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Remedial Investigation/Feasibility Study Comprehensive Sampling and Analysis Plan for Naval Air Station Pensacola Pensacola, Florida Final

Prepared for:

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Naval Air Station
Pensacola, Florida

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List of Acronyms, Abbreviations, and Symbols

The following list contains many of the acronyms, abbreviations, and symbols used in this report.

AASHTO	American Association of State Highway and Transportation Officials
ANOVA	Analysis of Variance
ASTM	American Society for Testing and Materials
bls	Below land surface
BNAs	Base-Neutral Acid Extractable Compounds
BRAC	Base Realignment and Closure Act
°C	Degrees Celsius
CFR	Code of Federal Regulations
Cl	Chlorine
CLEAN	Comprehensive Long-Term Environmental Action Navy
CLP	Contract Laboratory Program
cm^2	centimeters squared
CRDL	Contract Required Detection Limit
CSAP	Comprehensive Sampling and Analysis Plan
CTO	Contract Task Order
DBH	Diameter at Breast Height
DI	Deionized
DOT	Department of Transportation
DQO	Data Quality Objective
DS3	Hydrolab Datasonde 3
E/A&H	EnSafe/Allen & Hoshall
E&E	Ecology & Environment, Inc.
EIC	Engineer in Charge
EM	Electromagnetic
EPROM	Erasable Programmable Read Only Memory
FAC	Facultative Neutral Species
FACW	Facultative Wetland Species
FDEP	Florida Department of Environmental Protection (formerly called the Florida Department of Environmental Regulation [FDER])
FID	Flame Ionization Detector
GC	Gas Chromatograph
GPS	Global Positioning System
HASP	Health and Safety Plan
HCl	Hydrochloric Acid
IATA	International Air Transport Association
IDW	Investigation Derived Waste
IWTP	Industrial Waste Water Treatment Plant
K	Hydraulic Conductivity
KI	Potassium Iodide

LQAC	Laboratory Quality Assurance Coordinator
ml	milliliter
ml/L	milliliter/liter
MS/MSD	Matrix Spike/Matrix spike Duplicate
msl	mean sea level
NAD	North American Datum
NaI	Sodium Iodide
NaOH	Sodium Hydroxide
NAS	Naval Air Station
NCP	National Contingency Plan
NCR	NEESA Contract Representative
NEESA	Naval Energy and Environmental Support Activity
NIST	National Institute of Standards and Technology
OBL	Obligate Wetland Species
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response
OVA	Organic Vapor Analyzer
PCBs	Polychlorinated biphenyls
PID	Photoionization Detector
PPE	Personal protective Equipment
ppt	parts per thousand
PVC	Polyvinyl Chloride
QA/QC	Quality Assurance/Quality Control
QAP	Quality Assurance Plan
RAM	Random Access Memory
Redox	Oxidation Reduction Potential
RI/FS	Remedial Investigation/Feasibility Study
RPD	Relative Percent Difference
SAP	Sampling and Analysis Plan
SOP/QAM	Standard Operating Procedure/Quality Assurance Manual
SOUTHNAVFACENGCOM	Southern Division Naval Facilities Engineering
SOW	Statement of Work
TAL/TCL	Target Analyte List/Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
USCS	Unified Soil Classification System
USEPA	United States Environmental protection Agency
VOA	Volatile Organic Analysis
vocs	Volatile Organic Compounds

EXECUTIVE SUMMARY

This Comprehensive Sampling and Analysis Plan (CSAP) provides overall guidance on sampling and analytical techniques to be used during the investigations to be completed at NAS Pensacola. Also included in the CSAP are general procedures for sample and data management, and conducting ecological assessments.

Due to the number and diversity of sites to be investigated at NAS Pensacola, a site-specific sampling and analysis plan (SAP) will be used in conjunction with the CSAP. Each SAP will document any deviations from the CSAP and/or previously submitted work plans. The site-specific SAP will also outline specific sampling procedures and analytical methods to be used during each site investigation.

1.0 INTRODUCTION

As part of the U.S. Navy Comprehensive Long-Term Environmental Action Navy (CLEAN) Program, a Remedial Investigation/Feasibility Study (RI/FS) or [Preliminary Site Characterization] will be completed by EnSafe/Allen & Hoshall (E/A&H) at sites throughout the Naval Air Station (NAS) Pensacola in Pensacola, Florida. Several Work Plans for NAS Pensacola were completed by Ecology & Environment, Inc. (E&E), and submitted to the Southern Division Naval Facilities Engineering Command (SOUTHNAVFACENGCOM). [The investigation for each site shall be completed in accordance with each site's final approved site-specific Sampling and Analysis Plan (SAP) and this Comprehensive Sampling and Analysis Plan (CSAP). All activities and procedures contained in this CSAP shall supersede any activities and procedures specified in any previously submitted documents associated with the process, including the Work Plan. Consequently, the Work Plan for a site shall not be considered complete until the corresponding site-specific SAP is finalized.] The investigative work will be performed in accordance with the procedures in the [United States Environmental Protection Agency] (USEPA) document *Standard Operating Procedures and Quality Assurance Manual*, February 1,1991 (*SOPIQAM*). A copy of the USEPA SOPIQAM will be kept onsite during all field operations.

The investigations will consist of various activities depending upon the nature of the subject site and the work [E&E] previously completed. Tasks may include physical surveys, field sampling, and laboratory analysis. The physical surveys axe screening tools and may consist of a preliminary air survey, radiation survey, habitat/biota survey, soil-gas survey, aerial photograph reconnaissance, a contaminant source survey, and [Dexsil Cr or immunoassay screening]. Physical surveys will be conducted at USEPA Level II protocol where applicable. The field sampling is used to [assess] the extent, nature, and/or magnitude of contamination in the selected media. Surface water, sediment, soil, groundwater, and biota will be sampled and analyzed.

[Bold items in brackets denote changes to the first draft of document.]

[The laboratory to be used will be Naval Energy and Environmental Support Activity (NEESA)-approved. Contract Laboratory Program (CLP) analytical methods using Level IV protocol will be used by the selected laboratory.]

A report will be submitted to the Navy, **[USEPA and Florida Department of Environmental Protection (FDEP) when the]** investigative work **[is complete]** and will include laboratory analyses, a summary of the field activities, and the results and conclusions of the investigations. The results will provide a basis for **[assessing]** human health risk and/or ecological risk at the subject site.

This CSAP will provide overall guidance on sampling and analytical techniques to be used at the sites. In addition, this plan will outline proper documentation procedures for all phases of the investigations. Site-specific SAPs will be provided to address specific techniques and concerns for each site.

[Bold items in brackets denote changes to the first draft of document.]

2.0 GENERAL REQUIREMENTS

2.1 Orientation Meeting

Before performing any field activities at NAS Pensacola, sampling personnel will attend an orientation meeting summarizing general [and] site-specific requirements for sampling and documentation at NAS Pensacola. General topics to be discussed will include the location of the Naval Air Station in Pensacola; the locations of the site office trailer; subject site, and decontamination areas at NAS Pensacola; and the Health [and] Safety Plan (HASP). Sampling requirements to be discussed will include: general sampling protocol; the Unified Soil Classification System (USCS); [using] stainless-steel sampling sleeves[, if applicable]; the sample-numbering system; quality assurance/quality control (QA/QC) sampling requirements; and sample packaging. Documentation requirements to be discussed will include [using] field forms, field logbooks, and photographs. A checklist of requirements and an acceptance form indicating the above items have been reviewed by sampling personnel are provided in Appendix A. *[All* site locations at NAS Pensacola are presented on Plates 1 and 2.]

2.2 General Sampling Requirements

General procedures for field personnel to follow when collecting environmental samples are included in this section. Detailed sampling procedures are discussed in Sections 4, 6, 7, and 8 of this plan. These general procedures are designed to prevent [sample] cross-contamination.

General Sampling Procedures:

- Field sampling teams will consist of [at least] *two* people. One person will collect the sample as the other ensures adherence to the sampling procedures, records any difficulties encountered, and documents other information pertinent to the investigation.
- All sampling activities in each medium will be conducted [so] the sampling order *[begins* at] the area of least contamination [and concludes at] the area of [greatest suspected]

[Bold items in brackets denote changes to the first draft of document.]

contamination. If free product or contaminant saturated media are encountered, grab samples will be collected from [the] area.

- The preferred order of sample collection will be as follows (on a parameter basis): volatile organic compounds (VOCs), total organic carbon, extractable organics (including pesticides, herbicides, and polychlorinated biphenyls (PCBs), total metals, dissolved metals, cyanide, inorganics, and turbidity.
- A clean pair of protective gloves will be donned by the sampler before [collecting] each sample.
- Sample[s collected] for chemical analysis will be performed with either disposable sampling devices or decontaminated stainless-steel or Teflon devices. When composite samples are required, the sample will be homogenized in stainless-steel bowls. All sampling equipment will be decontaminated [following] the procedures outlined in Section 11.
- Disposable sample equipment will be constructed of Teflon or polyvinyl chloride (PVC). The device will be decontaminated by the manufacturer before shipment to the site. An equipment rinsate blank will be collected before use.
- Fill all sample bottles, except for volatile organic analysis (VOA) bottles, to the shoulder to compensate for temperature and pressure changes during transport. If the container is filled below the shoulder, mark the level with a permanent marker or grease pencil. VOA bottles will be filled until there is zero headspace.
- samples collected for VOC analysis will not be homogenized.
- [All samples requiring chemical preservation shall be preserved immediately upon collection in the field or the bottles may be preserved before sample collection].
- After collection, samples [exhibiting obvious visual or olfactory contamination will be placed in separate coolers from the samples not exhibiting such contamination.]

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- Precleaned sample containers will be provided by the analytical laboratory except the stainless-steel sleeves used for soil sampling, which will be decontaminated onsite. All data relative to sample container *integrity* shall be documented in the *site* log.
- [Heterotrophic plate count samples will be collected with sterile containers and scoops provided by the laboratory.
- Water samples collected for hexavalent chromium analysis will be collected only in the afternoon, Monday through Thursday. This is required to meet the 24-hour holding time for hexavalent *chromium.]*

Sample Processing:

Some of the analyses [to] be performed on selected samples require [preserving them] immediately after collection to maintain their *integrity.*

- Clearly identify the chemical preservative on the sample label.
- [Chill] all samples to 4 [degrees Celsius] (°C) [±2°C] immediately after collection and during shipment to the *laboratory.* In each cooler, include a 40-milliliter (mL) vial of tap water (temperature blank) or place a temperature strip on a sample bottle to measure sample temperature [at the time of receipt].
- Handle the samples as infrequently as possible. Use extreme care to ensure samples are not cross-contaminated. .Use resealable plastic bags to protect samples from cross-contamination.
- A trip blank, prepared by the laboratory, will be *shipped* with each set of samples to be analyzed for VOCs. It is not necessary to refrigerate trip blanks before use; store in a dust-free, organic-free environment away from fuels, solvents, and volatile compounds. Discard any trip blanks with bubbles larger than pinheads.
- Avoid headspace (bubbles) in all VOC samples. VOC samples effervescing due to dissolved *gases* or high carbonate content will not be preserved with hydrochloric acid

(HCl). **[Unpreserved]** VOC samples will be documented on the chain-of-custody form and the laboratory will be notified.

- Identify and fully document all samples in the field logbook, on the chain-of-custody forms, and on the sample labels. Refer to the specific instructions for completing sample labels and chain-of-custody forms in Sections 12.3, **[12.4, and 12.5]** of this plan. Document all samples in accordance with Section 14 of this plan.
- Follow chain-of-custody procedures to assure sample custody is maintained **[reliably]** and to assure each step in transportation to the laboratory **[is documented]**. This process will be initiated in the field and followed throughout the sampling process. Document chain-of-custody in accordance with the procedures described in Section 12.5 of this plan.
- Every effort will be made to ship all samples overnight to the laboratory on the day of collection via express air courier. Refer to Section 12.3 for sample shipment procedures. Record airbill numbers on the chain-of-custody forms.
- The laboratory will be notified in advance of sample shipment, and will be notified of any shipments held overnight.

3.0 PHYSICAL SURVEYS

31 Well Inventory

Before beginning any [site] activities, [all existing monitoring wells will be inventoried] at NAS Pensacola to ensure the validity and accessibility of groundwater sampling locations. A well integrity checklist is provided in Figure 3-1.

Before the Well Inventory

[Before beginning] the well inventory, the following information will be recorded on the well integrity checklist from previous reports.

- Well number
- Reported dimensions of the monitoring wells including:
  - Diameter
  - Total well depth
  - Last available depth to water
  - Screened interval
  - [Suspected] contaminant

A site map will be included with the well inventory checklist for locating the monitoring wells.

During the Well Inventory

The condition of all monitoring wells will be *checked* and recorded on the well integrity checklist. [The following conditions will be checked.]

- Legible labeling of the monitoring well. (If labeling is [illegible], the monitoring wells will be relabeled during the well inventory.)
- Presence of a protective casing and [the] presence of weep holes
- Presence of yellow bumper posts
- Condition of the *cement* surface seal

- Presence of a well cap and lock. (All locks will be replaced during the well inventory regardless of condition.)
- Presence of odor or ionizable organic vapors using an [photoionization detector (PID)] or organic vapor analyzer (OVA)
- Construction of the well including:
  - Construction material
  - Diameter
  - Depth to water and depth to bottom

After the Well Inventory

All wells found to be damaged (unable to be sampled) will be abandoned in accordance with [Northwest Florida Water Management District] regulations. If additional monitoring wells are needed to replace the abandoned [ones], they will be installed during the site-specific investigation. Damaged surface seals will be removed and replaced, bumper posts will be installed and/or painted, and protective casings will be repaired or replaced as necessary during the site-specific investigation.

[Each of the wells checked during the well inventory will be assessed to compile a list of parameters for which reliable information (i.e., groundwater elevations only, VOCs only, full Target Analyte List/Target Compound List [TAL/TCL] scan, etc.) may be obtained from each well. Conditions to be evaluated for each well include construction materials, construction methods, condition of the well, screen length, and screen placement.]

3 3 Soil-Gas Survey

A soil-gas survey [is] effective [for] screening VOC contamination and is a useful guide for establishing soil and groundwater sampling points. This survey will require [establishing] a grid

WELL INTEGRITY CHECKLIST

Project: NAS Pensacola

Field Personnel:

Date:

						Reported Dimensions				Field-Observed Dimensions			Calculation			
Well #	Location/ Coordinates	Protector/ Manhole	Cement Surface Seal	Cap/ Lock	PID/FID Response or Odor (ppm)	Reported Elev. (inches)	Const. Depth (feet)	Last Avail. W.L. (feet)	Screened Depth (feet)	Obsv. Elev. (inches)	Obsv. W.L./ Time (feet)	Obsv. Depth (feet)	(Depth)-(W.L.) Depth (feet)	Volume of Water (gallons)	Bottom. Sediment	Comments

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system across the site, using procedures outlined below, then collecting samples at each of the established grid points.

Establishing the Grid System:

1. A Florida-registenxi surveyor or E/A&H personnel will define the two baselines (x and y axes) and record the[m] and *other* key [grid] elements on report maps.
2. The baselines will be flagged at regular intervals, in accordance with the site-specific *SAP*.
3. The internal grid points then will be established *using* a Brunton compass and measuring tape.

General Soil-Gas Sampling Procedures

1. Collect measurements at each established grid point and record the values in the field logbook. If necessary, further investigate areas of elevated soil-gas readings by redefining the survey grid to a smaller interval.
2. Collect additional soil-gas readings at the redefined *grid* nodes. If the elevated readings need further definition, decrease the survey *to* smaller intervals as needed.
3. Note the.sampling points on a site *map*.
4. Install the soil-gas probes using either a manual disposable drive-point method or a hydraulically powered, van-mounted Geoprobe.
5. Collect one duplicate sample for every 20 samples. Collect one rinsate blank for every 20 Samples to check decontamination procedures, or one rinsate blank sample for every 14 days, whichever occurs first.
6. Between each sampling location, decontaminate the soil-gas probe. *Do not* use solvents. *Do not* muse Teflon tubing.
7. Place any investigation-derived wastes (IDW) into 55-gallon drums for disposal by the Navy.

8. Based on the survey results, select locations for heated-headspace analysis. This method requires collecting groundwater samples through the stainless-steel sampling point for analysis by the portable gas chromatograph (GC). The quality assurance plan (QAP) for soil-gas analytical services will be included in the site-specific SAP.

Sample Collection with a Perforated Drive-Point

1. Assemble the soil-gas sampling point of stainless-steel pipe to a disposable sampling point.
2. Decontaminate the stainless-steel drive point assembly before use and advance it to slightly above the water table.
3. Use Teflon tubing to connect the soil-gas sampling point to the sample collection device; attach a vacuum pump with additional Teflon tubing.
4. Purge at least three volumes from the apparatus before collecting samples.
5. Collect sample in a pre-evacuated glass vial.
6. Detach the self-sealing vial and analyze the sample with a portable GC.
7. Remove the sampling point.
8. If appropriate, advance the soil-gas sampling points into the water table at selected locations based on soil-gas readings to collect comparative groundwater samples.
9. Collect groundwater samples through the sampling point and analyze them using a heated-headspace method on the portable GC.

Sample Collection with a Van-Mounted Geoprobe

1. Advance the stainless-steel pipe, outfitted with a disposable stainless-steel tip on the lead drive point, into the ground with the percussion hammer.
2. After the pipe has been advanced to the desired depth, disengage [the drive point] and withdraw the drive pipe 8 to 10 inches to create a void [in which] soil gases can collect.

3. Insert the Teflon sample tubing into the drive pipe and connect the tubing to a sample collection device. Use additional Teflon tubing to attach to a vacuum pump.
4. Purge at least three volumes from the sampling apparatus before collecting samples.
5. Collect the sample in a pre-evacuated glass vial.
6. Detach the self-sealing vial and analyze the sample with a portable GC.
7. As required, advance the soil-gas sampling points into the water table at selected locations [to collect] comparative groundwater samples, based on soil-gas readings and proximity to the source areas.
8. Collect groundwater samples through the sampling points and analyze them using the heated-headspace method on the portable GC. When sample collection is complete, remove the stainless-steel sampling tube.
9. Decontaminate all sampling equipment before use and between each sample collection point. *Do not* use solvents. *Do not* reuse Teflon tubing.
10. Place the [IDW] in 55-gallon drums for disposal by the Navy.

3.3 Geophysical Surveys

3.3.1 Magnetometer Survey

A magnetometer survey identifies areas of buried metallic objects and geologic anomalies (magnetic mineral formations) contrasting with the surrounding rock [or subsurface soil]. The magnetic field strength, measured by the detector as a magnetic signal intensity, varies between $1/r$ and $1/r^3$ (r being the distance from the sensor to the buried object), depending upon the type of object. Metal location and depth of burial is indicated by the shape and width of the anomaly. The accuracy of this method is within 40 percent of the interpreted value. Total field and vertical gradient measurements are two types of magnetic surveys. Setup procedures apply to both types of surveys.

a

Setup Procedures:

1. Review past disposal practices to identify target and non-target areas.
2. Determine the minimum size of target to be identified.
3. Perform a site reconnaissance to identify areas of **[potential magnetic]** interference (e.g., metal fences, metal buildings or power lines).
4. Review the site geology to determine if any geologic anomalies **[might]** interfere with target detection.
5. If anomalies are expected, estimate their intensity.
6. Establish a sampling grid or transect across the site **[as described in Section 3.2.]** The distance between sampling points depends on the **[resolution required for a particular site and the estimated]** size of the target. The closer the sampling points are to each other, the greater the resolution. Use non-metallic station markers, such as wooden stakes, to identify stations. If possible, establish the grid so **[its]** lines are perpendicular to the target axes. If not possible, align the grid north to south or anchor **[it]** to a permanent site feature.
7. Check the **[magnetometer's]** calibration date. If **[it]** has been calibrated more than one year ago, return instrument for recalibration.

Total Field Measurement Survey

The total field measurement is a scalar measurement of the total magnetic field intensity. The person operating the magnetometer must be free of any magnetic material (e.g., steel-toe boots).

Survey Procedures:

1. Place the magnetometer at a station, properly orient the sensors, and collect the reading in accordance with the manufacturer's operating manual.
2. Hold the magnetometer approximately 0.5 meters above the ground surface to obtain a reading. At subsequent grid nodes, the magnetometer must be held at the same height

above the ground surface. A *0.5* meter mark on a *staff* may be used to estimate this height.

3. Record the [magnetometer] reading, measurement time, [grid node identification], and [applicable] comments in the field logbook.

Vertical-Gradient Field Measurements

The vertical gradient field measurement consists of two or more total field measurements taken at different sensor heights. This helps [quantify] regionally pervasive magnetic effects from nearby buildings or ubiquitous bedrock magnetization.

Survey procedures:

1. [At each grid node,] collect total field measurement at 0.5 meters above the ground surface.
2. Collect a second reading with the sensor approximately 1 to 2 meters above the point where the first reading was taken. A staff will be designed to hold the two sensors [in order for] the sensor Separation [to remain constant].
3. Record the second value and the distance between the readings.
4. Record any additional comments m the field logbook.
5. Collect readings at the remaining grid nodes with the same distance between the first and second reading.

In most cases it will be *necessary to* correct for drift and sudden fluctuation in the earth's magnetic field intensity. This *can* be done in one of two ways. Method 1 is to *we* a "tie base station" and repeat the measurements there at least once every hour. The data obtained between repeats at the base station then *can* be corrected by a linear interpretation. Method 2 is to use a second magnetometer continuously monitoring the magnetic field. The data are then corrected

manually or by software in digital magnetometers. Method 2is more costly but more accurate, and is sometimes necessary m active parts of the 11-year solar activity cycle.

3.3.2 Electromagnetic Induction Survey

This section describes the procedures for conducting an electromagnetic (EM) survey with an EM-31 terrain conductivity meter. Survey procedures are detailed below.

Induction *Survey Setup* **Procedures:**

1. Review past disposal practices at the site **[to identify]** buried targeted and non-targeted metallic objects.
2. Review the site geology **[for]** variable geologic conditions or features **[possibly causing]** spurious anomalies **[affecting target detection]**.
3. If anomalies are expected, estimate their intensities.
4. The EM survey can be completed with horizontal and/or vertical dipoles, and with conductivity with/without in-phase component.
5. The intervals of the grid system will be defined in the site-specific SAP.
6. Tie the grid system to existing permanent features (i.e., roads and buildings) so the grid may be used for **[locating and mapping physical site features such as]** monitoring well placement and tracing contaminant plumes.
7. Mark the grid system origin and key axes using a Brunton compass and **[measuring]** tape to ensure accurate instrument **[placement]**.

EM Instrument Calibration

EM instruments are calibrated by the manufacturer. Instrument calibration checks will be performed [before] use each day in accordance with manufacturer's specifications.

If site activities are expected to last more than one day, select a local standard site in the field to provide a reference base station. [The instrument will be calibrated daily at the base station] to check for drift in [its] performance.

EM Instrument Field Check Procedures:

1. Select a [reference base station] without nearby conductors and obtain a reading with the EM instrument.
2. Record the site location, orientation of each coil (e.g., east-west vs. north-south), coil spacing, and the EM reading in the field logbook.
3. At the beginning of each subsequent day, obtain a reading at the test site with the same coil spacing and orientation as before. Variation should be less than ±5 percent.
4. Record the reading and location in the field logbook, and compare with the initial reading to cross-check for instrument drift.

Data may be obtained using horizontal or vertical dipoles. For an EM-31, the horizontal dipoles are selected when the instrument is placed with the meter facing up; vertical dipoles are selected when the meter faces the horizon. In both cases the long boom is held parallel to the ground at a fixed height. Horizontal dipoles are usually used since they provide the [deepest] penetration (about 12 meters). Vertical dipoles are only useful in certain applications [(i.e., when better resolution at shallower depths is required.)]

In addition, one can choose conductivity mode and/or in-phase mode. Always use at least the conductivity mode. In-phase can be run in addition to conductivity to help better define buried metals.

3.4 Geodetic Positioning/Cadastral Survey

When the field investigation is complete, all sampling locations [will be located] both horizontally and vertically. The vertical elevations will be [measured] man accuracy of ±0.01 foot. The horizontal locations will be supplied m [northing and easting or] latitude and longitude, in accordance with North American Datum (NAD)'83. In addition, all utilities, above-ground structures, and surface improvements (e.g., pavement) [will be located. Geodetic positioning will be conducted using a differential Global Positioning System (GPS). If a cadastral survey is conducted, it will be handled by a registered land surveyors in the state of Florida.]

3.5 Habitat/Biota Survey

A habitat/biota survey during the initial investigation will help determine if there are any terrestrial and aquatic habitats onsite or nearby [potentially] affected by contaminant migration. [Habitat/biota surveys presented in the Interim Data Reports completed by E&E will be used as a preliminary guide for all habitat/biota surveys to be completed during this investigation.] Any rare, threatened, and endangered species will be documented, in addition to the general population of animals and plants. See Section 8 of this CSAP for a detailed description of the habitat and biota survey procedures and its function m an ecological assessment.

