**ENVIRONMENTAL
RESTORATION
PROGRAM**

**Work Plan for Support
to Upper East Fork Poplar Creek
East End VOC Plumes
Well Installation Project
at the Oak Ridge Y-12 Plant,
Oak Ridge, Tennessee**

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LOCKHEED MARTIN ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY

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East End VOC Plumes
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Oak Ridge, Tennessee**

Date Issued—March 1998

Prepared by
Science Applications International Corporation
Oak Ridge, Tennessee
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Environmental Management Activities at
OAK RIDGE Y-12 PLANT
Oak Ridge, Tennessee 37831
managed by
LOCKHEED MARTIN ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY
under contract DE-AC05-84OR21400

PREFACE

This document was prepared in accordance with requirements under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 for the Y-12 Environmental Restoration Program. The Upper East Fork Poplar Creek (UEFPC) Characterization Area (CA) is the subject of a remedial investigation (RI). The overall objectives of the UEFPC RI are to evaluate the nature and extent of known and suspected contaminants, to provide the data necessary to perform an ecological risk assessment and a human health risk assessment, to support the evaluation of remedial alternatives for the feasibility study, and to develop a Proposed Plan and Record of Decision for the CA. Work as outlined in this document is to support alternative evaluation in the engineering evaluation/cost analysis for an early action consistent with the valley-wide feasibility study. This work will be performed under Work Breakdown Structure 01.10.01.10 for Y-12 (Cost Center Activity Data Sheet 2337, "Upper East Fork Poplar Creek East End DNAPL Plume").

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ABBREVIATIONS

bgs	below ground surface
BOD	biological oxygen demand
CA	Characterization Area
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
COD	chemical oxygen demand
DO	dissolved oxygen
DOE	U.S. Department of Energy
EDD	electronic data deliverables
EE/CA	Engineering Evaluation/Cost Analysis
Energy Systems	Lockheed Martin Energy Systems, Inc.
EPA	U.S. Environmental Protection Agency
FS	feasibility study
gpm	gallons per minute
MCL	maximum contaminant level
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
QA	quality assurance
QC	quality control
RI	remedial investigation
SAIC	Science Applications International Corporation
TDEC	Tennessee Department of Environment and Conservation
TDS	total dissolved solids
TOC	total organic carbon
TSS	total suspended solids
UEFPC	Upper East Fork Poplar Creek
VOC	volatile organic compound

EXECUTIVE SUMMARY

The Oak Ridge Y-12 Plant, located within the Oak Ridge Reservation (ORR), is owned by the U.S. Department of Energy (DOE) and managed by Lockheed Martin Energy Systems, Inc. The Y-12 Plant is one of three major facilities on the ORR. Under the Resource Conservation and Recovery Act of 1976 guidelines and requirements from the Tennessee Department of Environment and Conservation (TDEC), the Y-12 Plant initiated investigation and monitoring of various sites within its boundaries in the mid-1980s. The entire ORR was placed on the National Priorities List of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) sites in November 1989. Following CERCLA guidelines, sites within the ORR require a remedial investigation (RI) to define the nature and extent of contamination, evaluate the risks to public health and the environment, and determine the goals for a feasibility study (FS) or an engineering evaluation/cost analysis (EE/CA) of potential remedial actions.

Data from monitoring wells at the east end of the Y-12 Plant have identified an area of groundwater contamination dominated by the volatile organic compound (VOC) carbon tetrachloride; other VOCs include chloroform, tetrachloroethene, and trichloroethene. The plume is present in groundwater in the Maynardville Limestone from depths of ~200 to 500 ft below ground surface (bgs), with maximum concentrations of nearly 9000 µg/L. The area of contamination extends from the central portions of the Y-12 Plant into Union Valley and terminates in the vicinity of Scarboro Creek. The VOC plume is considered to be a significant contaminant problem. Representatives of the U.S. Environmental Protection Agency, TDEC, and DOE have determined that containment of the plume at the Y-12 Plant boundary is an appropriate early action; this action is being taken under the scope of an EE/CA and subsequent action memorandum.

The area of contamination falls within the Upper East Fork Poplar Creek (UEFPC) Characterization Area (CA). The UEFPC CA consists of the main plant area and is an operationally and hydrogeologically complex area that contains numerous contaminants and contaminant sources, as well as ongoing industrial and defense-related activities. The overall objectives of the UEFPC CA RI are to evaluate the nature and extent of known and suspected contaminants, to provide the data necessary to perform an ecological risk assessment and a human health risk assessment, to support the evaluation of remedial alternatives for the EE/CA and for the valley-wide FS, and to develop a Proposed Plan and Record of Decision for the CA. The scope of the EE/CA is consistent with objectives of the RI and FS for the UEFPC CA.

To evaluate the feasibility of plume interception actions, a well will be installed to gather data to assist in the preparation of an EE/CA. The short-term extraction and treatment process will be used to develop data to support the development of remedial alternatives in the EE/CA and FS and to evaluate the effectiveness of a pump and treat strategy for plume containment. The well, designated GW-845, will be located southeast of New Hope Pond and will be completed to an approximate depth of 500 ft bgs.

1. INTRODUCTION

The Oak Ridge Y-12 Plant, located within the Oak Ridge Reservation (ORR), is owned by the U.S. Department of Energy (DOE) and managed by Lockheed Martin Energy Systems, Inc. (Energy Systems). The Y-12 Plant is one of three major facilities on the ORR. Under the Resource Conservation and Recovery Act of 1976 guidelines and requirements from the Tennessee Department of Environment and Conservation (TDEC), the Y-12 Plant initiated investigation and monitoring of various sites within its boundaries in the mid-1980s. The entire ORR was placed on the National Priorities List of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) sites in November 1989. Following CERCLA guidelines, sites within the ORR require a remedial investigation (RI) to define the nature and extent of contamination, evaluate the risks to public health and the environment, and determine the goals for a valley-wide feasibility study (FS) and a plume-specific Engineering Evaluation/Cost Analysis (EE/CA) of potential early remedial actions.

