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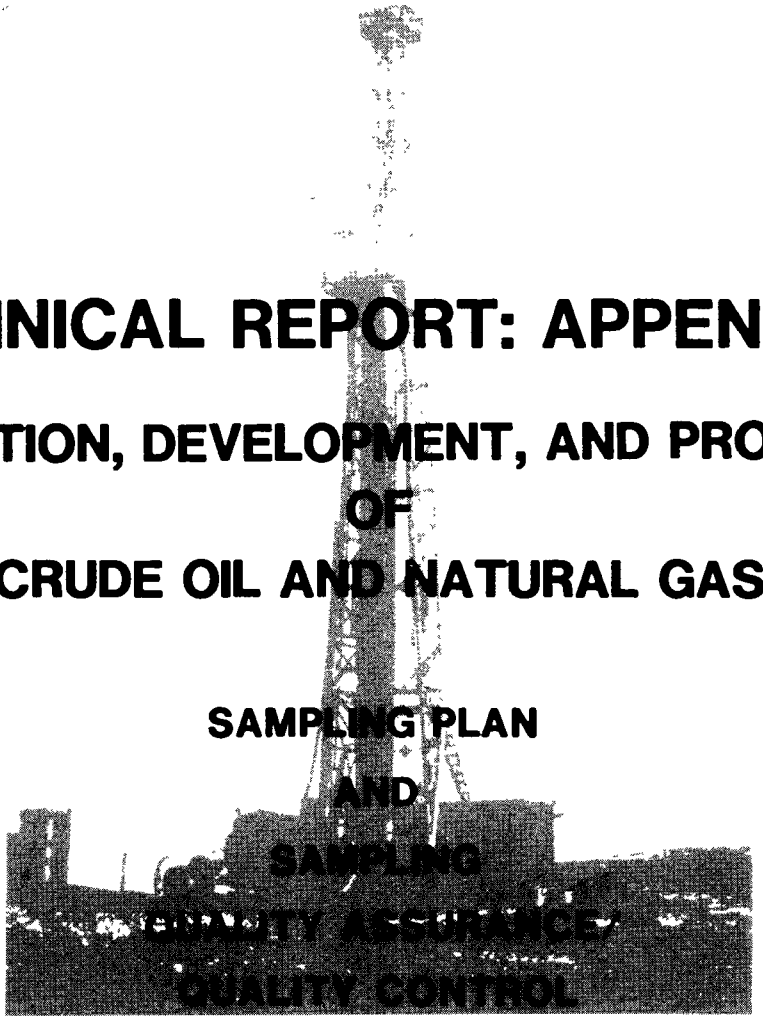
EPA



TECHNICAL REPORT: APPENDIX G

EXPLORATION, DEVELOPMENT, AND PRODUCTION OF CRUDE OIL AND NATURAL GAS

SAMPLING PLAN AND SAMPLING QUALITY ASSURANCE/ QUALITY CONTROL

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OSW/OW - ITD
OIL AND GAS EXPLORATION, DEVELOPMENT, AND PRODUCTION
SAMPLING PLAN AND
SAMPLING QUALITY ASSURANCE/QUALITY CONTROL PLAN

PREPARED FOR
U. S. ENVIRONMENTAL PROTECTION AGENCY
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DISCLAIMER

Mention of trade names or commercial products does not constitute EPA endorsement or recommendation for use.

LIST OF ABBREVIATIONS

AA	--	Atomic absorption
COD	--	Chemical oxygen demand
cm	--	Centimeter
DOT	--	Department of Transportation
EPA	--	Environmental Protection Agency
ft	--	Foot
GC	--	Gas Chromatography
GC/MS	--	Gas Chromatography/Mass Spectrometry
ICP	--	Inductively Coupled Plasma
ICR	--	Ignitability, corrosivity, reactivity
in	--	Inch
ITD	--	Industrial Technology Division
ml	--	Milliliter
mm	--	Millimeter
NH_3	--	Ammonia
NO_2	--	Nitrite
NO_3	--	Nitrate
OSW	--	Office of Solid Waste
OWRS	--	Office of Water Regulations and Standards
pt	--	Pint
POC	--	Purgeable Organic Compounds
QA	--	Quality Assurance
QC	--	Quality Control
RCRA	--	Resource Conservation and Recovery Act
TCLP	--	Toxicity Characteristic Leaching Procedure
TOC	--	Total Organic Carbon
VOA	--	Volatile Organics Analysis

OIL AND GAS EXPLORATION, DEVELOPMENT, AND PRODUCTION
SAMPLING PLAN AND SAMPLING QUALITY ASSURANCE/QUALITY CONTROL PLAN

1.0 PROJECT DESCRIPTION

This document presents the sampling plan and the quality assurance/quality control (QA/QC) plan for the Office of Solid Waste/Office of Water Regulations and Standards Exploration, Development, and Production of Crude Oil and Natural Gas Field Sampling and Analytical Results Project.[1,2] The sampling project began in early June 1986. The sampling project was completed in September 1986. This final revision to the project sampling plan and QA/QC plan reflects comments received and includes clarifications to the original text.

The objective of this sampling project was to collect preliminary information regarding the constituents of wastes from oil and gas exploration, development, and production activities. A secondary objective was to develop technical information regarding the sources, volumes, and characteristics of wastes generated from oil and gas activities. The results were included in a technical report providing information about the wastes from this industry and their waste management practices (EPA 530-SW-87-005). Samples were collected from exploration, development, and production sites. After collection and preservation, samples were shipped to laboratories for analysis. Laboratory tests were performed for organic compounds, metals, classical wet chemistry parameters, and for certain other analytes.

This document describes the sampling and quality assurance/ quality control (QA/QC) requirements for the field sampling portion of the OSW/OWRS Exploration, Development, and Production of Crude Oil and Natural Gas Project only (see EPA 530-SW-87-005). This document describes practices and procedures for sample collection, preservation, and shipment, and for quality assurance of these activities. This document does not include any portion of the analytical QA/QC or data validation procedures.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITY

The sampling project was administered through EPA's Industrial Technology Division (ITD). It was organized as shown in Figure 1. Ms. Susan de Nagy was the EPA Project Manager. Ms. Kerri C. Kennedy was the Sampling Project Manager. Day-to-day sampling activities were conducted by EPA contract sampling teams in direct contact with the EPA Project Manager and the Sampling Project Manager.

On-site activities were managed by a Sampling Engineer. The Sampling Engineer was responsible for all onsite decisions pertaining to safety, equipment, sample collection, and sampling personnel.

William A. Telliard was the EPA Project Quality Assurance Officer. Reporting to Mr. Telliard was Mr. Andrew Procko, the Sampling Project QA Officer. Mr. Telliard was responsible for the quality of the entire sampling project. Mr. Procko was responsible for quality assurance of sampling activities. The Project QA Officer and the Sampling QA Officer had full authority to visit sites, audit sampling activities, and audit reports and data to assure that all sampling activities resulted in data which met Agency requirements.