[3.6 Dexsil Cl⁻ Screening

Dexsil Cl⁻ screening is effective for pesticide/PCB screening and is useful for establishing soil sampling points. This screening technique measures total chloride available. This

survey will require establishing a grid system across the site. This may be done *using* the grid establishment procedures provided in Section 3.2. Soil samples may be collected from the designated intervals using any of the procedures provided in Section 4 of this plan. Procedures for using the Dexsil equipment are provided below.

Before Sampling

1. Attach power supply.
2. Fill the electrode with filling solution provided by the manufacturer.
3. Empty the electrode by pressing down on the white cap.
4. Refill the electrode with the filling solution to the hole.
5. Fill one 40-ml VOA vial with rinse solution provided by the manufacturer.
6. Place the electrode in the rinse solution.

Calibration

7. Turn power on.
8. Fill one 40-ml VOA vial with calibration solution.
9. Remove the electrode from the rinse solution and wipe with Kemwipe.
10. Place electrode in calibration fluid and swirl for a few seconds.
11. Move selector knob to "CAL."
12. Press "Start."
13. When "READ" light comes on, adjust to "50."
14. Remove electrode from calibration solution, wipe with Kemwipe, and place in rinse solution.

Sample Preparation

15. **Tear a white-capped tube removing the cap** provided by the manufacturer.
16. **Weigh 10 grams of soil in tube.**
17. **Empty contents of one extract solution into tube.**
18. Shake for 1 minute. **Let settle for 2 minutes.**
19. Set up **drying tube/syringe apparatus. Place apparatus in black-capped** *tube.*
20. **Use polyethylene pipette** to **remove at least** 7 ml **of extraction solvent from** top of soil. **Place solvent in open syringe.**
21. Apply **pressure** to syringe to **force the solvent through drying** column *at* a rate of **two** *to* three **drops** per **second.**
22. **Fill black-capped tube to the 5 ml** line. **Replace** black cap tightly.
23. Break the bottom clear ampule. **Shake for 10 seconds.**
24. Break the top gray ampule. Shake for 10 **seconds.** Continue to *shake* **intermittently** for 60 seconds.
25. Add 5 **ml extract solution** (using 5 ml pipette). Shake for 10 seconds. Vent cap (turn 1/2 turn), squeeze tube, **and cap** tightly. Shake vigorously for 20 **seconds.**
26. **Allow** tube to **settle** upside **down** for 2 **minutes.**
27. Filter bottom **phase through polyethylene filter funnel into analytical vial (small** white vial). Stop filtering **when first** drop of yellow liquid hits the filter.
28. **Allow extracted** fluid *to* **cool** for 5 **minutes.**

Analysis

29. **Remove electrode from rinse solution. Wipe dry with Kemwipe.**
30. **Place electrode in extracted solution.**
31. Press "start."
32. Read and record **results.**

[Bold items denote changes to the first draft of document.]

After Analysis

33. Place **all IDW** in **55-gallon drums** for disposal by the Navy.

3.7 Immunoassay Screening

Immunoassay **screening also** is effective for PCB and **other analytes screening** and is **useful** for establishing **soil** sampling **locations. This survey will require establishing** a **grid** *system* across the *site.* This may be done *using* the **procedures provided** in **Section** 3.2. **Soil** samples may be collected from the designated **intervals using** procedures in Section 4 of this pian. Detailed procedures for *using* the immunoassay **screening** equipment are provided in *each* test **kit.]**

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4.0 SOIL SAMPLING

Soil sampling locations will be positioned in accordance with the site-specific work plan. Techniques for sample collection depend on the soil type and depth of the sample. Surface soil sampling will [adhere to] Section 4.11 of the USEPA SOP/QAM. Surface samples are defined as 0-1 foot below land surface (bls) exclusive of rocks, twigs, leaves, and vegetation. Surface soil samples may be collected manually with [a] hand auger or Xi-Tech sampler. Power devices such as drill rigs or backhoes frequently are used for deeper subsurface samples, depending on the depth of the sample to be collected and the soil type. Samples collected with a drill rig may include split-barrel samplers with stainless-steel liners, split-barrel samplers without liners, or Shelby tubes. **[If stainless-steel** liners **are** used, **all samples (except for VOC) will be homogenized in the laboratory before analysis.]**

Each soil sampling team will [have] at least two members. *One* person will collect the sample as the other documents [information] in the field logbook [regarding] adherence to sampling procedures, difficulties encountered, and other pertinent information.

4.1 Labeling Soil Collection Points

Soil brings, surface soil collection points, and test trenches will be labeled by site, media sampled, and unique number. For example, if soil boring 04 were advanced at Site 36 the boring designation would be "36S04." Another example, if a surface soil [sample was] collected at location 12 at Site 33 the designation would be "33812." Care should be taken to ensure [unique] identification numbers [are designated] for surface soil collection points and soil brings. For example, if a surface *soil* sample is to be collected *at* location 01 *at* Site 33 and a soil boring designated 01 was also advanced *at* Site 33, the identification number [should not] be the same ("33S01"). These errors are easily avoided with careful planning.

[Bold items in brackets denote changes to the first draft of document.]

4.2 Soil Description

Samples will be described [on a soil boring log] by a qualified geologist using the USCS. A USCS summary and sample boring log are included as Figures 4-1 and 4-2, respectively. If trenching is used to uncover subsurface soil, soil characteristics (such as color, type, and moisture content) [should be described] in the field logbook. All soil colors will be described wet, [therefore] it may be necessary to wet the soil. Refer to Appendix B for the American Society for Testing and Materials (ASTM) standards for Description and Identification of Soils (Visual-Manual Procedure) (ASTM D2488-90) for describing soil.

4 3 Surface Soil Sample Collection

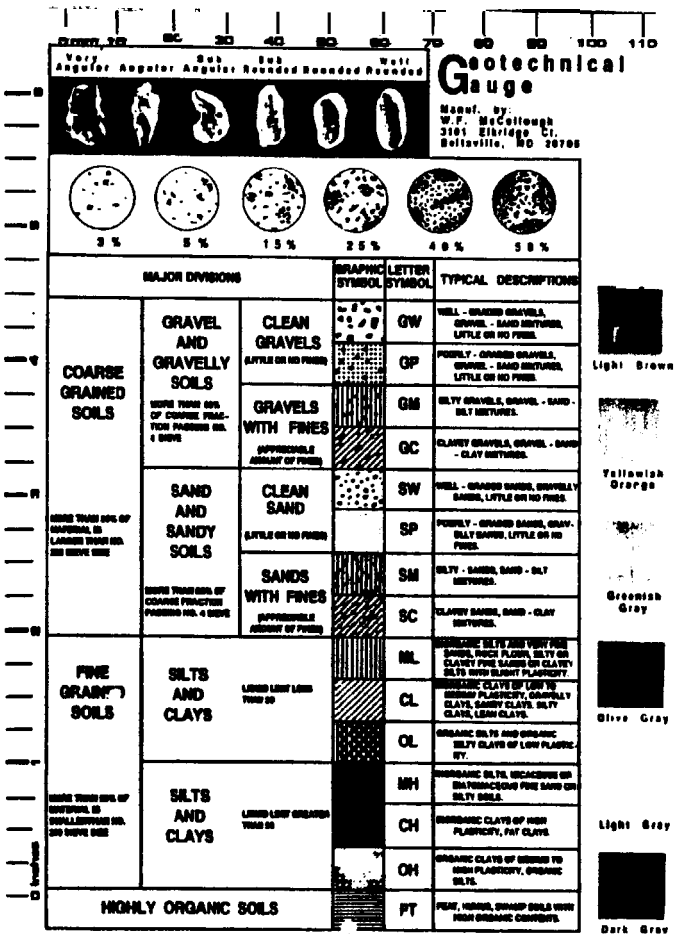
Before Surface Soil Sampling:

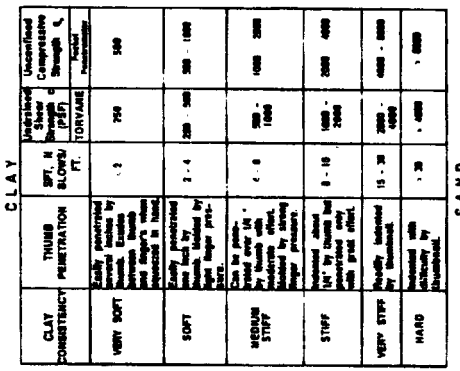
1. Don personal protective clothing and *equipment* as required by the site-specific health and safety plan.
2. Survey and *stake* the location(s) to be sampled.
3. Clear vegetation and other debris from the surface around the boring location.
4. Place clean plastic sheeting on the ground surface near the sample collection point to contain decontaminated sampling equipment.
5. Set up a decontamination area for sampling equipment, if required.

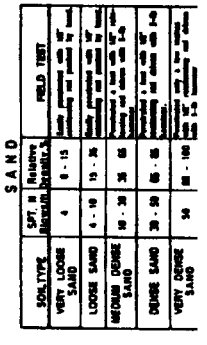
During surface Soil sampling:

6. Remove surface debris from the sample location.
7. With a *stainless-steel* device, scrape the surface of the sample collection point to *obtain* a previously unexposed sample surface.
8. Use a decontaminated stainless-steel or Teflon-lined sampling device (e.g., *spoon,* spatula) to collect the volume needed to fill the sample container(s).

[Bold items in brackets denote changes to the first draft of document.]







Unified Soil Classification System (USCS)

	MILLIMETERS	INCHES	SIEVE SIZES
BOULDERS	> 300	> 11.8	
COBBLES	75 - 300	2.9 - 11.8	-
GRAVEL: COARSE	75 - 19	2.9 - .75	
FINE	19 - 4.8	.75 - .19	3/4" - No.4
SAND: COARSE	4.8 - 2.0	.19 - .08	No. 4 - No. 10
MEDIUM	2.0 - .43	.08 - .02	No. 10 - No. 40
FINE	.43 - .08	.02 - .003	No. 40 - No. 200
FINES: SILTS	< .08	< .003	< No. 200
CLAYS	< .08	< .003	< No. 200

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LOCATION OF BORING

JOB NO. | CLIENT | LOCATION

DRILLING METHOD: | BORING NO.

SHEET OF

SAMPLING METHOD:

DRILLING: START TIME | FINISH TIME

WATER LEVEL | TIME | DATE | CASING DEPTH

DATE | DATE

DATUM | ELEVATION | SURFACE CONDITIONS:

DRILLING CONTR _____

BY _____ CHK BY _____

DATE _____

SAMPLER TYPE	BLOW COUNT	DEPTH OF CASING	HAMMER WT.	BLOWS/6in SAMPLER	WATER CONTENT	DEPTH IN FEET	SOIL GRAPH
						0.5	
						1.0	
						1.5	
						2.0	
						2.5	
						3.0	
						3.5	
						4.0	
						4.5	
						5.0	
						5.5	
						6.0	
						6.5	
						7.0	
						7.5	
						8.0	
						8.5	
						9.0	
						9.5	
						0.0	

COMPREHENSIVE SAMPLING AND ANALYSIS PLAN
NAS–PENSACOLA
PENSACOLA, FLORIDA

FIGURE 4–2
BORING LOG

DATE: 01/28/93 | DWG NAME: CLMBOR.G

[Bold items in brackets denote changes to the first draft of document.]

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9. For **Grab** samples:
   - Completely fill the sample containers **directly** from **the** sampling device, avoiding twigs, large rocks, and **grass. [Collect the VOC samples first].**
   - Fill the sample container **so there is zero [or minimal] headspace.**

   For Composite samples:
   - **Empty contents of** the **sampling device into a decontaminated** stainless-steel or Teflon-lined bowl. **Collect enough** sample **to fill all the containers.**
   - ***Mix*** sample **[in accordance** with SOP/QAM **procedures]** using **a** decontaminated stainless-steel or Teflon-lined *spoon* or ***spatula.*** Do ***not mix samples for VOC analysis.***
   - **Place** the **homogenized mixture** into the appropriate sample containers.

   For **Toxicity** samples:
   - Empty **contents** of sampling device into ***appropriate*** sample container.
   - **[Toxicity** samples **will not be composited.]**
10. **Secure** container **with** Teflon-lined ***cap.***
11. Label each sample container and preserve **to** 4°C.

After Surface Soil Sampling:

12. **[Backfill the borehole with any excess soil.]**
13. **Record** pertinent information in **the** field logbook.
14. Clean site. **Place** contaminated disposable **materials** in the designated **drum** for disposal **by the Navy.**

4.4 Hand Augering Sample Collection

Before Augering:

1. Don **personal** protective clothing **and** equipment **as required by the site-specific HASP.**

[Bold items in brackets denote changes to the first draft of document.]

2. Survey and stake the location(s) to be sampled. The survey will include horizontal location and elevation relative to man sei level [(msl)] or other specified reference dat[um]. Horizontal and vertical surveying may occur before or after the sampling event, as applicable.
3. Clear vegetation and other debris from the surface around the boring location.
4. Place *clean* plastic sheeting on the ground surface near the sample collection point to contain decontaminated sampling equipment.
5. Set up a decontamination area for sampling equipment, if required.

During Augering:

6. Begin augering to the depth required for sampling.
7. *Make* detailed notes about geologic features of the soil or sediments on a field boring log.
8. While advancing the auger, it [my] be necessary to insert a PVC surface casing to minimize disturbance of the borehole walls.
9. Stop drilling at the top of the specified or selected sampling depth.
10. Collect sample.
    - Without homogenizing, [collect VOC sample from auger bucket and] immediately place into the appropriate container. Fill the container so there is zero headspace.
    - Place the remaining sample volume into a stainless-steel bowl. Mix the sample [in accordance with SOP/QAM procedures] until thoroughly homogenized and place into the appropriate containers. Label the samples and preserve to 4°C.
    - Record the sample identification number, sample [collection depth], and analyses required in the field logbook and[/or] on the appropriate field forms.
11. Proceed with additional sampling, as required by the site-specific work plan.

After Augering:

12. Backfill the borehole with [excess] cuttings or neat cement grout, or install temporary piezometer as stipulated by the site-specific work plan.
13. Decontaminate all equipment in accordance with Section 11 of this CSAP.
14. Place used plastic sheeting and other disposable sampling equipment in the designated drum for disposal by the Navy.
15. Complete the field logbook entry and soil boring log for the site.

4.5 Xi-Tech Sampler Collection

Note: Xi-Tech samplers may be used with or without stainless-steel liners.

Before Xi-Tech Sampling:

1. Don personal protective clothing and equipment as required by the Site-specific HASP.
2. Survey and stake the location(s) to be sampled. The survey will include horizontal location and elevation relative to [msl] or other specified reference data. Horizontal and vertical measurements may be surveyed before or after the sampling event, as applicable.
3. Clear vegetation and other debris from the surface around the boring location.
4. Place clean plastic sheeting on the ground surface near the sample collection point to contain decontaminated sampling equipment.
5. Set up a decontamination area for sampling equipment, if required.
6. Place a decontaminated stainless-steel sampling sleeve, if required, inside the soil core holder and attach to the sampling rod.

During Xi-Tech Sampling:

7. Hammer the soil core holder into the ground until the full length of the sampler has been driven. [A PVC surface casing may be used to minimize disturbance to borehole

walls.] It may [also] be necessary to overdrive the sampler several inches to ensure 100 percent recovery of the sample.

8. Processing for samples collected with stainless-steel liners:
   a. Remove holder from the ground and detach the rod from the soil core holder. Carefully remove the liner without disturbing *the* sample.
   b. Screen the sample with a photo- or flame-ionization detector (PID *or* FID). Record the reading in the field logbook.
   c. Immediately install Teflon septa over the ends of the liner and *cap* each end of the liner with [a] PVC *cap.*

   processing for samples collected without stainless-steel liners:
   a. Remove holder from the ground and detach the rod from the soil core holder exposing the sample.
   b. Screen the sample with a PID or FID. Record the reading in the field logbook.
   c. [From the sampler, collect and] immediately containerize samples [with zero headspace] for VOC analysis. Place the remaining sample into a stainless-steel bowl for *mixing.* After homogenizing [in accordance with SOP/QAM procedures], containerize the samples.
9. Label the sample and preserve to 4°C.
10. Record the sample identification number, the sample [collection depth], and the analyses required both in the field logbook and[/or] on the appropriate field forms.
11. Continue sampling m the same borehole following the *steps* listed *above.*
12. Submit the sleeves for laboratory analysis in accordance with the site-specific *SAP.*

After Xi-Tech Sampling:

13. Backfill the borehole with [excess] cuttings or neat cement grout, or install [a] temporary piezometer as the site-specific work plan [stipulates].
14. Decontaminate all *equipment* in accordance with Section 11 of this CSAP.

[Bold items in brackets denote changes to the first draft of document.]

15. Place used plastic sheeting and other disposable sampling equipment in the designated drum for disposal by the Navy.
16. Complete the field logbook entry and soil boring log for the site.

4.6 Sample Collection by Drill Rig/Backhoe

Soil borings advanced by a drill rig will use hollow-stem augers as outlined in Appendix E.2.1 of the USEPA SOP/QAM. **[During borehole advancement, the breathing zone will be monitored for volatile organic vapors** with a **PID** or **FID.]** The augers will be advanced without a center plug to facilitate split-barrel or Shelby tube sample collection. To improve recovery in sandy soil, continuous split-spoon sampling may be completed using a [Central **Mine]** Equipment **[continuous coring]** system in some areas. Locations of the soil borings will be determined based on the site-specific SAP. After soil samples are obtained to the proper depth, the borings will be abandoned with neat cement grout **or [completed]** with a monitoring well. Soil samples also **[may be]** collected from test trenches. Specific sampling procedures are provided below.

4.6.1 Split-Barrel

Before Split-Barrel Sampling:

1. Don personal protective clothing and equipment as required by the site-specific HASP.
2. Stake the location(s) to be sampled.
3. Clear vegetation and debris from the ground surface.
4. Prepare the site by placing plastic sheeting around the borehole and over the sampling table.
5. Align the derrick of the drill rig at the sampling location.
6. Set up a decontamination area for sampling equipment, if required.
7. Install four decontaminated, 6-inch stainless-steel liners in the split-barrel sampler, if required.

[Bold items in brackets denote changes to the first draft of document.]

During sampling:

8. Install a decontaminated split-barrel sampler on the center rod(s) and insert into the hollow-stem auger. Connect the hammer assembly and lightly tap the rods to seat the chive shoe at the ground surface.
9. If blow counts are needed, mark the center rods in 6-inch increments from the top of the auger flight(s).
10. Drive the sampler using the hammer. Use a full 30-inch drop as specified by ASTM Method D-1586. Record the number of blows required to drive the sampler through each 6-inch increment.
11. If blow counts arc not needed, push the sampler using the drill rig's hydraulics.
12. Cease driving or pushing when the M length of the sampler bas been driven or upon sampler refusal. Refusal occurs when little (<1 inch) or no progress is made after 50 [hammer] blows.
13. Pull the sampler free by using upswings of the hammer to loosen [it], or using the drill rig's winch. Pull out the center rod and sampler.
14. Unscrew the split-barrel assembly from the center rod and place it on the sampling table.
15. Remove the dxive-shoe and head-assembly. If necessary, tap the split-barrel sampler assembly with a hammer to loosen threaded couplings.
16. Processing for samples collected *with stainless-steel liners:*
    a. With the drive-shoe and head-assembly off, split the sampler and move the liners without disturbing the sample.
    b. Screen sample with PID or FID, and select two samples with highest readings for laboratory analysis. If there are no headspace readings, submit the two bottom liners for laboratory analysis.
    c. Immediately install Teflon septa over the ends of the selected liners and cap and seal the ends of the liners with PVC caps.

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d. If additional samples are needed for quality control (e.g., duplicates, matrix spike samples [MS], matrix spike duplicates [MSD]), the other two liners will be covered and capped.

Note: If the recovery is not complete (< 2 feet), submit the two sleeves with the most wmplete recovery.

Processing for samples collected without stainless-steel liners:

a. With the drive-shoe and head-assembly off, split the sampler and [expose] the sample.

b. Screen sample with PID or FID.

c. Immediately containerize samples for VOC analysis with zero headspace. Place the remaining sample into a stainless-steel bowl for mixing. After homogenizing [in accordance with SOP/QAM procedures], containerize the sample.

17. Label the samples in accordance with Section 12 of this plan.

18. Preserve the samples collected at 4 °C.

19. Decontaminate sampling equipment as needed in accordance with Section 11 of this plan.

20. Attach the hollow-stem auger with the cutting head and center rod(s).

21. Proceed to the next sampling depth.

22. Slightly raise the auger flight(s) to disengage the cutting head and rotate without advancement to clean [cuttings from] the bottom of the hole.

23. Collect samples as outlined above by inserting the split-barrel sampler into the hollow-stem auger.

24. Describe sample lithology [on soil boring logs based on observations of the auger cuttings, the bottom end of the sample in the liner, or the sample inside the split-barrel sampler (when liners are not used).]

After Split-Barrel sampling:

25. **Backfill the borehole** with **[excess] cuttings or neat cement grout,** *or* **install a temporary** piezometer **as stipulated** by **the site-specific work plan.**
26. Remove **the drill** *fig* to the **heavy-equipment decontamination area.**
27. **Place** used plastic sheeting and **other disposable** sampling **equipment in the designated drum** for **disposal** by the Navy.
28. **Record all relevant information in the field logbook before leaving the site.**

4.63 Shelby Tube

Before Shelby Tube Sampling:

1. Don personal protective clothing and equipment as **required** by the *site-specific* **HASP.**
2. Survey and stake the location(s) to be sampled.
3. **Clear vegetation and debris from the ground surface.**
4. Prepare the site by placing plastic around the **borehole and** over the sampling table.
5. **Align the decontaminated drill rig to the sampling location.**
6. **Set up a decontamination area** for **sampling equipment** if **required.**

During Sampling:

7. Advance augers to the **desired sample** depth.
8. Attach a head-assembly to a decontaminated Shelby *tube.* Attach the Shelby tube to the center **rods.**
9. Lower the Shelby **tub** and **center rods into the hollow-stem augers until seated at** the bottom.
10. **Use the rig's hydraulics to push the Shelby tube to its full length or until refusal.** Attach a hoisting plug to the upper **end of the center rod, twist** to break **off** the sample, **and pull** it out of *the* **borehole** witb **the** *fig* winch.

[Bold items in brackets denote changes to the first draft of document.]

11. Retrieve the Shelby tube to the surface, detach it from the center rod, and move the head assembly.

    Note: ***Shelby tubes may not retain loose, sandy soil.***

12. If the Shelby tube does not have a *full* recovery, pack the remaining space with aluminum foil [or paraffin] to prevent [soil] movement within the tube.
13. Seal the en& of the Shelby tube immediately. *Mark* the top *end* of the tube for transport to the laboratory.

After Shelby Tube Sampling:

14. Abandon the borehole with cuttings or neat cement grout a the site-specific work plan [stipulates].
15. Remove the drill rig for decontamination.
16. Place used plastic sheeting and any other disposable equipment in the *appropriate* drum for disposal by the Navy.
17. Record relevant information in the field logbook before leaving the site.

4.6.3 Test Trenching

Test pits and trenches are open excavations used to determine the [site's] shallow subsurface conditions. Test pits and trenches *can* be excavated manually or mechanically with a backhoe or bulldozer.

Before Trenching:

1. Don personal protective equipment as required in the site-specific HASP.
2. Collect surface soil samples if required in the site-specific work plan.

During Trenching:

3. Carefully excavate soil in 1-foot increments and stockpile in a designated area on plastic sheeting.
4. Collect subsurface: soil samples as required m the site-specific work plan. Avoid [entering] the test trenches. Use sampling devices such as a band auger or a Xi-Tech sampler with extension handles/rods to collect samples. If necessary, collect samples from the [center of the] backhoe bucket from a previously unexposed surface. Conduct sampling in accordance with Sections 4.4 or 4.5 of this CSAP.
5. If the test trench is deeper than 3 feet [and personnel entry is required, walls must be stabilized] according to Occupational Safety and Health Administration (OSHA) requirements.
6. Water or other liquids removed from the excavation must be considered contaminated. Contain the liquid until it can be properly disposed of by the Navy or returned to the excavation.
7. Sample liquids in a test trench according to surface water sampling procedures presented in Section 7 of this CSAP [or sample using a decontaminated stainless-steel well screen and decontaminated bailer].
8. Photograph all significant features in the test trench. Record all pertinent information in the field logbook as listed in Section 4.2.

After Trenching:

9. As required, collect samples of the stockpiled soil for Toxicity Characteristic Leaching Procedure (TCLP) analyses.
10. Backfill the trench with clean material or stockpiled soil to the land surface after all samples have been collected m accordance with the site-specific work plan.
11. Place all used plastic sheeting and other disposable equipment in the designated drum for disposal by the Navy.

[Bold items in brackets denote changes to the first draft of document.]

12. If stockpiled soil **[is]** contaminated, dispose of **[it]** in accordance with applicable state and federal regulations.

