 drops conc. HCl or $NaSO_4$ to pH<2	3x40 mL glass septa vial
	1/10	1/10	0	COD	410.1	III	24 hr/ 14 Days	5	Ice to 4°C H_2SO_4 to pH<2	1x500 mL P
	1/10	1/10	0	Oil & Grease	413.1	III	24 hr/ 14 Days	5	Ice to 4°C H_2SO_4 to pH<2	Can go with COD
	1/10	1/10	0	TSS	160.2	III	24 hr/ 14 Days	5	Ice to 4°C	1x500 mL P
	1/10	1/10	0	Total Copper (Cu)	220.1	III	24 hr/ 14 Days	5	Ice to 4°C, HNO_3 to pH <2	1x500 mL P
	1/10	1/10	0	Total Lead (Pb)	239.2	III	24 hr/ 14 Days	5	Ice to 4°C, HNO_3 to pH <2	Can go with Cu
	1/10	1/10	0	Total Mercury (Hg)	245.1	III	24 hr/ 14 Days	5	Ice to 4°C, HNO_3 to pH <2	Can go with Cu
	N/A	N/A	N/A	pH	150.1	N/A	5	5	N/A	On-site Analyses

*Excludes duplicate, QA and trip blank samples.

**Important: Samples taken during system start-up/shakedown will be analyzed on a 24-hr turnaround basis to determine if treated water meets discharge requirements. Once treated water proves to be in compliance the first time, water may be discharged prior to receipt of results, and turnaround time can be increased to 14 days.

All sampling equipment that comes in direct contact with an analytical sample and is not disposable will be decontaminated prior to each sampling episode using the following procedure.

- Scrub equipment with a low-sudsing, non-phosphate detergent in potable water;
- Rinse with potable water;
- Rinse with 0.1N nitric acid solution (4.2 ml of conc. reagent grade nitric acid added to 1000 ml deionized water); and
- Rinse with distilled water to sufficiently neutralize.

3.0 EEC PROJECT ORGANIZATION AND FUNCTIONAL AREA RESPONSIBILITIES

3.1 Project Organization

The Program Manager, David Schaer is responsible for the quality of all work performed under USACE Contract DACA 21-94-D-0040. Kim Veal serves as the Project Manager (PM). The PM has primary responsibility for implementing the investigation. The PM is supported by the Field Operations Leader (FOL) and the Field Health and Safety officer (HSO). The FOL is responsible for onsite management of activities during the field investigation. Joel Davis will be the FOL. Mr. Weldon Evans will be the HSO.

Additional project personnel are listed on Table 3-1. This table also denotes quality control officers. Resumes of all EEC personnel proposed for this work are provided in Appendix D. All EEC field personnel are hazardous waste health and safety trained and medically monitored.

3.2 Quality Assurance/Quality Control

Project quality assurance and quality control will be performed under the direction of Mr. Ashton Pearson from EEC's corporate QA/QC group. The project QA officer will be Sue Jones who is responsible for laboratory activities. Additional details are provided in Sections 4 and 5 of this plan.

All project personnel are responsible for ensuring the quality of work on the project. Project quality control officers are identified in Table 3-1. Each officer is responsible for the quality of work performed under their direction. Mr. Schaer is responsible for quality control at the program level and Ms. Veal is responsible for the quality of work at the project level. Mr. Davis is responsible for quality control in the field.

3.3 Analytical Laboratories

TBD laboratory will be utilized during this project to provide for all analyses identified in Tables 2-1 through 2-3. Their current USACE Missouri River Division (MRD) validation will be provided to the Corps Project Manager upon request.

TABLE 3-1

EEC PROJECT PERSONNEL

Program Manager

David Schaer*

Project Manager

Kim Veal*

Field Operations Leader(s)

Joel Davis*

Health and Safety Officer

Weldon Evans

Field Sampling Technician

Dewayne Buskey

Corporate Health and Safety

Gerry Delaney
Diane Morrell

Corporate QA/QC

Ashton Pearson

QA Officer

Sue Jones

* Quality Control Officers

4.0 CHEMICAL DATA QUALITY OBJECTIVES (CDQO)

The primary objective of field sampling for this project is to collect and analyze environmental samples to determine the quality of influent water to the water treatment system and compliance with National Pollutant Discharge Elimination System (NPDES) permit requirements for the effluent. To achieve this objective, a multi-step process is used to develop site-specific CDQO needed for this task. CDQO are developed to ensure that:

- Data needs for the engineering requirements are met.
- Alabama and Federal Applicable Relevant and Appropriate Requirements (ARARs), risk-based criteria, and data needs for engineering requirements are met.
- Samples are analyzed using well defined methods that will provide confident detection limits sufficiently below the NPDES permit conditions and Federal ARARs.
- The precision and accuracy goals of data are well defined and adequate to provide defensible data.
- Samples are collected using approved techniques and are representative of existing environmental conditions.
- Quality Assurance/Quality Control procedures for both field and laboratory methodology meet the USACE guidance document requirements.

Data Quality Level III was selected for this project because of the nature of the investigation. This level of quality represents data generated under laboratory conditions using USEPA-approved procedures. This type of data is used for determination of source, extent, or characterization of contaminants and to support evaluation of remedial technologies and treatability studies, if applicable. These data are both qualitative and quantitative. The specifics of the chemical data quality objective as it applies to field and laboratory procedures are discussed in the quality assurance/quality control section of this FSAP.

In addition to the general level of effort required for DQO III, there are additional factors that will aid in judging the quality of the data. The first of these is the use of split samples. To judge reproducibility and the quality of data from the contractor laboratory, samples will be split in the field and also sent to the MRD laboratory in Marietta, Georgia. Upon evaluation of these samples and receipt of contract lab data, the MRD lab will generate a QA report of its findings. The contractor laboratory will be required to have a current MRD validation that involves onsite inspections and successful evaluation of performance samples.

5.0 FIELD AND LABORATORY DATA MANAGEMENT

5.1 Field Documentation

During drilling of each boring, a daily detailed driller's report will be maintained and be available upon request at the well site. The report shall give a complete description of all number of feet drilled, number of hours on the job and dates, shutdown due to breakdown, and water level encountered.

During drilling of each boring a drill log will be kept by a qualified geologist setting forth the following parameters:

- The reference point for all depth measurements (formations, samples, total depth, etc.);
- Depth of each change of stratum and stratum thickness;
- Identification of material from each stratum (according to USCS);
- Hole instability, special drilling problems, odors, and evidence of contamination;
- Depth at which hole diameter (bit sizes) change;
- The depth at which the first water was encountered; and
- The depth at which bedrock was first encountered.
- Total depth of completed well;
- Location of any fractures, joints, caves, etc.
- Depth of grouting;
- Nominal hole diameters;
- Amount of cement used for grouting;
- Depth of well casing;
- Description of well screen(s) and filter pack(s),
- Static water level upon completion of well and after development;
- Health and safety readings;

- Flow rate and volume at total depth, measured by blow test; and
- Settling rate of sediment in groundwater using sedimentation test.

During groundwater sampling, the date, time, appearance of the sample (e.g. turbidity), and any other significant information about the sample will be recorded on the field logbook. Each sample collected will have its own number, which will apply during the duration of the project. The sample numbers will consist of a multi-faceted alpha-numeric code, that will identify: 1) the type of sample, 2) the sample location (i.e., test well no., port no., roll-off box no.), and 3) other qualifiers such as the first or third sample of a group.

5.1.1 Sample Codes

Sample codes will be as follows:

SS - Soil Sample
CAR - Spent Carbon Sample
TW - Test Well Sample
NPD - NPDES Sample
D - Duplicate Sample
TB - Trip Blank Sample
MS/MSD - Matrix Spike/Matrix Spike Duplicate Sample
PEP - Prepreservative Sample
PTP - Post - Preservative Sample
QA - USACE QA Split

In order to eliminate unnecessarily long sample IDs., general designations such as "RSA", "RSA-10", or "Unit 1" will be omitted.

Example A sample taken from Test Well Number 3, during pump testing at the 1-hour point (first sample of 3 in a group) would have the designation:

TW-#3-01

Sample taken at 10 hours: TW-#3-02

Sample taken 30 minutes before end of test: TW-#3-03

QA/QC Sample Designation: Blind duplicates will be designated by a fictitious sample location number, followed by the letter "D" and the date of sampling. For example:

TW-#100-D/10-15-94

Blind duplicates must be clearly noted and cross-referenced in the field log book and on EEC's copy (not the lab's copy) of the chain-of-custody form.

USACE split samples will be labeled the same as the original sample, followed by "QA" (e.g. TW-#3-01-QA). Trip blank samples will be designated "TB" followed by the relative number 1,2,3, etc. for first, second, third, etc. sample, and the date (e.g. TB/10-15-94). Matrix spike/matrix spike duplicate samples will be labeled the same as the original sample, followed by MS/MSD, and the date (e.g. TW-#3-01-MS/MSD/10-15-94). Table 5-1 lists the QA/QC samples necessary for this project.

As field activities progress it may become necessary to alter the procedures outlined in this FSAP to respond to field conditions. Any major changes or deviations from this FSAP will be documented by the FOL in the site logbook and a Field Change Request (FCR) Form initiated (see Figure 5-1). The FCR will be signed by the Project Manager, distributed to the Program Manager, the USACE Project Manager and the project file. A copy will also be kept in the onsite office trailer with the FSAP. Major changes will be discussed with the USACE Technical Manager (TM) before implementation.

A copy of the field logs shall be submitted to the USACE Project Manager following completion of the Field Program.

5.2 Sample Handling

To maintain and document sample possession, chain-of-custody (C-O-C) procedures are required. These procedures are necessary to insure the integrity of samples from collection to data reporting. C-O-C provides the ability to trace possession and handling of samples from the time of collection through analysis and data deposition.

A sample is considered under custody if:

- It is in your possession; or
- It is in your view after being in your possession; or
- It was in your possession and you locked it up; or
- It is in a designated secure area.

Personnel collecting samples are personally responsible for the care and integrity of these collected samples until they are properly transferred or dispatched. Therefore, the number of people handling a sample will be kept to a minimum.