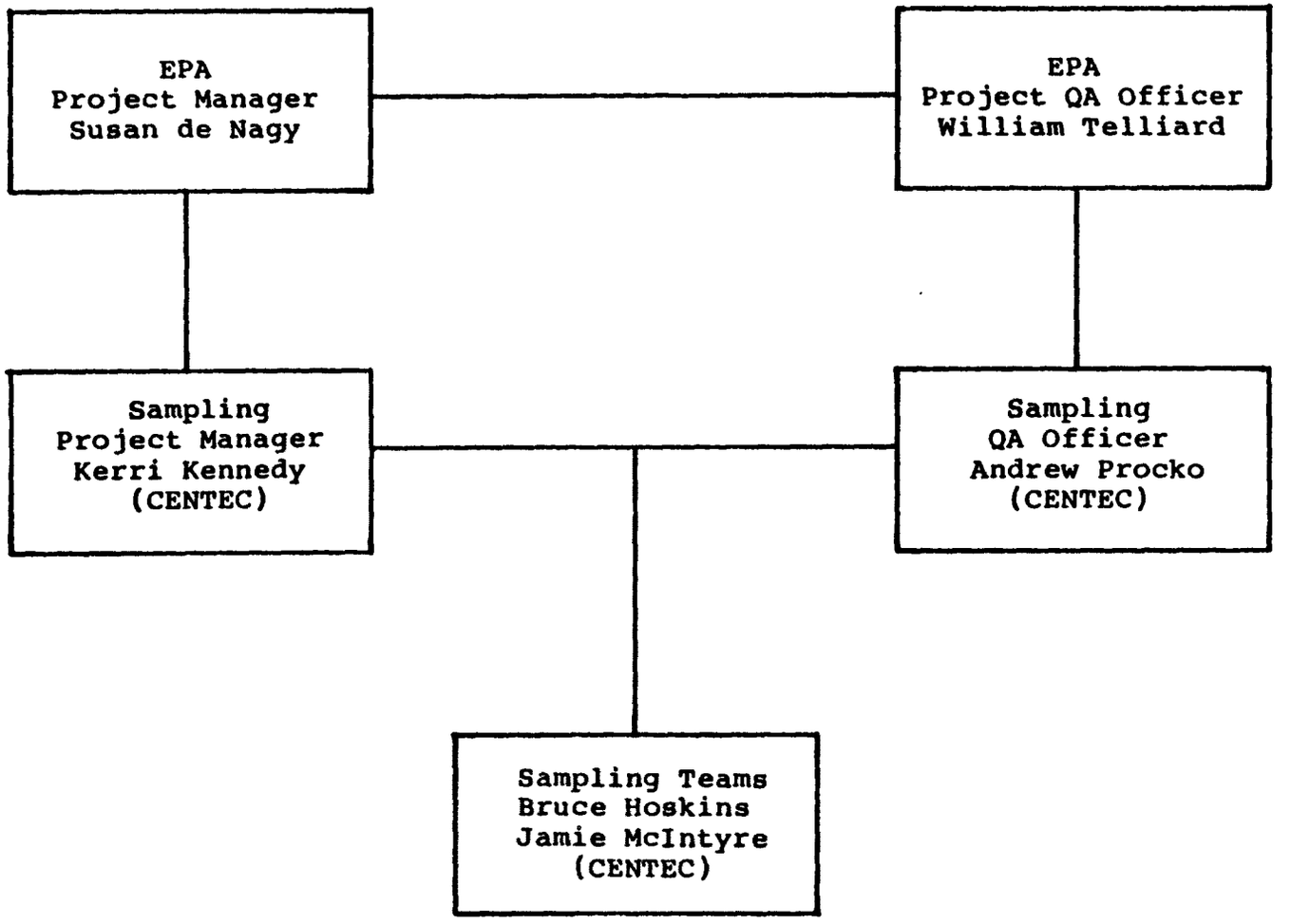


Figure 1. Sampling Project Organization

The Sampling Engineer conducted onsite evaluations, and supervised sampling, sample preservation, and sample shipment. The Sampling Engineer was in daily or near daily telephone communication with the Sampling Project Manager and the EPA Project Manager for resolution of technical and logistical problems. She or he kept detailed records of these activities in the form of Sampling Reports (Appendix C of the EPA Technical Report [EPA 530-SW-87-005]) that became a permanent record of these activities. These Reports were forwarded to the Sampling Project Manager and Sampling QA Officer after each site visit. The Sampling QA Officer audited the Sampling Reports to assure that proper sampling procedures were followed and documented.

3.0 DATA QUALITY REQUIREMENTS AND ASSESSMENTS

3.1 Field Site Investigations

During the site visit, data regarding the physical characteristics of the site were documented. This data included information regarding operating, control, or disposal practices, and physical characteristics of specific features of the site (for example, the size of a pit). These technical data and any modification of the sampling procedures were documented in the Sampling Report (Appendix C of the EPA Technical Report [EPA 530-SW-87-005]) for each site.

3.2 Documentation of Sampling, Preservation, and Shipping

The sample site locations were documented in the Sampling Reports in sufficient detail to permit the Agency and the operator to unambiguously reference the location from which a given sample was taken. The sampling records showed the date, time, and location sampled. The individual bottles used for each fraction of each sample collected were documented on the EPA-ITD Sample Control Center "Traffic Report" for that sample. A copy of the Traffic Report became a permanent part of the Sampling Report. Shipping records, in the forms of copies of bills of lading or airbills became a permanent part of the sampling records, so that sample holding times could be audited.

4.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA IN TERMS OF PRECISION, ACCURACY, COMPLETENESS, REPRESENTATIVENESS, AND COMPARABILITY

4.1 Precision and Accuracy

Measurements of concern to this sampling project included length, width, height, and volume. Linear measurements (length, width, and height) were essential to identify and obtain the sampling location within a site (for example, the center of a quadrant in a pit). These measurements were taken using a standard tape measure, accurate to 0.32 cm (1/8 in).

Volume measurement was needed to assure that an adequate size sample was taken. Sampling kits were designed which carried the essential type, number, and size of sample containers. If these containers were more than 80 percent full, an adequate sample was obtained. (VOA vials were completely filled without any air space.) Table 1 lists the contents of one complete sample kit.

4.2 Completeness

Completeness was assured through onsite audits of the sample kit and containers. The completeness objective was greater than 98 percent for the sampling portion of this project.