[Bold items in brackets denote changes to the first draft of document.]

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5.0 INSTALLING MONITORING WELLS

[The following section provides procedures for installing of temporary monitoring wells, installing permanent monitoring wells in unconfined and confined aquifers, and developing those monitoring wells. The use of temporary monitoring wells will be evaluated site-by-site based on the objective of the well (i.e., is the well to be used as part of a groundwater monitoring network). The type of monitoring well to be used will be agreed upon by all members of the Partnering Tier 1 team before field activities begin.]

5.1 Labeling Monitoring Wells

Temporary and permanent monitoring wells will be labeled according to site, media to be sampled, [whether] the well is temporary, and the unique well number. For example, if a permanent monitoring well #4 is installed at Site 11, the [groundwater] monitoring well identification would be "11G04." Another example: if a temporary monitoring well [No.] 79 [is] installed at Site 36, the monitoring well identification would be "36GR79." If [it] is a previously existing well, the well number [will] be *changed* to correlate with this identification system. [For example, monitoring well GM-41 near Site 11 would become 11GM41. Proper attention must be given to ensure a unique number is assigned to all wells. Consult the well inventory before assigning a number to a new or old monitoring well.

A stainless-steel tag will be attached to the monitoring wells detailing the monitoring well identification number, the date of installation, the driller, the total deptb of the monitoring well, the screened interval, and the top-of-casing elevation.]

5.2 Drilling Methods

For a permanent monitoring well, boreholes [generally] will be advanced using hollow-stem augers with a PVC plug as outlined in Appendix E2.1 of the USEPA SOP/QAM. The PVC plug is necessary to keep the augers clear while drilling in *saturated* [media. Where flowing

sand prohibits using hollow-stem augers, and/or when Type III wells are installed,] mud rotary wash drilling techniques may also be used.

For a *temporary* monitoring well, soil borings will be advanced *using* manual (hand) auger drilling methods or hollow-stem auger.

5.3 Monitoring Well Construction

All monitoring wells win be constructed in accordance with the Northwest Florida Water Management District regulations (Chapter 40A-3, Florida Administrative Code) and as outlined in Appendix E.4.1 and B.4.2 of the USEPA SOP/QAM with the following modifications.

- All monitoring wells will be constructed of 2-inch inside diameter [continuous-slot] PVC materials.
- The PVC well construction materials will meet NSF Standard 14, in addition to ASTM Schedule 40. Refer to Figures 5-1 and 5-2 for typical monitoring well construction diagrams in unconfined and confined aquifers, [respectively]. Detailed monitoring well construction procedures are [outlined] below.

1. If the well casings, tremie tubings, etc., arrive onsite with printing and/or writing on them, remove the printing with emery cloth or sandpaper before being cleaned. No solvents or hot water may be used to clean the PVC materials.
2. After installing the monitoring well, [notch the] top of the inner casing. This point will be the reference mark for elevation measurement.
3. To reduce the risk of cross-contamination, the outer protective casings of the monitoring wells will not be painted onsite.

Monitoring well construction in an unconfined aquifer and a confined aquifer will be documented on monitoring well *construction* logs provided in Figures 5-3 and 5-4, respectively. Detailed monitoring well construction procedures are provided below.

53.1 Monitoring Well Installation (Unconfined Aquifers)

Before Installation:

1. Make sure area is clear of all underground and overhead utilities. Clear vegetation and debris from monitoring well site.
2. Place plastic sheeting on ground near the area to contain decontaminated equipment.

During Installation:

Drill the Hole

3. Advance the borehole to the required depth using a bit or auger flight with PVC plug of a diameter sufficient to allow for [the tremie pipe to be inserted] when the Casing is centered. The borehole should be at least 4 inches larger [in diameter] than the casing. Drill the hole slightly deeper, [approximately 6 inches more] tban required, for the combined length of casing and screen. Sound the final completion depth with a decontaminated, weighted tape before continuing well placement.
4. Condition the borehole by circulating drilling fluids (mud, water, or air) or by rotating augers without drilling until the hole is cleaned of cuttings. Remove cuttings from the area around the auger.

Prepare the casing

5. Prepare the casing and screen for installation. [Seal the threaded couplings with Teflon tape or Viton O rings.] Decontaminate [them] in accordance with Section 11. Do not clean the PVC casing and screen with hot water or solvent Mse.

[Bold items in brackets denote changes to the first draft of document.]

6. Withdraw the drill rods and bit or the auger flights. (If installing a casing through hollow-stera augers, skip this step. Withdraw auger flights after installing the *casing.)* Check depth of hole with a weighted surveyor's tape.
7. Hang the casing string, screen down, over or in the top of the borehole. Lower the casing string to the bottom of the well.

Set the Casing

8. If a filter pack is required, prepare the dry sand.
9. When the casing string is set to the desired depth, hang the centered casing in place and insert the tremie pipe. There should be 2 to 3 feet *of stickup* once the well has been lowered to its final position, unless tbe wellhead is flush-mounted because *of* its location.

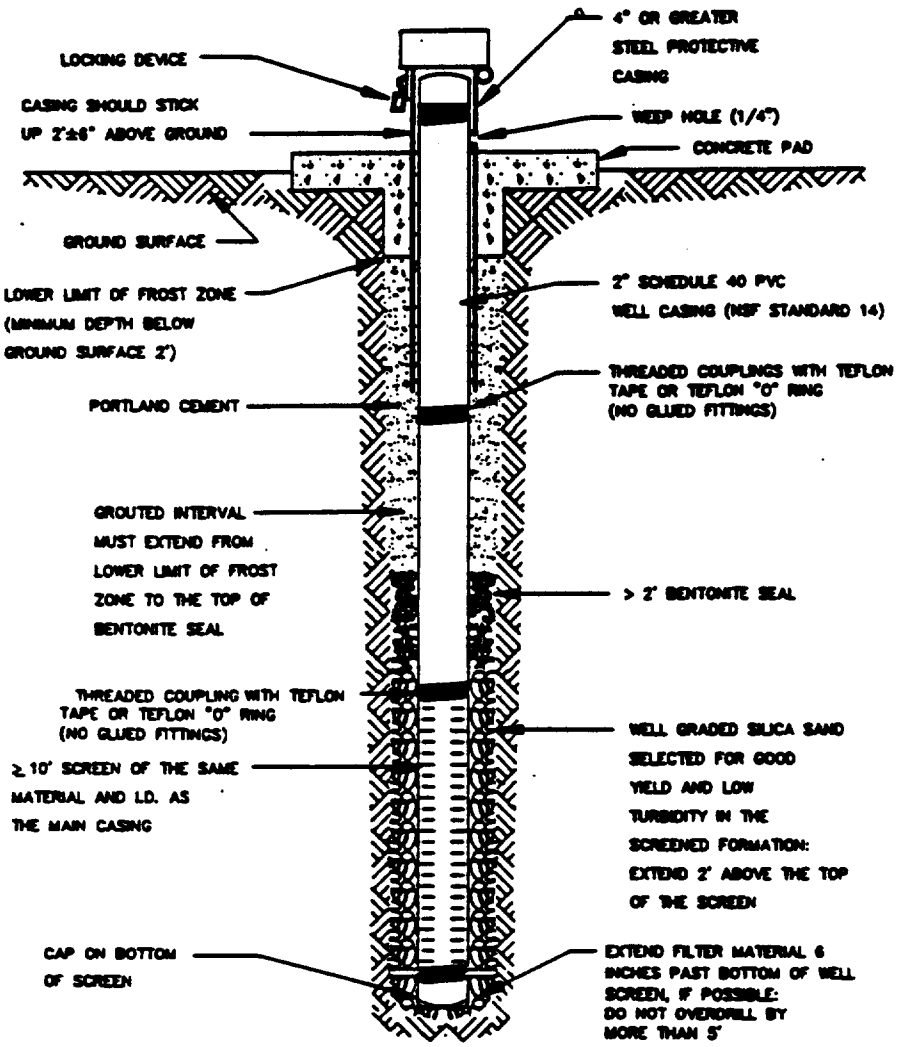
Install the Filter Pack

10. Install the filter pack through the tremie pipe. Six inches or more of filter pack material must be spotted *at* the bottom of the bok, under the screen. Withdraw the tremie slowly so the filter pack is placed evenly around the screen without bridging. The filter pack will be installed mat least 2 feet above the top of the screen.
11. Check depth to top of filter pack with a weighted tape.
12. Do not remove the tremie pipe unless a larger diameter pipe is needed for installing the bentonite *seal* and grout.

Install Bentonite Seal

13. Tremie bentonite pellets (not powder) on top of tbe filter pack. Use pellets if the seal is to be seated below the water table. Granular, flake, or slurried bentonite may be used above the water table. Slowly withdraw the tremie pipe as the bentonite is added to ensure even placement of the bentonite seal around the annulus. Check the depth with a weighted tape. *At* least 2 feet of bentonite is required *above* the screen.

TYPICAL ILLUSTRATION OF MINIMUM SPECIFICATIONS
FOR MONITORING WELL CONSTRUCTION



COMPREHENSIVE SAMPLING AND ANALYSIS PLAN
NAS–PENSACOLA
PENSACOLA, FLORIDA

FIGURE 5–1
UNCONFINED AQUIFER
MONITORING WELL DESIGN

DATE: 10/08/93 | DWG NAME: 04BTYPE2

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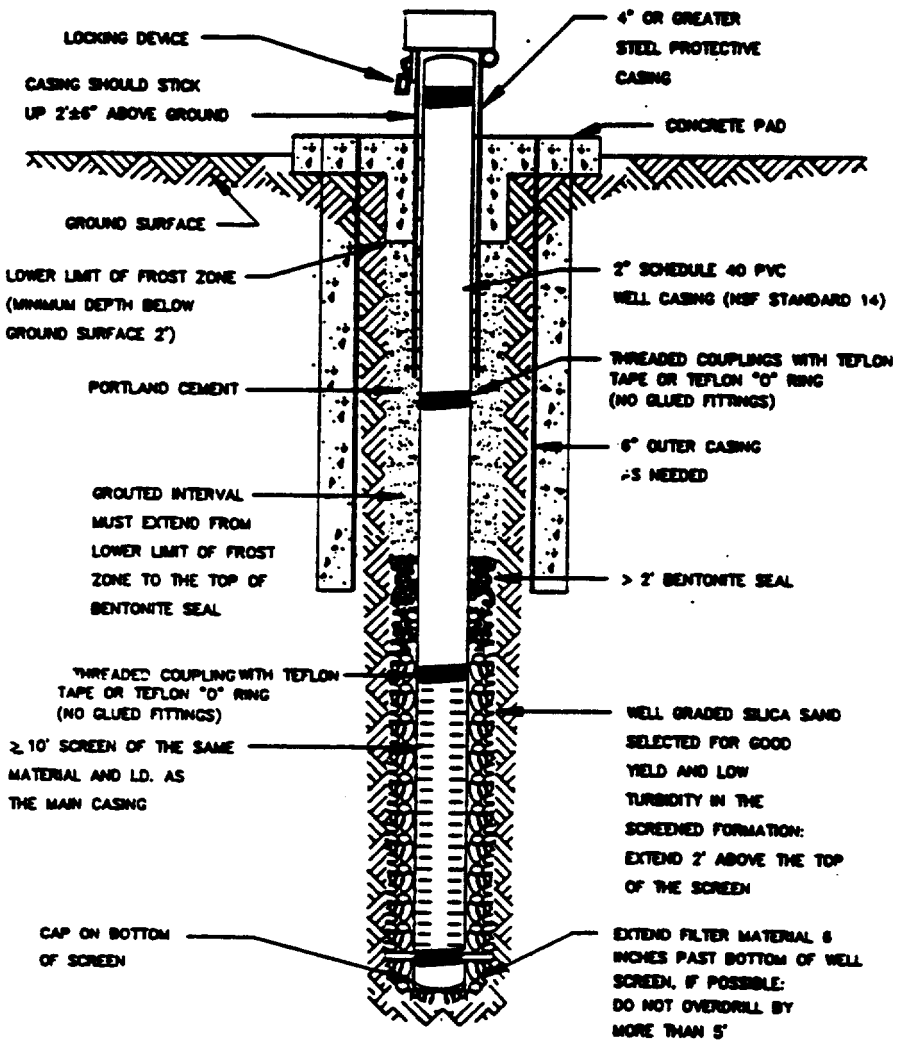
TYPICAL ILLUSTRATION OF MINIMUM SPECIFICATIONS
FOR MONITORING WELL CONSTRUCTION



COMPREHENSIVE SAMPLING AND ANALYSIS PLAN
NAS–PENSACOLA
PENSACOLA, FLORIDA

FIGURE 5–2
CONFINED AQUIFER
MONITORING WELL DESIGN

DATE: 10/08/93 | DWG NAME: C13MGWEL

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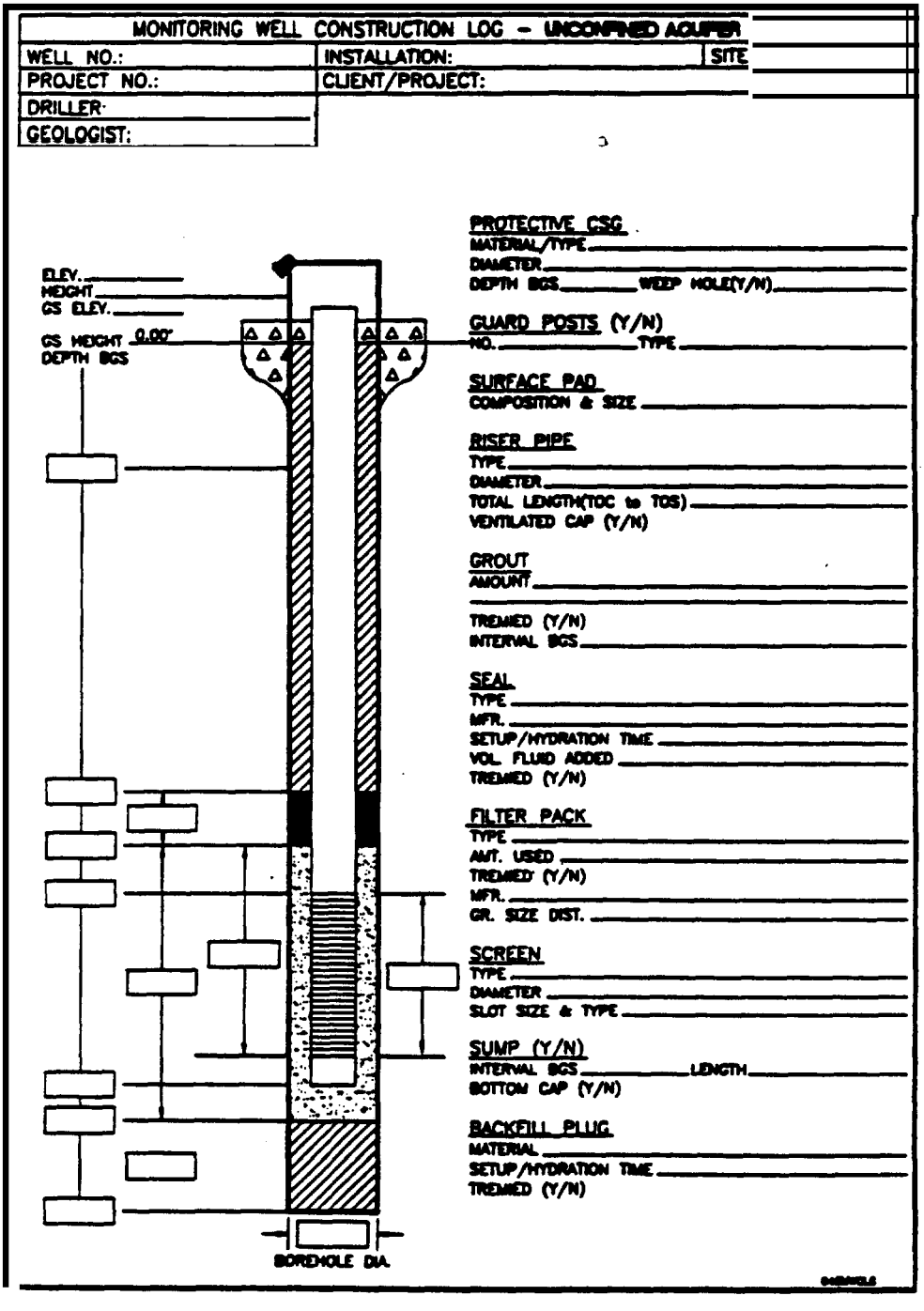
Figure 5-3



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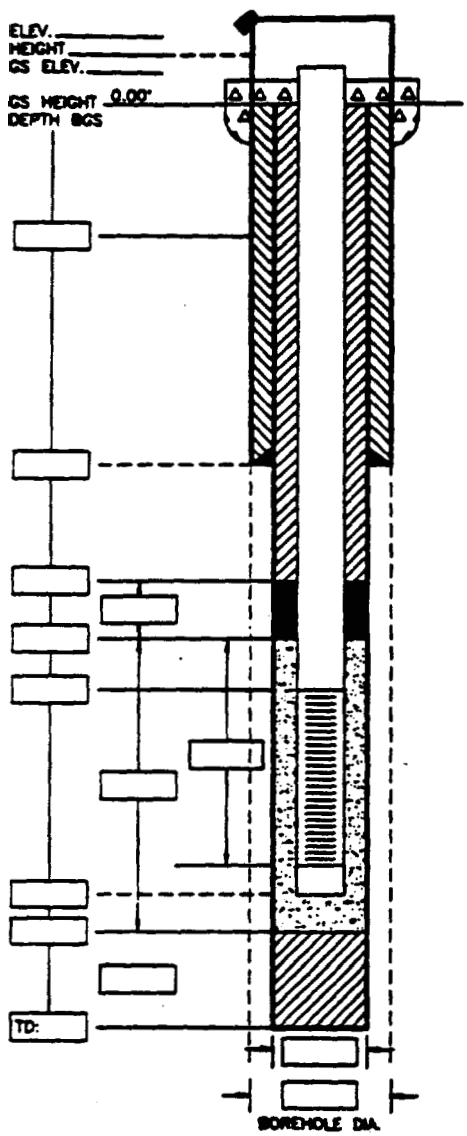
WELL NO.:	INSTALLATION:	SITE:
PROJECT NO.:	CLIENT/PROJECT:	
DRILLER:		
GEOLOGIST:		



PROTECTIVE CSG
MATERIAL/TYPE
DIAMETER
DEPTH BGS WEEP HOLE(Y/N)

GUARD POSTS (Y/N)
NO. TYPE

SURFACE PAD
COMPOSITION & SIZE

SURFACE CSG
TYPE
DIAMETER TOTAL LENGTH

RISER PIPE
TYPE
DIAMETER
TOTAL LENGTH(TOC to TOS)
VENTILATED CAP (Y/N)

GROUT SETUP/HYDRATION TIME
AMOUNT
TREMIED (Y/N)
INTERVAL BGS

CENTRALIZERS (Y/N)
DEPTH(s)

SEAL
TYPE
MFR
SETUP/HYDRATION TIME
VOL. FLUID ADDED
TREMIED (Y/N)

FILTER PACK
TYPE
AMT. USED
TREMIED (Y/N)
MFR
GR. SIZE DIST.

SCREEN
TYPE
DIAMETER
SLOT SIZE & TYPE

SUMP (Y/N)
INTERVAL BGS LENGTH
BOTTOM CAP (Y/N)

BACKFILL PLUG
MATERIAL
SETUP/HYDRATION TIME
TREMIED (Y/N)

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14. If the seal is installed above the water table, hydrate according to manufacturer's specifications.

Grout the Annular Space

15. *Mix* Portland cement and water [(approximately 6 gallons to each 94-pound (lb.) bag of cement)] to make a pumpable slurry.
16. Tremie the grout into the annulus using a side-exiting tremie. Slowly withdraw the tremie pipe as the annulus fills. Grout the well to within 2 to 4 feet of the surface. Note the amount of grout used in the field logbook.
17. After installing grout, dismantle and decontaminate tremie equipment. Allow [the grout to cure adequately] (–24 hours) before [developing the well].

Construct Wellhead Pad

18. Mix and pour concrete for the wellhead pad. Concrete must extend to the top of grout. It may be convenient to first fill the annulus to the bottom of the pad form and then set the locking well cover or locking protective casing. After the protective casing has been installed, the remaining concrete should be poured into the pad form.
19. Finish the concrete pad so it slopes away from the wellhead in all directions with a minimum thickness of 6 inches. If weather umditions warrant, cover the concrete until cured. Lock the well cover.
20. If the well design specifies traffic barriers, dig holes and set barrier posts in concrete separate from the concrete pad. Posts and concrete must extend 2 feet beneath the ground surface.

After Installation:

21. Record appropriate construction/completion information in the field logbook and[/or] on appropriate field log forms.
22. Return to the well site after concrete has cured for at least 24 hours and remove the form. Drill two weep holes on opposite sides of the protective casing, just above the concrete pad.
23. Mark the well identification [number] on the protective casing.
24. Paint bumper guard posts.

Note: [Per SOUTHNAVFACENGCOM,] posts are to be painted with high-visibility yellow epoxy paint [American Association of State Highway and Transportation Officials] (AASHTO M220).

5.3.2 Monitoring Well Installation (Confined Aquifers)

Before Installation:

1. Make sure area is clear of all underground and overhead utilities, and clear vegetation and debris from monitoring well site.
2. Place plastic sheeting on ground near the area to [contain] decontaminated equipment.

During Surface Casing **Installation:**

Drill the Hole

3. Using hydraulic rotary or auger techniques, advance an oversized borehole through unconsolidated surface deposits to a depth of 2 to 3 feet into the top of the confining bed. The borehole *should* be 4 inches larger [in diameter] than the casing.
4. Condition *the* borehole by circulating drilling fluid (mud, water, or air) or by rotating augers without drilling until the hole is cleaned of cuttings. While conditioning the borehole, prepare necessary length(s) of surface *casing.*

Prepare and set the ***Surface Casing***

(Follow these **procedures** for each **separate** aquifer *to* be **cased off.)**

5. Pressure grout **[the** neat] cement **grout to** fill the portion of **the** borehole in the confining **bed.**
6. **Insert** the *surface* casing into **the borehole** and push **firmly** into **the confining** bed.
7. *Mix* portland *cement* **and** water **to** make a pumpable slurry.
8. **Insert** side-exiting tremie pipe into the borehole **and** begin pumping **grout.** Slowly withdraw the tremie pipe **as the** annulus fills *to* ensure even placement with[out] bridging.
9. **Allow** grout *to* cure *at* least 24 hours before **[installing** the **well].**

Drilling *and* ***Installation of Monitoring Well***

10. After the grout **has cured,** continue **drilling** with **a** smaller diameter bit or auger **string.** Advance borehole **to** the **desired depth.,** Drill the hole **a** few feet deeper **than** necessary **to allow** for cavings during casing placement. If **more than** one [hydraulic unit] will **be** encountered during drilling, **the** well **must be** cased **in** separate stages *to* prevent **cross-**contamination.
11. Condition the borehole **by** circulating drilling fluid (mud, water, **or air) until** the hole is cleaned of cuttings. **Pull** the drill **string** out of **the** borehole when **no** additional **cuttings** reach the surface. Check depth *of* the hole with **a** weighted surveyor's **tape.**

Prepare *and* ***Set*** the ***Casing String***

12. Prepare **the** casing String in manageable sections while conditioning **the** borehole. Decontaminate the casing **and** *screen* in accordance with **Section 11,** but *do* not wash **PVC materials** with hot water or **rinse** with **solvents. Tighten** casing joints.
13. **Insert** first segment of the casing ***string*** and lower ***to*** **a** convenient height for adding the second casing segment.

[Bold items in brackets denote changes to the first draft of document.]

14. Chock the casing, add the second segment, then release the chock and lower the casing. Repeat this process until the full casing string is hanging in the well.

15. *Allow* the *casing string* to *hang* in the well rather than *sit* on the bottom. Never allow *casing strings* with Schedule 40 PVC to sit on the bottom because the [casing's] weight will significantly reduce the slot size and may cause the screen to collapse.

Install Filter Pack

16. If the well is to be completed without a filter pack, insert a decontaminated pump tube or submersible pump so unconsolidated sediments will collapse *against* the *screen.*

17. Lower a weighted surveyor's tape to make sure the formation sand *or* gravel has collapsed to a distance of 2 feet or more *above* the top of the screen. Continue pumping until sufficient *collapse* has occurred. If pumping *does* not cause collapse, then a Nter pack should be spotted *at* the screen as described m the next *step.*

18. If a Nter pack is required, as is most common, prepare the dry sand or sand slurry, then proceed from the previous *step* listed above.

19. Insert a tremie pipe near the bottom ofthe screen and begin running the filter material through it. Slowly withdraw the tremie pipe so the filter pack is placed evenly around the screen without bridging. Six inches or more of filter pack material should be spotted at the bottom of the hole, under the screen. The filter pack will be installed *to* at least 2 feet above the top of the screen. If the top *of* the screen is below the bottom of the confining layer, extend the filter pack to the confining layer, if appropriate.