The area of contamination falls within the Upper East Fork Poplar Creek (UEFPC) Characterization Area (CA). The UEFPC CA is an operationally and hydrogeologically complex area that contains numerous contaminants and contaminant sources, as well as ongoing industrial and defense-related activities. Boundaries of the UEFPC CA include the base of Pine Ridge to the north, the base of Chestnut Ridge to the south, the eastern boundary of the Bear Creek CA to the west, and the DOE/ORR property line to the east.

The overall objectives of the UEFPC CA RI are to evaluate the nature and extent of known and suspected contaminants, to provide the data necessary to perform an ecological risk assessment and a human health risk assessment, to support the evaluation of remedial alternatives for the FS and the EE/CA, and to develop a Proposed Plan and Record of Decision for the CA. This action is being taken under the scope of an EE/CA and subsequent action memorandum. The scope of the EE/CA is consistent with the objectives of the RI and FS for the UEFPC CA.

Data from monitoring wells at the east end of the Y-12 Plant have identified an area of groundwater contamination dominated by the volatile organic compound (VOC) carbon tetrachloride; other VOCs include chloroform, tetrachloroethene (PCE), and trichloroethene (TCE). The VOC plume is present in groundwater in the Maynardville Limestone from depths of ~200 to 500 ft below ground surface (bgs). The range of concentrations of carbon tetrachloride is large, with maximum reported concentrations of nearly 9000 µg/L from monitoring wells just west of New Hope Pond. Concentrations in excess of the U.S. Environmental Protection Agency (EPA) maximum contaminant level (MCL) of 5 µg/L have been detected in a monitoring well and spring in Union Valley, ~0.5 mile east of the DOE property boundary.

A well is proposed for installation at the east end of the Y-12 Plant as part of an action (i.e., the EE/CA) to address the off-site groundwater contamination. The well will be used for evaluating the feasibility of containing the groundwater plume to prevent off-site migration. Upon completion, the well will be used for short-term pumping and tracer tests. The hydrologic properties of the bedrock system will be evaluated and, if appropriate, the well will be used as part of a containment system. Data will also be used to evaluate the feasibility of a treatment/containment system for contaminated groundwater.

2. PURPOSE AND SCOPE

The VOC plume is in the Maynardville Limestone, which is the uppermost unit of the Conasauga Group and the exit pathway for groundwater from the Y-12 Plant. Elevated concentrations of carbon tetrachloride, which dominate the plume composition, generally are found at depths of ~200 to 500 ft bgs (Fig. 1). This depth interval is below the karstic portion of the Maynardville, and flow generally is through fractures; fracture porosity has been enhanced by solutional processes. Although most of the carbon tetrachloride is found in deeper groundwater, elevated concentrations of carbon tetrachloride have been found in shallower wells near New Hope Pond (e.g., GW-151, GW-220). Other VOCs present within the area of contamination include chloroform, PCE, and TCE.

Shallow groundwater flow near New Hope Pond and Lake Reality has been influenced by a sump pump installed in 1990 to reduce the hydraulic pressure that raises the synthetic liner in Lake Reality. Hydrostatic head data from overburden and shallow bedrock monitoring wells have been defined as elongated, strike-parallel water table depression in the Nolichucky Shale, and decreased water levels in the Maynardville Limestone are coincident with the main channel of UEFPC (Energy Systems 1996). As a consequence of operation of the Lake Reality sump, carbon tetrachloride concentrations in monitoring wells GW-151 and GW-220, which are just east of New Hope Pond, have increased substantially. The pumping has promoted groundwater flow toward the sump, thereby pulling contaminated groundwater upward.

In addition to the sump pump at Lake Reality, an underdrain that was constructed for UEFPC to bypass New Hope Pond acts as a preferential pathway for groundwater migration. The underdrain runs along the southern and eastern boundaries of New Hope Pond, crosses under Second Avenue, runs along the east side of Lake Reality, and empties into UEFPC upstream of Station 17. The underdrain consists of a perforated pipe with gravel backfill. In early 1996, Energy Systems installed GW-832, a 12-ft-deep well, into the underdrain system to evaluate the role of the underdrain in groundwater migration. A pumping test was completed in the well on May 21, 1996. At a pumping rate of ~75 gal per minute (gpm), the test ran until the containment tankers for pumped water were full. The well had a drawdown of ~1 ft and drawdown was observed in the Lake Reality sump indicating hydraulic connection. A sample from GW-832 was analyzed for VOCs, and the carbon tetrachloride concentration was 23 µg/L.

The new well will be located southeast of New Hope Pond to the east of the Pistol Range and will be designated GW-845 (Fig. 2). Data from nearby monitoring wells suggest that the proposed location will be optimal for intersection of the VOC plume. The well will be double-cased and completed with an open-hole interval of sufficient length (~300 ft) to transect most of the vertical extent of the plume; the total depth is estimated at ~500 ft bgs, which corresponds to the estimated depth of the Maynardville Limestone/Nolichucky Shale contact.

Fig. 1. Carbon tetrachloride in groundwater in the eastern plant area.

Y-12 PLANT KEY LOCATOR

SITE LOCATION

LEGEND:

- MAIN BUILDINGS
- SECONDARY BUILDINGS
- PRIMARY ROAD
- FENCE
- GROUNDWATER WELL LOCATION
- NEW DEEP WELL
- Y-12 PLANT GRID

SAIC

Science Applications
International Corporation

UEFPC CA RI REPORT
OAK RIDGE, TENNESSEE

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Fig. 2. Location of new GW-845 and groundwater wells to be sampled.