TABLE 1. SAMPLE CONTAINERS REQUIRED FOR SAMPLE KITS

SAMPLE CONTAINER SIZE	REQUIRED ANALYSIS	SAMPLE PHASE
1 gallon (glass)	GC/MS for semivolatile organics	Liquid
1 gallon (glass)	GC/MS for semivolatile organics	Solid
(6) 40 ml VOA vials (glass)	GC/MS for volatile organics	Liquid
(4) 40 ml VOA vials (glass)	GC/MS for volatile organics	Solid
1 gallon (glass)	GC/MS for dioxins/furans	Liquid
1 gallon (glass)	GC/MS for dioxins/furans	Solid
1 gallon (glass)	GC for pesticides/herbicides	Liquid
1 gallon (glass)	GC for pesticides/herbicides	Solid
(2) 40 ml VOA vials (glass)	TCLP volatile fraction	Solid
1 quart (glass)	TCLP semivolatile fraction	Solid
(2) 40 ml VOA vials (glass)	Purgeable organics	Liquid
1 quart (plastic)	ICP and AA for metals	Liquid
1 quart (plastic)	Cyanide	Liquid
1 quart (glass)	Oil and grease	Liquid
1 quart (glass)	TOC, COD, NH_3, NO_2 and NO_3	Liquid
100 ml (plastic)	Sulfide	Liquid
1 quart (plastic)	Conventionals, RCRA ICR	Liquid
1/2 gallon (glass)	Metals, cyanide, conventionals, RCRA ICR, TCLP metals	Solid
(2) 40 ml VOA vials (glass)	Purgeable organics	Solid
1 gallon (glass)	Refrigerate and retain	Liquid
1 gallon (glass)	Refrigerate and retain	Solid

4.3 Representativeness

Verification was established that each type of facility to be sampled (e.g., waste pit, produced water) had sufficient number of samples for data analysis. For pit sampling, representativeness of liquid samples was assured by compositing grab samples taken from horizontal and vertical intervals as described in detail in Section 5.2. Produced water samples were similarly composited (see Section 5.3). Representativeness of sludge samples was assured by directing sampling and compositing of sludge, as described in Section 5.2. The sampling and compositing procedures described herein were a balance of representativeness, consideration of sampling practicality, and logistics.

4.4 Comparability

The following measures were taken to ensure comparability of field work performed by different sampling teams:

- Uniform written sampling procedures and equipment were provided to each sample team.
- Standardized field sampling data forms (SCC Traffic Reports) were used.
- Uniform handling and shipping procedures were implemented for all collected samples.
- Uniform sampling containers were prepared by one contractor for use by each sample team.

5.0 SAMPLING PROCEDURES AND PROTOCOLS

This section discusses in detail the sampling methods and procedures that were implemented by each sample team at each designated sample site. Protocols were established on the sampling equipment to be utilized, sampling performance for pits, produced waters, centralized treatment facilities, and tank bottoms, and safety measures to be observed.

5.1 Sampling Equipment

This section discusses the equipment used by the sample team in the field to collect the required samples.

5.1.1 List of Sampling Supplies and Equipment

The following supplies and equipment were used in this sampling project:

Cleaning supplies and equipment

- Cleaning brush
- Clean cloth
- Tap water
- Pressure sprayer for water

Sampling equipment

- Sample kit (See Table 1. Proper containers were supplied by an EPA contract laboratory. Sample kit preparation is discussed below.)
- Five gallon glass carboy
- Coring devices and accessories (Wildlife Supply Co., Catalog No. 2440-A10)
- Coring tube liners (glass and Teflon)
- Ponar dredge (6 inch x 6 inch) (Wildlife Supply Co., Cole Parmer Catalog No. J-5471-10)
- Liquid thief, Bacon Bomb Type (1 pint) (Fisher Scientific, Catalog No. 14-209)

- Gauging tape (Sentry Tank Associates, Inc., Item No. 4464)
- Hammer (1 pound)
- Wood stakes
- Neoprene gloves
- Surgical gloves
- Measuring tape (100 feet)
- Compass
- Range-finder
- Camera and film (35 mm)
- Stainless steel spoon
- Teflon sheets (used as funnels)
- pH test kit
- Free chlorine field test kit

Miscellaneous

- Bound field logbook
- Masking tape
- Packing tape
- Writing tools
- Cooler boxes or ice chests (for refrigerated samples)
- Ice for shipping
- Shipping materials
- Shipping instructions and appropriate shipping forms
- Rope
- Rowboat (2-3 person)
- Plastic trash bags
- Draeger tubes
- Respirator masks
- Life jackets

5.1.2 Field Sample Kit Preparation

This section discusses the methods used by the laboratory to prepare bottles included in the kits assembled for each sample site visit. Further discussion of the preservatives and holding times associated with each sample bottle is presented in Section 6.2, "Sample Preservation."

VOA Vials. The bottles, caps, and cap liners were washed with Alconox soap and water. They were rinsed with three volumes of tap water. A final three volume rinse with deionized water

was performed. The bottles and liners were dried in an oven at 105°C for one (1) hour. Preservatives were added to the bottles as soon as they were cool. The bottles were then assembled and labeled.

Organic GC/MS, Dioxin, and Pesticide/Herbicide Bottles. The bottles, caps, and cap liners were washed with Alconox soap and water. They were rinsed with three volumes of tap water, followed with a three volume rinse with deionized water. The bottles and liners were dried in an oven at 105°C. The bottles and liners were rinsed with one volume of methylene chloride and allowed to air dry before assembling.

Bottles for Metals and RCRA Analysis. The bottles, caps, and cap liners were washed with Alconox soap and water. They were rinsed with three volumes of tap water, followed by a three volume rinse with deionized water. They were then acid rinsed as follows: 1:1 nitric acid followed by tap water, and 1:1 hydrochloric acid followed by tap water. They were given a final three volume rinse with deionized water. Preservatives were added and the bottles were assembled and labeled.

Bottles for Cyanides. The bottles, caps, and cap liners were washed with Alconox soap and water. They were rinsed with three volumes of tap water. A final three volume rinse with

deionized water was performed. Preservatives were added and the bottles were assembled and labeled.

Bottles for COD, TOC, NH_3, NO_2, AND NO_3. The bottles, caps, and cap liners were washed with Alconox soap and water. They were rinsed with three volumes of tap water. The bottles and liners were then rinsed in NO-CHROMIX - Sulfuric Acid. They were again rinsed with three volumes of tap water, followed by three volumes of deionized water. Preservatives were added and the bottles were assembled and labeled.

Bottles for Sulfide. The bottles, caps, and cap liners were washed with Alconox soap and water. They were rinsed with three volumes of tap water, followed by a three volume rinse with deionized water. Preservatives were added and the bottles were assembled and labeled.

Bottles for Oil and Grease. The bottles, caps, and cap liners were washed with Alconox soap and water. They were rinsed with three volumes of tap water, followed by a three volume rinse with deionized water. They were rinsed with acetone. The bottles and liners were dried in an oven at 105°C. Preservatives were added and the bottles were assembled and labeled.

Bottles for POC and Volatile TCLP. The bottles, caps, and cap liners were washed with Alconox soap and water. They were rinsed with three volumes of tap water. A final three volume rinse with deionized water was performed. The bottles and liners were dried in an oven at 105°C for one (1) hour. Preservatives were added to the bottles as soon as cool. The bottles were then assembled and labeled.