20. If the filter pack was installed *dry,* do not remove the tremie unless a larger diameter pipe is needed for installing the bentonite seal and *grout.*

Install Bentonite Seal

'21. Tremie the bentonite pellets on top of the filter pack. Bentonite pellets will be used where the seal is installed below the water table. The bentonite seal must extend 2 feet into the confining layer, if possible. Slowly withdraw the tremie pipe as bentonite is added to ensure even placement around the casing without bridging.

22. If the bentonite seal is installed above the water table, hydrate the bentonite according to the manufacturer's specifications.

Grout the Annular Space

23. Mix Portland cement and water to make a pumpable slurry.

24. Tremie the grout into the annulus. Slowly withdraw the tremie pipe as the annulus fills to ensure even placement. Grout the well to within 2 to 4 feet of the surface.

25. After installing grout, dismantle and decontaminate the tremie equipment. Allow adequate cure time (~24 hours) before [developing the well].

Construct Wellhead Pod

26. Mix and pour concrete for the wellhead pad. Concrete must extend to the top of [the] grout. It may be convenient to first fill the annulus to the bottom of the pad form and then set the locking well cover or locking protective casing. After the protective Casing has been installed, the remaining concrete should be poured into the pad form.

27. Finish the concrete pad so it slopes away from the wellhead in all directions, with a minimum thickness of 6 inches. If weather conditions warrant, cover the concrete until cured. Lock the well cover.

28. If the well design specifies traffic barriers, dig the holes and set the barrier posts in concrete separate from concrete pad. Posts and concrete must extend to a depth of 2 feet.

After Installation:

29. Record the appropriate construction/completion information in the field logbook and[/or] on the appropriate field logbook forms.
30. Return to the well site after the concrete has cured for at least 24 hours and remove the form. Drill two weep holes on opposite sides of the protective *casing* and just above the concrete pad.
31. *Mark* the well identification number in the protective *casing.*
32. Paint bumper guard posts.

Note: Posts will be painted with high visibility yellow epoxy paint (AASHTO M220).

53.3 Temporary Monitoring Well Installation (Unconfined Aquifers)

Before **Installation:**

1. Make sure area is clear *of* all underground and overhead utilities. Clear vegetation and debris from piezometer *site.*
2. Place plastic sheeting *on* ground to [contain decontaminated] equipment.
3. If using a drill rig, align the rig to sampling location.

During **Installation:**

4. Hand-auger or drill with a rig to the desired depth.
5. Prepare the decontaminated screen with attached drive point for installation.
6. Drive the screen into the ground until the top of screen is approximately 1 foot above the ground surface. Keep the screen vertical while *it* is being driven.
7. Attach the decontaminated riser pipe segments to the screen and continue driving until the screen is at the correct depth.

[8. Allow the natural sand to collapse around the well screen or install a filter pack to above the top of tbe well screen.]

[Bold items in brackets denote changes to the first draft of document.]

After Installation:

9. Cap the riser.
10. Decontaminate the equipment [following] procedures in Section 11 of this document.
11. Record construction information in the logbook.

5.4 Developing Monitoring Wells

Monitoring wells are developed after the neat cement *grout* in the *annular* space of the well has cured at least 24 hours. Development restores the normal hydrologic conditions of the geologic formation near the borehole. Monitoring wells *can* be developed using techniques such as bailing, surging and bailing, or surging and pumping. **[Wells with low aquifer recovery will be developed by bailing, or a combination of surging and bailing. Wells with high aquifer recovery will be developed by a combination of surging and pumping. For temporary monitoring wells, development and** purging are synchronous and require turbidity **stabilization.]** ***Before development*** **and** ***after development*** procedures apply to surging, bailing, and pumping. Monitoring well development will proceed until the water withdrawn is relatively free of turbidity based on the geology of the area, and **[until] pH, temperature, and** specific conductivity have stabilized.

Before Development:

1. Don personal protective clothing and equipment as required in the site-specific HASP.
2. Cover the ground surface around the well with clean plastic sheeting to contain my spilled development water.
3. Open the well cover and check the condition of the wellhead.
4. Measure the depth to static water level with an electronic water-level indicator.
5. Prepare the necessary equipment [to develop tbe well according to] the USEPA SOP/QAM.

During Development:

Wells may be developed by bailing, surging and bailing, or surging and pumping. These techniques are discussed separately but may be used [either] separately or in combination. [Various pumps that may be used during well development include:

- **Brainard Kilman hand pump**
- **Centrifugal pump**
- **Peristaltic pump**
- **Bladder pump**
- **Grundfos pump]**

Surging:

1. **Attach rope or PVC rod to a surge block.**
2. **Lower the surge block into the monitoring** well with rope or rods.
3. Raise **and** lower the *surge* **block so groundwater will** be **surged** m and aut of the monitoring well **screen.**
4. **Continue** for approximately **10 to 15 minutes.**
5. Remove the surge block **from the** well for **decontamination.**

Bailing:

1. Assemble and lower the **decontaminated bailer** into the monitoring well and begin **bailing.**
2. Continue until the groundwater **withdrawn** is below **0.5 milliliters per** liter **(ml/L)** of settleable solids in 15 **minutes** *using* an **Imhoff Cone,** *or* as **free** *of* turbidity as possible given the subsurface **conditions.**
3. **The new monitoring well shall be developed until the [water] column** is as free of visible turbidity as possible given the subsurface **conditions, and [until]** the **pH, temperature,** and specific conductivity have stabilized.

[Bold items in brackets denote changes to the first draft of document.]

Pumping:

1. Prepare the decontaminated pump and tubing, and lower it into the well.
2. Begin pumping the well.
3. If the productivity of the monitoring well is low, it will be alternately pumped then left idle to allow for recovery. The onsite geologist will determine when development is complete based on normal development criteria.
4. Continue well development until the groundwater withdrawn is below 0.5 ml/l of settleable solids in 15 minutes using an Imhoff Cone, or as free of turbidity as possible given the subsurface conditions, and [until] the pH, temperature, and specific conductivity have stabilized.

After Development:

1. Groundwater withdrawn from the monitoring wells during development will be placed in 55-gallon drums for disposal by the Navy.
2. Remove development equipment from the monitoring well and decontaminate (if required) in accordance with Section 11 of this *CSAP*.
3. Lock the well cover before leaving the site.
4. Record all pertinent information in the field logbook.

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6.0 GROUNDWATER SAMPLING

Groundwater samples will be collected **in accordance with** Section 4.9 of the USEPA SOP/QAM with the following **additions and/or** modifications. **[All monitoring** wells will **be purged and sampled by using either a peristaltic, bladder, or Grundfos-type (helical rotor submersible) pump, depending on the depth of the well. If a pump is ineffective or impractical for successful purging and/or sampling, a Teflon bailer** with **a stainless-steel leader will be used.]**

6.1 Purging Static Water

Field personnel will purge monitoring wells **before** sample collection **to** remove stagnant water from the well casing **and** surrounding well borehole *space.*

General Purging Procedures

- Purge monitoring wells with **[either] a decontaminated [pump or Teflon bailer.]**
- Remove at least three well volumes before sample **collection. Place** purge water in **a** dedicated drum.
- Continue purging until three readings of specific **conductance,** temperature, and pH **stabilize** within 10 percent of previous reading.
- **[Monitor** turbidity of **groundwater. If high turbidity remains after purging** three **well volumes, the monitoring** well may **need to be re-developed** *(see* **Section 5.4). If the quiescent sampling technique is being** used, **purging may need to be continued until turbidity has stabilized.]**
- **Record** well purging **data** in **the** field **logbook and[/or]** on **the** Groundwater **Sampling Form** provided in Figure 6-1.
- When purging is complete, allow **monitoring** wells ***to* recharge** before **beginning** sampling. Wells **evacuated** while purging **will** be sampled **when** sufficient sample volume **has reentered** the well. **This** project **[defines]** low **recharge** monitoring wells **as [these]**

[Bold items in brackets denote changes to the first draft of document.]

with recharge rate[s] not allowing sample collection within 12 hours of initial purging. These wells will be documented as *dry*. Specific procedures for monitoring well purging are provided below.

Before Purging:

1. Don personal protective clothing and equipment as *specified* in the site-specific HASP.
2. Cover the ground surface around the well with clean plastic sheeting to contain water spilled during purging *or* sampling.
3. Check condition of the wellhead and protective casing and lock.
4. Open the well cover and immediately insert the PID or FID into the wellhead to measure ionizable organic vapors for approximately [1] minute. If vapors are detected, an interface probe will be used to determine [the thickness of] free product, [if] present. If product is present, a one-way check ball valve will be used to sample the layer.
5. Measure static water level to the nearest 0.01 foot using an electronic water-level indicator. Record the measurement [in the field logbook or] on the groundwater sampling field form.
6. Calculate static volume using the following formula, taken from Section 4.9.7.2 of the USEPA SOP/QAM.

static Volume Formula:

$$V = 0.041\, d^2 h$$

Where:

V = volume of water in gallons
d = diameter of well in inches
h = depth of water in feet (total well depth - static water level)

The static volume also may be calculated using the following formula:

$$V = hr^2(0.163)$$

Where:

V = volume of water in gallons
h = depth of water in feet (total well depth - static water level)
r = radius of well in inches

Figure 6-1

GROUNDWATER SAMPLING | Sample ID: _____

PROJECT NAME: _____ JOB NO: _____ DATE: _____

WELL NO.: _____ LOCATION _____

WEATHER CONDITIONS: _____ AMBIENT TEMP: _____

PERSONNEL: _____

PURGING DEVICE

Type Device? _____

How was the device decontaminated? _____

How was the line decontaminated? _____

Which well was previously purged? _____

SAMPLING DEVICE

Type Device? _____

How was the device decontaminated? _____

How was the line decontaminated? _____

Which well was previously sampled? _____

INITIAL WELL VOLUME

Well diameter (in.) _____

Stickup (ft.) _____

Depth to bottom of well from TOC (ft.) _____

Depth to water surface from TOC (ft.) _____

Length of water (ft.) _____

Volume of water (ft.) _____

(gal.) _____

Amount of sediment at bottom of well (ft.) _____

3 Volumes of water (gal.) _____

PURGING

Time started _____ Finished _____

Volume purged _____

Comments on Well Recovery _____

Depth to water (ft.) _____

Completion _____

Additional Comments _____

Sample Collected: Start _____

Finish _____

IN-SITU TESTING Time: ____ ____ ____ ____ ____ ____ ____

	1	2	3	4	5	6	7
Well Volume Purged (gal.)							
Turbidity							
Odor							
OVA (ppm)							
pH (units)							
Conductivity (µmhos)							
Water Temperature (°C)							
TDS (mg/l)							
Depth to water (ft.)							

NOTES: 1 ft. length of 4" = 0.067 ft³ or 0.65 gal. 1 ft. length 2" = 0.022 ft³ or 0.16 gal.
Turbidity choices: clear, turbid, opaque Revision Date: 12/93

[Bold items in brackets denote changes to the first draft of document.]

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During Purging:

7. Prepare the decontaminated pump or [Teflon bailer] and lower into the casing.
8. Begin purging the well, [move] at least three volumes of water (water column).
9. Withdraw groundwater until temperature, pH, and conductivity have stabilized. A monitoring well is stabilized when three readings [each] of temperature, pH, and specific conductivity are within ±10 percent of the previous reading.
10. Purge upgradient and background wells before downgradient wells to reduce the cross-contamination [risk].
11. While purging the well, [spot *check* purge water for free chlorine and sulfide.]

    Free Chlorine Spot Check:

    — Place drop of purge water on the potassium iodide (KI) test paper.
    — If paper turns blue, free chlorine is present. Cyanide samples will require preservation as described in Section 12.2 of this *CSAP*.

    Sulfide Spot Check:

    — Place drop of purge water on the lead acetate test paper.
    — If paper turns bluish-black, sulfide is present. Cyanide samples will require preservation as described in Section 12.2 of this *CSAP*.

12. If a non-Teflon [or non-stainless-steel] device is used, a "polish" volume should be extracted using a Teflon [or stainless-steel] device.

After Purging:

13. Record data in the field logbook and[/or] *on* the Groundwater Sampling Form (Figure 6-1).

14. If well is purged *dry*, allow [it] to recharge before sampling. [However, every effort should be made to avoid purging the monitoring well dry.]
15. Document the well as *dry* if [it] does not recharge within 12 hours *of* initial purging.
16. All [IDW] produced while purging will be drummed for *disposal* by the Navy.

6.2 Bailer and Pump Groundwater Sampling

Groundwater samples will be collected [according to] the procedures in Section 4.9 of the USEPA SOP/QAM with modifications outlined below.

- Collect groundwater samples as recharge of the monitoring well allows.
- Collect samples using a decontaminated [pump. If a pump is ineffective or incapable of successfully sampling the monitoring well, a] Teflon bailer [may be used].
- Measure temperature, pH, and specific conductance for each sample collected and record [results in the field logbook or] on the groundwater sampling form (Figure 6-1).
- Chemically preserve samples as specified in Section 12. After chemical preservation and labeling, the samples will be *chilled* to 4°C.
- Record weather conditions at the time *of* sample collection in the field logbook. Refer to specific procedures for groundwater sample collection provided below.

Before Groundwater Sampling:

1. Don protective clothing and equipment as specified in tbe site-specific HASP.
2. Prepare the site by covering the ground surface around the wellhead with plastic sheeting and arrange the required sampling equipment for convenient use. If onsite decontamination is required, arrange the necessary supplies in a [separate] nearby location, away from the wellhead.

3. Purge the well according to the procedures in Section 6.1 of this plan. [If using a bailer,] allow the water level in the well to recover deep enough to completely submerge the bailer without [touching] the well bottom.
4. While the well is recovering from purging, [prepare a decontaminated pump or, if required, a Teflon bailer.] If the bailer was decontaminated before arrival at the site, remove the protective wrappings.
5. [If using a bailer,] securely attach [it] to [a] decontaminated Teflon-coated stainless-steel leader. Then, securely attach the leader to the line. The end of the line also should be secured to prevent [losing] the bailer down the well.
6. Arrange the sample containers in the order of sample collection. VOC samples will be obtained first, followed by base-neutral/acid extractable organic compounds (BNAs) and other samples.

During Groundwater Sampling:

7. Lower the [pump hose or] bailer into the water slowly to prevent aeration, particularly when VOC and BNA samples are being collected.
8. [Start pump or] retrieve full bailer to the surface. [If bailing,] do not allow the line to [touch] the ground.
9. Unless the same [pump or] bailer is used for both purging and sampling, [allow initial water from pump to discharge into drum or, if using a bailer,] use the first [volume] of water to Mse out the [device]; discard the water.
10. [If using a bailer,] repeat Steps 7 and 8.
11. [when collecting VOC samples from pump discharge, decrease flow rate. If using bailer,] either fill the VOC vials from the top of the bailer or attach VOC bottle filler to the bailer['s base]. For VOC samples, the sample bottles should be tilted when filling to prevent aeration. Check the filled vial for bubbles making sure [it] has zero headspace.

12. Perform sample filtration with a **0.45-micron filter** as soon as possible after **retrieval**, if **required** for *the cyanide* **samples based on the sulfide** *spot check.* **[Samples collected for total metals analysis will not be filtered.]**
13. **If [using a bailer and]**, after **collecting VOC and BNA** samples, the **[remaining]** water is **[insufficient]** to **completely fill another container, discard [it]. Lower the bailer again** to collect more water for **additional** sample **volume.**
14. **Fill the remaining sample containers** to capacity. Add preservative **(if needed), cap,** *seal,* **and properly label all containers.** Place the filled containers in the cooler(s) immediately and preserve to 4°C.
15. **If the free chlorine or sulfide** *spot* **checks** are positive, **[preserve]** the cyanide samples in accordance with Section 12.2 *of* this plan.

After Groundwater **Sampling:**

16. **Record** sample identifications, types and amounts collected, as well as the time and date **of collection** in the field logbook **and[/or] on the** *groundwater* sampling form. Prepare chain-of-custody and analytical request **documents** as **required** in Section 12 of this plan.
17. Decontaminate sampling **equipment** if it is **not dedicated** to the monitoring well.
18. Clean up the **area** and place **disposable materials** (plastic sheeting, **gloves,** *rope)* in the **designated** drum for **future disposal** by **the Navy.**
19. Close and lock *the* well cover.

[6.3 Vacuum/Transfer Groundwater Sampling

The following groundwater sampling procedure combines developing and purging into one concurrently performed procedure and may be used at monitoring wells not requiring excessive development. This procedure is not appropriate for monitoring wells installed using mud rotary drilling techniques. Groundwater samples will be collected according to

the procedures in Section 4.9 of the USEPA SOP/QAM with **modifications** outlined **below.**

- Collect groundwater samples **as monitoring** well recharge allows.
- Collect samples **using** a decontaminated peristaltic pump with dedicated **Teflon tubing** and in-line collection/transfer bottle.
- Measure temperature, pH, specific conductance, and turbidity for ***each*** sample collected and record results in the field logbook or **on** the groundwater sampling form **(Figure** 6-1).
- Chemically preserve samples **as** specified in **Section** 12. After chemical preservation and labeling, **chill** the samples to 4°C.
- Record weather **conditions** at the time of sample collection in the field **logbook.** Refer to specific procedures for groundwater sample collection provided **below.**

Before Groundwater Sampling:

1. Don protective clothing and equipment **as** specified **in the site-specific HASP.**
2. Prepare the site by covering the ground surface around the wellhead with plastic **sheeting** and arrange the **required** sampling equipment for convenient **use.** If onsite decontamination **is required,** arrange the necessary supplies in a separate nearby location, away from the wellhead.
3. **Open** the **well** cover and immediately insert the PID or FID **into** the wellhead **to** measure ionizable **organic** vapors for approximately **1** minute. **If** vapors are detected, an interface probe **will be** used **to** determine the thickness of free product, if present. If product **is** present, a one-way ***check* ball** valve **will** be **used to** sample the layer.
4. **Measure** static water level and total **depth** of the **monitoring well to** the nearest 0.01 foot **using** an electronic water-level **indicator.** Record the **measurement** in the field logbook or **on** the groundwater sampling field form. Calculate the static water volume.

[Bold items in brackets denote changes to the first draft of document.]

5. **Insert the dedicated, decontaminated 1/4-inch-diameter** Teflon tubing down the monitoring well to immediately below the groundwater surface for purging. Connect the tubing to the peristaltic pump's dedicated, decontaminated silicon tubing. Attach the silicon tubing to the pump's intake valve. Additional silicon tubing will be connected to the pump and used as an effluent hose. All effluent will be containerized as IDW.

6. *Begin* purging the well at approximately 0.05 to 0.25 gallons per minute (gpm).

7. During purging, monitor the purge volume, time, purge rate, temperature, pH, conductivity, and turbidity. Record the measurements on the groundwater sampling form or in the field logbook. Continue purging until at least three well volumes are removed and when temperature, pH, conductivity, and turbidity have stabilized. Turn off the pump.

8. Arrange the sample containers in the order of sample collection. VOC samples will be obtained last, proceeded by BNAs, pesticides, PCBs, cyanide, and metals samples.

During Groundwater Sampling:

9. Immediately following well purging, collect the groundwater sample. Using the same peristaltic pump and tubing, connect the in-line collection/transfer bottle apparatus. The apparatus [illegible] a two-aperture Teflon cap attached to a dedicated 300 series lab[illegible]-certified, 80-ounce glass bottle. The two-aperture cap and bottle are attached to the Teflon tubing before it reaches the peristaltic pump.

10. The pump is then turned on, creating a vacuum in the collection/transfer bottle sufficient to lift the groundwater from the well and filling the bottle at a low controlled flow rate (approximately 0.05 to 0.25 gpm).

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11. Groundwater collected in the bottle is immediately transferred to appropriate BNAs, PCBs, cyanide, and metals sample containers. VOC samples will be collected using the technique provided below.
12. Turn the pump off when sufficient volume is collected to fill all containers.
13. Remove the collection/transfer bottle system from the pump system. The downhole Teflon tubing is then connected to the pump and inserted in the monitoring well. Turn on the pump at a low flow rate and allow the monitoring well to be purged for approximately 1 minute.
14. Disconnect the Teflon tubing from the pump and remove it from the monitoring well.
15. Allow the unagitated groundwater volume retained in the line to flow backward into 40-milliliter VOA vials.
16. Samples collected for total metals analysis will not be filtered.
17. Add preservative (if needed), cap, seal, and properly label all containers. Place the filled containers in the cooler(s) immediately and preserve to 4°C.
18. If the free chlorine or sulfide spot checks are positive, preserve the cyanide samples in accordance with Section 12.2 of this plan.

After Groundwater Sampling:

19. Record sample identifications, types and amounts collected, as well as the time and date of collection in the field logbook and/or on the groundwater sampling form. Prepare chain-of-custody and analytical request documents as required in Section 12 of this plan.
20. Decontaminate sampling equipment if it is not dedicated to the monitoring well.
21. Clean up the area and place disposable materials (plastic sheeting, gloves, rope) in the designated drum for disposal by the Navy.
22. Close and lock the well cover.]

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7.0 SEDIMENT/SURFACE WATER *SAMPLING* PROCEDURES

7.1 Labeling Sediment/Surface Water Sample Collection Points

Sediment and surface water sample collection points will be labeled according to site, media sampled, and unique number, For example, if a sediment sample were collected at location 06, Site 42, the location would be labeled "42M[06]." Another example: if both a sediment and surface water sample were collected at location 12, Site 41, the location would be identified by "41M12" and "41W12," respectively.

7.2 Sediment Sampling

[Sediment will be sampled] in accordance with Section 4.8 of the 1991 USEPA SOP/QAM. The USEPA SOP/QAM lists several acceptable sampling techniques (dredging, scooping, coring) for collecting sediment samples from surface water bodies and *dry* land areas depending upon sampling objectives. [Sediment samples generally will be collected to a maximum depth of 6 inches.] Several general sampling precautions must be followed to provide a representative sediment sample and to minimize disturbance regardless of sampling technique.

General Sediment Sampling Precautions:

- Avoid sediment plumes and density currents.
- If sediment and surface water samples are to be collected at the same location, collect the surface water first.
- Sediment sampling locations may be accessed by wading or by boat, depending upon water depth and the [substrate's] nature. If wading to *the* sample location, approach from downstream to minimize sample disturbance.

Specific procedures for sediment sampling by dredging, *coring,* and scooping are discussed below. Any variations from the procedures will be discussed in the site-specific *SAP*.

7.2.1 Dredge Samples

A Ponar *grab* sampler will be used to collect [underwater] dredge samples. The Ponar sampler is a steel, clam-shell type scoop activated by a [cantilever] system. procedures for operating the Ponar *grab* sampler are provided below.

Before [Dredge] Sampling:

1. Don personal protective clothing and equipment as required inthe site-specific HASP.
2. Lock open the decontaminated sampler['s jaws].

During Dredge Sampling:

3. Lower the sampler into the sediment.
4. Release tension on the rope and close [the sampler's] jaws.
5. Retrieve the sampler and open the jaws to collect the sediment sample.
6. [To collect the VOC sample, either push a stainless-steel sleeve into the *dredge* sampler and *cap* or release the sediment sample into a stainless-steel bowl, and immediately collect the VOC samples.] Fill the sample containers to capacity to achieve zero headspace.
7. Repeat the sample collection process [(Step 3 to 5)] until enough volume has been collected to make the necessary composite samples. Homogenize the [material in the stainless-steel bowl in accordance with SOP/QAM procedures] and place in *appropriate* sample containers, using stainless-steel implements.
8. Describe lithology of sample collected and [sample collection] depth in the field logbook.

[Bold items in brackets denote changes to the first draft of document.]

After Dredge Sampling:

9. **[After completing sampling], decontaminate all** equipment in **accordance** with Section 11 of **this** plan.

7.2.2 Core Samples

Coring is a useful sampling **technique** because it **preserves any** sequential layering of **the** sample and provides a **historical** profile. In **addition,** coring **minimizes** sediment **disturbance** caused **by** shock waves and, if **used** in **conjunction** with insertable sleeves, coring **minimizes** the cross-contamination **[risk]. [Core** samples **will be collected in areas where samples must be collected at a depth** greater **than 6 inches.]**

Coring Equipment: A Wildco-type or modified stainless-steel split-barrel push **tube** sampler with **a [2-inch** diameter,] 2-foot long sample barrel will be **used.** These devices will **be used** with or without insertable 12-inch or 6-inch **Teflon** or stainless-steel **sleeves.** If **sleeves are to be** used to **collect analytical** samples, a **second core** will be **collected** *at* the **location** *without* sleeves for lithology description. In the **offshore environment, extension rods** will **be used to** collect samples in water deeper **than wading depth.** procedures **for** sample **collection using** the **coring** devices **are** described below.