Despite the importance of the Maynardville Limestone as a pathway for groundwater migration, no testing has been completed in the eastern plant area to determine the hydrologic parameters of the unit, such as hydraulic conductivity, storativity, transmissivity, and the degree of connectedness between shallow and deep fracture systems. Consequently, when the well is installed, a pumping test will be conducted for the evaluation of hydrologic properties of the groundwater system in the Maynardville Limestone. Data obtained from pumping tests will be used to optimize the containment system alternative in the EE/CA.

3. SAMPLING PLAN

This section describes the procedural guidance that will be used for the installation and testing of the well. Fieldwork will be conducted in accordance with this document; any significant deviations from the plan will be documented on Y-12 Plant Field Change Request Forms and approved by the Y-12 Environmental Restoration Project Manager.

3.1 BACKGROUND

Installation, development, and testing of the well will be conducted using the appropriate Standard Operating Procedures provided in *Environmental Surveillance Quality Control Program*, ES/ESH/INT-14 (Energy Systems 1988).

3.2 FIELD TASKS

The field tasks will consist of providing geological support for drilling, testing, installing, and sampling one deep monitoring well (GW-845), sampling groundwater well GW-722 by the Y-12 Groundwater Protection Program, collecting water samples from 10 springs, and collecting water samples from 10 shallow wells. The deep monitoring well is being installed by Highland Drilling under the supervision of MK Ferguson. No subsurface soil samples will be collected during the well drilling. Table 1 lists samples to be collected and analysis for each sample. All sampling activities, where applicable, will follow the technical procedures established in *Environmental Surveillance Procedures, Quality Control Program*, ES/ESH/INT-14 (Energy Systems 1998) and applicable Science Applications International Corporation (SAIC) Field Technical Procedures.

3.2.1 Well Installation

The installation of the well will begin with completion of a pilot hole drilled into competent bedrock to a depth of ~200 ft bgs. The pilot hole will provide information regarding the thickness of the unconsolidated and weathered, cavatose bedrock intervals. The pilot hole will be reamed using a two-stage hole-opener to a diam of 12 1/4-in. to a depth determined from the pilot hole data. An 8 5/8-in.-outer-diam steel casing will be installed and grouted in place. Finally, a 7 3/4-in.-diam borehole will be completed to a depth of ~500 ft bgs. Actual casing set points and the well depth may vary based on actual field conditions. The borehole will be left as an open-interval at completion. Figure 3 is a schematic cross section of well GW-845.

Table 1. Samples and analyses

Sample	Analyses
Well GW- 845 (new well)	VOCs, gross alpha/beta, bio-treatability study
Well GW-722	VOCs, TOC, BOD, COD
Shallow wells	TOC, BOD, COD
Surface water springs/seeps	pH, DO, BOD, ORP, TSS, TDS, turbidity, VOCs, metals, gross alpha/beta/gamma
TOC = total organic carbon	VOC = volatile organic compound
BOD = biological oxygen demand	DO = dissolved oxygen
COD = chemical oxygen demand	ORP =
TSS = total suspended solids	TDS = total dissolved solids

Once GW-845 is developed, it will be sampled for VOCs, gross alpha, gross beta, and a sample will be obtained for a bio-treatability study.

After installation, development, and sampling of the well, a 7-d pumping test will be completed to obtain hydrologic parameters for the Maynardville Limestone at the east end of the Y-12 Plant. Previous pumping tests at Y-12 Plant have been either in the Bear Creek Valley CA or in the Nolichucky Shale in the vicinity of the S-3 Ponds. Specifics of the pumping test are still in the process of being finalized and will be added to this work plan, as appropriate, prior to initiation.

Water level monitoring during the tests will be accomplished using both transducers and water level indicators. A network of monitoring wells of variable total depth are located near the proposed well location. These monitoring wells monitor the overburden and various bedrock intervals and include GW-151, GW-152, GW-153, GW-154, GW-169, GW-170, GW-220, GW-240, GW-380, GW-381, GW-382, GW-385, GW-605, GW-606, GW-733, GW-762, and GW-763. Twelve of these wells will be continuously monitored during the 7-d pump and tracer test discussed in Chap. 7. Key wells that are known to intersect the plume, based on historical data, will be monitored with a transducer. The transducer will be connected to a data logger that will enable project personnel to download the data for analysis and evaluation. Water levels in the other wells will be taken manually, at least two times a day, for the duration of the pumping test.

The data collected during the pumping test and tracer test as discussed in Chap. 7 will be used to evaluate the performance of GW-845 and the hydrologic properties of the Maynardville Limestone at the east end of the Y-12 Plant. Calculations from the data will include (at a minimum) drawdown, radius of influence, well efficiency, hydraulic conductivity, and transmissivity. These calculations, in turn, will be used to evaluate the ability of the well to contain the plume, the degree of interconnectedness between shallow and deep fracture systems, and the feasibility of pumping and treating the contaminated groundwater.

3.2.2 Well GW-722 Sampling

Well GW-722 is routinely sampled as part of the Y-12 Ground Water Protection Program. The well is equipped with a West Bay sampling system with sampling and measurements ports for 33 discrete zones. Five of these zones, representing shallow, intermediate and deep, are of interest

Y-12 PLANT GROUNDWATER PROTECTION PROGRAM

WELL NO. GW-845

WELL INSTALLATION DIAGRAM

LOGGED BY: _____

DRILLING DATES

DRILLING COMPANY: _____

STARTED: _____

DRILLER: _____ HELPER: _____

FINISHED: _____

Fig. 3. Well installation diagram for GW-845.

for this project. This well was sampled in December 1997 and is scheduled to be sampled again in mid-February 1998. Sample analysis includes carbon tetrachloride, which is the contaminant of interest, as well as other volatile organics. The data from the routine sampling events will be requested and will satisfy the data needs from this well. Also during the February 1998 sampling effort, five samples will be gathered for biological oxygen demand (BOD), chemical oxygen demand (COD), and total organic carbon (TOC).