TABLE 5-1

ANALYTICAL METHODS AND DATA QUALITY OBJECTIVES

Matrix	Parameter	Analytical Method	Quantitation Limit (μg/L)	Precision (RPD)	Accuracy (%R)
Water	VOCs	8240	5-1000	*	*
	COD	410.1		*	*
	Oil and Grease	413.1		*	*
	TSS	160.2	4000	*	*
	Antimony	6010	32	*	*
	Arsenic	7060	1	*	*
	Beryllium	6010	0.3	*	*
	Cadmium	6010	4	*	*
	Chromium	6010	7	*	*
	Copper	6010	6	*	*
	Lead	7421	1	*	*
	Mercury	7470	0.2	*	*
	Nickel	6010	15	*	*
	Selenium	7740	2	*	*
	Silver	6010	7	*	*
	Thallium	6010	40	*	*
	Zinc	6010	2	*	*
	Manganese	7460	2	*	*
	Iron	7380	7	*	*
	Carbonate	2320		*	*
	TCLP VOCs	1311	Note 1	*	*
	TCLP Metals	1311	Note 1	*	*

* To be calculated upon receipt of analytical results.
Note 1: One-half the Regulatory Limit

FIGURE 5-1
FIELD CHANGE REQUEST
-TYPICAL-

Site Name EEC Charge Number Field Change Number

____

To______________________ Location______________________ Date______________

Description:

____
____
____

Reason For Change:

____
____
____

Recommended Disposition:

____
____
____

____
Field Operations Leader (Signature) Date

Disposition:

____
____
____

____
Project Manager (Signature) Date

Distribution: Program Manager

Others as required: ______________
USACE Project Manager ______________
Quality Assurance Manager ______________
Project File

The C-O-C Form (Figure 5-2) will be completed by the sampler. The sampler will sign the form where indicated and record site identification, sample number, date and time of sampling, sample location, and requested analysis for each sample collected. The FOL will check off each sample analysis required on the C-O-C Form and check the sample label and C-O-C record for accuracy and completeness.

When transferring custody of samples, the individuals relinquishing custody and receiving custody will sign, date, and record the time on the C-O-C Form. The C-O-C Form documents the transfer of samples from the sampler to the analytical laboratory. Upon receipt of shipment at the laboratory, a designated sample custodian will accept custody of the samples and verify that information on the sample labels matches the C-O-C Form. Pertinent information on shipment, pickup, courier, date, and time will be recorded on the record. It is then the laboratory's responsibility to maintain internal logbooks and custody records throughout sample preparation and analysis.

Based on existing information, it is not anticipated that any environmental samples will be hazardous enough to warrant special considerations for packaging and shipping. Samples will be shipped for overnight delivery in waterproof coolers using the following procedure:

- Place about 3 inches of inert cushioning material such as vermiculite in the bottom of a plastic bag-lined cooler.
- Enclose the sample bottles in clear plastic bags through which sample labels are visible and seal the bag. Place bottles upright in the cooler in such a way that they <u>do not touch</u> and will not touch during shipment.
- Put in additional inert packing material to partially cover sample bottles (more than halfway). Place bags of ice around, among, and on top of the sample bottles. If chemical ice is used, it should be placed in a plastic bag.
- Fill cooler with cushioning material.
- Put paperwork (chain-of-custody record) in a waterproof plastic bag and tape it to the inside lid of the cooler.
- Tape the drain shut.
- Secure lid by taping. Wrap the cooler completely with strapping tape at a minimum of two locations. Do not cover any labels.
- Attach completed shipping label to top of the cooler.
- Put "This Side Up" labels on all four sides and "Fragile" labels on at least two sides.

FIGU[illegible]-2

EBASCO SERVICES INCORPORATED
CHAIN OF CUSTODY RECORD

PROJECT

SAMPLERS: (Signature)

SAMPLE NUMBER	DATE	TIME	COMP.	GRAB	NO. CONTAINERS	P P METALS	P P MERCURY	BASE/NEUTRAL EXT.	ACID EXT.	VOLATILE ORG.						REMARKS OR SAMPLE LOCATION	PRESERVATION	
																	ICED	SPECIFY CHEMICALS ADDED AND FINAL pH IF KNOWN

Relinquished by: (Signature) ①	Date / Time	Received by: (Signature)	Relinquished by: (Signature) ④	Date / Time	Shipped via:
Relinquished by: (Signature) ②	Date / Time	Received by: (Signature)	Received for Laboratory by: (Signature)	Date / Time	Shipping Ticket No.
Relinquished by: (Signature) ③	Date / Time	Received by: (Signature)	Remarks		

- Affix numbered and signed custody seals on front right and back left of cooler. Cover seals with wide, clear tape.

All samples will be shipped to the laboratory on the day the samples are taken. Samples will be stored at 4°C, with a trip blank stored with all aqueous volatile organic samples from the time of sample collection. If sample integrity if compromised by the Contractor holding samples or allowing coolers to run out of ice, the sites will be re-sampled at no cost to the government.

5.3 Laboratory Analytical Program

5.3.1 Laboratory Analytical Procedures

The samples collected will be analyzed using the methods specified in USEPA SW-846, "Test Methods for Evaluating Solid Wastes" and "Methods for Chemical Analysis of Water and Wastes" EPA 600/4-79-020 (1983). This section is designed to provide information on analysis type, sample preparation, analytical methods, and QA/QC information necessary to achieve the project goals.

5.3.2 Method Data Quality Objectives

This section is intended to discuss data quality objectives as applied to the various methods for sample analyses. Analytical methods are selected based on the precision, accuracy, reproducibility, completeness, and comparability (PARCC) parameters necessary to satisfy the intended end use. The criteria used for evaluation of data quality is dependent on the specific analytical method which will contain method-specific quality control requirements.

The description and procedures to assess the PARCC parameters of the measurement data are discussed in the following section. The objectives for the PARCC parameters are shown in Table 5-1.

Precision

The measurement of precision will be performed for both sample collection and laboratory analysis procedures. The goal of this evaluation is to determine how much the quality of data is affected due to variation associated with field and/or laboratory techniques. For the purpose of evaluation, precision data will be obtained by calculating Relative Percent Difference (RPD) for field and laboratory duplicate sample results. The formula to be used is as follows:

$$RPD = \frac{|R_1 - R_2|}{(R_1 + R_2) / 2} \times 100$$

Where R_1 and R_2 are initial and duplicate results, respectively.

Accuracy

Accuracy measures the bias in a measurement system. The measurement of accuracy will be performed in accordance with specifics provided in the analytical methods. For all analyses, one field sample in an analytical batch (20 samples) will be spiked with a known amount of arsenic and percent recoveries will be calculated. The general formula for calculation of accuracy is as follows:

$$\%R = \frac{\text{Concentration of spike found X 100}}{\text{Concentration of spike added}}$$

Additionally, laboratory control samples will be run at least once during every batch analysis.

Representativeness: Representativeness expresses the degree to which sample data accurately and precisely represent an environmental condition. This criteria will be met by making certain that sampling locations are selected and samples are collected properly.

Comparability: Comparability is a qualitative parameter expressing the confidence with which one set of data can be compared with another. For this project, comparability will be measured by ten percent of actual field samples being split between the USACE laboratory and EEC's contracted laboratory. In accordance with the Statement of Work for this project, samples will be shipped to the USACE laboratory for monitoring of the contract laboratory. The results of these samples will be reviewed by USACE and final recommendations provided to the USACE Project Manager for action, if necessary.

Additionally, the following measures will be taken to further ensure the comparability of the data:

- Appropriate selection of sampling and analysis procedures.
- Standardized written sampling and analysis procedures.
- Standardized handling and shipping procedures for all collected samples.

Completeness: Completeness is the percentage of reported analytical data that is usable. This procedure should be performed and determined during data validation. EEC will achieve a high level of completeness by ensuring that work is performed by well-trained personnel who know the project-specific objectives in both the field and laboratory. Furthermore, the guidance document requirements for QA/QC will be employed to help define and maintain the data quality level for the project. The USACE can expect to obtain a completion percentage of at least 90. The remaining data may be rejected by validation processes.

5.3.3 Laboratory Analytical Methods and Reporting

Samples will be prepared and analyzed using the methods specified in Tables 2-1 through 2-4. The methods selected are from "Test Methods for Evaluating Solid Wastes" (USEPA SW-846, third edition) and "Methods for Chemical Analysis of Water and Wastes" (USEPA 600/4-79-020, 1983). The details of the sample preparation and analysis techniques are contained in the respective method documentation as referenced above.

The laboratory will submit to EEC a data package that will include but not be limited to summaries of sample and quality control results, a narrative section addressing unusual events, and C-O-C information. A complete validated data package will be submitted by the EEC at the completion of the project.

5.4 Chemical Data Quality Assurance/Quality Control

The collection of samples and the analyses of the samples for this project will include quality control samples designed to monitor general techniques and practices. The field and laboratory quality control samples will comprise approximately ten percent (10 %) of the total field samples. Evaluation of the results of the impact on actual field samples will be the responsibility of the USACE QA Group. The report of their findings will be submitted to EEC for project applications. Details of how the QC samples will be applied are discussed in the proceeding section of this text.

5.4.1 Field Quality Control Samples

Field QC samples will be used to monitor the techniques used during sample collection, shipment, and equipment/container cleaning. The following QC samples will apply for the field activities:

Trip Blanks: Trip blanks will be used to determine potential cross-contamination resulting from the transportation and storage of samples. The blank will consist of organic-free reagent water originated by the laboratory in appropriate sample containers. Trip blanks will be shipped and stored with aqueous VOC samples from the time of collection to analysis. The analysis of the trip blank will be for VOC only. Trip blanks will be sent with every cooler of aqueous VOC samples to both the USACE QA laboratory and the contractor laboratory.

Split/Duplicate Samples: Split samples are samples that are collected as a single sample then homogenized, divided, and placed in two separate sets of containers. Duplicates are multiple grab samples, collected separately, that equally represent a medium at a given time and location. A minimum of 10 percent each split and duplicate samples will be shipped for quality assurance purposes to the USACE QA laboratory for splits and contract laboratory for duplicates.

5.4.2 Laboratory Quality Control

Method Blank: Each analytical batch will contain at a minimum one method blank. Generally, the blank will consist of laboratory grade water carried through the analytical process as if it were an actual environmental sample. This analysis will measure any laboratory generated contamination.

Matrix-Spike/Duplicate Samples: Matrix-spiked samples, which are known in organic analysis as matrix spike/matrix spike duplicate, and in inorganic analysis as duplicate and spike samples will be used to evaluate precision and accuracy. Spiked samples will be applied one in every twenty actual field samples per matrix. Triple volume of sample will be collected at this frequency and spiked at the laboratory. The inorganic duplicate is split in the laboratory and then analyzed as if it were a regular sample.

Surrogate Samples: For GC/MS analyses, designated concentrations of surrogate compounds will be added to each sample prior to sample preparation to determine method compliance. The GC/MS methods give criteria for surrogate recoveries on each sample which are used to determine if the sample must be reanalyzed.

Calibration Procedures and Frequency

Initial Calibration: On the first day of analysis for a given analytical method, the instrument will be calibrated as specified in the method. A minimum coefficient of correlation of 0.995 will be used unless specified by the method or alternative evaluation technique provided.

Daily Calibration: On subsequent days daily calibration will be performed if no other analytical activities were conducted on the instrument in the interim period. Daily calibration will consist of the analysis of one of the standards. This determination must agree within two standard deviations or 25 percent of the mean of previous calibration standards at chosen concentrations. If the calibration standard is not within these two determinations, the standard will be reanalyzed. If the results of the second determination still do not fall within the guidelines, the analyses will be considered invalid, and the samples will be reanalyzed after initial calibration is reported.