Before Core Sampling:

1. Locate the sample **collection** point on **the** site *map* **and reference** *it* **appropriately** in **the** field logbook.
2. **Don personal** protective clothing **and** equipment **as required** in the **site-specific HASP.**
3. Place **a decontaminated** stainless-steel sampling sleeve inside **the decontaminated** sampler.

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During core Sampling:

Note: [Except for VOA samples, all] samples collected in sleeves will be composited [and] homogenized [before] laboratory analysis.

4. Drive the full length of sample- into the substrate.
5. Carefully remove the sampler from the substrate.

Samples collected with stainless-steel sleeves:

6. Remove sleeves from the sampler, minimizing [sample] disturbance.
7. Immediately install Teflon septa over the [liner] ends and seal each end with [a] PVC cap.
8. These cores will be submitted to the laboratory for analysis [in accordance with the site-specific SAP].

Samples collected without stainless-steel sleeves:

9. Extract sediment from the sampler and immediately fill the VOC container. Be sure the sample container has zero headspace.
10. Remove the remaining sample volume and place m a stainless-steel bowl. Homogenize the sample [in accordance with SOP/QAM procedures] with a stainless-steel spoon or spatula.
11. Fill the remaining sample containers.
12. Label the samples and preserve to 4°C. Mark top of the sample on outside of the liner.
13. Repeat above sampling procedures for a second 24-inch core *without* the sleeves. This core will be examined [but not disturbed] in the field by a geologist, who will describe [sample] lithology *using* the USCS.

Special Precautions for Deep Underwater Core Sampling:

A boat will be required for sampling sediment in water deeper than wading depth. Extension rods for sampler and/or diver assistance may be required in *deep* water locations. Although sampling procedures will be the same as the procedures listed above, special precautions must be taken:

- Cap top of the sampler while it is in *the* substrate to prevent suction during extraction from extruding the sample through bottom of *the* sampler.
- When the sampler is free from the substrate, *cap* [its] bottom end before removing from the water.
- In deeper water, have a diver *cap* the sampler and assist in sampling.

After Core Sampling:

14. Decontaminate sampling equipment in accordance with Section 11 of this plan.
15. Record all pertinent information in the field logbook before leaving the site.
16. Place contaminated disposable materials in a designated drum for future disposal by the Navy.

7.2.3 Scoop Samples

Samples from sediment buildup in constructed drains, gutters, or other impervious surfaces will be acquired with a stainless-steel spoon and bowl. Procedures for scooping are provided below.

Before scoop sampling:

1. Locate the sample collection point on the site *map* and reference it appropriately in the field logbook.
2. Don personal protective clothing and equipment as required in the site-specific HASP.
3. Place clean plastic sheeting on the ground *surface* near the sample collection point to contain decontaminated sample collection equipment.

During scoop sampling:

4. Scrape the sediment surface with a decontaminated stainless-steel spoon or spatula to [uncover] a previously unexposed surface.
5. Scoop the sediment with a decontaminated stainless-steel spoon or spatula.
6. For Grab or VOC samples:
   - Completely fill the sample containers directly from the sampling device, avoiding twigs, large rocks, and grass.
   - Be sure to have zero headspace in the VOC sample container.

   For Composite samples:
   - Empty contents of the sampling device into a decontaminated stainless-steel or Teflon-lined bowl. Collect enough [sediment] to fill all the sample containers.
   - Homogenize sample [according to SOP/QAM procedures].
   - Place mixture into the appropriate containers.

   For Toxicity samples:
   - Empty contents of the sampling device into appropriate container.
   - collect sufficient [sediment] to fill all the sample containers.
7. Secure container with Teflon-lined cap.
8. Label each sample container with appropriate information.

After scoop sampling:

9. Place the samples in a cooler and preserve to 4°C.
10. Record pertinent information in the field logbook.
11. Place contaminated disposable materials in the designated drum for disposal by the Navy.
12. Decontaminate sample equipment in accordance with Section 11 of this plan.

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7.3 Surface Water Sampling

Surface water sampling will be conducted **[according to] Section 4.8** of the USEPA SOP/QAM. The sample will be collected either by placing the sample bottle in the **surface** water body or by using a Kemmerer sampling device. After selecting sample locations, the number of samples to be collected will depend on the following criteria:

- water depth
- estuarine or fresh water
- tidal influence
- salinity profile
- type of water body (lake, *stream*, impoundment, or wetland).

Where the water **[is deeper than] 3 feet, [surface water quality parameter measurements (e.g., dissolved oxygen, temperature, pH, conductivity, salinity, and depth) will be collected at the following depths: 1 foot below the water surface, mid-depth, and 1 foot above the bottom.]**

General Surface Water Sampling Concerns:

- Collect samples from areas of **least [to greatest] contamination** and from [upstream] to downstream.
- Approach surface water sample locations from **downstream to minimize** sediment disturbance.
- Collect samples **[so as]** to **minimize agitation** of underlying sediments.
- If surface water samples and sediment samples **are** *to* be collected at the same location, collect the surface water sample first.

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- Determine the number of sample collection depth at the sample location.
  - If water is less than 1 foot deep, collect one sample at the surface.
  - If water is [deeper] than 1 foot [but] less than 10 feet deep, the sample shall be collected at mid-depth unless the salinity profile indicates the presence of a halocline (salinity stratification). If a halocline is present, a surface water sample shall be collected from each stratum.
  - If water is [deeper] than 10 feet, collect samples at 1 foot depth, mid-depth, and 1 foot above the bottom.

Surface water sample collection procedures for both submerged bottle and Kemmerer devices are discussed below.

7.3.1 Submerging Laboratory Bottle

Submerging the laboratory bottle is feasible only for surface water sample locations accessible by wading. If samples are to be collected from more than one depth, or if the sample location is not accessible by wading, another method should be used.

Before Sampling with Laboratory Bottle:

1. Locate the sample collection point on a site map and describe in the field logbook.
2. Don personal protective clothing and equipment as required in the site-specific HASP.

During Sampling with Laboratory Bottle:

3. point open end of vials upstream. Slowly submerge unpreserved VOA vials completely and fill. Do not disturb bottom sediments. If the sample is to be collected at depth, uncap the bottle at the required sampling depth. Recap containers before returning bottle to the surface.
4. Cap the VOA vial under water. Be sure to have zero headspace before sealing [it].

[Bold items in brackets denote changes to the first draft of document.]

5. If VOA vials are pre-preserved, collect surface water samples [with] a decontaminated glass or stainless-steel device and carefully decant into VOA vials.
6. Slowly submerge other unpreserved bottles into the surface water and fill. If the sample is to be collected at depth, uncap containers at the required depth and allow to fill. Recap the containers before returning sample to the surface.
7. Chemically preserve the samples as needed and seal with Teflon-lined caps.
8. Collect additional surface water in the sample collection device for field measurement of pH, temperature, and conductivity. If the sample interval is at depth, probes will be used to measure these parameters. Other parameters may be added as required in the site-specific SAP.

After Sampling with Laboratory Bottle:

9. Place bottles in cooler and preserve to 4°C.
10. Note pertinent sampling information, including the tidal phase, in the field logbook.
11. Decontaminate all sampling equipment in accordance with Section 11 of this plan.

7.3.2 Kemmerer Sampler

Use a Kemmerer or similar sampling device when samples are needed at discrete intervals in a vertical water column. A Kemmerer is a cylinder with Teflon stoppers on the ends. The [Teflon] stoppers are open while the device is being lowered in a vertical position, [allowing water to pass freely] through the cylinder. When the Kemmerer has reached the designated sampling interval, a weight (messenger) is dropped down the rope to close the device. Specific procedures for surface water sampling with a Kemmerer sampler are provided below.

Before Kemmerer Sampling:

1. Locate the sample collection point on a site map and describe in the field logbook.
2. Don personal protective clothing and equipment as required in the site-specific HASP.
3. Determine the number of sample collection depths at the sample location.

During **Kemmerer Sampling:**

4. Lower the decontaminated **Kemmerer device to the designated depth.**
5. **Drop** a messenger down the **rope** to **close** the cylinder.
6. **Raise the** Kemmerer device.
7. Immediately **fill** VOA vials. **Make sure [then is]** zero **headspace,** chemically preserve **the** sample **if** needed, **and secure with** a **Teflon-lined** *cap.*
8. **Fill remaining bottles. Continue** to collect **sample [volume from each]** designated **depth until** all bottles are **filled.**
9. Measure field parameters **of** pH, temperature, **and** conductivity **and record** in **the** field **logbook** at each **sample depth.**
10. Repeat **procedure for each designated** sample **interval.**

After Kemmerer Sampling:

11. **Place bottles in** cooler and preserve **to** 4°C.
12. **Note** sampling information **in** the **field logbook.**
13. **Decontaminate** all sampling equipment **in accordance** with **Section** 11 **of** this plan.

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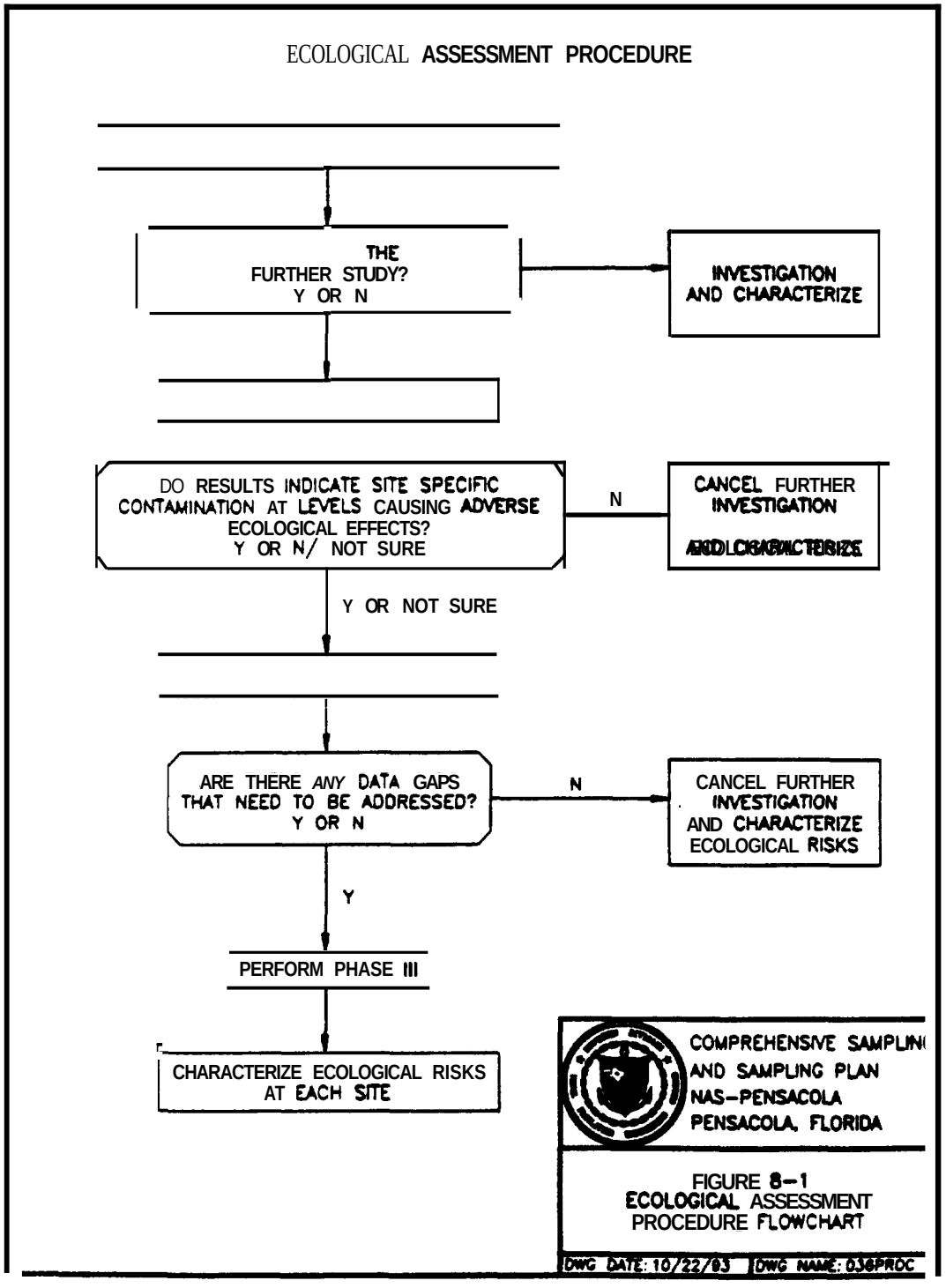
8.0 ECOLOGICAL ASSESSMENT

The objective of the ecological assessment is to develop a qualitative and quantitative appraisal of the actual or potential effects [from site contamination] on the ecosystem. Information gathered from this assessment will be incorporated into an ecological risk assessment to quantify any current and future effects [from all sites, terrestrial and aquatic. For the larger sites, 40 through 42, only those portions suspected of being impacted by an identified RI site will be investigated during the ecological assessments].

The ecological assessment approach at each site is divided into three phases. The goal of each phase is to yield specific information about the site through source, pathway, and receptor identification. The first phase concentrates on reviewing [each] site through primarily qualitative information and developing a sampling strategy for Phase II of the investigation. Phase II involves gathering specific quantitative data about the site that *can* be compared with the qualitative data from Phase I. Phase III is planned in *case* there are any outstanding data needs after Phase II is completed. Information from all phases will be incorporated into an ecological risk assessment at each site to measure or estimate current and future effects on the ecosystem. A flowchart describing the entire ecological assessment is included as Figure 8-1.

wetlands are given a high priority because they are recognized as a valuable ecological resource and are useful as wildlife habitat and spawning areas. They are also beneficial for filtering contaminants and in flood control. Consequently, since wetlands are a likely area of contaminant migration and deposition they are] given high priority when evaluating ecological effects at each site. Because of their unique attributes, the ecological assessment procedures at the wetlands vary from procedures used in upland areas. However, most sites at NAS Pensacola contain both wetland and upland areas while some axe exclusively upland. In these cases, the assessment [methods are] modified for upland areas only. The [methods are]



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also modified for Pensacola Bay and Bayou Grande. Although wetlands, uplands, Pensacola Bay, and Bayou Grande have varied protocols, they will all be studied using the same basic approach. The only variations in protocol are based on the [sampling methods for] each site. **[These]** will be explained as they am encountered during this sampling plan.

8.1 Phase I — Habitat and Biota Survey

Phase I is a qualitative survey of the site to identify **[its]** basic biological characteristics and how they may relate to contamination. It is also important during Phase I to **[prepare a conceptual model and]** develop a sampling strategy for Phase II of the ecological assessment at each site, both upland and wetland areas. Phase I data will be used with the results from Phase II to provide an integrated ecological assessment.

Because there is no standard **[protocol]** for conducting the habitat and biota survey, the ecologist(s) will use the general biological survey methods outlined in Section 8.3 of ***Ecological Assessment of Hazardous Waste Sites: A Field and Laboratory Reference*** **(USEPA/600/3-89/013).** Specific approaches will vary based on habitat type, size, and diversity. Other procedures performed during Phase I am described below.

Phase I will begin with a review of all relevant site data, including data from previous investigations, topographic maps, aerial photographs, and any other information about the site and its history. Many studies have been performed at NAS Pensacola by the USEPA, E&E, and others. The Navy is currently performing investigations throughout NAS Pensacola. Where possible, data from these investigations will be used to supplement or replace data planned **[to be collected]** as part of each site ecological investigation. **[These additional data and other relevant information** will **be included as an appendix to** *each SAP* **for Sites 40 through 42, which will be written after the Phase I portion of the investigation.**

8.1.1 Previous Data Review

At many of the terrestrial sites and several of the wetlands, data from chemical analysis have already been collected. During Phase I, this data will be reviewed to determine whether there is enough information about the nature and extent of contamination to quantify risk. If there is not enough data, additional sample locations will be proposed for Phase IIA to address any data gaps.

If there is enough data available to perform a risk assessment, E/A&H will review the data in relation to reference conditions to determine whether the constituents detected are site specific. If the constituents are determined to be site related, concentrations will be compared to ARARs, screening values and human health risk-based concentrations. Literature searches will also be conducted to help determine exposure and effects levels and fate and transport of that contaminant. Specific literature to be reviewed will include results from toxicity tests and bioaccumulation studies to determine which contaminants, and associated concentrations are of concern.

Modeling may also be performed to help quantify the bioavailability, potential migration, and impacts of that constituent to the food chain based on the conceptual model. Literature searches will also be performed to establish bioaccumulation potential and food chain impacts of particular co ' 'nants. This information can also be useful in the selection of measurement and assessment endpoints.

If it is determined that there is minimal risk through exposure and effects, or if risk can be quantified, no further investigation will be necessary. However, if it is not possible to adequately quantify risk and impacts are suspected, further data may be collected in Phase IIB and possibly Phase III.

8.1.2 Conceptual Model Development

The conceptual model will be based on site-specific information such as known or potential contaminants and potential receptors. The conceptual model will outline the primary and secondary release and exposure mechanisms associated with physical contaminant migration and contaminant migration through the food chain. Primary release mechanisms are anticipated to occur from contaminant migration through soil, groundwater, and surface water. Primary exposure mechanisms are anticipated to be from organisms living or feeding in contaminated media. Secondary exposure mechanisms are anticipated to occur from bioaccumulation through the food chain in higher order species. Exposed biota can continue and often accelerate the transportation process through the food chain.]

The above pathway information *can* be refined into the design of a more accurate sampling approach as data becomes available from the current investigations at several of the JR sites. The general procedure for accomplishing this objective is outlined in Section 4 of this work plan.

8.1.3 Measurement and Assessment Endpoint Selection

Measurement and assessment endpoints, the expressions of actual environmental values to be measured and protected, must be evaluated. [These endpoints are based on the conceptual model and reflect key exposure and *effects* pathways shown in the conceptual model]. If these endpoints are suspected of being impacted, further study and possible remediation may be needed. For example, a site within a developed area surrounded by buildings [may result in minimal exposure to any measurement or assessment endpoint.] However, if contamination from this site is suspected of having spread into an ecologically sensitive area, [the likelihood of impact to a measurement or assessment endpoint would probably be greater. The site visit will be an integral part of determining the assessment endpoints.]

8.1.4 Site Visit

After all relevant data about the site have been reviewed, [a site visit will be performed.] A qualified ecologist who is experienced in *assessment* procedures and familiar with the flora and fauna of the Pensacola area will accompany personnel on the initial visit to NAS Pensacola. The ecologist will identify common plant communities [and] sensitive resources [as well as] assess the probability of threatened *or* endangered species within the area. The ecologist then will observe how the ecosystem appears to be affected by any *site-specific* contamination by noting any anomalous features such as stressed *or absent* vegetation [or any unexpected fauna], unusual odors, colors, or *stains.* Reference areas will also be identified as a basis for comparing each *site.* They will be close to the *site,* and *similar* in habitat, topography, geology, and hydrology. The reference areas will have no apparent impacts from the site(s) or other sources of contamination based on field observations and a historical study of the area. *Once* identified, a particular habitat may *act* as a reference area for several sites.

8.1.5 Wetland Delineation Procedures

[This section pertains only to those wetlands found to be impacted by one of the terrestrial sites requiring an RI/FS or identified as a reference wetland.] Before an accurate *strategy can* be devised for sampling a wetland, its boundaries [may] be delineated. An initial study of wetland boundaries *at* NAS Pensacola was published by Parsons and Ruitt (1991). The scope of their investigation, however, did not include sufficient detail required to perform an ecological assessment. Wetlands identified by Parsons and Ruitt and those discovered subsequent to their investigation will be [more accurately delineated]. After these wetland types and boundaries *are* known, a more accurate sampling strategy *can* be devised to assess environmental impact. The wetland delineation procedure is included in Section 8.5.

8.1.6 Sediment Mapping

This section pertains to those sites with associated wetlands, Pensacola Bay, and Bayou Grande. At these areas, it is important to map the sediment depth and overall distribution of grain size and total organic carbon in the sediments. After [the sediment is mapped], it [may] be possible to judge where contaminants and organisms may be *concentrated.* It [also] will be possible to determine the areas with the highest probabilities of contaminant bioaccumulation and overall ecological [impact. Because of the presumed homogeneous sediment distribution within the wetlands, samples for sediment distribution analysis will be collected during Phase IIA. Because of its wide variability and impact on subsequent sampling locations, sediment distribution analysis within the Bay and Bayou will be performed during Phase I.] This procedure is included in Section 8.6.

8.1.7 Sampling Strategy

After site wetland boundaries and sediment distribution have been identified and mapped, it will be possible to accurately establish sampling locations for the entire site, both wetland and upland. The actual sampling will be performed in Phase II. However, it is important to plan the sampling strategy during Phase I. [At many of the terrestrial *sites,* sampling already has been completed during the RI investigations. After reviewing this data during Phase I, sampling for the ecological assessment may not be necessary and the investigation can move directly into the next phase. These decisions will be made on an individual site basis.]

The initial sampling locations at each site will focus on areas where contaminants are suspected to accumulate, [also called] hot spots. These will be primarily based on surface features, drainage patterns or fine-grained sediment distribution where contaminants are most likely to be located. If, at a later point in the investigation, it is determined hot spots may *exist* in other areas based on other factors, those areas [also] will be sampled. If the hot *spot* samples exceed

[reference concentrations] and a particular benchmark for either surface water, soil, ,or sediment, then those areas may be [subject to additional sampling] during Pbase IIA. [These additional sample locations will be biased, surrounding the particular hot spot. The goal of focused sampling will be to characterize the extent of contamination in the media of concern.]

818 Phase I Results

After Phase I is finished, *site* history, [the conceptual model, endpoint selection, previous sample results], wetland boundaries, general [site and] ecological conditions, should be known in sufficient detail to develop an accurate Phase II sampling *strategy*. It is possible at any given site [or a portion of Sites 40 through 42,] Phase I will not need to be completed in its entirety. If site history and the initial visit do not reveal any likelihood of site-specific ecological effects or [significant endpoint exposures, the investigation may be] discontinued. However, at areas having possible contamination and ecological resources worthy of protection, Phase 11 will be implemented [following] the Phase I assessment.

8.2 Phase II — Ecological Sampling

In order to establish a link between any observed effects and possible contamination noted in Phase I, Phase II sampling [may] be required. Phase II is divided into Phase IIA [,the exposure assessment, and Phase IIB [,the effects assessment]. Phase IIA includes sampling for [the stressors of concern at NAS Pensacola, or] chemical constituents only. [The goal of Phase IIA, unique from Phase I, is to characterize the extent of contamination in the media of concern.] If the results of Phase IIA reveal no evidence of site-related contamination above [reference concentrations] and a given benchmark, then the investigation will *end* [here]. However, if contaminants are above [reference concentrations,] the benchmark[, and are suspected of *causing* an ecological impact based on Section 8.1.1], then Phase IIB [may] be

implemented. Phase IIB [uses] diversity studies and toxicity tests to refine ecological impact [assessment through quantifying ecological *effects.*

All sampling for Phase IIA will be conducted in accordance with the protocols listed in Section 4 and Section 7 of this CSAP. [The minimum number of sampling techniques possible will be used when sampling any media.] Samples within the wetlands, Pensacola Bay, and Bayou Grande shallower than wading depth and all upland samples will be collected using stainless-steel hand augers. All sample locations deeper than wading depth will be taken using Ponar dredges.

8.2.1 Phase IIA — Chemical Parameters

Selected soil, sediment, and surface water locations within each site and their reference areas [initially] will be sampled for the presence of contaminants according to the site-specific *SAP.* Soil samples will be collected from 0 to 12 inches below [the surface] and sediment samples will be collected from 0 to 6 inches below the substrate. These samples [initially] will be collected from areas of suspected release and locations identified by using information developed during Phase I. Once these results are known, contaminant [concentrations] *can* be compared with reference areas and existing benchmarks, [similar to the procedure described in Section 8.1.1. This comparison will] help determine the likelihood of site-specific ecological impact and the need to [further characterize] the extent of contamination. Contaminant transport and uptake modeling *can* also be performed to determine how that contaminant may impact the food chain and help determine strategies for further investigation.

[Because there are no published ecologically-related benchmarks for soil contaminant levels, evaluation of these levels will be done using a more qualitative approach. Specifically, Contaminant concentrations in the soil will be compared to two times reference concentrations, for inorganic compounds only, to establish whether that constituent is site-

related. If the organic or inorganic constituent is site-related, *general* distribution of that constituent and frequency of detection will be evaluated to help determine whether that constituent is widespread or localized. If that constituent is considered to represent a risk based on its frequency, distribution, and toxicological effect, further study may be performed to determine the possible mode of action of that constituent and impacts to endpoint species. If it is determined that a threat may *exist,* further study may be necessary in the form of contaminant transport and uptake modeling. Toxicity tests and bioaccumulation studies, described m Sections 8 3 3 and 8 3, may also be performed to further quantify impact.]

8 3 3 Phase IIB — Diversity Studies

When necessary, species diversity studies will be performed on macroscopic organisms within the [appropriate media] of each *site* and a corresponding reference area. [Because of seasonal variations, quarterly diversity studies will be performed in each reference area. This will ease the burden of seasonally coordinating diversity studies for a particular site with its reference area.]