3.2.3 Shallow Well Sampling

Groundwater samples will be collected from the following 10 wells: GW-151, GW-153, GW-167, GW-223, GW-381, GW-605, GW-735, GW-750, GW-170, and GW-384. The wells selected for sampling will be representative of shallow groundwater conditions in the area of concern. These 10 wells will be sampled for BOD, COD, and TOC analysis. Figure 2 illustrates the 10 wells to be sampled.

3.2.4 Surface Water Spring/Seep Sampling

Ten surface water seeps and springs will be sampled in the Union Valley area along Scarborough Creek. The following seeps/springs will be sampled: SCR 7.1SP, SCR 7.17SP, SCR 7.11SW, SCR 7.12SW, SCR 7.8NSP, SCR 7.8SSP, SCR 7.13SP, SCR 7.18SP, SCR 7.10SP, and SCR 7.4SP. The spring sample locations have been identified and are marked by flagging in the field and are illustrated on Fig. 4.

3.3 SAMPLE TRACKING AND RECORDS MANAGEMENT

Samples will be tracked by chain-of-custody forms until the samples are received in the laboratory, and by the laboratory tracking system thereafter. Analytical results will be provided to SAIC on a daily basis for the lined pit during well installation and within a 7-d turnaround on other analyses. This section describes the steps required of each of the participants and how the transfer of samples will take place between them.

3.3.1 Field Data Custody

The samples collected in the field will be recorded onto chain-of-custody forms as well as in a field notebook maintained by the oversight geologist. Both of these entries will include the sample location, the sample number, the type of bottle in which the samples are placed, the analyses required for the sample, and the person(s) responsible for the samples. Whenever the samples leave custody of a person, the custody transfer is signed in the appropriate place on the form. A custody seal will be affixed to the sample vials before custody transfer occurs. The original chain-of-custody form will be retained by the oversight geologist for inclusion in the project files. The laboratory should retain a copy for its records.

3.3.2 Laboratory Data Custody

Upon receiving the samples, a representative of the laboratory will sign the chain-of-custody form, note the condition of the sample, and log the sample into the Energy Systems laboratory tracking system as appropriate. The laboratory tracking system may be either computer-based or

Y-12 PLANT KEY LOCATOR

- LEGEND:**
- MAIN BUILDINGS
 - SECONDARY BUILDINGS
 - PRIMARY ROAD
 - FENCE
 - LOT BOUNDARY
 - STREAM & TRIBUTARY
 - PONDS
 - SEEP / SPRING SAMPLING LOCATION
 - DOE BOUNDARY
 - Y-12 PLANT GRID

Fig. 4. Seeps/springs sampling locations.

managed by a laboratory employee. Biological samples, VOC screening of drilling effluents, and dye analyses are specialized services performed by Oak Ridge National Laboratory (ORNL); sample quality assurance/quality control (QA/QC) requirements will be dictated by the laboratories conducting these analyses.

3.3.3 Well Installation and Development Records

At the conclusion of the well installation, the oversight geologist will, from his records, complete the following:

- a geologic log,
- an activity/progress report,
- a well cuttings field screening/disposal form,
- a well development summary,
- an equipment decontamination summary, and
- a well diagram.

These items will comprise the well installation portion of the well installation report.

Also included in the well installation report will be the sampling and analysis data as discussed in Chap. 3, as well as pump and tracer test conclusions.

4. HEALTH AND SAFETY

The tasks and associated responsible organizations are as follows:

- groundwater well boring and installation—Highland Drilling/MK Ferguson;
- sampling of existing well (GW-722)—Energy Systems; and
- sampling of new well (GW-845), sampling of surface water spring/seeps, sampling of 10 groundwater wells, pumping test, and dye tracer study—SAIC.

Highland Drilling will perform the well drilling and installation under the requirements of an existing MK Ferguson subcontractor health and safety plan for this task. Highland Drilling will provide a site health and safety officer for the drilling and well installation. The Y-12 Groundwater Protection Program personnel will sample GW-722 following standard Energy Systems health and safety procedures. SAIC will perform the tasks referenced above pursuant to the SAIC Environmental Compliance and Health and Safety procedures.

On-the-job hazards that may be encountered are presented in Table 2, and a chemical hazards analysis is provided in Table 3. Drilling activities are conducted under a separate hazard analysis prepared by MK Ferguson.

Table 2. Hazards analysis

Safety and health hazards	Controls	Monitoring
<i>Groundwater sampling at GW-845 and 10 shallow wells, surface water sampling from springs/seeps, pumping test, and dye tracer test</i>		
General safety hazards (moving equipment, slips, falls)	Level D PPE (field work clothes, safety shoes, and safety glasses when eye hazards are present). HAZWOPER training. Buddy system or capability to contact assistance. Medical clearance.	None
Radiological contamination	Compliance with relevant Radiological Work Permit(s). As a minimum, frisking out of contaminated and potentially contaminated areas, anti-contamination gloves for handling potentially contaminated material.	As required by RWP
Exposure to chemicals (carbon tetrachloride)	Natural rubber, nitrile, or similar gloves for contact with potentially contaminated material. Washing face and hands prior to taking anything by mouth. Minimal contact. Medical clearance for HAZWOPER work. 15-minute eyewash within 100 ft when pouring corrosive sample preservatives or using chemicals that might be hazardous to the eyes. Inventory and MSDSs on site for all chemical tools used on site.	None
Noise	None needed.	None
Fire (fuels)	Exclude ignition sources from areas where fuels are stored or transferred. Fire extinguisher maintained near fuel storage.	None
Animal hazards (bees, ticks, wasps, snakes)	PPE (boots, work clothes). Pants tucked into boots or wrapped with duct tape, as necessary. Insect repellent, as necessary.	Visual survey
Electric shock	Ground fault circuit interrupters for portable power tools and portable electrical equipment used outdoors or in wet locations.	None
Temperature extremes	If temperatures exceed 80°F: frequent breaks in cool area, chilled water readily available. If temperatures are less than 32°F: access to warm break area, dry change of clothing available.	Ambient temperature