Preventive Maintenance: All standards are purchased from commercial suppliers and are traceable to the National Institute of Standards and Technology. Preparations and dilutions made in the laboratory are documented for this use. Dates are placed on all standards when they arrive, and records showing when the standards are opened and used are also documented.

The laboratory will periodically maintain and calibrate its major equipment including gas chromatograph/mass spectrophotometer, gas chromatograph, atomic absorption spectrophotometer, inductively coupled plasma spectrophotometer, etc.

This maintenance requirement will apply to all test and measurement equipment used in the laboratory. A spare parts inventory is maintained for all major equipment.

All equipment maintained and calibrated will have an assigned record number permanently affixed to the instrument. A label will be affixed to each instrument showing: description, manufacturer, model number, serial number, date of test calibration or maintenance, by whom it was calibrated/maintained, and due date of next service. Calibration reports and compensation or correction figures will be maintained with the instrument.

5.5 Corrective Actions

Corrective action will be taken when practices, procedures, or documentation are not in conformance with project direction, goals, or USACE QA requirements. Such actions are most effective if discrepancies are recognized and resolved at the lowest level since, at these levels, the actions tend to be most immediate.

In accordance with this philosophy, when a discrepancy in the analytical system is observed, actions will be designed to correct the problem immediately and to bring the system into conformance with project QA/QC requirements demonstrating reestablishment of control. The corrective action will be implemented at the lowest level to ensure rapid response. Problems that cannot be resolved at one level will be brought to the attention of the next successive level for action.

Data resulting from a nonconforming action will be reviewed by EEC's QA Officer for validity. If data are deemed questionable, action will be taken either to verify the results or to repeat the procedure after the problem is corrected. In no case will invalid data be used or reported.

5.6 Laboratory Turn-around Time

EEC will arrange to receive chemical data not more than 30 calendar days after collection of samples except in the case of rapid turnaround samples. Proposed turn-around times are shown in Tables 2-1 through 2-4 of Section 2.0.

5.7 Laboratory Documentation

EEC will ensure that all activities associated with sample analyses be documented on hard copy and computer tapes/diskettes as appropriate, including bound notebooks, standard laboratory QA forms, and binders. These forms of documentation will be available for review during laboratory audits.

5.8 Data Reduction, Validation, and Reporting

The equations used in calculating actual sample results are identified in the Laboratory's Quality Assurance Manual previously submitted to the USACE Missouri River Division for laboratory certification.

Data evaluation will be performed by EEC's QA Officer Laboratory using EPA functional guidelines. The evaluation of chemical data will include evaluation of blanks, quality control results, and verification of results. Upon completion of data validation, the data will be incorporated into the operation report.

All of the contractor laboratory data will be included in the operation report. This will include sample results, QC results, a Quality Control Summary Report, and a narrative describing any problems encountered. As it is received, all of the contractor laboratory data will also be sent to the USACE Quality Assurance Laboratory for the completion of the USACE Quality Assurance Report.

6.0 INVESTIGATIVE DERIVED WASTE (IDW) HANDLING

All discarded materials, waste materials, or other objects will be handled in such a way as to control the potential for spreading contamination, creating a sanitary hazard or causing litter to be left on site. All personnel protection equipment materials, (e.g., Tyvek suits, gloves, etc.) will be collected and drummed for appropriate disposal. All waste determined to be hazardous will be removed from the site within 90 days from the time the waste is first placed in its container (i.e., time of generation).

6.1 IDW Soil

All cuttings generated from drilling activities will be stored in roll-off boxes placed in areas approved by RSA personnel. The cuttings will be analyzed and characterized, and the roll-off boxes properly labeled and sealed. Contained cuttings will remain onsite until analytical results indicate the presence or absence of contamination. Soil which is determined to be nonhazardous will be disposed of in the RSA-10 landfill. Nonhazardous wastes will be disposed of only after proper authorization from RSA and CESAS. If analytical results indicate that the soil concentrations are above the TCLP maximum criteria, as presented in the Code of Federal Regulations, the soil will be classified as hazardous and will be disposed of or treated at an approved hazardous waste facility.

6.2 IDW Groundwater

All groundwater generated during this field effort will be temporarily contained on site in 20,000 gallon frac tanks. All water will then be treated onsite by the carbon treatment system. Samples of the treated effluent will be collected prior to disposal. Treated water generated during system startup/shakedown will be sampled and recirculated through the system until lab analyses indicate that the water meets NPDES permit discharge requirements. It is proposed to discharge the treated effluent to the nearby surface tributary to Wheeler Lake as shown on Figure 2-1.

The Arsenal currently maintains an installation NPDES Permit No. AL 0000019. The proposed discharge point is currently permitted as a stormwater discharge point called DSN 013. Because of the short-term nature of this project, it is desired to discharge treated effluent to DSN 013. The USACE is requesting permission from ADEM to discharge for this project.

If granted, the USACE will provide written notification to EEC. An excerpt from the Arsenal's NPDES permit pertaining to DSN 013 is included as Attachment C.

6.3 Air Rotary Waste

During air rotary drilling, soil cuttings, rock, and water will be forced from the borehole. These materials will be controlled using a shroud and diversion device. As materials exit the borehole, they will be captured and diverted to 55 gallon drums staged near the borehole. Solids will be allowed to settle in the drums. Fluids will then be allowed to evaporate or will be decanted to the on-site water treatment system. Remaining sediments will be transferred from the drums into the on-site roll-off box(es).

6.4 Spent Carbon

The onsite carbon treatment system will include tanks to remove particles in the groundwater. The resulting spent carbon and filtered particles will be sampled and analyzed for the parameters shown in Table 2-1 and disposed according to the analytical results. The carbon was selected to last the duration of the field program; therefore, it is anticipated that only one composite sample of carbon will be required at the end of the project.

6.5 PPE and Miscellaneous Waste

The determination of the hazardous/nonhazardous status of PPE and other waste trash generated during drilling and sampling will be made by evaluating analytical results of the waste soil sampled at the site. If the soil from the site is hazardous, then the PPE or waste trash will be considered to be hazardous and disposed appropriately.

6.6 Decontamination Water

Decon water will be funnelled from the decon pad into 55 gallon drum(s). All decon water will then be fed to the onsite treatment system, as described above.

7.0 LIST OF REFERENCES

EEC Services Incorporated. EEC Field Technical Guidelines.

EEC Environmental. Final Work Plan, Interim Corrective Measure Design at Unit 2, Redstone Arsenal, Alabama. February 26, 1993 as revised in April 1993.

Kirk-Othmer. Encyclopedia of Chemical Technology, Third Edition, Volume 9: New York: John Wiley & Sons, Inc. 1978.

U.S. Army Corps of Engineers, Washington, D.C. Chemical Data Quality Management for Hazardous Waste Remedial Activities. ER 1110-1-263. October 1, 1990.

U.S. Army Corps of Engineers, Missouri River Division, Minimum Chemistry Data Reporting Requirements for DERP and Superfund HTW Projects Memorandum. August 16, 1989.

U.S. Army Corps of Engineers, Missouri River Division. Installation of Groundwater Monitoring Wells and Exploratory Borings at Hazardous Waste Sites. May 1990.

Environmental Compliance Branch, Standard Operating Procedures and Quality Assurance Manual, February 1, 1991.

U.S. Environmental Protection Agency, Methods for Chemical Analysis of Water and Wastes. EPA-600/4-79-020. March 1983.

U.S. Environmental Protection Agency, Test Methods for Evaluating Solid Waste, SW-846, November 1984.

U.S. Environmental Protection Agency, Guidance for Data Useability in Risk Assessment. October 1990.

APPENDIX A

IMHOFF CONE METHOD PROCEDURES

IMHOFF CONE METHOD PROCEDURES
VOLUMETRIC TEST

from "Standard Methods for the Examination of Water and Wastewater," 17th Edition, American Public Health Association, 1989.

1. GENERAL DISCUSSION

Settleable solids in surface and saline waters as well as domestic and industrial wastes may be determined and reported on either a volume (mL/L) or a weight (mg/L) basis.

2. APPARATUS

The volumetric test requires only an Imhoff cone.

3. PROCEDURE

Fill an Imhoff cone to the 1-Liter mark with a well-mixed sample. Settle for 45 minutes; gently stir sides of cone with a rod or by spinning; settle 15 minutes longer, and record volume of settleable solids in the cone as milliliters per liter.

If the settled matter contains pockets of liquid between large settled particles, estimate volume of these and subtract from volume of settled solids. The practical lower limit of measurement depends on sample composition and generally is in the range of 0.1 to 1.0 mL/L. Where a separation of settleable and floating material occurs, do not estimate the floating material as settleable matter.

4. ACCEPTABLE SOLIDS CONTENT

[An acceptable value (ml/L) of solids is not presented in the "Standard Methods" text. Please consult Paragraph 2.2.4 of the RSA-10 FSAP for acceptable limits in ml/L.]

APPENDIX B
PUMP TESTING PROCEDURES

PUMP TEST (AQUIFER TEST) PROCEDURES

1.0 FIELD INFORMATION

Certain information should be recorded in field book before start of any pump test and should include the following:

- Well information including depth of boring, width of boring, screened zone, size of casing/screen, filter pack material/size, length of filter pack, and water level.

- Type of aquifer (confined or unconfined), recharge or boundary conditions if known, thickness of aquifer, and description of aquifer material.

- Pumping rate, meter reading at start of test, meter reading at end of test, total gallons pumped, start time, end time, total time of pumping, and any disruptions to pumping.

- Weather factors including temperature, precipitation, and cloud cover.

2.0 PROCEDURES

The transducer should be set below the pump for the most accurate readings.

As the water level in the well falls with pumping, the pumping lift increases, and the discharge of the pump tends to decline. To avoid this, the valve on the discharge pipe should be partially closed to restrict the initial flow. During the course of the test, the valve can be opened as necessary to keep the pumping rate constant. There should be no more than a 10 percent variation in rate during the test.

If more than one observation well is to be monitored during the pump test, then the ideal situation is to have the second observation well in a radial line at a greater distance than the first observation well. The observation wells should fully penetrate the aquifer, so that they measure the average head in the formation at that location. Use of observation wells screened in aquifers other than the one in which the pumping well is screened will result in meaningless data.

For the most accurate results, collect field background data on the well to be pump tested by recording water level data for a 12 to 24 hour period prior to the test. This information will be useful if groundwater levels have a long-term trend of rising or falling. The water levels may be affected by tides or changes in the barometric pressure. If the static water level is known to fluctuate, then detailed pretest measurements must be made for at least twice the expected length of the pumping test. If a long-term linear trend is observed, the drawdown observed during the pumping test must be corrected by taking the difference between the measured water level and the projected static level.

3.0 HERMIT DATALOGGER

The datalogger is a field instrument oriented towards the acquisition of environmental data. The front panel control consists of a five digit liquid crystal display and an eight key keypad. The keys are divided into two groups: the white keys for basic operations and the blue keys for data entry and modifications. Basic operations include CLOCK, XD (for transducer) and DATA. Data modifying operations such as START, STOP, and changing test parameters require a sequence of keystrokes to prevent their accidental use.