Bottles for Semivolatile TCLP. The bottles, caps, and cap liners were washed with Alconox soap and water. They were rinsed with three volumes of tap water, followed by a three volume rinse with deionized water. They were dried in an oven at 105°C. They were then rinsed with methylene chloride and dried in an oven at 105°C. The bottles were then assembled and labeled.

5.2 Pit Sampling

This section explains both the rationale for selecting sampling locations and the proper protocols for sample collection and handling.

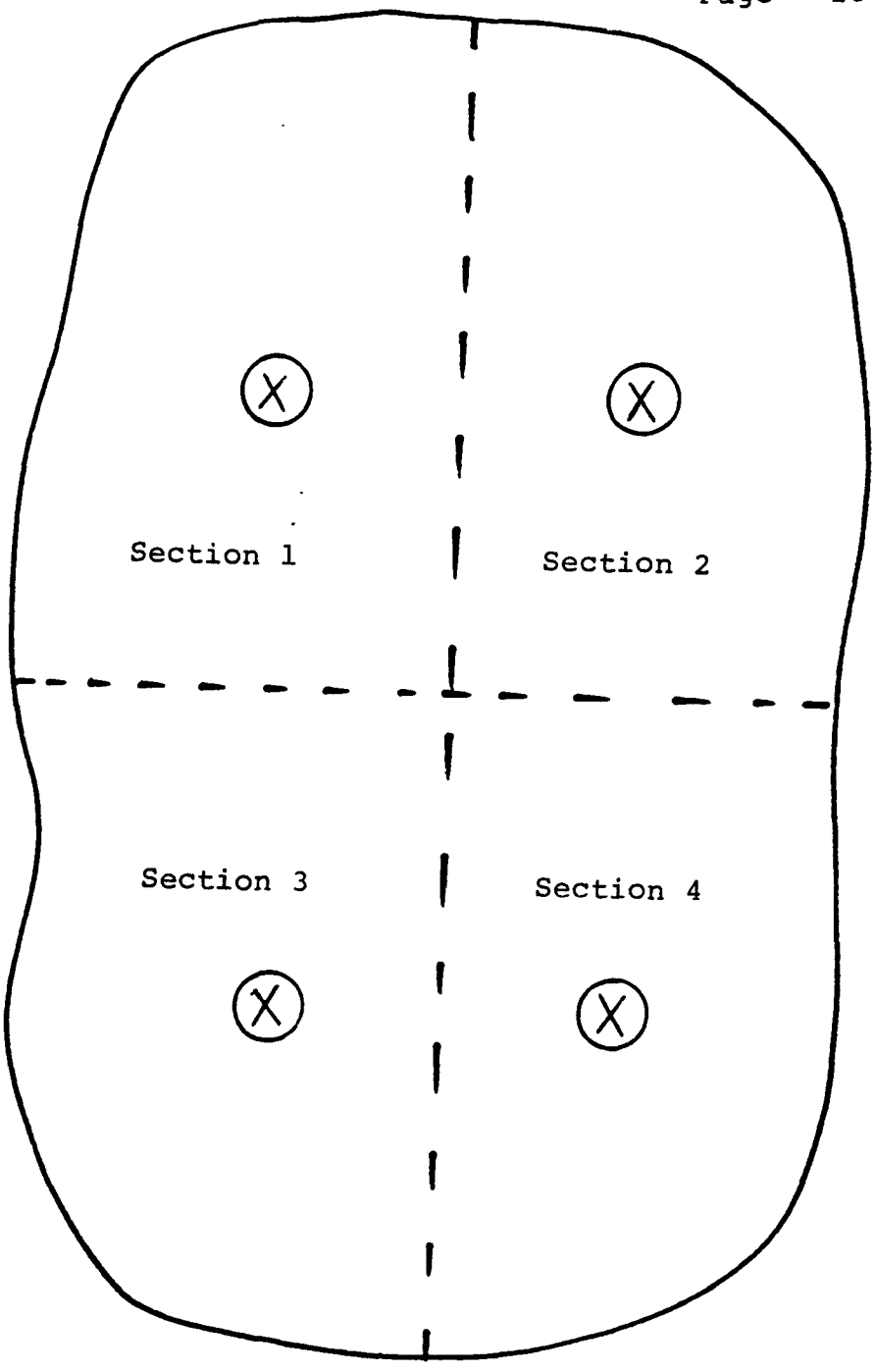
5.2.1. Sample to be Collected

All pit samples were composited grab samples. For each pit to be sampled, two composited samples were taken: one of solids (sludge) and one of liquid (supernatant). If no discrete liquid

phase existed in a particular pit, no liquid composited sample was taken.

Only one pit was sampled at a given site. When a site had multiple pits, one pit was chosen using the following selection process: At a drilling site where there were working pits in addition to a reserve pit, the reserve pit was sampled. At a centralized pit or treatment facility where there was more than one pit in use, the sampled pit was chosen based on its status at the time of sampling. Factors involved in pit selection included the quantities of sludge and liquid in the pit, the amount of activity the pit was involved in, accessibility of the sample points, and safety considerations. For a site with multiple centralized pits used primarily for evaporation, a recently active pit was favored over an inactive pit as such a pit inactive for a long period of time would probably consist of analytes in a concentrated form. Clearly, an inaccessible pit or a pit judged unsafe for sampling was not selected at a multiple pit site. Reasons for the selection of one pit from a choice of more than one pit were documented in the individual Sampling Reports (Appendix C of the EPA Technical Report [EPA 530-SW-87-005]).

The selection of precise sampling locations within a pit was by a specific design. Using this design, a standard scheme for selecting sampling points was followed. As shown in Figure 2,



X - Sample Point

Figure 2. Sampling Subdivisions of a Mud Pit

each pit was divided into four equal area sections. Samples were taken from the center of each section. The reason for this approach was that regardless of the shape or size of the pit, the method would introduce no subjective judgments that would influence the sampling.

5.2.2. Pit Sample Collection Procedures

The following are the chronological steps taken by the sampling team for proper sample collection.

I. The Sampling Engineer established sample points as described in Section 5.2.1.

II. To remove any contamination potential, all sampling equipment was rinsed by dipping at least twice in the pit prior to taking the sample.

III. The sampling team attained the sampling location.

IV. At each sampling point, the required amount of sample was collected by means of the relevant sampling procedures explained below.

A. Solids sample collection

At the sample point, a sample of solids (mud or sludge) was collected using either a coring device or a dredge (Figure 3 and Figure 4, respectively). The preferred method was the coring device as the cores contained stratified solids samples that penetrated the sludge by up to 2 feet. Dredge samples were collected only if site specific conditions prevented the use of the coring device. Dredge samples contained mostly solids from the top of the sludge level.

The coring devices were equipped with liner tubes for easy removal of the collected sample. The liner tubes were made of glass or Teflon. Plastic liners were not used in this project as they would have contaminated the sample.

Within the same pit, core liners were reused without cleaning. Since the final sample was composited, individual sample point cross-contamination was irrelevant.

B. Liquid sample collection

At the sample point, liquid was collected with a stainless steel liquid thief sampler. The thief is pictured in Figure 5.