Table 3. Potential exposures

Chemical	TLV/PEL/STEL/IDLH ^a	Health effects/ potential hazards ^b	Chemical and physical properties ^b	Exposure route(s) ^b
Carbon tetrachloride	TLV/TWA: 5 ppm A2 PEL/TWA: 10 ppm IDLH: Ca [200 ppm]	Potential cancer causing agent per NIOSH, irritation of eyes and skin, dizziness, drowsiness	Liquid with ether-like odor; VP: 91 mm; FP: NA	Inhalation Ingestion Absorption Contact
Hydrochloric acid (used for sample preservation)	TLV: 5 ppm ceiling IDLH: 50 ppm	Irritation of eyes, skin, respiratory system	Liquid; VP: fuming; IP: 12.74 eV; FP: none	Inhalation Ingestion Contact
Isopropyl alcohol (potentially used for equipment decontamination)	TLV/TWA: 400 ppm STEL: 500 ppm IDLH: 2000 ppm	Irritation of eyes, skin, respiratory system; drowsiness, headache	Colorless liquid with alcohol odor; VP: 33 mm; IP: 10.10 eV; FP: 53°F	Inhalation Ingestion Contact
Liquinox (used for decontamination)	TLV/TWA: None	Inhalation may cause local irritation to mucus membranes	Yellow odorless liquid (biodegradable cleaner); FP: NA	Inhalation Ingestion
Chloroform	TLV: 10 ppm, A3 PEL: C50 ppm IDLH: Ca [500ppm]	Cancer, dizziness, eye and skin irritation	Liquid; VP: 160 mm FP NA; IP: 11.42 eV	Inhalation Absorption Ingestion Contact
Trichloroethylene	TLV: 50 ppm A5 PEL: 100 ppm IDLH: Ca [1000 ppm]	Cancer, eye and skin irritation, dizziness, headache	Liquid; VP: 58 mm FP: ?, IP: 9.45 eV	Inhalation Ingestion Absorption Contact
Perchloroethylene	TLV: 25 ppm A3 PEL: 100 ppm IDLH: Ca [150 ppm]	Cancer, eye and skin irritation, dizziness, headache	Liquid; VP: 14 mm FP: NA; IP 9.32 eV	Inhalation Ingestion Absorption Contact

^aFrom 1997 Threshold Limit Values, NIOSH Pocket Guide to Chemical Hazards, 1994.^bFrom 1994 NIOSH Pocket Guide to Chemical Hazards.

A2 = suspected human carcinogen

FP = flash point

IP = ionization potential

PEL = permissible exposure limit

NA = not available

NIOSH = National Institute for Occupational Safety and Health

STEL = short-term exposure limit

TLV = threshold limit value

TWA = time-weighted average

VP = vapor pressure

IDLH = immediately dangerous to life and health

5. WASTE MANAGEMENT

Waste management practices used during the installation, operation, and testing of the well are specified in a site-specific waste management and best management plan prepared by MK Ferguson. The practices associated with well installation and other field sampling activities will comply with procedures for the Environmental Restoration Program at the Y-12 Plant, *Waste Removal and Disposition through the Y-12 ER Program*, ER/Y-P2102 (IAD), Rev. 0, and with procedures outlined in *Environmental Surveillance Quality Control Program*, Method ESP-105, "Field Waste—Control of Fieldwork-Contaminated Materials," ES/ESH/INT-14 (Energy Systems 1988).

Waste types will consist of water and mud generated during drilling; water generated during development and testing; excess sample volume; analytical sample residue; gloves; personal protective equipment (e.g., Tyvek); decontamination water; isopropyl water; and miscellaneous waste such as plastic sheeting, paper towels, sample containers, aluminum foil, and plastic garbage bags. Water and mud generated during drilling and water generated during development will be discharged to a pit excavated near the wellhead. SAIC will coordinate with Y-12 Waste Management Division personnel to obtain approval for containment and disposition of effluents if discharge levels are exceeded. Y-12 Waste Management Organization personnel will coordinate and approve the disposition of effluents. Water generated during the pumping test will be treated by a temporary air stripper and then discharged to UEFPC via a temporary National Pollutant Discharge Elimination System Discharge Point. Excess sample volume that is not needed for analysis will be discarded in the pit near the wellhead. Analytical sample residue, consisting of laboratory extracts, digestates, and unused samples, will be disposed of by the laboratory in accordance with Energy Systems protocol. Decontamination water generated during sampling activities will be containerized and transported to the West End Treatment Facility for disposal. Personal protective equipment and miscellaneous trash will be deposited into a dumpster designated by the Environmental Restoration Program, and disposed of in the Y-12 Plant Landfill.

6. QUALITY ASSURANCE/QUALITY CONTROL

These QA/QC activities have been developed for use in the sample collection and sample analysis associated with development of a new deep well in the UEFPC CA to ensure that appropriate levels of QA and QC are achieved. All QA/QC procedures will be in accordance with applicable professional technical standards, EPA requirements, government regulations, DOE Orders, and Y-12 Plant requirements. Specifications in the *Environmental Restoration Quality Program Plan*, ES/ER/TM-4R4 (Energy Systems 1994) will be met.

QA objectives for data collection and analysis are to generate data that will withstand scientific and technical scrutiny; to use appropriate procedures for sampling, analysis, chain-of-custody, data documentation, and reporting; and to produce data of known precision, accuracy, and sensitivity. Analytical data will be reported in accordance with definitive data deliverables consistent with the EPA Control Laboratory Program process and Energy Systems "Analytical Services Master Specifications."