The datalogger uses a technique referred to as "sleeping" to help conserve power consumption. Whenever there is no task to be performed the unit enters its sleep mode, recognized by a blank display.

3.1 Setting Datalogger Parameters

Lightly press any key to wake unit and to get the dot (.) prompt. First, all dataloggers need to have their clocks set and synchronized with field personnel watches. Set the clock and calendar by performing the following:

- Hold down ENTER key and press CLOCK key.
- Current date is displayed first - use SCAN keys to correct value. Use STOP/NEXT key to blink the next digit. Press ENTER key to store the date.
- The time is now displayed and is changed by same procedure as date. Press ENTER (see next step below) to store corrected time.
- To synchronize the clock with your watch set the time 1 minute ahead of your watch and press ENTER when time matches.

The pump test parameters need to be set next by performing the following:

Test Number

- At the dot (.) prompt hold down the ENTER key and press the DATA key.
- To select the test number (0-9) press ENTER when the display shows the SEL. 0 parameter. The current test # will blink. Use the scan keys to change the test number to the desired value. Test numbers cannot be skipped. Press ENTER to store value.

Sample Rate

- Use SCAN DOWN key to move display to next item on menu (RATE).
- To select the sampling rate, press ENTER when the display shows the rate parameter. Press SCAN UP to select the logarithmic mode or SCAN DOWN to select the linear sampling mode. Press ENTER to store the new mode.

- The unit then displays the current sampling rate in hours and minutes. Use the SCAN and STOP/NEXT keys to change the next digits to the desired values. Press ENTER to store the sampling rate.

- Setting the rate to 00:00 causes the unit to default entirely to the preprogrammed logarithmic scale and rate (0-2 sec, 2-20 sec, 20-120 sec, 2-10 min, 10-100 min, 100-1000 min, etc.).

Number of Inputs

- Use SCAN DOWN key to move display to next item on menu (INP).

- To select the number of active inputs (transducers plugged into datalogger) press ENTER when the display shows the input parameter. Use the SCAN keys to change the number of inputs to the desired value (1 or 2). Press ENTER to store the new selection.

Type of Inputs

- Use SCAN DOWN key to move display to next item on menu (TYPE).

- To change the type of transducer used for an input, press ENTER when the display shows the type parameters. If two inputs are active, the input number is displayed with a blinking digit. Use SCAN keys to change the number. Press ENTER to select the input number.

- Use SCAN keys to select the LEVEL parameter and press ENTER to store. If a second input is used, use SCAN keys to change number to next value and press ENTER. Select LEVEL and press ENTER to store.

The transducer parameters define how raw transducer data is to be converted to meaningful units. From the dot (.) prompt hold down the ENTER key and press the XD key. If two inputs are active, the input number is displayed with a blinking number. Use the SCAN keys to select input number and press ENTER key to select. Set all the following by the same procedures used above.

- Reference (REF) - Set to 0.

- SCALE - Set to value as marked on transducer.

- Offset (OFFS) - Set to zero or as marked on transducer.

- Display (DSP) - Select top of casing (SI:toc) and English units (EN:Sur).

3.2 Starting/Stopping the Pump Test

Connect transducer(s) to unit and set transducer(s) in well below the pump and anticipated drawdown level. Measure the water level in the well before start of test and record in field book. Press START key to begin collecting data. Record datalogger number, well number(s), and time of start of test in field book.

At the conclusion of the pump test record recovery data for a minimum of one (1) hour. To stop recording data hold down the ENTER key and press the STOP/NEXT key.

APPENDIX C
GRAVITY SEDIMENTATION TEST PROCEDURES

GRAVITY SEDIMENTATION TEST PROCEDURES

INTRODUCTION

Sedimentation is the removal of suspended solid particles from a liquor stream by gravity settling. This field may be divided into the two functional operations of thickening and clarification. The primary purpose of thickening is to increase the concentration of a relatively large quantity of suspended solids in a feed stream, while that of clarification is to remove a relatively small quantity of fine suspended particles and produce a clear effluent. Both these functions are related, and the terminology merely makes a distinction between the process results desired. Gravity thickening requires much higher torques than clarification, while clarifiers frequently require the inclusion of special flocculating devices to assist in the coagulation and clarification of dilute feeds.

1.0 SETTLEMENT

A descriptive classification of settlement (pulp) and the commonest test methods employed with each class to size a sedimentation basin are included in Table 1. Clarifiers handle Class 1 and some Class 2 settlement, whereas thickeners handle some Class 2 and all Class 3 and Class 4 settlement. The empirical testing methods indicated are designed to evaluate, for sizing purposes, the dynamics of a population of particles as they settle in a fluid medium. Empirical methods are necessary because of the many complicating including factors: liquid and particle densities, viscosity, degree of flocculation, and particle size, shape, and concentration.

In a sedimentation basin the solids concentration varies from that of the solids-free overflow leaving the basin to that of the concentrated underflow stream. Although the variation is continuous, the concentrations may be grouped into four zones as shown in Fig. 1. This figure illustrates a continuous unit in which feed wastewater enters through a feed well at the center of the tank, clear liquor leaves at the tank periphery, and thickened sludge discharges at the bottom.

Determination of the *size of a sedimentation basin* requires consideration of both clarification (rise rate and clarification detention time) and solids-handling capacity. For Class 1 and some Class 2 solids clarification is normally controlling, while solids handling is normally controlling for the more concentrated sludge.

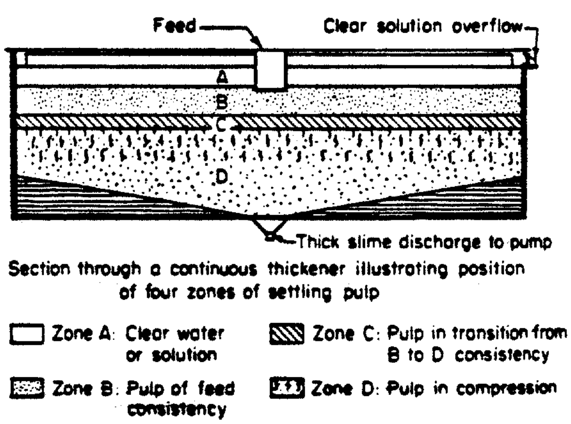
2.0 FLOCCULATION

Supernatant clarity requirements often dictate some form of flocculation to remove the finely divided particles that would otherwise remain in the effluent. Flocculation is usually accomplished by a mechanical or chemical means, although a magnetic field may be used on certain iron-bearing particles. Mechanical flocculation requires gentle circulation of the particles to provide contact opportunity and time for the resulting flocs to grow. While solids contact alone is sometimes sufficient, the assistance of a chemical reagent is frequently required and will usually speed up the flocculation reaction and materially improve final effluent clarity.

TABLE 1
CLASSIFICATION OF SEDIMENTATION PULPS AND METHODS OF TESTING

Pulp Description	Description of Initial Sedimentation	Example	Methods to Determine Unit Area	Methods to Determine Height of Compression Zone
Dilute, Class 1: independent particle subsidence	Particles or flocs settle independently. No definite line of subsidence. Settling unhindered. Settling rate mainly dependent upon size of particle or floc.	Turbid water and trade wastes. Silt	Long tube	Coe and Clevenger, Roberts
Intermediate, Class 2: phase subsidence	Upper zone of independent particle subsidence. Lower zone of collective subsidence. Line of demarcation not sharp.	Chemical and metallurgical pulps. Raw sewage. Flue dust.	Long tube, Coe and Clevenger, Kynch (Talmage and Fitch).	Coe and Clevenger, Roberts
Concentrated, Class 3: Collective subsidence or mass subsidence	Definite line of subsidence. Settling rate decreases with increasing concentration of solids. Settling rate retarded by particle or floc interference.	Chemical and metallurgical pulps. Activated sludge.	Coe and Clevenger, Kynch (Talmage and Fitch)	Coe and Clevenger, Roberts
Compact, Class 4: Compact subsidence	Flocs or particles in intimate contact subsidence due to compression.	All pulps by sedimentation pass to this.	Coe and Clevenger	Coe and Clevenger, Roberts

FIGURE 1
FOUR ZONES OF SETTLING PULP, ILLUSTRATING CONTINUOUS THICKENING



Section through a continuous thickener illustrating position of four zones of settling pulp

When mechanical action is required for the flocculating reaction, standard "jar test" equipment should be used. Typical apparatus consists of a number of shafts capable of being driven simultaneously at speeds of 20 to 100 r.p.m., each fitted with a flat rectangular paddle about 1 inch wide and with a length equivalent to about one-half the diameter of a corresponding beaker. The beakers used may be of any convenient size (preferably 800 to 1000 ml).

In a jar test the paddle should be operated initially at the maximum speed for good solids suspension. Desired chemical flocculants should be added at the recommended solution concentration, and high-speed agitation should be continued for 0.5 to 2.0 min. to ensure the dispersion of the chemical throughout the sample. At the end of the flash mixing period, the paddle speed should be reduced to "flocculation speed" and held there for various periods up to 20 min. Flocculation time is very significant, and its effect should be thoroughly checked. Flocculation speed is that speed which is just capable of preventing suspended solids from settling out on the bottom of the test beaker and yet is capable of providing the motion necessary for agglomeration. At the end of the flocculating period, the sample may be allowed to settle quiescently in the test beaker or may be transferred to some other apparatus depending upon the type of test being conducted.

Many samples, particularly those containing too many solids to be considered dilute particles (generally greater than 1 to 5 percent suspended solids), will flocculate rapidly (some almost instantaneously) when treated with the proper chemical reagent. Mechanical flocculation is not required, and the chemical reagent will be added to the sample after it has been place din a 2-liter graduate in preparation for a settling test. The problem becomes one of introducing the reagent evenly throughout the sample with mixing sufficient to ensure dispersion but insufficient to break down the flocs which form. While the chemical reagent could be dispersed in the sample in a beaker and then introduced into the test cylinder, it is difficult to carry out this transfer without causing undue breakdown of the flocs which have been formed. Therefore, it is preferable to add the reagent to the sample in the graduate to be used for the settling test. Efficient use of the chemical reagent required that the total dose be added in one operation and not incrementally with mixing after each increment. One convenient method consists of using a pipette or other suitable tubing fitted at its discharge end with a rubber stopper at least one-half the diameter of the settling tube. When the chemical reagent is added as the tube and stopper are moved vertically within the settling tube, good agitation and dispersion will be obtained throughout the sample.

3.0 SETTLING-TEST METHODS

Determination of Basin Cross Section. The choice of *test method to be used on dilute particles* (Class 1 and some Class 2 particles) depends to some extent upon the temperature of the particles, its flocculating characteristics, the required supernatant clarity, and the equipment available. The classical long-tube test may be used for all materials which settle without a clearly defined interface. However, where the feed in question is strongly flocculent, either naturally or artificially, a simplified test method may be substituted. If the feed temperature is significantly above ambient, special precautions must be observed and a well-insulated tube must be used in order to obtain significant data.