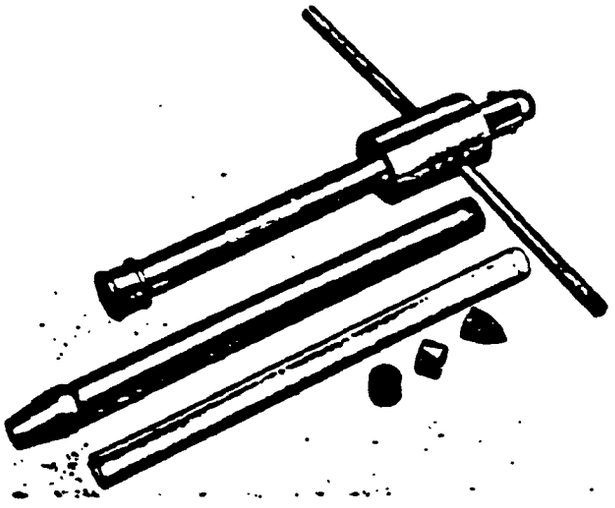


Figure 3. Hand Coring Device and Accessories
(From Kahl Scientific Instrument Corp.)

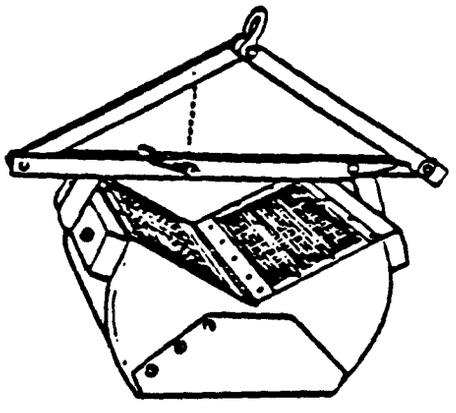


Figure 4. Ponar Grab Dredge
(From APHA, 1976)

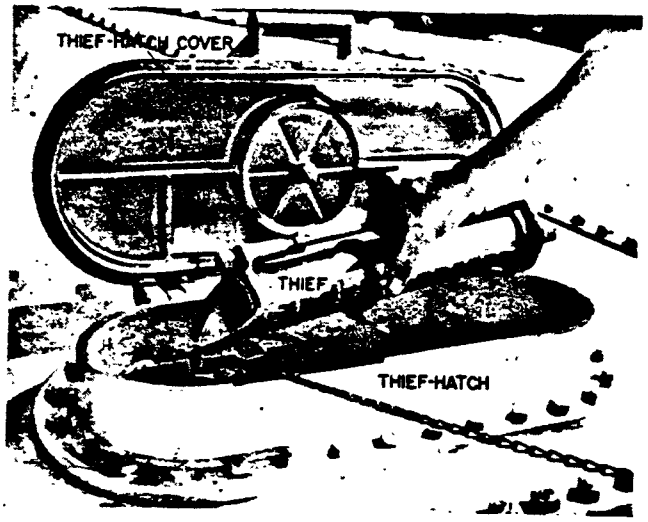


Figure 5. Liquid Thief and Tank Thief Hatch (From American Petroleum Institute, Primer of Oil and Gas Production, 1976.)

The design of the thief sampler allowed a liquid sample to be taken at any specific depth. Several samples were taken at the same lateral position but at different depths to create a more representative composited grab sample. In this project, liquid samples were taken at four evenly spaced depths between the liquid surface and the bottom of the pit. The reason for this approach was that regardless of the shape or size of the pit (also for tanks), no subjective judgments influenced the sampling. The amount of liquid collected at each depth approximately equaled one-fourth of the composited volume required to fill all necessary sample bottles.

In the same pit, the thief was not cleaned between individual samples. However, the exterior of the thief was wiped free of any oil, sludge, or debris picked up by the thief between samples within the same pit.

V. Once the individual samples were collected, they were composited, mixed, and transferred. For sludge samples, the cores or dredge samples were placed in a stainless steel container where they were thoroughly mixed. The mixed sample was then transferred to the required sample containers by means of a stainless steel spoon or glass scoop.

For liquid samples, the first collected grab sample was used to fill the VOA vials. The remaining individual samples were placed in a 5-gallon glass container and mixed. Mixing was accomplished by manually agitating the container until the contents were visually homogeneous. The combined grabs were then transferred to sample containers by means of funnel formed from a Teflon sheet. Sample transfers between containers were kept to a minimum to limit sample contact with the atmosphere.

Before sample transfer, foreign material such as stones, nails, or trash was discarded. After placing the sample in the proper sample containers, all disposable items were discarded (glass coring tube liners, intermediate glass sample holding containers, etc.) and all Teflon and reusable glass items cleaned. Cleaning required washing the equipment with detergent and hot water followed by rinses with tap water. Teflon items were shipped from the field to a laboratory for cleaning with methylene chloride. Reusable items not in direct contact with the sample were cleaned with water.

VI. The sampling team collected all necessary field data regarding the samples and attached identifying labels

to the containers. The samples were packed, preserved, and shipped promptly via overnight shipping service.

VII. The sampling team prepared site documentation for the approval of the Sampling Engineer. This included recording pertinent data in the log book, drawing site maps, documenting Sample Control Center information[3] and photographing the site along with identifying landmarks. Further information about each site was obtained by discussing the operation of the facility with a representative of each site operator.

5.3 Produced Water Sampling

This section explains both the rationale for selecting sampling locations and the proper protocols for sample collection and handling.

5.3.1. Samples to be Collected

Produced water samples were either grab samples from process lines or composited grab samples from tanks. One sample was collected at each designated site. Samples were taken from produced water tanks or process lines.

The following sampling methods were used for produced water sampling. Sampling from storage tanks consisted of grab samples

taken from four depths evenly spaced from the liquid surface to the bottom of the tank, and then combined. The design of the thief hatch at the top of a tank prohibited taking samples at different lateral positions. When a storage tank was inaccessible to sampling from the top, a sample point was sought in the form of a tap that provided direct discharge from the tank, or a tap in a flow line exiting the tank. Samples obtained at taps or from process lines were taken as grab samples.

5.3.2. Produced Water Sample Collection Procedures

The following is the chronological steps taken by the sampling team for proper sample collection.

I. The Sampling Engineer established sample points for storage tank or process line as described in Section 5.3.1.

II. To remove any contamination potential, all sampling equipment was rinsed by repeated dipping in the tank or flow line prior to taking the sample.

III. The sampling point location was attained by means of accessing the top of storage tanks, or a valve or other process line from the source.

IV. At each sampling point, the required amount was collected by means of a liquid thief or similar device at evenly spaced intervals from the liquid surface to the bottom. If an alternate sampling device was required, glass, Teflon, or stainless steel construction was used.