6.1 FIELD QUALITY CONTROL

To ensure the quality and consistency of data, specific approved sample collection and handling procedures will be followed in accordance with the current version of *Environmental Surveillance Procedures Quality Control Program*, Rev. 4, ES/ESH/INT-14 (Kimbrough et al. 1994) unless otherwise approved by Energy Systems.

The selection criteria for appropriate sample containers, sample preservatives, and holding times shall be in accordance with ESP-701, *Sample Preservation and Container Materials*. Types of sample containers and sample preservation methods used will be documented in the sampling logbook. Handling, shipping, and storage of samples and data resulting from field activities will adhere to chain-of-custody procedures and will ensure that sample integrity for analytical purposes is maintained. The procedures required to properly preserve, package, ship, handle, and store containers of environmental samples will be based on *Sample Classifying, Packaging, Marking, Labeling, and Shipping for Analysis through the K-25 and Y-12 Environmental Restoration Programs*, ER/C-P2303 (IAD).

Each environmental sample collected during this project will be assigned a unique sample identifier, which will be permanently affixed to the sample container and recorded in the field logbook and chain-of-custody record.

Chain-of-custody procedures require documentation of sample possession from the time of collection to time of disposal. These procedures allow the possession and handling of samples from the time of collection through analysis and final disposal to be traced. Chain of custody shall be maintained in accordance with ER/K-I1600, *Chain of Custody* (Field SAP Procedures Manual). After sample receipt and throughout analysis, the laboratory will maintain custody of all samples, aliquots, resultant extracts, and digestions. Tracking and internal chain of custody will be recorded by the laboratory, however, this documentation will not be required as part of the analytical deliverable.

Field instrumentation will be calibrated according to the procedures specified in the manufacturer's operating manual or more frequently should the conditions dictate it for the particular instrument.

Screening of organic vapors, alpha radiation, and beta/gamma radiation may be conducted at the sample location or field sample handling area for health and safety purposes as well as screening-level investigation data. Organic vapor screening will follow SAIC FTP-750. Screening for alpha and beta/gamma radiation will follow FTP-451. Water quality parameters (specific conductance, pH, temperature, ORP, DO, etc.) will be measured in the field during sampling and will follow the *Environmental Surveillance Procedures Quality Control Program*, Rev. 4, ES/ESH/INT-14 (Kimbrough et al. 1994).

Data collected during field activities will be evaluated by checking the procedures used and comparing the data to previous measurements. The SAIC QA/QC Officer, or designee, and appropriate field personnel will be responsible for checking field QC sample results to ensure that field measurement and sampling protocols have been observed. Field QC samples will include field duplicates (10%) and trip blanks (one per shipment).

6.2 LABORATORY QUALITY CONTROL

Organic, inorganic, and radiochemical analytical methods prescribed for use in this project have been taken from EPA SW-846 Method Guidance 3rd Edition, other EPA procedures, and DOE manuals. Table 4 presents analyte container, preservative, and holding time information, while Table 5 provides parameter-specific methodologies and reporting levels.

All analytical instrumentation will be calibrated against certified equipment and/or standards having known valid traceability to nationally recognized standards. Laboratory equipment will be calibrated according to the procedures specified in the analytical methods and in the operating manual for the particular instrument. Calibration frequency will be based on the analytical methods used, type of equipment, inherent stability, manufacturer's recommendations, values given in national standards, intended use, and experience.

Laboratory review is responsible for ensuring that data reduction and calculations follow correct procedures, are documented, and are checked by qualified personnel. All information, including reduced and summarized data will be retained with the raw data. Specific calculations used for data reduction will also be included. The laboratory is responsible for maintaining comprehensive documentation for all data produced.

The laboratory will be responsible for hard-copy deliverables as defined by Energy Systems "Analytical Services Master Specifications." Electronic data deliverables (EDD) will be submitted for each sample grouping and be consistent with the hard copy provided. EDD formats will be arranged during laboratory procurement to provide information that can be used by the project data base to produce an OREIS data deliverable. All project data will be evaluated to ensure a complete, consistent, and usable project dataset.

Laboratory QC samples will be analyzed to check and monitor laboratory performance, precision, and accuracy. The laboratory must follow specific quality processes as defined by the methods and include appropriate QC measures such as calibration verification samples, instrument blank analysis, surrogate determinations, internal standards, and tracer analysis, etc.

6.3 QA AND REPORTS TO MANAGEMENT

Procedures cannot fully encompass all conditions encountered during a field investigation. Variances from the operating procedures, sampling and analysis plan, and/or health and safety plan will, therefore, likely occur and must be documented on a field change order form or a nonconformance report and be noted in the appropriate logbooks. The approach to controlling and documenting field changes will follow ER/C-P1719.

All documents concerning the project (e.g., internal and external correspondence, sampling and analysis plan, field logbooks and forms, chain-of-custody forms, data packages, audit reports,

Table 4. Container requirements for UEFPC new well investigation

Analyte group	Container	Minimum sample size	Preservative	Holding time
Volatile organic compounds	2 - 40 mL glass vials with Teflon®-lined septum (no headspace)	40 mL	Cool, 4°C	7 d
Metals	1 - L polybottle	500 mL	HNO ₃ to pH <2 Cool, 4°C	180 d, metals 28 d, Hg
TOC and COD	250 mL polybottle	100 mL ea.	H ₂ SO ₄ to pH <2 Cool, 4°C	28 d
BOD	1 - L glass bottle	1000 mL	Cool, 4°C	48 hr
TDS/TSS/Turbidity	500 mL polybottle	100 mL ea.	Cool, 4°C	28 d
Radionuclides	1 gal container	4 L	HNO ₃ to pH <2 Cool, 4°C	180 d