3.1 The Long-Tube Method

The long-tube apparatus consists of a plastic tube approximately 3 in. in inside diameter and about 8 ft. long with taps at every foot of height to permit samples to be withdrawn for suspended-solids analysis. For a static test the tube in filled with representative feed pulp. Then, a timed intervals a 100- to 200-ml. sample is withdrawn from each tap, starting with the uppermost and continuing downward to be the bulk of settled solids. The time interval for each set of samples is so chosen that the range of supernatant clarities obtained will bracket the desired value. A s a rule, three or four sets of samples are taken.

The long-tube method can be used to determine the suspended solids in the overflow as a function of rise rate and detention time by analysis of suspended solids in a settling pulp at various heights and at various time. The data recorded in this static testing procedure are position, time, sample volume, and solids concentration. Detention time and rise rate are calculated from these data. The detention time is the total elapsed time after the feed was introduced; the rise rate is the corrected depth of the tap divided by the detention time. The depth of the tap must be corrected for the lowering of the contents of the long tube due to withdrawal of the samples.

A plot is made of suspended solids (as sampled from the tube) against equivalent rise rate with parameters of detention time. If the particles do not flocculate with time, all data should correlate on one representative curve, regardless of detention time. If parameters of detention time appear, the solids are flocculating, and detention time as well as rise rate must be taken into account.

Any sample removed during a long-tube test will contain only particles with terminal velocities less than the velocity equivalent to the sample point. These particles will also be present at the same point. These particles will also be present at the same concentration as in the original feed. However, a portion of each of these slower-settling particle regimes would have passed a sample point to an extent equal to the ratio of its terminal settling velocity to the velocity equivalent of the sample point. In an actual basin the overflow concentration will be less than the observed long-tube sample concentration because of this effect. Therefore, in order to predict the overflow quality of a continuous unit from long-tube data, the integral $(1/U_{t2}) \int^{c2}_{0} U_t \, dc$ must be evaluated and subtracted from the observed suspended-solids concentration at the chosen rise rate U_{12} and detention time. In the integral, U_t is velocity or rise rate and c is the suspended-solids concentration. The integral is evaluated by use of the proper curve in the graph of suspended-solids concentration vs. rise rate constructed from the raw long-tube data.

3.2 Simplified Methods

Simple for tests are conducted to determine clarification performance for a pulp, flocculated naturally or because of chemical additives, of the type which yields a constant suspended-solids concentration throughout the supernatant after a period of 10 to 15 min. The pulp is placed in a glass container and, after being suspended and treated with flocculating chemicals as may be required, is allowed to clarify quiescently. Note is made of the time required for the bulk of the solids to settle and of the distance settled. Flocculation is a time function following the empirical relation $c=kt^m$, and supernatant samples for suspended-solids analysis should be taken after settling times of 10, 15, 30, 60,90, and 120 min. A long-log plot of these data usually will yield a straight line of slope *m*. The static detention time calculated for the desired overflow clarity and the observed bulk settling rate may be used with proper scale-up factors to determine sedimentation-basin area and depth requirements.

3.3 Other Simplified Methods

Other simplified methods of estimating thickener cross section for material that settles with a definite interface are due to Coe and Clevenger [*Trans. Am. Inst. Mining Met. Engrs.* 55, 356 (1916)], and to Kynch [*Trans. Faraday Soc.*, 48, 166 (1952)] and Talmage and Fitch [Ind. Eng. Chem., 47, 38 (1955)]. Each has its own limitations, and must be applied properly and with caution. Each requires the use of a slowly turning rake (about 0.1 r.p.m.) in the test graduate (preferably 2-liter size) to duplicate full-scale operating conditions. These and other simplified test methods are criticized and compared usefully by Fitch [*Ind. Eng. Chem.*, 58(10), 18 (1966)].

4.0 DETERMINATION OF BASIN DEPTH

A sedimentation basin includes the following zones: clear solution, feed, transition, and compression (Fig. 19-66). The methods for determining surface area yield data for rise rate and detention time; these in turn may be used to predict the total height required for the clear solution and feed zones. Height of the transition zone is always empirically established. Height of the compression zone can be determined by laboratory tests designed to allow its estimation.

The dilution at the start of compression is arbitrarily determined from a settling curve of pulp height vs. settling time constructed from a test carried out in a graduated cylinder equipped with rakes rotating at 0.1 r.p.m. The straight-line portion of the compression-zone settling curve is extrapolated until it intersects the ordinate axis. The height equivalent to the mid-point between this intersection and the height of the pulp at zero time is taken to represent the solids concentration at the start of compression.

The concentration of the underflow is selected at any desired value less than the ultimate obtainable. The height equivalent to this concentration that the solids would occupy in the graduated cylinder is calculated and the value is indicated on the settling curve. The difference between times corresponding to the desired underflow concentration and the start of compression represents the solids-retention time required in the compression zone.

The average compression-zone volume per weight of dry solids is found by integrating the settling curve between the limits of entering and leaving the zone. From this quantity the depth of the compression zone in the thickener is inferred easily.

4.1 Roberts Method

Another method of estimating compression-zone height is that of Roberts [*Trans. Am. Inst. Mining Engrs.*, 1, 61 (1949)]. Sedimentation readings are taken up to the ultimate compression point, from which the logarithm of D - D is plotted against time, where D is the dilution at any finite time and D the dilution at infinite time. D is determined by trial and error, its value being that which results in a straight-line plot. This plot is then used in a manner analogous to the previous method.

4.2 Other Methods

Other methods for determine the unit area and compression-zone depth are covered in the references cited. Confident use of them and of the ones described above demands the skill and judgement of an experienced investigator.

APPENDIX D
RESUMES

D. W. SCHAER
Principal Geologist

SUMMARY OF EXPERIENCE (Since 1977)

Total Experience - Fourteen years experience in performing and managing remedial investigations, feasibility studies, site inspections and economic minerals exploration.

Education - B.S., Geology, MESA State College, 1977
AAS, Civil Engineering Technology, MESA State College, 1975

Courses - Volcanic Rocks and Their Vent Areas - Mackey School of Mines
Tailings Ponds and Their Impoundments, Colorado State University
40 Hour Health and Safety Training for Hazardous Waste Site, 1985
Principals of Groundwater Hydrology, NWWA, 1992

Registrations - North Carolina No. 236
South Carolina No. 446
Florida No. 495
Tennessee No. 544
Wyoming (in progress)

REPRESENTATIVE EEC EXPERIENCE (Since 1987)

Principal Geologist/Hydrogeology Supervisor

Supervises a group of professional geologists/hydrogeologists and chemists. Responsible for job cost control and overhead accounts, in addition to making intragroup decisions.

Technically responsible for design, implementation and managing of remedial investigations for government agencies and industrial facilities. Tasks typically include preparing and implementing work plans for remedial investigations, site inspections and baseline environmental surveys for determining the presence or absence of contaminated soils and water.

Projects Include:

U.S. EPA Region IV - Sangamo Weston Site, Pickens County, South Carolina. Site Manager for an EPA Superfund Project that was designed to assess the effects of PCB contamination at several county landfills. Responsible for planning and managing the overall project and coordinating project activities with the EPA and state officials. This project was completed on schedule with a cost savings of $40K from the budget of $160K.
Georgia Pacific Corporation, Spartanburg, South Carolina. Project Manager responsible for providing client with integrity/inspection of five solid waste management units at GP's container plant to determine the environmental impact caused by each individual SMU. Tasks included providing the client with a report suitable for submission to the EPA

documenting the investigations findings. Additional tasks include the removal and thermal treatment of contaminated soils.

U.S. EPA - Tri-City Industrial Disposal Site, Bullitt County, Kentucky. Site Manager for an EPA Superfund RI/FS Project. Responsible for planning and managing both the remedial investigation and the feasibility study for the entire project and coordinating project activities with the EPA and state officials. These responsibilities included assisting the EPA at public meetings with technical responses to concerns voiced by the community.

U.S. EPA - Whitehouse Waste Oil Pits Site, Duval County, Florida. Responsible as Site Manager for planning and investigating bioremediation and solidification/stabilization technologies that could be used in support of a remedial action. A portion of this project included obtaining data sufficient to prepare a risk assessment and providing the EPA with a final risk assessment.

U.S. EPA - Zellwood Groundwater Contamination Site, Orange County, Florida. Responsible as Site Manager for assisting the EPA with a soil solidification/stabilization project. Additional responsibilities included planning, managing and implementing a groundwater monitoring system for monitoring the solidified product and investigating the extent of existing groundwater contamination to support a remedial design for groundwater remediation.

U.S. EPA - Picillo Farm Site, Coventry, Rhode Island. Remedial Investigation Task Leader on a RI/FS project which focused on assessing the areal extent of contamination attributable to six years of illegal bulk dumping of toxic and hazardous wastes. Tasks included developing and coordinating the plans for a field investigation for soils, surface waters, and the groundwater system.

U.S. EPA - Bluff Road Site, Columbia, South Carolina. Project Task Leader on a remedial investigation/feasibility study to assess the environmental impact caused by unregulated disposal of hazardous materials.

Teledyne-Brown Engineering/U.S. Army Missile Command - Redstone Arsenal, Huntsville, Alabama. Technical Lead responsible for the design of a monitoring plan for soils and groundwater to determine any environmental impacts associated with the destruction of Pershing missile motors at two sites in the western United States. Tasks included preparing detailed field plans for State and Federal agencies review.

Georgia Pacific Corporation, Atlanta, Georgia. Project Leader on a baseline environment survey of an existing plant which was being considered for purchase by the client. Tasks included supervision of field sampling, well installation, and preparation of final reports.

D. W. SCHAER (Continued)

PRIOR EXPERIENCE

Versar Inc., Manager of Technical Services. Responsible as technical manager for all remedial investigations and feasibility tasks associated with an EPA technical support contract (TES 7). Duties included providing EPA with independent cost analysis for remedial alternatives identified in feasibility studies generated by primary responsible parties. Additional duties included presenting feasibility studies alternatives, and EPA preferred methods at public meetings.

Project Geologist, Camp Dresser and McKee

Responsible for all aspects of groundwater monitor systems and supervision of field crews conducting remedial investigations. Other responsibilities included project planning and report preparation.

Superfund Projects Include:

Munisport Landfill, North Miami, Florida. Hollingsworth Solderless Terminal, Fort Lauderdale, Florida; Mowbray Engineering Company, Greenville, Alabama (Celanese-Shelby Fiber Operations), Shelby, North Carolina; Coleman-Evans Wood Preserving Company, Whitehouse, Florida; Newsom Brothers/Old Reichold, Columbia, Mississippi; Bypass 601 Groundwater Contamination, Concord, North Carolina; Hipps Road Landfill, Duval County, Florida; Maxey Flats Nuclear Disposal, Hillsboro, Kentucky and Perdido Groundwater Contamination, Perdido, Alabama.