V. From each sample site location, the collected individual samples were placed in a container and mixed to create the total liquid sample. Refer to Section 5.2.2.B. for mixing and transferring protocols for liquid samples. Foreign material such as stones, nails, or trash was discarded. After placing the mixed sample in the proper containers, all disposable items were properly discarded and all reusable items cleaned as previously discussed in Section 5.2.2.

VI. The Sampling Engineer was responsible for collecting all necessary field data regarding the sample and for attachment of identifying labels to the containers. Samples were packed, preserved, and shipped promptly via overnight shipping service.

VII. Proper site documentation was prepared under direction of the Sampling Engineer. This documentation included recording pertinent data in

the log book, drawing site maps, and photographing the site along with identifying landmarks. Further information about each site was obtained by discussing the operation of the facility with a representative of each site operator.

5.4. Centralized Treatment Facilities

This section explains both the rationale for selecting sampling locations and the proper protocols for sample collection and handling.

5.4.1. Sample to be Collected

All samples were a series of composited grab samples. Both liquid and solid samples were collected. For each treatment facility, three samples were taken: liquid influent, liquid effluent, and effluent sludge. Specifically directed samples for treatment facilities were taken from pits, tanks, or process lines, using the procedures previously described. For pit samples, the procedures in Section 5.2.1 were used. For tank or process line samples, the procedures in Section 5.3.1 were used.

5.4.2. Centralized Treatment Facility Sample Collection Procedures

The following are the chronological steps taken by the sampling team for proper sample collection.

I. To remove any contamination potential, all sampling equipment was rinsed by repeated dipping in the pit or tank prior to taking the sample.

II. The sampling team attained the sampling location.

III. At each sampling point, the required amount was collected using equipment specified in the protocols. Pit sampling procedures are discussed in Section 5.2.2. Tank and process line sampling procedures are discussed in Section 5.3.2.

IV. The individual samples from each sample site were placed in a container and mixed to create the total sample as previously described in Sections 5.2.2 and 5.3.2. See Sections 5.2.2 and 5.3.2 for equipment and protocols. Foreign material such as stones, nails, or trash was discarded. After placing the mixed sample in the sample containers, all disposable items were properly discarded and all reusable items cleaned as previously discussed in Section 5.2.2.

V. The Sampling Engineer was responsible for collection of all necessary field data regarding the sample and for attachment of identifying labels to the containers. The

samples were packed, preserved, and shipped promptly using an overnight shipping service.

VI. The Sampling Engineer was responsible for preparation of proper site documentation. This documentation included recording pertinent data in the log book, drawing site maps, documenting Sample Control Center information and photographing the site along with identifying landmarks. Further information about each site was obtained by discussing the operation of the facility with a representative of each site operator.

5.5 Field Tank Sludge

All samples were composited grab samples. The preferred method of sample collection at a particular tank was using the coring device with the glass or Teflon liner. If this was not feasible, sampling was conducted with the Ponar dredge. After sample collection, the sample transfer and identification protocols described in the above section were followed.

5.6 Safety Considerations

It was not known whether the sampled wastes were hazardous. It was therefore recommended that the sampling team observe EPA Level D protection as a baseline.[4] EPA Level D protection provided a minimal level of protective equipment including:

- Protective gloves
- Steel toe shoes
- Cloth coveralls
- Hard hat
- Safety glasses
- Ear plugs (optional)

In addition, life jackets were worn when sampling from the boat. Also, when sampling required the use of chest waders to wade into a pit, a life line was connected from the sampler to the shore. The Sampling Engineers were fully knowledgeable in the required levels of EPA protection for different sampling projects and experienced in conducting field sampling of potentially hazardous materials.

At each site, an evaluation was made by the Engineer prior to sampling to determine if any additional levels of protection were necessary. This evaluation included the use of portable Draeger tubes and hand pumps for detection of hydrogen sulfide. The preliminary waste characterization identified hydrogen sulfide as a constituent which might have been encountered during sampling. If the ambient concentration of hydrogen sulfide at a site was greater than the threshold limit value ceiling of 15 mg/m^3 (10 ppm)[5], sampling would have been aborted. No sampling at any site investigated was cancelled for this reason.

A Draeger unit consists of a calibrated glass tube filled with a reactant (lead acetate is used in hydrogen sulfide tubes). A hand pump is used to draw a known volume of gas through the glass

tube as shown in Figure 6. The degree of color change in the reactant denotes the concentration. Several scales are usually presented on the tube for high and low concentrations. According to Neil Adams[6], the quantitative measurements obtained with the Draeger unit are accurate. In the hands of trained personnel, they can be used to detect a wide range of concentrations by using various tubes and pumped volumes. Since they are not electronic, they are not subject to electronic malfunction onsite. The unit and tubes are rugged; previously opened tubes even can be reused for hydrogen sulfide provided that in previous uses no hydrogen sulfide was detected.[6]

The Sampling Engineer had the option to abort sampling if workers experienced eye, skin, or bronchial irritation, or if they were experiencing narcosis of sufficient degree to increase accident proneness, impair self-rescue, or materially reduce work efficiency.

Any further protective equipment required at any particular site was at the discretion of the Sampling Engineer. Also at the discretion of the Sampling Engineer was whether safety conditions (or the lack of them) warranted cancellation of sampling at a particular site. Such conditions included (but were not limited to) the inability to safely reach the designated sample point, adverse weather conditions, or incomplete sampling teams. When sampling required the opening of a tank thief hatch, the Sampling