Benthic macroinvertebrates — often serving as the primary food source for higher trophic level species — living in the sediment will be used for testing. [In *sites* 40 through 42] they are abundant, relatively stationary, and serve as continuous monitors of the [site's] ecological health. In offshore areas and wetlands with enough standing water to support benthic organisms, samples will be taken using a Ponar dredge *(see* Section 8.7). These samples will penetrate the upper [6] inches of the sediment. All *species* will be [counted and] identified to *at* least the genus level. This procedure is adapted from the 1989 version of *Standard Methods for the Examination of Water and Wastewater* (p. 10-95 through 10-109). Diversity will not be [studied) on organisms within the surface water because of *the* highly variable nature of surface

water populations due to precipitation, tides, and other non-site-related influences. Organisms in the sediment provide a more accurate representation of the [site's] ecological health and are easier to compare with a reference area.

In upland areas or wetlands having little to no standing water to support benthic organisms, diversity studies will not be performed because of the lack of species diversity in the naturally sandy soil of the area. **[Toxicity tests** will **be emphasized in areas suspected of having naturally low diversity.]**

8.2.3 Phase IIB — Toxicity Tests

Toxicity tests *can* help establish a quantitative link between the diversity studies and any toxicological effects on organisms. Toxicity tests measure the effect of contaminated media on the survival, growth, and/or reproduction of aquatic and terrestrial organisms. These tests provide an integrated index of the bioavailable toxic contaminants *at* the sites **[through quantifying exposure and effects].**

Selected test organisms *are* chosen based on their wide acceptance in laboratory analysis and the wealth of information available about their behavior. Organisms were chosen for toxicity testing based on their representation of different trophic levels, *ease* of study, and the available information about their behavior patterns. Table 8-1 shows the organisms initially chosen to be analyzed in the media of concern. The organisms will be lab-cultured and will be directly exposed to the water, sediment, and soil during the tests. **[Other organisms may be chosen depending on site-specific conditions.]**

Table 8-1
Organisms Chosen for Toxicity Tests

Type of Media	Organism Chosen	Common Name
Marine Sediment	*Ampelisca abdita* *Mysidopsis bahia*	Marine Amphipod Mysid Shrimp
Marine Surface Water	*Menindia berrylina* *Mysidopsis bahia*	Silverside Minnow Mysid Shrimp
Freshwater Sediment	*Hyalella azteca* *Chironomus tentans*	Freshwater Amphipod Chironomid Midge
Freshwater Surface Water	*Ceriodaphnia dubia* *Pimephales promelas*	Water Flea Fathead Minnow
Soil	*Eisenia foetida* *Latuca sativa*	Sludge Worm Lettuce Plant

The use of sediment, soil, or surface water in each toxicity test depends on the type of contaminants suspected in the area sampled and the amount of available surface water. Due to the uncertainty of the contaminants at NAS Pensacola, samples will be collected from both the sediment and the surface water (if available). In areas not having standing water, samples will be collected from the soil. All sampling for the toxicity tests will be collected in accordance with the protocols listed in section 4 and Section 7 of this CSAP.

[Information from the toxicity tests am be used to help quantify impact and should be viewed in relation to the literature reviewed in earlier phases. If there are other potential effects that may not show themselves during toxicity analysis, further study may required in Phase III.

Seasonal variations should not affect the results of toxicity tests. Each reference location sampled during the Phase IIB sampling event will serve as an adequate control for its

[Bold items in brackets denote changes to the previous draft of document.]

respective area of concern. If additional toxicity testing is required during Phase III, additional reference samples will be collected.]

8.3 Phase III — Assessment of Bioaccumulation

Phase III of the ecological assessment is needed in case Phases I and II do not yield sufficient information. **[The goal of Phase III, different from** Phase **II,]** involves a more refined determination of whether contaminated media are either toxic to organisms or bioaccumulating in the food chain. Phase III tests may be performed if further information is needed to gauge the **[site's]** ecological impact. The potential infoxmation gained from these tests must be weighed against time and expense.

The test organisms selected for Phase 111 Assessments will vary from site to site, depending on the types of organisms living in and around the particular area in question. [Analyses **will involve bioaccumulation studies or more refined toxicity tests to determine the contaminant which may be the cause of ecological impact.]** The selected **organisms will be** identified during the habitat and biota survey and diversity studies. Specific procedures for sampling and testing individual **organisms** vary and will **[follow]** established **USEPA** and ASTM guidelines. Appropriate sampling methods and test **organisms** will be selected based on the results of the previous studies and consultations with the contracted laboratory.

8.4 Risk Characterization

After all relevant site data have been assimilated, ecological risk *can* be **characterized.** Ecological risk assessment has not yet evolved to where **standard risk [can be calculated,]** as in human health risk assessments. Much more professional judgment **[is]** involved. The principal goal of the ecological risk assessment is to determine whether adverse effects are occurring or will occur as a result of contamination associated with a site. Important issues to

be addressed include [assessing] exposure, [quantified in Phase IIA], in relation to] the observed or predicted ecological effects [in Phases IIB and III] and their type, extent, and severity. [All impacts should be viewed in relation to the conceptual model and measurement and assessment endpoints.]

Uncertainties should be summarized and their ecological *significance* interpreted. [It is likely that results or aspects of the conceptual model or endpoint *species* will not be certain. Sources of this uncertainty should be described in detail to enable the risk manager to make a more informed decision about remedial options.]

The potential for natural recovery [a b] should be addressed to help base decisions for remedial action and mitigation. [All decisions concerning remedial options should be viewed in relation to the possible impact caused by remediation versus taking no further action.]

8.5 Wetland Delineation Procedures

In defining a wetland and its boundaries, three criteria must be met: hydrophytic vegetation, hydric soil, and wetland hydrology. The following abbreviated method, adapted from the *Corps of Engineers Wetland Delineation Manual* (1987) will be followed by all field biologists at NAS Pensacola. Adequately characterizing the wetlands to develop an accurate sampling approach for Phase II will be emphasized over performing a jurisdictional delineation.

8.5.1 Hydrophytic Vegetation

Hydrophytic vegetation is defined as total Visible plant life growing in water, soil, or on a periodically inundated substrate at a duration [that] exerts a controlling influence on all plant species present. During wetland delineation, the percentage of plant species dominating the community, or the percent dominance, will be emphasized over individual species. This is

because plants commonly associated with wetlands could be scatted about an upland area. Similarly, species *not* associated with wetlands could be scattered about wetland areas.

Hydrophytic vegetation will be assumed in areas where 50 percent or more of the dominant species have the wetland indicator status of obligate wetland species (OBL), facultative wetland species (FACW), or facultative neutral species (FAC). Plants will be identified through taxonomic references or by qualified biologists familiar with local vegetation. Once the species have been determined, their wetland indicator status can be determined by consulting the *National List of Plant Species that Occur in Wetlands: 1988 National Summary* (U.S. Department of the Interior, 1988).

Determining percent dominance involves analyzing four strata: trees, saplings/shrubs, herbs, and woody vines. For the tree strat[um], each species occurring within a 30-foot radius of a selected observation point is noted. A tree is defined as any non-climbing, woody plant with a diameter at breast height (DBH) of at least 3 inches, regardless of its height. The percent dominance of a species is determined by comparing the approximate crown area of each species (with] the total crown area of all species. If the tree species making up at least 50 percent or greater of the crown area are OBL, FACW, or FAC, then the tree strata will be considered hydrophytic.

For the sapling/shrub strata, each sapling or shrub within 10 feet of the same selected observation point will be identified. A sapling/shrub is any woody plant at least 3.2 feet high with a stem diameter less than 3 inches, except for woody vines. Species will be ranked in descending order of dominance based on number and heights of all individual species found in the sample plot. If the species making at least 50 percent of the total height classes are OBL, FACW, or FAC, then the sapling/shrub [stratum] is considered hydrophytic.

Herbs are plants less than 3.2 feet high with a DBH less than 3 inches, exclusive of woody vines. When evaluating the herb *strata,* make a 1.64-foot radius plot from the same observation point. Estimate the percent cover for each of the herbaceous or woody seedling species having foliage within the study area. If the species making up at least 50 percent of the crown area are OBL, FACW, or FAC, then the herb strata is considered hydrophytic.

For the woody Vine [stratum], all woody vines within 10 feet of the same observation point will be identified by counting the number of stems of each woody vine at ground level. If the species making up at least 50 percent of the total number of stems are either OBL, FACW, or FAC, then the woody vine [stratum] is considered hydrophytic.

All four strata, if present, must be hydrophytic for the area to be classified as having hydrophytic vegetation. Note the same species might be considered in different [stratum]. For example, a mature oak tree may be considered in the tree [stratum], an oak sapling may be considered in the sapling/shrub [stratum], and an oak seedling may be considered in the herb [stratum]. The above procedure is only one of many to determine relative dominance of plant species. This procedure may not be *necessary* in [stratum] where one plant clearly dominates or when no plants or a limited number of plants in a particular [stratum] are present. Professional judgment should be used when determining how to modify this procedure when calculating relative dominance.

8.5.2 Hydric Soil

Hydric soil is saturated, flooded, or ponded long *enough* during the growing season to yield anaerobic conditions in the upper portion favoring the growth of hydrophytic vegetation. Often, county soil maps will show predominant soil types in the area of study, including hydric soil.

Hydric soil typically is poorly drained and shows evidence the water table was or is within 18 inches of the surface at least one week during the growing season. However, hydric soil may be drained and not support hydrophytic vegetation. Therefore, not all areas having hydric soil will qualify as wetlands. The soil be classified as a wetland soil only when it supports or would normally support hydrophytic vegetation and the area has indicators of wetland hydrology.

Many indicators [are] used to determine the presence of hydric soil, such as physical and chemical characteristics, soil staining, and soil colors. Soil color, which is strongly influenced by the frequency and duration of soil saturation leading to reducing soil conditions, is often the best indicator of hydric soil. Typically, gleyed soil (gray) or soil that has a matrix chroma (an index of soil color) of 2 or less is considered to be hydric soil. A Munsell soil color chart will be used to determine matrix chroma of suspected hydric soil. The Corps of Engineers Wetlands Delineution *Manual* will be used to determine unique conditions pertaining to a particular site and exceptions to those and other rules.

Much of the soil at NAS Pensacola is sandy. In areas containing predominantly sandy soil, there are separate criteria for determining hydric soil. In most of these sandy conditions, soil color may not be the best indicator. However, other indicators *can* be used including high organic matter content in the surface, streaking of subsurface layers, and layers of hardened organic matter within 12 inches of the surface.

8.5.3 Wetland Hydrology

Wetland hydrology encompasses all hydrologic characteristics of areas periodically inundated or saturated to the surface at some time of the growing *season.* Hydrology is the most important characteristic in defining a wetland. The presence of water for at least seven days during the

growing season typically creates the anaerobic conditions giving wetlands their unique characteristics.

Generally, the well-drained sandy soil of the Pensacola area has wetland hydrology when the watertable is less than 12 inches from the surface for at least a week during the growing season. If wetland hydrology is not present at the time of the investigation, various field indicators can be used to determine whether wetland hydrology existed at one time during the growing season. Common indicators are watermarks on nearby trees and other vegetation, lines of debris deposited during high water, sediment deposits, or drainage patterns within a wetland. It is also advisable to speak with people familiar with the area or consult topographic or floodplain maps to determine how often the area may be inundated.

8.5.4 Atypical Situations

Based on aerial photographs of NAS Pensacola, much of the base has been recently disturbed by human activities. In several locations, vegetation has been recently planted, which presents three major problems in delineating wetland boundaries. First, native vegetation has not had adequate time to re-establish itself. Plant species introduced into the area could be wetland indicator species even though the area has not been confirmed as a wetland. Second, these recently planted areas were devoid of vegetation in the recent past. Sandy soil, common in the Pensacola area, may not have organic deposits or horizons indicative of hydric soil. Third, sandy soil drains very well, making the identification of wetland hydrology very difficult.

When human activities have hindered the identification of wetlands, specific guidelines to determine their boundaries are listed in the *Corps of Engineers Wetlands Delineation Manual*. The first goal should be to establish exactly what the disturbance was and what effect it had on the area, followed by review of aerial photographs and other sources to determine what the area

looked like in the past. It may be necessary to find an undisturbed reference area nearby to aid in this determination. Once an idea of past conditions has been determined, it may be possible to delineate wetland boundaries based on indicators existing before the alteration.

8.5.5 Delineation Conclusions

The abbreviated procedure described above does not have to be followed when delineating the entire boundary of a wetland. General trends in areas analyzed *can* be applied to all areas of the wetland. However, areas appearing different or suspect should be analyzed using the method outlined in this section. Common trends used in delineating wetland areas includes noting general breaks in topography or patterns in vegetation diversity. After determining the areas meeting all three criteria for being a wetland, boundaries should be mapped as accurately as possible. The size and characteristics of each wetland will guide the sampling strategy for the Phase II and Phase III portions of the ecological assessment. All wetlands related to a particular site should be delineated and included in the ecological assessment.

8.6 Sediment Mapping

To adequately characterize the sediment of the Pensacola Bay and Bayou Grande, a procedure must be followed for establishing transects and sample locations. The overall goal is to develop an accurate sediment map to guide the Phase IIA sampling. If there are important outfalls or other locations deserving special consideration, emphasis should be placed on characterizing these areas more precisely.

Sediment shallower than wading depth within Pensacola Bay and Bayou Grande will be collected using a stainless-steel hand auger. Deeper locations will be sampled using a Ponar dredge. It is not likely every sample location along the transect will be sampled. Because the entire goal of this part of the investigation is to map sediment distribution, it is not considered cost-effective

to analyze a sediment sampk with no significant *change* from the previous sample. Analysis will be performed for *grain* size and total organic *carbon.* Professional judgment should be used on a site-specific basis when determining the sampling locations giving the best overall picture of the sediment distribution; however *specific* sampling locations will be presented and/or discussed in the site-specific SAPs and work plans.

At every location along the transect, depth will be noted using a depth rod. Because of the tidal fluctuation of the water bodies, depth will be measured relative to a reference location easily read at all times. Afterwards, a map will be developed showing the approximate distribution of depth, sediment *size,* and total *organic carbon* throughout the body of water. This information will be useful in determining hot *spots* to sample and the possible location of sampling zones.

Pensacola Bay and Bayou Grande Gridding Procedures

Sediment samples will be collected along previously mapped transects approximately 300 feet long. The transects will be located approximately *500* feet apart. Each transect will be sampled at distances of 0 feet, 150 feet, and 300 feet from the shore. Some of the transect locations will be biased at outfalls or other locations of surface contamination. All transects will be aligned using the GPS.

8.7 Benthic Diversity Collection Procedures

Petite Ponar Dredge

This is an efficient way to collect sediment samples for species diversity analysis and other parameters within the wetlands. The dredge typically samples the upper 6 inches of the sediment. The following procedures should be used [to collect] biota when using the dredge during the Phase II and Phase III portions of the Ecological Assessment.

Benthic Diversity Sampling **Procedure:**

1. Measure water depth in feet and record relative **to** tidal information.
2. Attach the precleaned petite **Ponar** to the necessary length **of** clean sample line.
3. Measure and mark the distance **to** the bottom on the sample line. **A** secondary mark, one meter shallower, will indicate proximity **so [the]** lowering rate *can* **be** reduced, thus preventing **unnecessary** bottom **disturbance.**
4. Open sampler jaws until latched and insert spring pin. ***At* this** point, **the** sampler must remain taught against the line or it will **be tripped** and the jaws will close.
5. Tie the **free** end of the sample line to fixed support **to** prevent loss of the sampler.
6. **Begin** lowering the sampler until the proximity **mark** is reached.
7. Slow the **rate** of descent through the last meter until contact is felt.
8. Allow the sample line to slack[en] several **centimeters to** release the closing mechanism. In strong currents, more slack may **be necessary.**
9. Slowly raise the dredge clear of the surface, letting the water **drain.**
10. Place the Ponar into a stainless-steel bowl and ***open,*** then remove the sample.
11. Perform the above until a minimum of three samples **are** taken within a minimum surface **area** of **225 square** centimeters (cm^2).
12. **Rinse** the sediments through a **No. 30 U.S.** stainless-steel **standard** screen, having openings of **0.0232** inches **(0.059** cm). If **coarser** debris remain in the screen, it may **be** necessary to place the contents into a bucket of water and ***stir.*** **The** supernatant is poured through the screen. The bottom of the bucket should **be inspected** for non-floating **snails** or other organisms.
13. Place the **collected** organisms **in** a sample **container** with a solution of formalin.
14. Send via overnight delivery to a laboratory **for** species diversity **analysis.**

[Bold items in brackets denote changes to the previous draft of document.]

In areas where soil samples will be collected, a stainless-steel spoon or spatula will be used to take samples from the upper foot.

The samples will be sent to a laboratory for taxonomic identification [and enumeration]. Samples will be collected consistently at each sample location. Therefore, the results of the analysis may be compared by an analysis of variance (ANOVA) test to determine if the populations [differ] statistically. Trends in population also [may] be assessed non-statistically.

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9.0 AUXILIARY DATA COLLECTION

9.1 Hydrolab Datasonde

The Hydrolab Datasonde 3 (DS3) Multiparameter Water Quality Dataloggers [may] be deployed to measure in-situ water quality and tidal phases m bodies of water on or near the site. The multimode device will measure [temperature,] pH, dissolved oxygen, conductivity, salinity, depth, and oxidation/reduction potential (Redox). Refer to Appendix C for Hydrolab operating procedures and to the site-specific SAPs for deployment locations.

9.2 Current Meter

A current meter [may] be deployed with the Hydrolab Datasonde surveyor to aid in physical[ly] characteriz[ing] the surface water body. The Niskin Winged Current Meter will be deployed with the DS3 approximately 2 feet above the bottom during one of the wettest and [one of the] driest months of the year (based on historical climatological data). The meter measures current by measuring the angle of tilt of its own housing when suspended from a suitable mooring. The current meter will be operated, calibrated, and maintained in accordance with the manufacturer's specifications. The operating manual for the Niskin Winged Current Meter is provided [in] Appendix D. Alkaline batteries will be used instead of the lithium battery listed in the operating manual.

9.3 Rain Gauge

Rain gauges [may] be installed near selected sites of interest to document rainfall influence on water level. Rain gauges will be [installed following] the manufacturer's specifications.

9.4 Water-Level Indicator

The static water level in monitoring wells and the depth of water at each surface water sampling location shall be measured [before collecting samples]. For monitoring wells, an electronic water-level indicator will be used. [If multiple water-level indicators are being used

concurrently, measure the groundwater level at one monitoring well using all of the water-level indicators to check the calibration.] The decontaminated probe will be inserted down the well. A tone will indicate the probe's contact with water. Pinpoint the water level by slowly raising and lowering the probe until the tone is heard consistently below and not above a specific point. Water level will be recorded to the nearest 0.01 foot on the Measurement of Groundwater Level Form provided in Figure 9-1 [or in the field logbook].

9.5 Secchi Disk

[Before collecting surface water samples, measure] water clarity at each surface water sampling location. A secchi disk attached to the end of a graduated rope will be lowered into the water. The first depth [at which] the disk is no longer visible from the surface (or when the disk touches the bottom) will be recorded in the appropriate field logbook.

9.6 Hydrogeologic Assessment

The objective of the hydrogeologic assessment is to better understand the hydrogeology underlying the site(s). The hydrogeologic assessment will include an elevation survey of newly installed monitoring wells; water-level measurements in all onsite monitoring wells and/or adjacent surface water bodies; and, as appropriate, pumping tests (single well and multiwell) and slug tests on newly installed or existing monitoring wells.

All newly installed and existing monitoring wells will be surveyed during the cadastral [or geodetic] survey. The wells will be referenced to a [common datum for elevation in accordance with NAD '83 standards]. In addition, staff gauges will be placed in the surrounding surface water bodies and surveyed relative to the same benchmark.

Figure 9-1 Measurement of Groundwater Level Form

MEASUREMENT OF GROUNDWATER LEVELS									
PROJECT NO.					DATE:				
OWNER:					BY:				
LOCATION:					METHOD OF MEASUREMENT:				
Well Number	Time	Reference Point	Elevation of Reference	Depth to Product (feet)	Depth to Water (feet)	Water Elevation	Product Thickness	Adjusted Water Elevation	Notes

[Bold items in brackets denote changes to the first draft of document.]

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Static water levels will be measured in all monitoring wells on the site complex. Water levels will be used to determine groundwater elevations for [delineating] groundwater flow direction and [calculating] the hydraulic gradient. As appropriate, and especially for low-yield wells, slug tests will be conducted. Falling-head and rising-bead slug tests will be conducted using electronic data loggers [following] the procedures provided below.

9.6.1 Slug Testing

Slug testing is a rapid and easy way to estimate the [an aquifer's] hydraulic conductivity and transmissivity. An advantage of slug testing over pumping testing in most remedial investigations is [that it produces] little or no contaminated water requiring containment and disposal.

General Procedures for Performing a Slug Test

1. Insert a decontaminated pressure transducer, calibrated to an electronic data logger, to an appmpriate depth in the well to be tested.
2. Add or remove a known volume to (or from) the well or piezometer to create a rapid rise (or fall) in water level. In most cases, a stainless-steel cylinder of known volume will be used.
3. Measure the rate of water-level recovery using the pressure transducer and data logger.
4. Graph data, in depth-time pairs, and determine hydraulic conductivity and aquifer transmissivity. A commercially available aquifer analysis will be used. Specific analytical techniques and assumptions made by the hydrogeologist will be provided in the site-specific SAP and/or the report.

Procedures for Falling-Head Slug Test

Before Slug Testing:

1. Place plastic sheeting around the wellhead. Arrange needed equipment and decontaminated materials on the sheet.
2. Put on personal protective clothing, as specified in the site-specific [HASP].
3. Open the locking and vented caps and inspect the wellhead. Note in particular the condition of the surveyed reference mark, if any.
4. Measure and record the static water level and the depth to bottom of the well. Record these data in the appropriate logbook.

During Slug Testing:

5. Check calibration of the pressure transducer at two different depths in the well. Check depths should be widely separated. Leave the transducer at the lower check point.
6. Rapidly insert slug (stainless-steel cylinder) into the water.
7. Using the data recorder, record fall in water level vs. time.
8. Continue recording depth-time data until the well has recovered to nearly static water level. When wing data recorders, check and record the reading every few minutes to ensure data are being properly recorded.

After Slug Testing:

9. Record the time of test completion in the logbook. If a data recorder with random access memory (RAM) or erasable programmable read only memory (EPROM) was used, record the file name used.
10. Decontaminate all equipment according to Section 11. Clean up the site, and close and lock the well before leaving. Take contaminated plastic sheeting and disposable protective clothing to the designated drum [for disposal by the Navy].

NOTE: Both rising- and falling-head slug tests may be carried out in the same operation by first measuring the rate of water-level fall immediately after slug insertion, then measuring the rate of water-level rise after slug withdrawal. Be sure the well has recovered to static water level before conducting the rising-head test.

Procedures for Rising-Head Slug Test

Before Slug Testing:

1. Lower a decontaminated slug (stainless-steel cylinder) of known volume into tbe well until it is fully submerged. Allow the well to re-equilibrate to Static water level.
2. Turn on the data recorder, ifused, or verify the static water level has been re-established with a water-level meter.

During Slug Testing:

3. Withdraw slug quickly, avoiding surging.
4. Using a data logger, record the rise in water level vs. time.
5. Continue recording depth-time data until the well bas recovered to nearly *static* water level. When using data recorders, check and record readings every few minutes to ensure data are being properly recorded.
6. Record time of test completion in the field logbook. If a data recorder with RAM or EPROM memory was used, record the file name used.

After Slug Testing:

7. Decontaminate all equipment. Clean up the site, and close and lock the well before leaving. Place any contaminated plastic sheeting and disposable protective clothing in a designated drum for disposal by the Navy.

Restrictions/Limitations

In wells where the static water level and water levels induced during testing are above the top of the screened or open hole interval, both rising-head and falling-head tests should be conducted to check results.

Quality Control Requirements for Slug Tests

- A pressure transducer and data logger, or strip chart recorder, must be used to perform these tests.
- Slug tests shall be performed after groundwater sampling to minimize contamination.
- All equipment must be decontaminated before each test.
- If possible, bath falling- and rising-head tests shall be performed.

9.63 Pumping Tests

Specific Capacity Tests

When possible *short-term* single well pumping tests (specific capacity tests) *shall* be completed immediately following well development, or in conjunction with purging of the monitoring wells. Results of specific capacity tests will be recorded on the aquifer test data form provided m Figure 9-2 [or in the field logbook]. The purpose of specific capacity testing is to obtain a first estimate of [the aquifer's] hydraulic conductivity. [Since this] stresses a larger portion of the aquifer near the well, [specific capacity testing] is preferable to *slug* tests.