Oak Ridge National Laboratory, Geologist. Team leader responsible for planning and conducting filed radiological surveys to investigate potential hazardous radioactive contamination. Prepared final reports from field-generated data for the Department of Energy's uranium mill tailings removal act.

Bendix Field Engineering Corporation, Staff Geologist. Project Geologist for remedial action programs dealing with the study of radioactive tailing piles. Duties included interpretation, sampling of tailings and installation of monitor wells. Also, as part the Bendix Exploration staff, conducted exploration drilling programs in the western United States. Planned and supervised the completion of, and lithologically logged, 54,000 feet of rotary and core test holes. Conducted comprehensive geochemical, geophysical, and reconnaissance mapping surveys as part of grass roots exploration programs in the Basin and Range Province of Nevada, California, and southeastern Utah.

Idaho Mining Company, Exploration Geologist. Conducted drilling programs in Colorado and Utah for mining exploration and development. Planned, supervised, and provided lithological and geophysical logging of more than 300 rotary test holes.

D. W. SCHAER (Continued)

SELECTED PUBLICATIONS

Publications

Schaer, D. W., 1981. A Geological Summary of the Owens Valley Drilling Project, U. S. Department of Energy, Open File Report GJBX-128(81).

Schaer, D. W., 1984. Monticello Remedial Action Project Site Analysis Report, Geological Investigation Section, U. S. Department of Energy, Open File Report GJ10.

Morrison, Schaer, Daniels, 1984. Minerals Evaluation of a Denied Area, Classified Document.

KIMBERLY S. VEAL
Environmental Engineer

SUMMARY OF EXPERIENCE

Ms. Veal has over five years of engineering and management experience in applications related to environmental compliance of solid and hazardous waste projects, including regulatory and licensing activities for the government and private sector. Her responsibilities include Preliminary Assessments under CERCLA, Remedial Investigations under DERP, Contamination Assessments, preparing Environmental Impact Statements, Environmental Resource Documents, RCRA Part A and Part B Permit Applications, Work Plans and Engineering Reports.

Education: B.S., Civil Engineering, 1988

Registrations: E.I.T./1988/New York
Medically monitored and 40-Hr. Health and Safety Trained

REPRESENTATIVE EEC EXPERIENCE

U.S. Army Corps of Engineers, Savannah District - Task Manager of four projects which involve the design of interim corrective measures to remove, treat, and dispose of groundwater contaminated with volatiles, semi-volatiles, BNAs, pesticides, and metals. The projects involve the preparation of work plans, design drawings and specifications plans, various installation and operation plans, construction and operation scheduling and cost estimating, and community relations.

City of Atlanta - Site Manager of the Hemphill Project Site. Developed a scope of work for the City to assess the level of soil and groundwater contamination near a water supply reservoir, including TCE, PCE, TCA, and aromatic hydrocarbons. She is providing overall project management of the effort which includes field sampling and preparation of engineering reports.

U.S. Army Corps of Engineers, Mobile District - Prepared environmental assessment for the Base Realignment and Closure (BRAC) action at Anniston Army Depot.

U.S. Army Corps of Engineers, Huntsville Division - Site Manager and Site Health and Safety Officer for DERP FUDS project area suspected of chemical ordnance contamination. She conducted an archives search to determine the potential for UXO/EOD contamination and prepared the work plans for remediation of the contaminated areas. She prepared a detailed report of findings and recommendations, including a risk assessment for each site.

U.S. Army Corps of Engineers, Mobile District - Prepared a classified (DOD-secret) environmental assessment for the storage and demilitarization of nuclear weapons.

KIMBERLY S. VEAL (Continued)

U.S. Army Corps of Engineers, Huntsville Division: Preparation of environmental assessment pertaining to interim remedial treatment of fuel contaminated soil and ground water at Defense Fuel Supply Point, Ozol, CA.

U.S. Army Corps of Engineers, Huntsville Division: Preparation of RCRA Part A and Part B permit applications for munitions deactivation furnaces at seven Army installations.

NASA, Marshall Space Flight Center: Determination of environmental baseline conditions at the entire facility and subsequent preparation of an environmental resource document.

The University of Alabama in Huntsville and U.S. Army MICOM: Preparation of supplemental environmental assessment for the addition of an Aero-Optics laboratory and photographic laboratory to the Aerophysics Test Facility on Redstone Arsenal, AL.

As an Environmental Engineer with Stone & Webster Engineering, Boston, MA, Ms. Veal managed preparation of environmental reports for the Federal Energy Commission and NY Public Service Commission and was responsible for permitting on federal, state and local levels of over 200 miles of pipeline in northeast U.S. She has been primarily responsible for the environmental impact assessments of large scale engineering and utility projects on water quality, ecological resources, topography, and other environmental resources.

Ms. Veal was assigned as an Environmental Inspector of construction and has participated in and testified at numerous public hearings.

Experience in Waste Management includes: Assisting in the development of Environmental Impact Statement for the ongoing New York City Sludge Management Project; siting studies for long-term sludge disposal; site assessments to identify potential hazardous waste sources at candidate construction site, and review of state-of-the-art and proven sludge processing and disposal technologies applying various site/technology constraints.

As an Engineering Aide for New York State Electric and Gas, Binghampton, NY, Ms. Veal designed weir to mitigate thermal plume effects of power plant cooling water discharge to meet NPDES permit requirements; coordinated contractors and vendors, prepared bid package and conducted prebid meeting site visits; and prepared numerous cost estimates and wrote technical specifications.

While employed with Broome County DPW Engineering Division; Binghampton, NY, she developed division's first computer-based engineering support system; produced computer-aided drawings of preliminary engineering projects; developed macros to complement existing software; and maintained traffic accident location maps.

J. A. DAVIS
Geologist

SUMMARY OF EXPERIENCE (Since 1982)

Total Experience - Four years of experience as a petroleum geologist. Four years experience in underground leak detection and investigation. Three years experience as an environmental geologist on hazardous waste projects.

Education - B.S., Geology, 1983, University of Southern Mississippi, Hattiesburg, Mississippi

Courses - Certified Petro-Tite Tank Tester through completion of Heath Consultants Inc., Petro-Tite Tank Testing Systems Training Course, May 19-23, 1987. Expiration date: May, 1989

Completed 40 hours of Health and Safety Training for Hazardous Waste Operations. Refresher Training Annually.

Attended USEPA, Region IV, Environmental Services Division, Regional Sample Control Center (RSCC) Workshop for regional users of RSCC

Attended EPA Leak Detection Methods for UST Seminar, 1988

Completed USEPA, Region IV, Environmental Services Division, Hazardous Waste Section, ARCS short course

Attended USEPA Revised Hazardous Ranking System (HRS) Orientation course

Member - National Water Well Association/Association of Groundwater Scientists and Engineers

REPRESENTATIVE EEC EXPERIENCE (Since 1987)

Geologist

Responsible for planning and conducting surface and subsurface investigations to determine geological and hydrological conditions such as aquifer properties, site stratigraphy, structure and potential for contaminant migrations for hazardous waste projects and other industrial and commercial projects.

J. A. DAVIS (Continued)

Projects include:

Fort Jackson, South Carolina. Served as Site Manager for preliminary investigations at three UST sites at the Fort Jackson military reservation for the Army Corps of Engineers (ACOE).Duties involved preparation of planning documents, coordination and oversight of field activities, and preparation of final engineering report.

Fort Gordon, Georgia. Served as Site Manager for preliminary investigations at 15 UST sites at the Fort Gordon military reservation for the ACOE. Duties involved preparation of planning documents, coordination and oversight of field activities, and preparation of final engineering report.

New Hanover International Airport, Wilmington, NC. Served as Site Manager for preliminary investigations at two landfills at the airport for the ACOE. Duties involved preparation of planning documents and coordination and oversight of field activities.

Geiger (C&M Oil) Site, South Carolina. Participated in post Record of Decision (ROD) field investigation. Duties involved site gridding, surface and subsurface soil sampling for full scan target compound list analysis. Additional duties included packing and shipping of samples in accordance with ESD SOP's and state and federal regulations.

Kimberly Clark Corporation, Beech Island, South Carolina. Supervised the installation of groundwater monitoring wells and the collection of surface soil samples in accordance with Kimberly Clark Corporation's sludge management plan and SCDHEC regulations.

Sangamo Weston Sites, South Carolina. Participated in Sampling Investigation to determine the presence, types and concentration levels of hazardous and toxic chemicals at the sites. Duties involved the collection of samples from surface waters, sediments, surface soils, subsurface soils and private wells. Additional duties included packing and shipping of samples in accordance with ESD SOP's and state and federal regulations.

SCRDI Dixania, South Carolina. Served as Field Operations Leader during groundwater sampling required for treatment system design modifications as part of the groundwater remediation program. Responsible for the supervision of technical staff during sampling operations.

Wrigley Charcoal Plant RI/FS. Served as Field Operations Leader (FOL) for the RI drilling, well installation, sampling and geophysical operations necessary to characterize site conditions, and contaminants. Responsible for the supervision of technical staff and subcontractors during site operations.

J. A. DAVIS (Continued)

Lee's Lane Land Fill. Participated in Operation and Maintenance (O&M) field investigation. Conducted monitor well groundwater sampling and air quality monitoring at both ambient and gas well stations. Additional duties included set up, operation and maintenance of meteorlogical station in support of ambient air monitoring operations.

Gwinnett County Georgia. Field manager responsible for the oversight and coordination of a county-wide Underground Storage Tank (UST) Precision Testing Program utilizing the Petro-Tite Superior Tank and Line Testing system.

A. L. Taylor Site. Participated in Operation and Maintenance (O&M) field investigation. Conducted monitor well groundwater and surface water sampling. Additional duties included packing and shipping of samples in accordance with ESD SOP's and state and federal regulations.

Distler Brickyard Site. Participated in Operation and Maintenance (O&M) field investigation. Conducted the sampling of public and private drinking water wells. Additional duties included packing and shipping of samples in accordance with ESD SOP's and state and federal regulations.

Newport Dump Site. Site manager responsible for coordinating and scheduling the Operation and Maintenance (O&M) field investigation. Performed groundwater monitoring and collected grab samples from gas wells utilizing evacuated stainless steel canisters.

U.S. EPA, Region I. Prepared comprehensive monitoring evaluations (CMEs) at RCRA hazardous waste facilities. Evaluated the adequacy of groundwater monitoring and assessment programs and their compliance with federal regulations.

Georgia Pacific Corporation. Project manager responsible for the monitoring of a product recovery and pump and treat system at an underground storage tank leak. Also responsible for the semi-monthly collection of groundwater samples, evaluation of hydrogeological data and monthly activity reports submitted to client and state regulatory agency.

Dow Corning Corporation. Participated in preparation of RCRA Facility Assessment (RFA). Duties involved preparation of section of report dealing with regional and local environmental setting and target populations in the vicinity of the facility.

Teledyne Brown Engineering/U.S. Army MICOM - Participated in the noise and air quality assessment portions of the Environmental Assessment of the Intermediate Range Nuclear Forces (INF) Treaty. Duties involved measuring noise levels 1.3 miles from the horizontal static firing of a Pershing II rocket motor at Redstone Arsenal in Alabama. Additional duties included photodocumentation of the horizontal plume for purposes of air quality assessment.