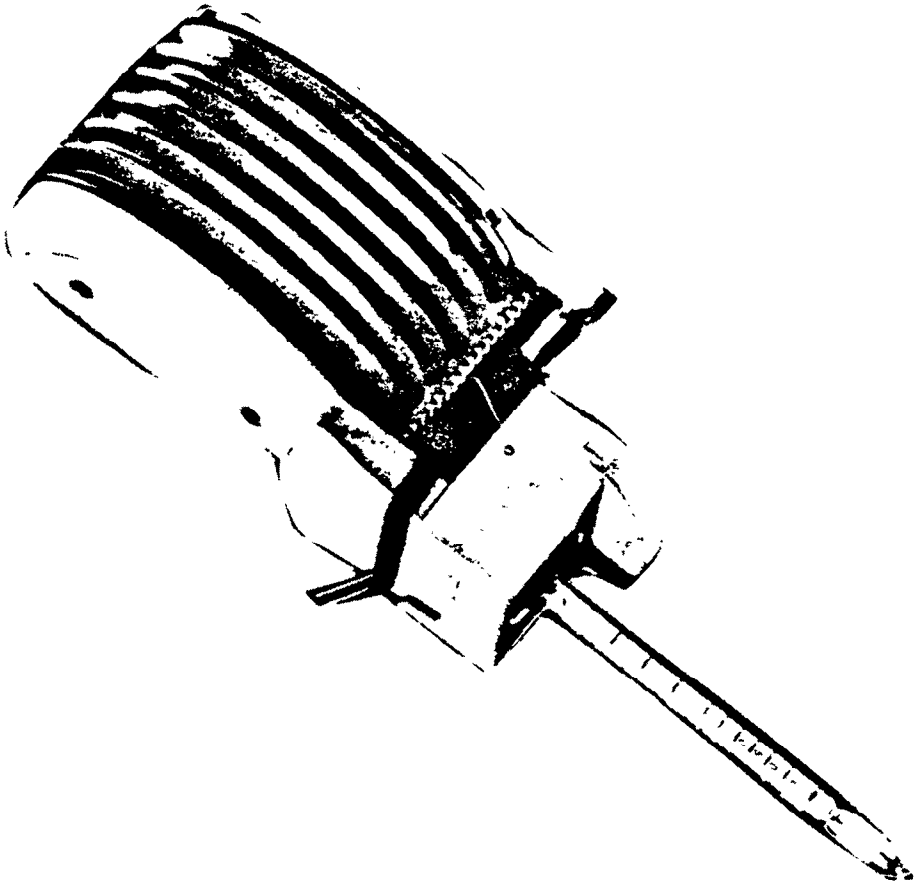


Figure 6. Draeger Tube and Hand Pump (From National Draeger, Inc. 1984)

Engineer wore a gas mask and used a Draeger tube for hydrogen sulfide gas detection as soon as the hatch was opened. If a dangerous level of hydrogen sulfide was found coming from the tank, sampling would have been aborted.

If sampling at a particular site was to be cancelled due to safety concerns, this would have been immediately reported to the EPA Project Manager and the Quality Assurance Officer along with the reasons for the cancellation. During the course of the sampling project, no sampling at a site was cancelled due to safety concerns.

Prior to sampling at each site, the sampling team was informed of emergency procedures, the location of the nearest hospital, the location of the nearest poison center, and the corresponding emergency phone numbers.

6.0 SAMPLE CUSTODY

This section describes the proper procedures for sample handling, preservation, and shipment.

6.1 Sample Handling

As described in Section 5, after collecting the individual samples, sample transfer was kept to a minimum. Sample contact with plastic was avoided unless the final sample container was plastic.

6.2 Sample Preservation

Once a sample has been collected, steps were taken to preserve the chemical and physical integrity of the sample during transport and storage prior to analysis. Depending upon the type of analysis to be performed on the sample, preservatives such as sodium hydroxide, sulfuric acid, or nitric acid were added to the sample bottles (see Section 5.1.2). All samples were shipped to the laboratories under ice. All required materials to preserve samples were included in the sample kits. Table 2 lists the preservatives and holding times associated with each sample container included in the sample kits.

6.3 Sample Shipment

All samples were shipped from the field on the day of collection using an overnight commercial delivery service unless circumstances did not permit this. In that event, samples were

TABLE 2. REQUIRED PRESERVATIVES AND MAXIMUM HOLDING TIMES

SAMPLE CONTAINER	REQUIRED PRESERVATIVES	MAXIMUM HOLDING TIME
Metals	HNO_3 to pH <2	6 months (except Hg, whose holding time is 28 days)
Cyanide	NaOH to pH >12 Cool 4°C	14 days
Oil and grease	H_2SO_4 to pH <2 Cool, 4°C	28 days
Sulfide	$Zn(C_2H_3O_2)_2$ Cool, 4°C	7 days
COD, TOC, NH_3, NO_2, NO_3	H_2SO_4 to pH <2 Cool, 4°C	28 days
Routine	Cool, 4°C	28 days (except BOD, whose holding time is 48 hours)
POC	Cool, 4°C	14 days
VOA vial	HCl, Cool, 4°C	14 days
VOA vial	$Na_2S_2O_3$, Cool, 4°C	14 days
VOA vial	Cool, 4°C	14 days
Extractable organics	Cool, 4°C	7 days until extraction; 40 days after extraction
Pesticides/herbicides	Cool, 4°C	7 days until extraction; 40 days after extraction
Dioxins/furans	Cool, 4°C	7 days until extraction; 40 days after extraction
TCLP - volatiles	Cool, 4°C	14 days
TCLP - extractables	Cool, 4°C	7 days until extraction; 40 days after extraction

shipped in the most expedient method available. The outside of the shipment container required the following information: a shipping label with the complete address of the receiving laboratory including the responsible laboratory person to receive the samples, a designated box number to indicate to the receiver exactly how many sample boxes were included in the shipment, and any required DOT or hazardous waste labels.

Sealed sample containers were packed and sealed in shipping containers prior to shipment. Shipping containers were turned over directly to the shipping agent (overnight shipper, airline, etc.) whenever possible. In exceptional circumstances, the Sampling Engineer enlisted a delivery service or hotel service staff to turn a shipment over to the shipping agent. Care was taken to ensure the integrity and promptness of shipment. Documentation of the transaction was maintained.

6.4 Field Custody Procedures

Each sample had an identification tag attached to it. Shipment record forms were written for each group of samples shipped to a particular laboratory. These forms were the standard Sample Control Center Organics Traffic Reports and Metals Traffic Reports shown in Figure 7 and Figure 8, respectively. At least one copy of each form accompanied sample shipment to a laboratory. One copy of each form remained in the custody of the sample team.

USEPA INDUSTRIAL TECHNOLOGY DIVISION
SAMPLE CONTROL CENTER
P.O. BOX 1407
ALEXANDRIA, VA 22313
703/557-5040 / FTS-8-557-5040

EPISODE NO:
RANGE OF SAMPLE NOS: —

ORGANICS TRAFFIC REPORT

INDUSTRIAL FIRM SAMPLED:	SAMPLING DATE
	BEGIN:
CITY:	END:
STATE:	SHIPPING INFORMATION
INDUSTRIAL CATEGORY:	SHIP TO:
	ATTN:
CONFIDENTIAL: ____ YES ____ NO	
SAMPLING OFFICE:	CARRIER:
	AIRBILL NO:
SAMPLER:	DATE SHIPPED:

	SAMPLE POINT DESCRIPTION								SAMPLE TYPE										
SAMPLE NUMBER	RAW WATER (CITY, RIVER, WELL)	IN LINE PROCESS	UNTREATED EFFLUENT (RAW WASTE WATER)	TREATED EFFLUENT	OTHER (SPECIFY)	ADDITIONAL SAMPLE DESCRIPTION	PH LEVEL	SAMPLE POINT FLOW UNITS:	C COMPOSITE (EXTRACTABLE ORGANICS)	CB COMPOSITE BLANK	G GRAB (EXTRACTABLE ORGANICS)	V1 VOA PRESERVED	V2 VOA PRESERVED (DUPLICATE)	V3 VOA UNPRESERVED	V4 VOA UNPRESERVED (DUPLICATE)	VB1 VOA TRIP BLANK	VB2 VOA TRIP BLANK (DUPLICATE)	OTHER SPECIFY:

WHITE — SCC COPY YELLOW — SAMPLER COPY PINK — LAB COPY FOR RETURN TO SCC GOLD — LAB COPY

Figure 7

USEPA INDUSTRIAL TECHNOLOGY DIVISION
SAMPLE CONTROL CENTER
P.O. BOX 1407
ALEXANDRIA, VA 22313
703/557-5040 / FTS-8-557-5040