[Before Specific Capacity Testing]

1. Place plastic sheeting around the well. Arrange needed equipment on plastic sheeting.
2. Don personal protective clothing, as required.
3. Open the locking cap and inspect the wellhead.

Figure 9-2 Aquifer Test Data

AQUIFER TEST DATA

Owner _____ Location _____
Project No. _____

Date _____ Measured By _____

Well No. _____ Distance from Pumping Well _____ Type of Test _____
Test No. _____

Measuring Equipment _____
_____

Time Data	Water Level Data	Discharge Data	Comments on Factors Affecting Test Data
Pump On: Date _____ Time _____ (t) Pump Off: Date _____ Time _____ (t') Duration of Aquifer Test: Pumping _____ Recovery _____	Static Water Level _____ _____ Measuring Point _____ _____ Elevation of Measuring Point _____	How Q Measured _____ Depth of Pump/Air Line _____	

Time	Elapsed Clock Time	Water Level Measurement	Water Level Change s or s'	Discharge Measurement	Rate	

[Bold items in brackets denote changes to the first draft of document.]

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4. Measure static water level with an electronic water-level indicator. Record water level on the appropriate field form [or in the field logbook]. If appropriate, also measure and record static water levels in adjacent wells.

[During Specific Capacity Testing]

5. Install a decontaminated pump in the monitoring well. .Allow water level to re-equilibrate.
6. Begin pumping at a constant rate.
7. Use the electronic water-level indicator to measure changes in water level during pumping. Record water levels and time of collection at the appropriate intervals on the field form [or in the field logbook].
8. Continue pumping and recording the pumping water levels until they stabilize or until purging is complete. If appropriate, measure and record water levels in surrounding monitoring wells or temporary piezometers installed near the pumping well.
9. Record the time of test completion and the final water level on the appropriate field form [or in the field logbook]. Turn the pump off.

[After Specific Capacity Testing]

10. Record recovery of water level(s) in the production well and, where appropriate, observation wells, using a water-level indicator and stopwatch.
11. Plot data on a time/drawdown graph (generally done using commercial software) to calculate hydraulic conductivity (K). Alternatively, specific capacity data can be used to estimate K using equations provided in Lohman (1972). Specific analytical techniques and assumptions used by the hydrogeologist will be provided in the site-specific SAP and/or the report.
12. Decontaminate all equipment in accordance with Section 11 of this CSAP.

13. Close and lock the monitoring well upon [completing] the aquifer test and well sampling.
14. Place all disposable items (i.e., plastic sheeting, protective equipment) and [IDW] in designated drums for disposal by the Navy.

Multiwell Pumping Tests

[In general, the investigation will contain slug and/or specific capacity test results and interpretations, sufficient for site characterization. If, after evaluation, it is determined groundwater remediation will be required and the aquifer test data are insufficient for remedial design, then they will be used to design a high volume test for remedial design purposes.] Multiwell pumping tests will be conducted [by] withdrawing groundwater at a constant, known rate from a designated production well. [If the well is capable of sustaining enough discharge to adequately stress the aquifer, then aquifer tests will be performed in the unconfined surficial zone for a minimum of 72 hours (48 hours of discharge, 24 hours of recharge), and in the underlying confined aquifer for a minimum of 48 hours (24 hours of discharge, 24 hours of recharge). A flow meter will be used during the tests to determine if the pumping rate remains constant.] During multiwell tests, water levels will be measured simultaneously in designated adjacent monitoring wells. In general, tbe tests will be based upon site-specific objectives (e.g., steady state conditions or boundary conditions). [water level] recovery in production and monitoring wells will be monitored after the pump is turned off until the water recovers to [its original level (less residual drawdown)]. Drawdown and recovery data from &pumping test will be plotted to produce time vs. drawdown graphs[, which] will be used to calculate hydraulic conductivity and transmissivity and to determine the hydraulic connection between zones. Specific analytical techniques and assumptions used by tbe hydrogeologist will be provided m the site-specific SAP, the report[, and/or appropriate deliverable documents].

[Bold items in brackets denote changes to the first draft of document.]

9.7 Radiation screening — Gamma Sources

This procedure provides guidance for the screening samples for gamma radiation sources.

Equipment Required:

- Ludlum model 3 survey meter
- Ludlum Model 44-2 gamma scintillation probe; 1" x 1" sodium iodide (NaI)
- Cesium - 137 check source

Radiation Screening Setup:

1. Check the coaxial cable for security and damage. Ensure coaxial connections are snug.
2. Conduct a battery test by rotating the multifunction rotary switch to the battery test option. Be sure the battery has sufficient charge. If battery replacement is necessary, be sure [during] disassembly and reassembly [that] gaskets are clean and properly installed [for] weatherproof operation.
3. Test survey meter and NaI pmbe response by selecting the x10 scale on the multi-function switch and holding the window of the NaI probe against the check source. The window is at the end of the cylindrical probe. The meter should read ± 15 percent of the check source. The current check source is 600 μR/hour. Any reading between 510 and 690 μR/hour is acceptable. Be sure to also note the meter calibration. All survey meters and probes will be factory-serviced and calibrated annually. If the survey meter is in constant use, the calibration schedule will be revised to [six] months.

Background Determination:

4. Select the xl scale of the multifunction switch. Hold the probe away from all known sources and make a measurement at ground surface and at [1] meter above ground surface. Do this by setting the rate switch to "S" for slow response and pushing the reset memory to clear the counting memory. Allow the count to continue for 30 seconds and

then document results. Background measurements should be conducted offsite and away from all sources.

Screening:

5. Screening samples for laboratory analysis **[should be collected]** by holding the probe against the container, resetting the survey meter, and counting the sample for 30 seconds. All μR/hour readings will be documented on the chain-of-custody forms. Be sure to document the daily background reading in the air and at ground surface on the chain-of-custody forms. Any sample **[for which]** the reading exceeds twice the background will be considered radioactive and other arrangements for shipping and analysis must be considered. In this case, notify the task order manager and the laboratory immediately for further direction.

10.0 ANALYSIS

10.1 Field Parameters

QA objectives for parameters to be measured in the field are presented m Table 10-1. Field measurements will include pH, temperature, specific conductivity, *salinity,* groundwater level, wellhead survey, and organic vapor detection.

Table 10-1
Field Measurements QA Targets

Field Measurements	Matrix	Precision	Accuracy	Completeness
pH	Water	± 0.5 Std. Units	± 0.2 Std. Units	90%
Temperature	Water	± 1.0°C	± 0.2°C	90%
Specific Conductivity	Water	± 10%	± 1% of full scale	90%
Static Water Level	Water	± 0.01 ft.	± 0.05 ft.	90%
Salinity	Water	± 20 ppt	± 1.0 ppt	90%
PID/FID	Air	± 10 ppm	± 2 ppm	90%
Depth	Water	**	± 0.14 ft.	90%
Level	Water	**	± *0.03* ft.	90%
Redox	Water	**	± 20 mV	90%
Dirsolved Oxygen	Water	**	± 2mg/L	90%
Wellhead Points	Spatial	± 6%	± 0.1 ft.	90%
	Vertical	± 0.05 feet	± 0.01 ft.	90%

[Notes:
mV — millivolts
ppt — parts per thousand]

Field Measurement References:

- **pH, Temperature, and Specific Conductivity:** **Methods** for Chemical **Analysis** of Water and Wastes, USEPA-**600/4/79-020, Revised** March 1983.
- **Static Water Level:** Manufacturer's SOP for static water level measurement.
- **Salinity:** Manufacturer's SOP for salinity measurement.
- **PID/FID:** Manufacturer'r SOP for operation of **Photovac MicroTIP, Foxboro** OVA, and HNu.
- **Depth, Level, Redox, Dissolved Oxygen:** Manufacturer's SOP for **the Hydrolab** Datasonde.
  SOP's precision values of these parameters = one month's stability *of* accuracy.
- **Wellhead Points:** Standard **Land Surveying** Methods in **accordance** with **National** Geodetic Sunny.

[Bold items in brackets denote changes to the first draft of document.]

Calibrating and Standardizing Equipment

Calibrate instruments used [for] field measurements at least twice daily according to manufacturer's specifications (before use and at the end of the day). Instruments also may be calibrated during the day if field personnel consider it necessary. Tracing each standard to National Institute of Standards and Technology [(NIST)] will be based upon the forms and product-specific information provided by the standard manufacturer/supplier. Instruments [calibration] will be recorded in the site logbook, and calibration procedures and calculations will be recorded on the calibration log forms presented in this section.

Calibrating and Standardizing Temperature Probes

1. Initially, calibrate all thermometers against an NIST-certified thermometer *or* one traced to [National Bureau of Standards (NBS)] certification. Glass mercury-filled thermometers will not be used.
2. Test temperature probes for calibration quarterly according to manufacturer's instructions by checking the unit [against] an NIST-certified thermometer. If values do not fall within specified ranges listed m Table 10-1, the probe vvill be [tagged out of service and serviced before reuse.]

Calibrating and Standardizing pH Meters

1. Check *the* pH meter before each field trip for any mechanical or electrical failures, weak batteries, and cracked or fouled electrodes.
2. [Standardize the pH meter using] a 2-point calibration performed each day in the field before use according *to* the method m the manufacturer's instruction book. The meter slope shall be checked initially *using* pH 4, 7, and 10 buffer solutions. [A meter slope outside the range of 85 to 115 percent indicates meter or probe failure.] Buffer solutions *at* pH 7 and 4 or 7 and 10 will be used, depending on the expected pH value of the samples to be analyzed. The calibration check process should be repeated

between sampling locations *using* [one of] two buffer solutions. Record the calibration in the site logbook, and all calibration procedures and calculations on the calibration log in Figure 10-1.

Calibrating and Standardizing for Specific Conductivity.

1. Refer to the designated cell constant of the conductivity cell in the manufacturer's instruction book. Determine the actual cell constant each day before use.
2. Use a conductivity calibration solution to check the *cell* constant according to procedures outlined in the instruction book. If *the* values obtained during the check are within specification, the measured error will be used to improve the accuracy of sample readings using the equation in the instructions. If accuracy is out *of* specification, the cell must be repaired by the manufacturer or replaced.
3. Check each conductivity meter before each field trip to ensure the probe is intact, batteries *are* sufficiently charged, and the cell is clean. Calibration procedures entail checking the conductivity cell with one potassium chloride standard in *the* expected range of the sample(s) to be collected during the sampling day.
4. If the conductivity meter used [does] not automatically compensate for temperature, manually recalibrate [it] to [do *so]*.
5. Record the calibration in the site logbook, and all calibration procedures and calculations on the calibration log in Figure 10-2.

Calibrating and Standardizing [PID/FID and OVA]

1. Calibrate the PID[/FID/OVA] or equivalent instrument in-house quarterly using the calibration kit provided by the manufacturer and following the instructions in the user's manual.

2. Check each PID/[FID/]OVA used in the field daily, both before use and at the end of the day with the calibration span gas [specified] by the manufacturer.
3. Record background readings at the site.
4. To ensure peak performance of the instrument[s], perform routine maintenance such as cleaning the [PID] ultraviolet lamp window, replacing the dust filter, and cleaning the exterior of the instrument.
   - Clean the lamp window by disassembling the detector cell and lamp and wiping the window with a methanol-moistened tissue. Only perform this procedure when a high span setting is insufficient to give an adequate readout.
   - Replace the instrument's dust filter when instrument sensitivity increases by more than 10 percent when the filter is removed. The instrument should not be run for more than [1] minute without the filter in position.
   - Clean the instrument's exterior quarterly by *wiping* with a damp cloth, using a mild detergent when necessary.
5. Correct all field readings collected for ambient background. To make a correction, manually subtract the measured background PID[/FID/OVA] reading from the metered response fix an individual sample (i.e., boring headspace, split-spoon sample). Under no circumstances should the meter be zeroed based on ambient conditions in the area of concern.
6. Recharge the instrument's battery when the low-battery indicator appears. The instrument should be allowed to discharge until the indicator appears and then *it* should be fully recharged[, thus maximizing the instrument's operating time]. Consistent charging before full discharge [diminishes] operating time. Follow charging instructions in the user's manual for the appropriate charge.
7. Record calibration in the site logbook, and all calibration procedures and calculations on the calibration log in Figure 10-3.

Figure 10-1
Calibration Log — pH Meter
NAS Pensacola — Pensacola, Florida

pH Meter

Model: _____ Date/Time : _____
Serial Number: _____ Checked by: _____

Instrument Checklist:

	YES	NO
Is the instrument clean and in good condition:	___	___
Is the battery charge acceptable:	___	___
Is the LCD display functioning properly:	___	___
Is the probe filled with proper solution:	___	___
Are there any visible cracks or problems with the probe:	___	___

Two- or **Three-point** Calibration

	Reading	Lot #	Expiration Date
Buffer 4.0:	_____	_____	_____
Buffer 7.0:	_____	_____	_____
Buffer 10.0:	_____	_____	_____

Initial Slope: _____

Remarks:

[Bold items in brackets denote changes to the first draft of document.]

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Figure 10-2
Calibration Log — Conductivity Meter
NAS Pensacola — Pensacola, Florida

Conductivity Meter

Model: _____ Date/Time: _____
Serial Number: _____ checked by: _____

Instrument Checklist:

	YES	NO
Is the instrument clean and in good condition:	___	___
Is the battery charge acceptable:	___	___
Is the LCD display functioning properly:	___	___
Is the conductivity cell clean:	___	___
Are there any visible cracks or problems with the probe:	___	___

Conductivity Calibration Standards:

Source: _____ Date of Receipt: _____ Lot #/Expiration: _____

Two-point Calibration

	NIST Lot #
100 µmhos/cm Solution	_____
1000 µmhos/cm Solution	_____

Temperature: _____ Instrument internal calibration: _____

Remarks:

[Bold items in brackets denote changes to the first draft of document.]

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Figure 10-3
Calibration **Log — PID/FID/OVA Meter**
NAS **Pensacola — Pensacola, Florida**

PID/FID/OVA Meter

Model: _____ Date/Time: _____
Serial Number: _____ Checked by: _____

Instrument Checklist:

	YES	NO
Is the instrument clean and in good condition:	___	___
Is the battery charge acceptable:	___	___
Is the readout display functioning properly:	___	___
Are there any visible cracks or problems with the meter:	___	___
Does W lamp window or dust filter need to be cleaned:	___	___

PID/FID/OVA Calibration Standards:

Span Gas Type/Source: _____ Date of Receipt: _____ Lot #/Expiration:

Remarks:

[Bold items in brackets denote changes to the first draft of document.]

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QA Targets for Precision and Accuracy in the Field

Precision and accuracy targets for pH, temperature, and specific conductivity measurements are those specified in Section 6 of the USEPA SOP/QAM and are provided in Table 10-1. QA targets for other measurements are based on manufacturer's information pertaining to the precision and accuracy of the associated instruments.

10.2 Laboratory Analysis

Parameters and Analytical Methods to Be Used:

Parameters and analytical methods are presented in Appendix E. Samples will be analyzed using the full CLP TAL/TCL analyses. Analyses will be performed in accordance with the applicable CLP [Statement] of Work (SOW). [The USEPA SOW document number for organic analysis is (OLM01.8): Statement of Work for Organics Analysis, *August* 1991. The most current SOW for inorganic analysis is USEPA document (ILM02.1): Statement of Work for Inorganics Analysis, September 1991. Detection limits will be lowered as needed to achieve Florida standards for soil and groundwater.] Additional analytical methods for [potentially analyzed] parameters not included in the CLP analysis are provided in the list below.

Additional Methods for Laboratory Analysis:

- *Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater*, 40 [Code of Federal Regulations] (CFR) *Appendix* A to Part 136, July 1987.
- *Test Methods for Evaluation of Solid Waste (Physical/Chemical Methods), SW-846*, Third Edition, September *1986.*
- *Methods for Chemical Analysis of Water and Wastes*, USEPA-600/4-79-020, Revised March 1983.

QA Targets for Laboratory Precision and Accuracy

Project QA objectives for analytical parameters for soil and groundwater are stipulated in the respective analytical methods, and as determined by the analytical laboratory's historical data quality evaluation for these methods. The NEESA-laboratory approval process will ensure laboratory method QA/QC standards are appropriate to meet goals for intended data uses. Anticipated general QA goals for these methods are presented in Tables 10-2 and 10-3. The contract laboratory's NEESA-approved QAP will be retained for reference.

Table 10-2
Metals Analyses Data QA Objectives Matrix Spikes/Duplicate Analyses

Compound (Metal)	Medium/High Sample Precision[a] (%RPD)	Low Sample Precision[b] (%RPD)	Accuracy (% Spike Recovery)
Aluminum	± 20	± CRDL[c]	75-125
Antimony	± 20	± CRDL	75-125
Arsenic	± 20	± CRDL	75-125
Barium	± 20	± CRDL	75-126
Beryllium	± 20	± CRDL	75-125
Cadmium	± 20	± CRDL	75-125
Calcium	± 20	± CRDL	75-125
Chromium	± 20	± CRDL	75-125
Cobalt	± 20	± CRDL	75-125
Copper	± 20	± CRDL	75-125
Iron	● 20	± CRDL	75-125
bad	± 20	± CRDL	75-125
Magnesium	± 20	± CRDL	75-125
Manganese	± 20	± CRDL	75-125
Mercury	± 20	± CRDL	75-126
Nickel	± 20	± CRDL	75-125
Potassium	± 20	± CRDL	75-126
Selenium	± 20	± CRDL	75-125

[Bold items in brackets denote changes to the first draft of document.]

Table 10-2
Metals Analyses Data QA Objectives Matrix Spikes/Duplicate Analyses

Compound (Metal)	Medium/High Sample Precision[a] (%RPD)	Low Sample Precision[b] (%RPD)	Accuracy (% Spike Recovery)
Silver	± 20	± CRDL	75-125
Sodium	± 20	± CRDL	75-125
Thallium	± 20	± CRDL	75-125
Tin	± 20	± CRDL	75-126
Vanadium	± 20	± CRDL	75-125
Zinc	± 20	± CRDL	75-125
Cyanide	± 20	± CRDL	75-125

Nota:
QA/QC Requirement8 excerpted from CLP SOW ILMO 1.0
a — Medium/High Samples = compound or metal present at 6 times (or more) the contract required detection limit (CRDL)[c]
b — Low Samples = compound or metal present at less than 6 times the CRDL
c — Contract Required Detection Limit
[%RPD — Relative Percent Difference]

Table 10-3
Data Quality Objectives
Matrix Spikes/Matrix Spike Duplicates/Surrogate Spikes

Fraction	Compound	Soil Precision (%RPD)	Soil Accuracy (% Recovery)	Water Precision (%RPD)	Water Accuracy (% Recovery)
VOA	**Matrix Spikes**				
	1,1-Dichloroethene	22	59-172	14	61-145
	Trichloroethsns	24	62-137	14	71-120
	Chlorobenzene	21	60-133	13	75-130
	Toluene	21	59-139	13	76-125
	Benzene	21	66-142	11	76-127
VOA	**Surrogate Spikes**				
	Toluene-d_8	—	**[84-138]**	—	**[88-110]**
	4-Bromofluorobenzene	—	**[59-113]**	—	**[86-115]**
	1,2-Dichloroethane-d_4	—	**[70-121]**	—	**[76-114]**

[Bold items in brackets denote changes to the first draft of document.]

Table 10-3 (Continued)
Data Quality Objectives
Matrix Spikes/Matrix Spike Duplicates/Surrogate Spikes

Fraction	Compound	Soil Precision (%RPD)	Soil Accuracy (% Recovery)	Water Precision (%RPD)	Water Accuracy (% Recovery)
BNA	**Matrix Spikes**				
Base/ Neutrals	1,2,4-Trichlorobenzene	23	38-107	28	39-98
	Acenaphthene	19	31-137	31	46-118
	2,4-Dinitrotoluene	47	28-89	38	24-96
	Pyrene	36	35-142	31	26-127
	N-Nitroso-Di-n-Propylamine	36	41-126	38	41-116
	1,4-Dichlorobenzene	27	26-104	26	36-97
Acids	Pentachlorophenol	47	17-109	50	9-103
	Phenol	35	26-90	42	[12-110]
	2-Chlorophenol	50	25-102	40	27-123
	4-Chloro-3-Methylphenol	33	26-103	42	23-97
	4-Nitrophenol	50	11-114	50	10-80
BNA	**Surrogate Spikes**				
	Nitrobenzene-d_5	—	[23-120]	—	[35-114]
	2-Fluorobiphenyl	—	[30-115]	—	[43-116]
BNA	p-Terphenyl-d_{14}	—	[18-137]	—	[33-141]
	Phenol-d_5	—	[24-113]	—	[10-110]
	2-Fluorophenol	—	[25-121]	—	[21-110]
	2,4,6-Tribromophenol	—	[19-122]	—	[10-123]

[Bold items in brackets denote changes to the first draft of document.]

Table 10-3 (Continued)
Data Quality Objectives
Matrix Spikes/Matrix Spike Duplicates/Surrogate Spikes

Fraction	Compound	Soil Precision (%RPD)	Soil Accuracy (% Recovery)	Water Precision (%RPD)	Water Accuracy (% Recovery)
Pesticides	**Matrix Spikes**				
	Lindane	50	46-127 *	15	56-123
	Heptachlor	31	35-130	20	40-131
	Aldrin	43	34-132	22	40-120
	Dieldrin	38	31-134	18	52-126
	Endrin	45	42-139	21	56-121
	4,4'-DDT	50	23-134	27	38-127
Pesticides	**Surrogate Spikes**				
	[Tetrachloro-m-xylene	—	**60-150***	—	**60-150***
	Decachlorobiphenyl	—	**60-150***	—	**60-150*]**
	Dibutylchlorendate	—	48-136*	—	20-150*
Herbicides (8150)	**Matrix Spikes**				
	2,4-D	40	40-150	30	40-130
	[2,4,5-TP] Silvex	40	40-150	30	40-130
Herbicides (8150)	**Surrogate Spikes**				
	[2,4-DB]	—	50-140	—	50-130

Not..:
QA/QC Requirements *for* CLP analyses excerpted from CLP SOW 3/90 (OLM01.0-OLM01.7);
Other QA/QC requirements were derived from the analytical method references (USEPA, SW-846).

VOA = Volatile Organics
EN = Base/Neutral Extractable
A = Acid Extractable
* = Advisory Limits
— = Not Applicable
[%RPD = Relative Percent Difference]

[Bold items in brackets denote changes to the first draft of document.]

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11.0 DECONTAMINATION

Decontamination will be performed in accordance with Appendix B, Section B-8 of the USEPA SOP/QAM for sampling equipment and in accordance with Appendix E, Section E-9 of the USEPA SOP/QAM for drilling equipment, with the following exceptions. The detergent for use on this project will be Liquinox' [because it] contains powerful chelating agents to bind and remove trace metals from sampling equipment. When available, hot water will be used for field decontamination. A stainless-steel bowl, sink, or glass bowl will contain the clean water wash solution. PVC well construction materials will not be solvent-rinsed or washed with hot water. Field reagent grade water will meet the specifications of ASTM Type III water (D 1193-77 re-approved 1983, federal test method number: 7916), providing deionized, filtered, and organic-free water for field use. The steam cleaner and/or high-pressure hot water washer will be capable of generating adequate pressure and producing hot water and/or steam.

11.1 Decontamination Area Setup

[Decontamination generally will occur in a clean indoor location. However, field decontamination also will be necessary. Field] cleaning and decontamination will occur at a designated area generally onsite but downgradient and downwind of the clean equipment storage area. The decontamination area will be lined with heavy-duty plastic sheeting and will be designed to promote surface runoff into a catch basin or pit. If a pit cannot be excavated, a catch basin will be constructed of wood and lined with plastic to contain the waste/rinse water until it can be containerized into 55-gallon drums. Isopropyl alcohol waste will be collected separately and containerized in its designated drum. All equipment will be [cleaned] on saw horses or auger racks above the plastic sheeting. [After drilling is completed and all waste/rinse water is removed,] from the pit, [it] shall be backfilled witb clean material. The Navy is responsible for [disposing] of all decontamination wastes.

[Bold items in brackets denote changes to the first draft of document.]

11.2 Cross-Contamination Prevention

Follow procedures below to reduce cross-contamination risk during decontamination.

1. Don a new pair of disposable outer gloves before handling sampling equipment.
2. Use only Teflon, glass, or stainless-steel spray bottles/pressurized containers to apply decontamination rinsates. Keep each solution in a [separate] container.
3. Transport all necessary decontaminated field equipment to each designated location to minimize the need for field cleaning.

11.3 Non-Sampling Equipment

Non-sampling equipment includes drill rigs and backhoes. Any paint or coatings (e.g., rust) [potentially touching] the sample will be removed from the equipment by sandblasting before it is brought to the site.

1. Decontaminate with high-pressure steam.
2. If necessary, scrub with a laboratory-grade detergent and clean water wash solution.
3. Rinse with clean water as necessary.