J. A. DAVIS (Continued)

Black & Veatch, Engineers-Architects. Participated in an aquatic study designed for the purpose of establishing baseline water quality and biological conditions at two proposed combustion turbine facility sites. Duties involved water quality, periphyton, plankton, benthic macroinvertebrate, ichthyoplankton, juvenile fish and adult fish sample collection.

PRIOR EXPERIENCE

Hughes Inc.
Geologist and Certified Petro-Tite Tank Tester.

Selected projects included:

Chevron USA, Exxon, and Gulf. Conducted volumetric tank tests utilizing Petro-Tite Superior Tank and Line Testing systems to determine underground storage tank leakage throughout the southeastern United States.

Gulf Petroleum, Forest, Mississippi. Supervised drilling operation for installation of soil boring and installed product recovery trench and recovery system.

Exxon. Supervised drilling operations for installations of monitoring wells and soil borings to determine extent of hydrologic and soil contamination at an underground storage tank leak.

Independent Consultant Research Geologist

Contracted work with oil and gas exploration companies to research and compile reports involving production, production trends, and surface and subsurface mapping. Worked on location as well-site geologist during drilling and completion operations.

Southstar Petroleum Corporation
Staff Geologist

Researched and compiled reports on production, production trends, and surface and subsurface mapping. Worked on location during drilling and completion operations.

Wyatt Interest Inc.
Geological Technician

Major responsibility was mapping potential oil and gas prospects. Worked as well-site geologist during drilling, completion, and connection of oil and gas wells into production lines.

J. W. EVANS
Senior Technician

SUMMARY OF EXPERIENCE (Since 1979)

Total Experience - Thirteen years of experience in boundary survey, construction layout, topographic mapping, and wetland studies.

Education - Kennesaw College, Continuing Education Courses

Certification - 40-Hour Refresher Health & Safety Training for Hazardous Waste Sites - 1992

24-Hour Safety Cross Training Program for Hazardous Waste Operations, Health & Safety Officer - 1993

8-Hour Annual Refresher/Supervisory Health and Safety Training for Hazardous Waste Operations

REPRESENTATIVE EBASCO EXPERIENCE (Since 1992)

Projects Include:

Redstone Arsenal - Huntsville AL. Participated in field sampling investigation to determine the presence or absence of hazardous and toxic chemicals. Responsibilities included monitor well installation, soil sampling, groundwater sampling, and supervision of subcontractors during site operation. Additional duties included packing and shipping of samples in accordance with Army Corps of Engineers, planning documents, and state and federal regulations.

Myrtle Beach Air Force Base - Myrtle Beach, SC. Provided contractor oversight and health and safety coordination for Army Corps of Engineers during site investigation at 12 sites. Responsibilities included health and safety monitoring, monitor well installation, soil sampling, ground water sampling, and direct push groundwater sampling. Additional duties included packing and shipping of samples in accordance with Army Corps of Engineers, planning documents and state and federal regulations.

New Hanover International Airport - Wilmington, NC. Participated in a comprehensive field sampling investigation to determine the presence, types and concentrations of hazardous and toxic chemicals at the site. Duties involved the collection of samples from surface waters, sediments, surface soils, subsurface soils, and groundwater monitoring wells. Additional duties included packing and shipping of samples in accordance with Army Corps of Engineers planning documents, and state and federal regulations.

Environmental Protection Agency - SCRDI/Dixiana, South Carolina Superfund Site (ARCS IV Program). Participated in a comprehensive field sampling program which included sampling groundwater from monitor wells and, influent and effluent samples associated with a 20-well groundwater extraction and treatment system. Additional responsibilities included general inspection of treatment plant to ensure proper functioning and packing and shipping of samples in accordance with Army Corps of Engineers planning documents, and state and federal regulations.

Fort Gordon - Augusta, GA. Participated in field sampling investigation to determine the presence, types, and concentration of hazardous and toxic chemicals at 15 underground storage tank sites. Responsibilities included monitor well installation and development, soil sampling, groundwater sampling, and supervision of subcontractors during site operation.

Travis Field - Savannah, GA. Participated in field sampling investigation. Responsibilities included monitor well installation and development, soil sampling, groundwater sampling, and supervision of subcontractors during site operation. Additional duties included packing and shipping of samples in accordance with Army Corps of Engineers planning documents and state and federal regulations.

PRIOR EXPERIENCE SINCE (Since 1984)

Projects Include:

- Southlake Festival - Morrow, GA
- Gwinnett County Courthouse - Lawrenceville, GA
- Ronald Reagan Parkway - Gwinnett County, Lawrenceville, GA
- South Mock Road - Albany, GA
- Liveoak Landfill - Ellenwood, GA
- Rolling Hills Landfill - Riverdale, GA
- B. J. Landfill - Norcross, GA
- Bumpass Cove landfill - Bumpass Cove, TN
- Homestead Air Force Base - Homestead FL
- Navel Surface Warfare Base - Dalgren VA

Responsibilities included the managing of field survey crews; managed boundary survey for control; staking and grading of building sites, parking lots, storm drain pipes, curb and gutters, leachate collection systems, detention ponds, and sanitary sewers lines and locating wetlands.

D. BUSKEY, E.T.
Assistant Environmental Scientist

SUMMARY OF EXPERIENCE (Since 1984)

Total Experience - Over ten years of experience in the environmental field; working as a Field Operations Leader and Health and Safety Officer. Additional duties involved contamination assessment support, various kinds of sampling, and field documentation. Experienced in the installation, operation, troubleshooting and maintenance of electromechanical, computerized control systems, and video surveillance systems.

Education - Asnuntuck Community College, Enfield, CT - Successfully completed 321 hours in the field of basic electronics. 1982.

Completed the NGWA Course - "Theory of Practice of Groundwater Monitoring and Sampling"

Certification - 40-Hour Health & Safety Training for Hazardous Waste Sites - 1989

Refresher Training Annually

Completed Corporate 24-Hour phase of Enserch Environmental Corporation Health & Safety Cross Training for Hazardous Waste Sites, September, 1994

Completed 80-Hour Field Evaluation phase of Enserch Environmental Corporation Health & Safety Cross Training for Levels B, C, and D, January, 1993 and February, 1994

Certified Well Driller - South Carolina, #1157, January, 1994

National Registry of Environmental Professionals, E.T. 2574, July, 1993

Member of National Groundwater Association (NGWA)

DOD SECRET SECURITY CLEARANCE - July, 1993

REPRESENTATIVE EBASCO EXPERIENCE (Since 1989)

Projects Include:

Ft. Gillem Contamination Assessment Project - Health & Safety Officer. Responsibilities included implementation of Site Specific Health and Safety Plan to ensure proper industrial hygiene practices and air monitoring to assess airborne contaminant hazards. Other duties included selecting appropriate personal protective equipment (PPE), calibration and maintenance of air monitoring and sampling equipment, setting up of appropriate work zones, and conducting daily health and safety briefings. The project included a comprehensive field sampling investigation to determine the presence, types and concentrations of hazardous and toxic chemicals at a 300 acre landfill, via installation of soil borings, test pits and groundwater monitoring wells.

Myrtle Beach Airforce Base - Field Activities Leader (FAL) and Health and Safety Officer (HSO).

(FAL) - Responsibilities included supervision of subcontractors, groundwater monitor wells and soil boring installations. Participated in sediment sampling, monitor well sampling, well development, and aquifer slug testing.

(HSO) - Responsibilities included implementation of the site specific Health and Safety Plan to ensure proper industrial hygiene practices and air monitoring to assess airborne contaminant hazards. Other duties included selecting appropriate personal protective equipment (PPE), calibration and maintenance of air monitoring and sampling equipment, set up of appropriate work zones and daily health and safety briefings. The project included a comprehensive field sampling investigation to determine the presence, types and concentrations of hazardous toxic chemicals at 12 sites, of which included landfills, and UST sites.

Redstone Arsenal - RCRA Facility Investigation - Field Operations Leader. Responsibilities included management of all day-to-day field tasks including drilling, sampling, groundwater monitoring well installation, well development, aquifer slug testing, and supervision of subcontractors during site operations. The project included a comprehensive field sampling investigation to determine the presence, types and concentrations of hazardous and toxic chemicals at the site.

Ft. Gordon Contamination Assessment Project, Phase II- Health and Safety Officer. Responsibilities included implementation of Site Specific Health and Safety Plan to ensure proper industrial hygiene practices and air monitoring to assess airborne contaminants hazards. Other duties included selecting appropriate personal protective equipment (PPE), equipment calibration and maintenance of air monitoring equipment, set up of appropriate work zones, daily health and safety briefings, well development, and groundwater sampling and aquifer slug testing.

Laurinburg-Maxton Army Airbase - Contamination Assessment Project - Health and Safety Officer. Responsibilities included implementation of Site Specific Health and Safety Plan to ensure proper industrial hygiene practices and air monitoring to assess airborne contaminants hazards. Other duties included selecting appropriate personal protective equipment (PPE), equipment calibration and maintenance of air monitoring equipment, set up of appropriate work zones and daily health and safety briefings.

New Hanover International Airport - Contamination Assessment Project - Field Operations Leader. Responsibilities included management of all day to day field tasks including drilling, sampling, groundwater monitoring well installation, and supervision of subcontractors during site operations. The project included a comprehensive field sampling investigation to determine the presence, types and concentrations of hazardous and toxic chemicals at the site.

Ft. Gordon Contamination Assessment Project Phase I - Field Operations Leader. Responsibilities included management of all day to day field tasks including drilling, sampling, groundwater monitoring well installation, and supervision of subcontractors during site operations. The project included 15 underground storage tanks sites.

Ft. Jackson Contamination Assessment Project - Field Operations Leader. Responsibilities included management of all day to day field tasks including drilling, sampling, groundwater monitoring well installation, and supervision of subcontractors during site operations. The project included 3 underground storage tanks sites.

Army Corps of Engineers (ACOE) - Environmental Compliance Assessment Systems (ECAS) for the Alabama Army National Guard (ALARNG), participated as a member of a twenty-team task force whose primary duty was the inspection of over 200 sites operated by the Alabama National Guard. The scope of the assessment was to identify areas of noncompliance with federal, state, local, and Army regulations and to suggest mitigation efforts.

Florida Department of Environmental Regulation - Petroleum Contamination Site Cleanup Program. Assisted with the assessment and remediation of 85 petroleum contamination sites resulting from leaking underground storage tanks. Responsibilities included Health and Safety Officer; groundwater sampling; site mapping; well elevation surveys; aquifer slug testing; water level measurement; and oversight of underground storage tank removals. Also assisted with the completion of site maps, invoicing, and various drawings using the LOTUS Freelance and LOTUS 3.1 programs.