EPISODE NO:
RANGE OF SAMPLE NOS: —

METALS TRAFFIC REPORT

INDUSTRIAL FIRM SAMPLED:	SAMPLING DATE
	BEGIN:
CITY:	END:
STATE:	SHIPPING INFORMATION
INDUSTRIAL CATEGORY:	SHIP TO:
	ATTN:
CONFIDENTIAL: ____ YES ____ NO	
SAMPLING OFFICE:	CARRIER:
	AIRBILL NO:
SAMPLER:	DATE SHIPPED:

	SAMPLE POINT DESCRIPTION								SAMPLE TYPE		
SAMPLE NUMBER	RAW WATER (CITY, RIVER, WELL)	IN LINE PROCESS	UNTREATED EFFLUENT (RAW WASTE WATER)	TREATED EFFLUENT	OTHER (SPECIFY)	ADDITIONAL SAMPLE DESCRIPTION	PH LEVEL	SAMPLE POINT FLOW UNITS: ____	M1 METALS TASK I (ICP ONLY)	M2 METALS TASK II (AA)	METALS OTHER (SPECIFY)

WHITE — SCC COPY YELLOW — SAMPLER COPY PINK — LAB COPY FOR RETURN TO SCC GOLD — LAB COPY

Figure 8

7.0 CALIBRATION PROCEDURES AND FREQUENCY

This section is not applicable to the field sampling portion of this project.

8.0 ANALYTICAL PROCEDURES

This section is not applicable to the field sampling portion of this project.

9.0 DATA REDUCTION, VALIDATION, AND REPORTING

During field activities, no analytical parameters were collected with the exception of tests for pH and free chlorine. These tests were conducted in the field by the Sampling Engineer to provide estimates of the pH and free chlorine content to the receiving analytical laboratories. These estimates were used by the laboratories in decisions about handling and analysis of the samples. Since the estimates were not reported as analytical data, they were not subject to any reduction or validation procedures.

The remainder of the data obtained were from observations noted in the field logbook. These data were not analytical parameters but site specific information such as the sizes of onsite pits or the sequence of treatment. Such data was confirmed by visual observation where possible in the field. Notes from logbooks remained in the possession of the Sampling Engineers until the conclusion of field sampling unless otherwise directed by the EPA Project Manager. Information from the logbooks was compiled and submitted as part of the Technical Report (EPA 530-SW-87-005).

10.0 INTERNAL QUALITY CONTROL CHECKS

The required field quality control check for this project was five percent field duplicates. Field duplicates were collected by the sampling team at the sites designated by the Sampling Project Manager. Shipment of field duplicates was concurrent with a shipment of regular field samples.

11.0 SYSTEM AUDITS

System audits were conducted in the field by the EPA Quality Assurance Officer and the Sampling QA Officer. The dates of these audits were documented in the Sampling Reports (Appendix C of the EPA Technical Report [EPA 530-SW-87-005]).

12.0 PREVENTIVE MAINTENANCE

The Sampling Engineer visually examined all sampling equipment upon arrival at the sample site to assure it was in proper working order. The Sampling Engineer re-examined the equipment upon completion of sampling to assure that sampling equipment remained in working order.

To prevent delays in field sample collection or shipment, the sampling team had in its possession spare parts and tools for field repair of critical sampling equipment. Spares of all glass or other breakable objects used in collection were available. Extra shipment containers were obtained in the case of damage to sample shipment containers.

13.0 SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS

This section is not applicable to the field sampling portion of this project as no data generated in the field was subject to the assessment procedures for statistical precision, accuracy, and completeness.

14.0 CORRECTIVE ACTION

This section describes the conditions or situations that might have been encountered that could have caused deviations in standard sampling methods or cancellation of sampling at any given site. First, no sampling was conducted with any method that, in the judgment of the Sampling Engineer, Sampling Project Manager, EPA Project Manager, Sampling QA Officer, or EPA QA Officer, endangered any member of the sampling team or would result in an inaccurate, imprecise, or non-representative sample being collected. If safe or representative sampling could not be achieved, no sampling was performed at that site.

For pit sampling, the following list of preferred and alternate sampling methods is given. They are listed in decreasing order of priority:

1. Use of coring tube; sampling points achieved by use of rowboat.
2. Use of Ponar dredge; sampling points achieved by use of rowboat.
3. Use of coring tube; sampling points achieved by wading into pit or using boards to walk into pit.
4. Use of coring tube while standing at edge of pit.
5. Use of Ponar dredge while standing at edge of pit.

If none of the above methods could have been safely used, no sludge sample would have been taken from the pit.

The limiting factor for pit sampling was the pit condition. The pit must have been reasonably accessible. A breached pit was sampled for solids only. A completely evaporated pit or a pit where the liquids were injected or land applied was sampled for solids only. A frozen pit was sampled using a manual auger, ice picks, or similar appropriate equipment.

Produced water or sludge sampling from tanks were dependent upon tank condition. An empty tank would not be sampled. A tank with no thief hatch, no valves, or other reasonably accessible opening would not be sampled. Any tank of questionable construction integrity would not be sampled.

Any deviations in sampling procedures were noted in the field logbook and the individual Sampling Reports (Appendix C of the EPA Technical Report [EPA 530-SW-87-005]). Any major deviations or cancellation of sampling for any reason at a site was immediately reported to the EPA Project Manager and Quality Assurance Officer.

15.0 REPORTS TO MANAGEMENT

15.1 Sampling Reports

A site-specific Sampling Report was generated for each location visited or sampled. Each Sampling Report contained the following information:

- Sample site name and location
- Description of facility
- Date sampled
- Attendees' list, including sampling team members, State and Federal Government representatives, and other observers
- Photographs of site
- Specific sampling equipment used
- Description of disposal or control technology used onsite
- Problems encountered during sampling visit
- Deviations from sampling quality assurance plans

These Sampling Reports became part of the Technical Report (EPA 530-SW-87-005).

15.2 Quality Assurance Reports

Quality Assurance Reports were generated by the Sampling QA Officer. They contained the results of any and all field audits conducted during the course of sampling along with any quality assurance problems and recommended solutions.

At the end of the sampling project, a summary report listing the non-conformances and corrective actions was produced by the sampling contractor.

REFERENCES

1. Environmental Protection Agency, Contract No. 68-01-7153.

2. Environmental Protection Agency. Decision Document on Onshore Oil and Gas Regulatory Issues, February 1986.

3. Environmental Protection Agency. Handbook for Sampling and Sample Preservation of Water and Wastewater, September, 1982.

4. Environmental Protection Agency. Dioxin Strategy, 1983.

5. American Conference of Governmental Industrial Hygienists. Threshold Limit Values for Chemical Substances in Workroom Air, 1977.

6. Adams, Neil, Well Control Problems and Solutions, Petroleum Publishing Company, Tulsa, Oklahoma, 1980.