**Table 5. Analytical/methods, parameters, and project quantitation limits
for UEFPC new well investigation**

Parameters	Analytical methods	Project quantitation levels ^a
	Water	Water ($\mu\text{g/L}$)
Volatile organic compounds	SW-846, 8260A	
Chloromethane		10
Bromomethane		10
Vinyl chloride		10
Chloroethane		10
Methylene chloride		5
Acetone		10
Carbon disulfide		5
1,1-Dichloroethene		5
1,1-Dichloroethane		5
1,2-Dichloroethene (total)		5
Chloroform		5
1,2-Dichloroethane		5
2-Butanone		10
1,1,1-Trichloroethane		5
Carbon tetrachloride		5
Bromodichloromethane		5
1,2-Dichloropropane		5
cis-1,3-Dichloropropene		5
Trichloroethene		5
Dibromochloromethane		5
1,1,2-Trichloroethane		5
Benzene		5
trans-1,3-Dichloropropene		5
Tribromomethane		5
4-Methyl-2-pentanone		10
2-Hexanone		10
Tetrachloroethene		5
Toluene		5
1,1,2,2-Tetrachloroethane		5
Chlorobenzene		5
Ethylbenzene		5
Styrene		5
Xylenes (total)		5

Table 5 (continued)

Parameters	Analytical methods	Project quantitation levels ^a
	Water	Water ($\mu\text{g/L}$)
Metals		
(Target Analyte List plus)	SW-846, 6010A/6020	
Aluminum		50
Antimony		10
Arsenic		5
Barium		5
Beryllium		1
Cadmium		1
Calcium		50
Chromium		5
Cobalt		5
Copper		5
Iron		10
Lead		3
Magnesium		50
Manganese		5
Mercury (CVAA)	SW-846, 7470	0.2
Nickel		10
Potassium		50
Selenium		5
Silver		5
Sodium		50
Thallium		10
Vanadium		10
Zinc		5
Additional metals:		
Uranium		5
Water parameters		(mg/L)
TOC	EPA 415.2	0.1
BOD	EPA 405.1	0.5
COD	EPA 410.4	1.0
TSS	EPA 160.2	10
TDS	EPA 160.1	10
Turbidity	EPA 180.1	1 NTU

Parameters	Analytical methods	Project quantitation levels ^a
	Water	Water ($\mu\text{g/L}$)
Radionuclides		(pCi/L)
Gross alpha	Proportional counter	5
Gross beta	Proportional counter	5
Gross gamma	Gamma spectroscopy	10

^a These are expected quantitation limits based on reagent grade water or a purified solid matrix. Actual quantitation limits may be higher depending upon the nature of the sample matrix. The limit reported on final laboratory reports will take into account the actual sample volume or weight, percent solids (where applicable), and the dilution factor, if any. The quantitation limits for additional analytes to this list may vary, depending upon the results of laboratory studies.

BOD = biological oxygen demand
 COD = chemical oxygen demand
 TDS = total dissolved solids
 TOC = total organic carbon
 TSS = total dissolved solids
 CVAA = cold vapor atomic absorption

surveillance reports, nonconformance reports, corrective action reports, etc.) will be submitted to the Project Manager for appropriate storage and retrieval. Records concerning the project will be forwarded to the Energy Systems Project Manager upon request for placement in the Environmental Restoration Records Center.

7. PUMP AND TRACER TEST PLAN

7.1 INTRODUCTION

A pump and tracer test will be completed following the drilling and installation of well GW-845. The test will consist of the monitoring for fluorescent dyes that have been injected into a nearby shallow well. The monitoring will occur during the well pumping operation to test the connectivity of the shallow and deep groundwater system. The elements of this test are

- determining the background dye levels in all wells to be used,
- determining the correct fluorescent dye and dye quantity to be injected,
- dye injection and initiation of pumping of well GW-845,
- monitoring water level in 12 surrounding shallow groundwater wells for drawdown, and
- monitoring for dye emergence with charcoal dye receptors and a continuous water sampler.

7.2 BACKGROUND DYE DETERMINATION

Prior to initiation of this test, the concentration and types of fluorescent dyes present within the groundwater system (background levels) will be determined. This is accomplished by the placement and changeout of charcoal dye receptor packets within the wells to be used during this test for a period of 2 weeks. The successful detection of the injected dye(s) requires this information to distinguish the injected dye from the dyes already within the system. Several dyes are suspected to be in the groundwater system, as groundwater tracing has been attempted in the area in the recent

past. Due to the short duration of this test and the anticipated short travel distances of the injected dye, a measurement of background dye levels for a 2-week period will be sufficient.

7.3 DYE SELECTION AND INJECTION

The information gathered during the background measurement period will be used to select an appropriate dye for injection. SAIC will use the laboratories and expertise of Crawford and Associates, Inc. to select one of the nine commonly used dyes for injection and to determine the quantity of dye required. Previous tracer tests at the Y-12 Plant and the East Tennessee Technology Park have used several of these dyes for groundwater tracing tests (Energy Systems 1992, 1995). Dyes will be transported to the injection well in liquid form and pumped slowly down the well using a peristaltic pump.

Well GW-380 will be used for the injection of the selected dye. This well is ~15.5 ft total depth and is installed within the Maynardville Limestone. The well will require a pre-injection flushing with ~500 gals of water and a post-injection flushing of similar volume. This input of water following dye injection pushes the dye away from the well screened interval and provides the head for forcing dye into the groundwater system. Following the completion of dye injection, the pumping of well GW-845 will commence and as will the monitoring for dye detection.

7.4 DYE DETECTION MONITORING

The detection of injected fluorescent dyes is dependent on the method of monitoring, the frequency of sample collection, the strength of the emerging dye at the monitored location, and the criteria used for a positive detection. Due to the relatively short detection period for this test, the design will be tailored to maximize the detection of the dyes.