PRIOR EXPERIENCE (5 Years)

Sensormatic Security Corporation
Technician

Installed anti-shoplifting systems in retail outlets. Systems included radio frequency and video surveillance systems. Duties included customer relations, installing concealed systems, concealed overhead systems, and pedestal systems. Other tasks included repairing and wiring, running cables, tuning, and trouble-shooting to chip level.

Centec Corporation
Technician

Participated as a team member of the National Dioxin Study sampling team under contract to the EPA. Prepared and verified the photo documentation for the final project report during the course of this study.

Managed a reconnaissance survey at eight separate laboratories located throughout the United States. This survey included the testing of the transfer efficiency of spray painting equipment for the Environmental Protection Agency.

Participated in on-shore oil and gas sampling projects for the EPA. Responsibilities included sampling, photo and written documentation and reporting, and the interviewing of corporate and state officials.

Rison, Inc.
Team Leader Technician

Private contractor to Centec Corporation. Duties included the construction of a mobile laboratory as a pilot program for the US Air Force. This laboratory was utilized for testing the viability of an electroplating wastewater treatment process. Additionally responsible for design interpretation, payroll, personnel management and assignment. Assisted in a sampling project which used ozone for wastewater treatment. Constructed rinse control timers for use in a US Air Force electroplating shop as part of a waste minimization program.

GERALD L. DELANEY
CIH Supervising Engineer

SUMMARY OF EXPERIENCE

Mr. Delaney has over 25 years of progressively responsible experience in safety, industrial hygiene, environmental engineering and project management for hazardous and toxic waste and environmental programs. He provided program oversight for the Department of the Army in both the occupational health and environmental health arenas.

Education: MS/1966/Environmental Engineering
BCE/1964/Civil Engineering

Registrations: 1980/Certified Industrial Hygienist

REPRESENTATIVE EEC EXPERIENCE

As Industrial Hygiene Consultant to the Army Surgeon General, LTC Delaney provided oversight of the Army's industrial hygiene program worldwide. As Director for Industrial Hygiene at the U.S. Army Environmental Hygiene Agency (USAEHA) Col Delaney managed a worldwide industrial hygiene support program which supported DERP, IRP, and the Kuwait Oil Fire Health Risk assessment.

As Director for Environmental Quality/Environmental Health Engineering at the U.S. Army Environmental Hygiene Agency, Col Delaney managed oversight of USAEHA support of the Army's DERP, IRP and all hazardous waste projects worldwide. He oversaw the USAEHA and the Agency for Toxic Substances and Disease Registry (ATSDR) interface on all hazardous waste projects/sites which the ATSDR evaluated. He developed and presented the 8-Hour annual OSHA update to employees requiring annual recertification within the Hazardous Waste Division at the USAEHA.

As Commander, U.S. Army Pacific Environmental Health Engineering Agency, Sagami, Japan, he directed studies and laboratory services in environmental health, environmental pollution, environmental sanitation, industrial hygiene, medical entomology, radiological health, and toxic and hazardous waste disposal, for all U.S. Army and selected DoD installations in the western pacific area of operations.

As Project Officer at U.S. Army Medical Laboratory, Ft. Baker, CA, he conducted radiation protection surveys and industrial hygiene surveys at U.S. Army facilities throughout the western United States and Alaska.

As Industrial Hygienist at USAEHA, he conducted comprehensive industrial hygiene studies at U.S. Army facilities worldwide.

ASHTON C. PEARSON
QA/QC Manager

SUMMARY OF EXPERIENCE

Mr. Pearson is a degreed Mechanical Engineer with over 14 years of quality-related experience, more than 12 years of which have been in nuclear power plant construction and operation. Areas of expertise include quality program management, procurement quality activities related to vendor evaluations, source surveillance, and procurement document reviews. Balance of expertise involves design-related activities in the manufacturing and chemical industries.

Education - B.S., Mechanical Engineering, 1977, University of Mississippi

Courses - OSHA 40-Hr. Hazardous Waste Operations
DOE Q Clearance
Certified Lead Auditor

REPRESENTATIVE EBASCO EXPERIENCE

Assigned as a member of the Environmental Restoration Waste Management (ERWM) Program team. Responsibilities include ensuring that all activities affecting quality within Ebasco meet the requirements of the DOE-approved ERWM Quality Assurance Plan (QAP). The ERWM QAP govern work at Oak Ridge, Tennessee; Portsmouth, Ohio; and Paducah, Kentucky. Compliance with the QAP is verified by performing audits and surveillances of discipline activities.

Assigned to the on-site Quality Assurance (QA) group. In this position, responsible for ensuring that quality-related activities within Ebasco meet the requirements of the TVA-approved Ebasco Nuclear Quality Assurance Program. Additionally, performed scheduled and unscheduled surveillances and audits of discipline activities.

PRIOR EXPERIENCE

Florida Power & Light Company - Assigned to the Nuclear Energy Department, Quality Assurance Procurement and Reliability Group, in support of St. Lucie Nuclear Plant, Units 1 and 2, Jensen Beach, Florida; and Turkey Point Nuclear Plant, Units 3 and 4, Florida City, Florida. In this position, assisted in the overall development of policies and methods, and directed the preparation, development, and implementation of operating procedures that affected safety-related functions. Additionally, utilized Statistical Process Control (SPC) techniques to collect data from information systems and computer programs to plan, implement, administer program of supplier quality audits and source surveillances, and to analyze supplier data to identify recurring problems. Also, responsible for personnel selection, supervision, and guidance of Florida Power & Light Quality Assurance Engineers and various contractor companies that performed safety-related services to support the operation of four nuclear power plants.

ASHTON C. PEARSON (Continued)

Mississippi Power and Light Company - Assigned as Quality Assurance Engineer Supervisor - Vendor Activities, in support of Grand Gulf Nuclear Station, Port Gibson, Mississippi. In this position, assisted the manager in development of policies and methods; directed the preparation and implementation of operating procedures and policies; planned, implemented, and administered program of supplier quality audits/surveys. Analyzed supplier data to identify recurring problems and to initiate corrective action; coordinated system for supplier quality programs evaluation activities and procurement document review; and was responsible for personnel selection, supervision, and guidance of Quality Assurance Engineers. Additionally, conducted internal and external Quality Assurance Audits.

General Cable Corporation - Responsibilities included the implementation and coordination of various plant projects, including new product design; prepared technical reports, supervised Quality Control personnel, and developed QA/QC standards relative to manufacturing CATV cable.

PPG Industries - Responsibilities included the development, review, and coordination of engineering maintenance work orders and providing project design. Additionally, responsible for the daily operation of the PPD chemical plant in Lake Charles associated with utility/power generating department activities.

S. K. JONES, REPA
Environmental Chemist and
Regulatory Specialist

SUMMARY OF EXPERIENCE (Since 1979)

Total experience - Work experience consists of thirteen years of environmental chemistry experience. This background covers hands-on laboratory analyses of a wide variety of environmental and industrial samples and supervisory level management of laboratory activities.

Education - B.S., Villa Maria College, 1979 - Biology/Chemistry

Member - American Chemical Society, National Registry of Environmental Professionals

Courses - 40 Hour Health and Safety Training for Hazardous Waste Site, 1988
REM III Supervisory Training, 1989
8 Hour Health and Safety refresher, 1990
Numerous Hazardous Waste Seminars and Conferences

REPRESENTATIVE EEC PROJECT EXPERIENCE (Since 1988)

Environmental Chemist

Ms. Jones is designated as the Regulatory Specialist for the Southeast Region of EEC. She also performs as Technical Lead on hazardous waste and other environmental projects. This involves writing and reviewing permit applications, FSAPs, QAPPs, subcontractor laboratory bid specifications, and other technical documents. Also consults with Project Managers regarding sampling and analysis protocols. Coordinates all non-CLP laboratory analysis.

REM III Program. Coordinated all laboratory support services provided by the REM team members. The analytical level of support for this project was in excess of 3 million dollars in lab fees over a 4 year period. Performed audits on mobile laboratory operations at Superfund sites.

EPA Regions I, III, and V. Data validation experience for Regions I and III consists of more than 400 hours of Contract Laboratory Program (CLP) protocol validation. Designed mobile lab specifications for the ARCS V program which was chosen out of three as the prototype lab trailer for the Region.

State of Georgia and Gwinnett County. Serves as laboratory liaison for the Underground Storage Tank (UST) programs for these two clients. This involves writing technical specifications for all laboratory activities and analyzing reported results. Writes Health and Safety Plans for field activities and serves as Health and Safety Officer for these sites. Performs well searches as part of Corrective Action Plans.

Army Corps of Engineers. Is Technical Lead for ongoing UST and hazardous waste sites that involves compiling all analytical data, evaluating it for usability, and writing Chemical Data Acquisition Plans, Work Plans, and Engineering Reports. Five sites are currently in progress in this program. Was Technical Lead on Part B Permit Applications at 20 sites across the country and developed waste characterization and analysis plans for these sites. These sites involved open burning and/or open detonation of waste munitions. Also prepared Part B Permit Applications for the United States Military Academy at West Point, Crane Army Ammunition Activity, and the NASA facility at Wallops Island.

FPL. Developed a Hazardous Waste/Materials Minimization Plan which included creating a database of all hazardous materials presently used or in design specifications and utilizing a hazard ranking system to prioritize minimization efforts.

Penelec. Developed contractor bid specifications for all environmental aspects of demolition of a coal-fired power plant. The environmental concerns included asbestos, fly-ash, and PCBs.

United States Postal Service and Various Clients. Has performed real-estate transfer audits to comply with various environmental regulatory and internal requirements.

Prior Experience (8 years)

Metallurgical Engineers, Div. of ATEC Associates (1987)

Ms. Jones was engaged to re-initiate activities of the chemistry laboratory at this division. She was responsible for planning and design of the laboratory and for all instrument and equipment maintenance and performance. She was also responsible for the hiring, training, and supervision of laboratory technicians.

One of Ms. Jones' principal tasks was to obtain certification of the laboratory by the American Association of Laboratory Accreditation and the State of Florida. To accomplish this, she composed and implemented a Quality Assurance/Quality Control Manual that was used by all three divisions of the Company, and successfully completed on-site evaluations by both agencies as well as analyses of performance evaluation samples. Ms. Jones was responsible for tracking all quality control activities and summarizing the information in graphs and charts.

Dunn Laboratories (1980-1987)

Ms. Jones obtained extensive background in the analysis of environmental and industrial samples. Because of the variety of the work load, Ms. Jones was called upon to develop a new methods or modify existing methods.

Ms. Jones regularly performed laboratory analyses of potable water using EPA-approved methodology. She also analyzed wastewater for its conformance to NPDES permitting limitations and assisted clients in completing permit applications and reporting. Ms. Jones has extensive experience in the analysis of solid waste for the determination of its hazardous characteristics, such as ignitability, corrosivity, reactivity, and EP Toxicity metals using the methods in SW-846. This testing was done for some clients as part of delisting petitions or for informational purposes prior to disposal. Ms. Jones also analyzed debris obtained from fire and/or explosion scenes to determine presence of accelerants.