7.4.1 Method of Monitoring and Sample Collection Frequency

The detection of the injected dyes will be accomplished through the use of a charcoal dye receptor packet placed in the well GW-845 and the continuous collection of water samples during the 7-d pumping test of this well. The water sampling method allows determination of the time of dye arrival (within the resolution of the collection interval) with the charcoal receptor as a backup detection method. As the charcoal packets will have been used during the background monitoring period, the concentrations of the dye within GW-845 can be compared to pre-injection background levels.

The charcoal packet will be suspended in the well using a weighted line at a height above the submersible pump to prevent entanglement. The receptor will be extracted and exchanged daily. Upon removal from the well, the packets will be stored until completion of the pumping period before submittal to the laboratory. Care must be taken during the handling of the packets to prevent cross-contamination and the creation of false positive detections. These packets are capable of absorbing dyes for up to 2 weeks without a loss of absorptive capacity and only require protection from light to prevent photodecay of any absorbed dyes.

The second method of detection involves an automated ISCO water sampler that collects a small volume of water at a programmed interval. The samples are stored within the bottles positioned around a carousel and represent a discrete sample at a point in time. The collection tube for the sampler will be positioned within the piping or at a valve on the exit line for the water pumped from the well. The sample interval will be hourly with the collection to be started approximately 2 h prior to dye injection and to continue for a 7-d period. The carousel of bottles will require replacing once every 24 h and can be accomplished between sample times.

All collected samples (packets and water samples) will be assigned a sample identification number and tracked as per chain-of-custody procedures. The estimated time from sample submittal to complete analysis is 2 weeks.

7.4.2 Criteria for Positive Detection

The detection of injected dyes requires the comparison of the concentration of the dye within samples collected following injection to those collected previous to injection. This comparison allows a determination if dye levels have increased due to migration of the injected dye to the monitored location, or alternatively, if the increase is only a fluctuation of background dye levels. The criteria for this test will be that dye must exceed 10 times the background concentration of the dye within GW-845 for at least two consecutive samples. Current detection limits for fluorescent dye are in the part per billion range.

7.5 ISSUES AND CONCERNS

Previous dye tracing in the eastern area of the Y-12 Plant will likely result in the presence of several dyes in the groundwater system in the area of GW-845. It is suspected these dyes may be at concentrations that could limit the dye selection and, thus, the dyes available for use. The information to select an appropriate dye will be collected during the background measurement period.

Results of previous groundwater tracer tests in the eastern area of the Y-12 Plant indicate dye migration may occur at very slow rates. For example, Fluorescein dye injected into well GW-382 by TDEC was not detected in nearby wells or surface water locations within a 2-month detection monitoring period. Recent sampling of this well indicates the water is noticeably green upon examination, the color of Fluorescein dye. The factor of slow migration may result in a lack of dye detection during the 7-d pumping period. If detection does not occur and pumping is terminated, monitoring can be continued by the routine changeout of charcoal receptor packets; however, continued monitoring is not currently planned.

8. SCHEDULE

The well installation is anticipated to begin in late January 1998. A Davis-Bacon review of the proposed well installation concluded that this is a construction activity; therefore, MK-Ferguson of Oak Ridge Company and their subcontractor, Highland Drilling, will be responsible for the installation of the well. Energy Systems personnel and subcontractors will be responsible for the

sampling of GW-845 and pump and tracer tests. It is estimated that it will take 3 to 4 weeks to install and develop the well. Testing will start as soon as possible after development of the well.

Also, as discussed in this work plan, data will be gathered as discussed in Chap. 3 in late February 1998. Sampling of GW-722 will be conducted on February 16, 1998.

9. REFERENCES

- Energy Systems (Martin Marietta Energy Systems, Inc.) 1988. *Environmental Surveillance Quality Control Program*. ES/ESH/INT-14.
- Energy Systems 1992. *Work Plan for the Second Dye Tracer Test at the Chestnut Ridge Security Pits, Y-12 Plant, Oak Ridge, Tennessee*.
- Energy Systems 1994. *Environmental Restoration Quality Program Plan*. ES/ER/TM-4/R4.
- Energy Systems 1995. *Work Plan for the Groundwater Tracer Test for the K-1070-A Burial Ground Focused Groundwater Remedial Investigation*. K/ER-237.
- Energy Systems 1996. *Calendar Year 1995 Groundwater Quality Report for the Upper East Fork Poplar Creek Hydrogeologic Regime, Y-12 Plant, Oak Ridge, Tennessee*. Y/SUB/96-KDS15V/4. Prepared by AJA Technical Services, Inc.
- Kimbrough, C.W., L.W. Long, and L.W. McMahon 1994. *Environmental Surveillance Procedures Quality Control Program*, Rev. 4, ES/EH/INT-14 (replaces ESH/SUP/87-21706/1), Martin Marietta Energy Systems, Inc., Oak Ridge K-25 Site, Oak Ridge, Tenn.
- Merriweather, R., C. V. Thompson, M. B. Wise, and M. R. Guerin 1996. Draft Method 8265, *Direct Sampling Ion Mass Spectrometry (DSITMS) Rapid Analytical Methods for Measuring Thirty-Four Organic Compounds on the EPA Target Compound List (TCL) in Water, Soil, and Air*. Lockheed Martin Energy Research Corp.
- NIOSH (National Institute for Occupational Safety and Health) 1994. *NIOSH Pocket Guide to Chemical Hazards*.
- U.S. Department of Energy 1995. *Remedial Investigation Work Plan for the Upper East Fork Poplar Creek Characterization Area, Oak Ridge Y-12 Plant, Oak Ridge, Tennessee*. DOE/OR/01-1396&D1.

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