11.4 Sampling Equipment

sampling equipment includes any downhole equipment (e.g., augers, drill pipe, split barrel samplers, Teflon-coated stainless-steel leaders, stainless-steel liners, bailers, etc.) and any sampling utensils (e.g., stainless-steel spoons, stainless-steel spatulas, stainless-steel bowls, etc.) not dedicated to the sample location. [Hollow] downhole equipment or [equipment with boles potentially transmitting] water or drilling fluids will be cleaned on the inside and outside.

1. Don protective gloves [before] decontaminating the equipment.
2. Wash and scrub with a laboratory-grade detergent and clean water wash solution or decontaminate with high-pressure steam.
3. Rinse with clean water.
4. Rinse with ASTM Type III water.

5. Rinse twice with pesticide-grade isopropyl alcohol.
6. Rinse with ASTM *Type* III water.
7. Air *dry.* If adverse weather prohibit[s] air *drying,* repeat the isopropyl alcohol rinse twice and final ASTM *Type* III water rinse.
8. Wrap in aluminum foil for storage if the sampling equipment is to be stored or transported.
9. Augers and drill rods will be covered in *clean* plastic after decontamination.

[Pump Decontamination

Decontaminating a pump is different than for most sampling equipment. Both the exterior and the interior of the pump require decontamination, as outlined below:

1. Don protective gloves before decontaminating the equipment.
2. Immerse pump head in a detergent solution (approximately 1 percent Liquinox solution) with the effluent hose prepared to discharge into a liquid IDW drum. A stainless-steel bucket or closed 4-inch pipe *can* be used to contain the pump head and pump solutions. All pump effluent will be containerized IDW.
3. Using a brush, scrub the pump and hose exterior with the detergent solution. Rinse the exterior of the hose with a clean water rinse solution followed by an ASTM *Type* III water rinse. Recoil the hose onto the spool.
4. Pump ASTM *Type* III water through the hose to purge the clean water rinse solution. Purge additional ASTM Type III water through the hose with the pump in reverse.
5. Rinse the outside of the pump housing and hose with deionized water.
6. Wrap the pump in plastic *sheeting* for transport to the field or for storage to prevent cross-contamination.

[Bold items in brackets denote changes to the first draft of document.]

11.5 Personal Decontamination

Personal decontamination procedures are outlined in the **[comprehensive]** HASP.

12.0 MANAGING SAMPLES

Samples will be managed in accordance with Section 4.2 of the USEPA SOP/QAM. Refer to the procedures listed below [for] containerizing, preserving, and packaging samples. [Appendix E provides detailed information on sample container size, type, and preservation requirements.] Ship all samples to the selected laboratory via overnight delivery the [same] day [they] are collected. Do not store overnight unless arrangements have been made with the laboratory. If samples are stored overnight, record storage container temperature in the field logbook.

12.1 Sample Containers, Preservatives, Holding Times

[The] appropriate number of sample containers, preservatives, and trip blank samples will be obtained from a CLP-approved laboratory. Stainless-steel sampling sleeves to be used for soil sample collection will be obtained from the manufacturer and decontaminated in the field before use. [Sample collection for heterotrophic plate count will be conducted with sterile containers and scoops provided by the laboratory.] All of the glass containers must have Teflon-lined caps.

12.2 Sample Preservation

Samples will be chemically preserved in accordance with the guidelines presented in Section 4.2.7 of the USEPA SOP/QAM. All samples requiring chemical preservation [either] shall be preserved immediately upon collection in the field [or pre-preserved before sample collection].

[Samples Not Requiring Preservation:]

In accordance with the USEPA SOP/QAM, the following samples will not be preserved:

- [Those] collected within a hazardous waste site thought to be contaminated with toxic materials [as well as] source samples collected from barrels, drums, closed containers, spillage, or other source areas.

- Samples witb extremely high or low pH [or those] generating dangerous gases if they were [to be] preserved.

[Unpreserved] samples will be documented on the chain-of-custody form and the laboratory notified at least 24 hours in advance of shipment.

The following procedures will be followed when preserving samples:

1. Care will be taken to ensure samples are not overpreserved. Overpreserved samples may be considered dangerous goods and will require shipment in accordance with procedures described in the current Dangerous Goods Regulations ([International Air Transport Association]). As a general rule, four drops of acid will preserve a 40-ml VOA [vial] and 40 drops of acid will preserve a 1-liter bottle.
2. When testing sample pH, use a disposable pipette to obtain a sample to place on the paper. Do not insert the pH paper into the sample bottle because the pH paper may contain traces of arsenic.
3. If the free chlorine test was positive (i.e., blue color change on the KI paper), preserve the cyanide sample using the following procedures:
   - Add a few crystals of ascorbic acid. Mix thoroughly.
   - Retest the sample for free chlorine. If the test is positive, continue adding ascorbic acid until [the result is] negative.
   - When the free chlorine test is negative, add a small amount of ascorbic acid crystals.
   - Add sodium hydroxide (NaOH) to the cyanide sample until the pH is > 12.
   - Properly document the sample preservation on the sample label and the chain-of-custody form.

4. If the sulfide test was positive (i.e., bluish-black color change on the lead acetate paper), preserve the cyanide sample following the procedures listed below:

   Add a small amount of lead carbonate to the sample. Mix thoroughly.

   — Continue the procedure until a precipitate is formed.

   — Filter the sample Using a 0.45-micron filter.

   — Add NaOH to the filtered sample until the pH is > 12.

   — properly document the sample preservation on the sample label and the chain-of-custody form.

12.3 Packaging Samples for Shipment

Pack all samples for shipment in accordance with Appendix C Section C.3 of the USEPA SOP/QAM to avoid breakage and prevent cross-contamination.

Sample Packaging Procedures

1. Select a cooler in good repair. Seal the drain plug on the inside and outside of the cooler with tape to prevent leakage.
2. Line the cooler with a *large* plastic bag.

While Packaging Samples

1. Place one sample container in each resealable plastic bag. Three VOC vials may be bagged together.

2. To prevent breakage, either:

   — Wrap samples in bubble wrap packing material. Seal bubble wrap around the containers with tape. Bubble wrap is not required for plastic containers, but take care when packing the coolers so containers do not directly touch;

   OR

— Place 2 to 4 inches of inert packing material on bottom of the cook. Place the bagged containers inside the cooler so the bottles do not touch each other.. completely fill any space with packing material such as vermiculite or cellulose insulation.

3. Include a temperature blank or temperature strip in each sample cooler.
4. Fasten the top of the cooler's large plastic bag with tape.
5. Place double-bagged ice inside cooler to preserve the samples to 4°C.
6. Place a chain-of-custody record describing the contents of each cook in aplastic bag and seal it inside each cooler.
7. seal cooler with tape and custody seals so it cannot be opened without breaking them.

Labeling the Package

1. Clearly print the words "This End Up" or "This Side Up" on top of the outer cooler. Place upward pointing arrows on sides of the package.
2. Mark cooler with the addresses of both shipper and receiver.
3. If more than one cook is to be shipped, mark with the sequential cook number and the total number of coolers (e.g., 1 of 3, 2 of 3, and 3 of 3).

12.4 Sample Labeling

Refer to Section 3 of the USEPA SOP/QAM for general instructions on labeling samples. Record the sample number as instructed below on the chain-of-custody form and in the field logbook.

A Joint Venture for Professional Services **EnSafe/Allen a Hoshall** (901) 383-9116
Site: NAS Penracola Sample Number: Preservative: 4°C Analysis: Date: Time: Sampler:

[Existing] **Sample Number: [The following sample-numbering system is to be** used **at all sites where the investigations** was **started or computed before the CSAP became final.]** Assign the sample identification number **[not to exceed eight digits,] following** the guidelines presented in **Figure** 12-1.

Site ID Number: The first two digits of the site ID represent the sample identification corresponding to the site number of the facility at **NAS** Pensacola. Refer to Plates [1 and 2] for the site names and numbers.

The Sample **Matrix** is represented by the third digit.

Common Sample **Matrices:**

G — groundwater

S — **soil** (surface soil and **soil** borings)

M — sediment (settled fluid-borne solid)

W — surface water

A — air

Other matrix codes may be **used** but **will be** limited to one **digit** to **allow for other information.**

[Bold items **in brackets denote** changes
to the first *draft* **of document.]**

Matrix Serial ID: The *matrix serial* ID will be the next two digits and will be the sample collection ID number, e.g., for a *soil* sample collected *at* boring E12 *at* Site 33 the identification would be "33S12." Another example: a groundwater sample collected *at* monitoring well location 22 at Site 07 would be "07G22." A third example: if a groundwater sample were collected from an existing monitoring well GM-77 at Site 33, the sample identification number would be "33GGM77."

Sample-Specific Identification Number: The next three digits represent a sample-specific identification number, [to] be the deepest sample depth rounded to the nearest foot. For example, a soil sample collected from *the* 18- to 20-foot depth *at* soil boring B-4 *at* Site 33 would be "33S04020." A second example: if a surface soil sample were collected from the 0 to 0.5-foot depth at sample location 40 at Site 10, the identification would be "10S4001." A sediment sample from the 1.5- to 2-foot depth *at* location 6 at Site 12 would be "12M06002." These three digits also designate quality assurance samples, with one digit designating the type of quality assurance sample or material blank. Common designations are listed below.

Quality Assurance Sample Designations:

T — trip blank	C — co-located samples	L — filter
E — equipment rinsate blank	X — matrix spike samples	N — bentonite
D — duplicate samples	K — matrix spike duplicate samples	O — grout
I — DI system blank	P — potable water	R — drilling mud
F — filtered samples		

Serial Numbers: The last *two* digits axe *serial* numbers [differentiating] between [QA] samples. If the first potable water field blank and deionized (DI) water field blank are collected while surface water sampling *at Site* 06, the blanks will be "06WP01" and "06WI01," respectively. If additional potable water and deionized water field blanks are collected while

Figure 12-1
Sample-Numbering System — Soil Borings

SITE ID (2 DIGITS)	Site # 36
MATRIX ID (1 DIGIT)	Surface/Sub Soils "S" Sediment "M"

One Boring/Station
 # 77 (soil)
 # 12 (sediment)

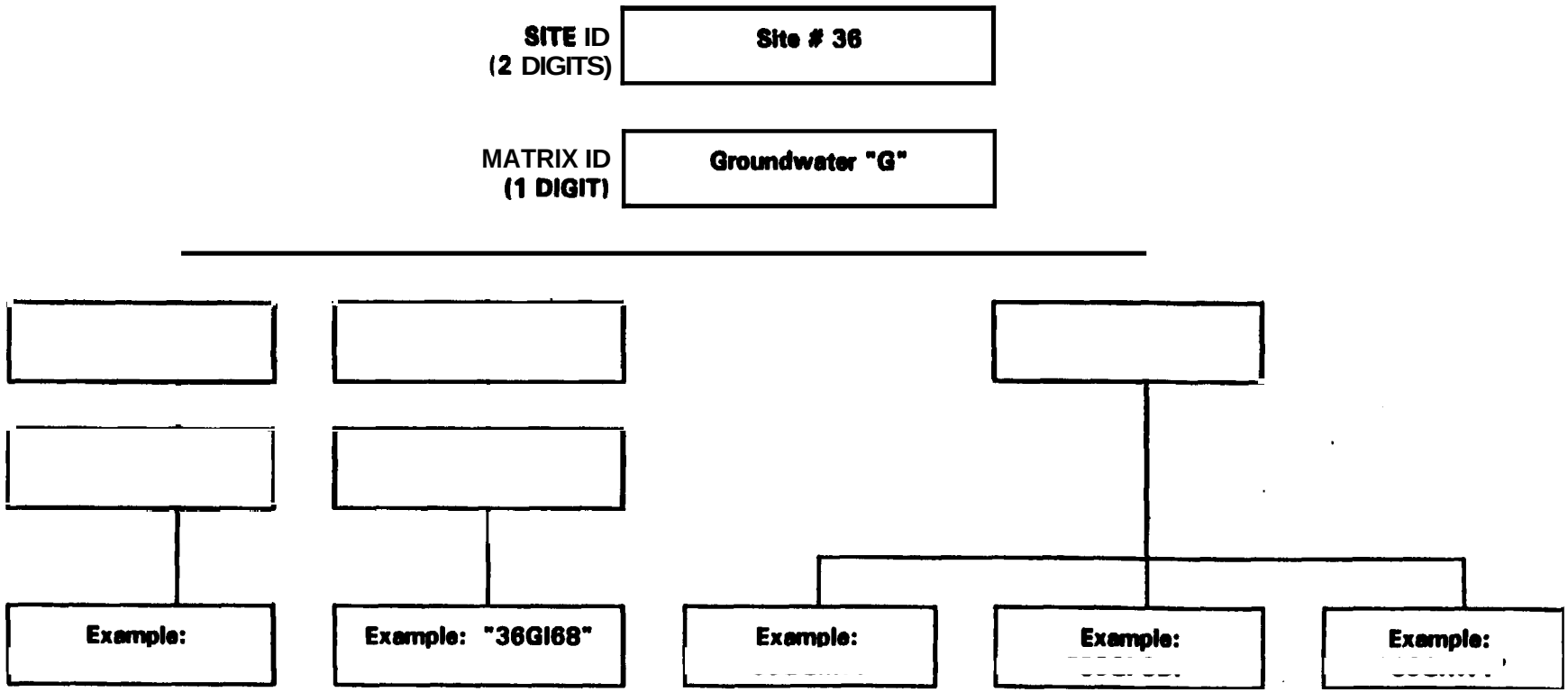
Bottom Depth to Nearest Foot
6" - 3687701
2'- 3657702
40'- 36S7740

Multiple Borings/Station
 # 15E, 15W, 15C
(East, West, Center)

Bottom Depth to Nearest Foot
6" - 36S15E01
12' - 36S15W12
13.6' - 36S15C14

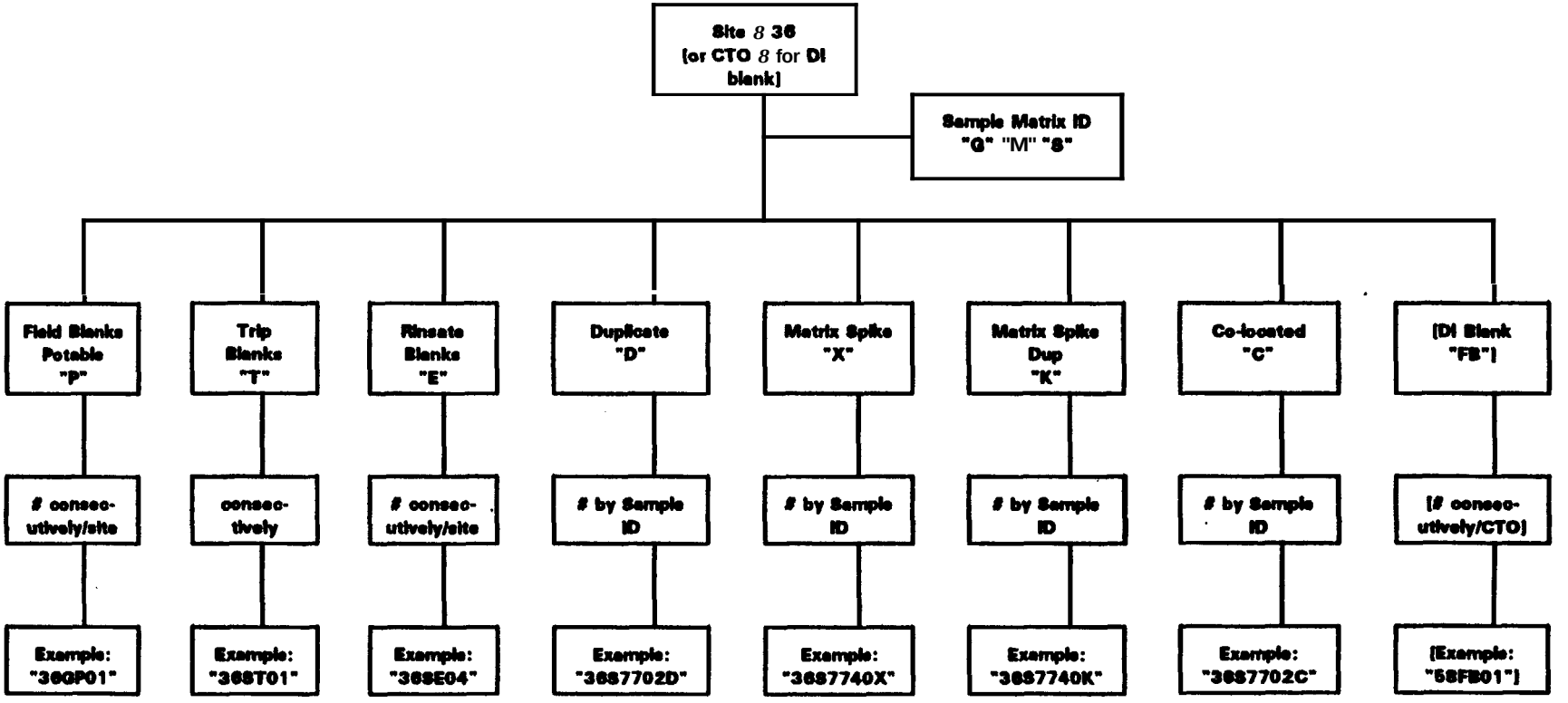
[Bold items in brackets denote changes to the first draft of document.]

Figure 12-1 (Continued)
Sample-Numbering System — Groundwater Samples



[Bold items in brackets denote changes to the first d document.]

Figure 12-1 (Continued)
Sample-Numbering System — QA/QC Samples



[**Bold items** in brackets **denote** changes to the **first draft** of **document.**]

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at Site 06, they would be numbered consecutively. Trip blanks will be [numbered .consecutively.]

[New Sample Number: For sites where the investigation has not been started before the finalization of the CSAP, the following sample-numbering system will be used. Assign the sample identification number according to the following format and guidelines:

Format: *XXXX/1234567890*

XXXX/ — This is a prefix that correlates all samples within a specific project. The prefix is not part of the actual sample identification. All samples collected as part of the NAS Pensacola investigation will use the prefix "NASP".

Field Samples:

123 — The first three digits are for the site where the sample was collected: sites, SWMUs, plumes, buildings, background, etc.

4 — This digit will represent the matrix of the sample. In order to keep the data consistent and facilitate data management, the following master list of abbreviations for common matrices will be used when applicable:

S — soil (surface, borings, and trenches)
C — soil duplicate sample
M — sediment (settled, fluid-borne solid)
N — sediment duplicate
G — groundwater
H — groundwater duplicate sample
W — surface water
R — surface water duplicate sample
U — sludge
Y — sludge duplicate
A — air
Z — liquid waste
V — solid waste

[Bold items in brackets denote changes to the first draft of document.]

5 6 7 8 — **These four digits designate the sampling location: boring or well number, sampling station, trench number, existing well identification, etc.**

9 0 — **The final two digits represent the sample-specific identification: depth to the nearest foot, depth interval, serial number for water samples, etc.**

QC samples:

1 2 3 — **The first three digits are for the site where the sample was collected, as above.**

4 — **This digit will represent the type of QC sample. Again, in order to keep the data consistent and facilitate data management, the master list of abbreviations for commonly collected QC samples below will be used when applicable:**

K — MS sample
X — MSD sample
T — trip blank
E — equipment rinsate blank
D — deionized water system blank
P — potable water blank
F — field blank
L — filter blank
B — USEPA blind spike sample
2 — cement blank
3 — drilling mud
4 — grout blank
5 — bentonite blank
6 — sand blank

5 6 7 8 — **These** four **digits correlate** the **QC sample with** the field samples **associated with it. A simple way to accomplish this is to use the sampling location, for example the boring** or well **number, of a sample** collected on **the same** day as the **QC sample. This also** will aid in keeping the **QC samples** blind to the **laboratory.**

[Bold items in brackets denote changes to the first draft of document.]

9 0 — "he final two digits are the serial number for the QC samples. For example, the first rinsate blank collected at a particular site will have the serial number "01," the second rinsate will be "02," etc.

Sample Numbering Guidelines:

- This sample-numbering system uses 10 digits for each sample number. All 10 digits must be used. A master list of sample matrix and QC sample abbreviations is supplied above. Any abbreviations may be used for job site and sample locations, but they must fit into the sample number format. All spaces in the sample number format must be filled and no *extra* characters included. If all of the spaces are not necessary for a sample identification, zeroes will be used as space-fillers.
- Even though the format for sample numbers is standardized, the *system* still requires planning on the part of the project or site *manager* to ensure that every sample has a *unique* number. For example, if multiple sampling events will take place at the same site, this information should be incorporated into the site or sample location abbreviations for samples collected there.
- Define site and sampling location abbreviations as much as possible before starting the sampling event. When necessary, consult the well inventory and sample logbook before assigning new sample numbers. 'his will reduce the possibility of duplicating abbreviations as sample numbers.
- The letters I and *O* and the numbers 1 and *0* are not used as the matrix/QC digit because they are easily confused on chains-of-custody and sample labels.
- The master abbreviation lists cover only routinely collected *QC* samples. Some sites may necessitate collecting uncommon sample matrices (i.e., animal or plant tissue samples, wipe sampling, building materials, etc.). These situations will require using a customized matrix and QC sample abbreviation list. When custom codes are necessary, all matrix codes will be defined and documented in the sample logbook

and associated field logbook. These custom codes will be carefully selected to avoid confusion with existing sample numbers.

- **If multiple soil samples from a trench are to be collected at the same depth, note each sampling location in the field logbook and incorporate both the trench number and sampling location into the sample identification as digits *5678*.**
- **If a project requires collecting samples for total and dissolved constituent analyses, set up site or sample location identifiers indicating which samples are filtered and which are not.]**

Completing the **Form** and **Correcting Errors:**

All information except date, time, and sample collector's signature will be preprinted on the labels. Record the remaining information on the label m non-erasable, waterproof, black ink. Correct errors *on the* sample label by marking through with a single line. Initial the error and [then] record the correct information.

12.5 Sample Custody

Refer to Section 3.3 of the USEPA SOP/QAM for general instructions on maintaining chain-of-custody. Exceptions are outlined below.

Maintaining **Field** *Custody*

1. After collecting samples, label and seal with a custody *seal* (see Figure 12-2).
2. Affix the seal so samples cannot be opened without breaking [it].
3. The sampler collector must *sign* and date the *seal.*

[Bold items in brackets denote changes to the first draft of document.]

NAVY CLEAN
ENSAFE/ALLEN & HOSHALL

ENSAFE/ALLEN & HOSHALL
5720 SUMMER TREES DR. SUITE B
MEMPHIS, TENNESSEE 38134
(901) 383-9115

OFFICIAL SAMPLE SEAL

SAMPLE #	DATE:
SIGNATURE:	
PRINT NAME & TITLE:	

COMPREHENSIVE SAMPLING AND ANALYSIS PLAN
NAS-PENSACOLA
PENSACOLA, FLORIDA

FIGURE 12-2
CUSTODY SEAL

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Chain-of-Custody Record

The chain-of-custody form will be used to record custody of the samples. An example of the chain-of-custody form is provided in Figure 12-3. The following information will be recorded in the appropriate spaces on the form.

Information** about **EnSafe/Allen & Hoshall:

- Client name (E/A&H) and address of E/A&H
- Project Name/Number (NAS Pensacola/[Contract Task Order] [CTO] Number)
- Project Manager's Name
- Signature of Sampler(s)

Information about the Sample:

- Field sample identification (as described in previous section)
- Date and time of collection (24-hour clock)
- Type of sample
- Type and size of sample containers
- Preservation temperature and chemical
- Number of sample containers/samples
- Type of laboratory analysis required
- Comments such as "strong odor" and radiation readings above background go in the remarks section

*Information about **Transfer,** Shipment, **and Disposal:***

- When sample custody is transferred, document it in the appropriate section of the form.
- The person relinquishing custody must print his or her name, company name, reason for the transfer, date, time and signature on the form.

- The method of shipment and the air-bill number of the shipment will be noted on the chain-of-custody form.
- During shipment, the chain-of-custody form must be sealed in a plastic bag and secured inside the shipping cooler.
- Note any special instructions (e.g., priority turnaround) or comments in the [appropriate] section of the chain-of-custody and discuss them with the laboratory before collection and shipment.
- Note sample disposal or storage instructions after completing laboratory analysis.

12.6 Chain-of-Custody Transfer

Refer to Section 3.3.5 of the USEPA SOP/QAM for general instructions on transferring custody and shipment of samples. Specifics are listed below.

Transferring Custody

1. Record the air-bill number in the appropriate section on the chain-of-custody record and in the field notebook. Seal the chain-of-custody form m aplastic bag and place it inside the shipping cooler before closing.
2. Secure shipping coolers with tape and place a custody seal on each side of outside of cooler to prevent opening without breaking the seal.
3. Ship samples overnight to the selected analytical laboratory.
4. When relinquishing custody to a shipper, advise the laboratory of any time constraints on analysis. Notify the laboratory as early in the week as possible regarding samples intended for Saturday delivery.

NAVY CLEAN
ENSAFE/ALLEN & HOSHALL
(901) 383-9115

FIGURE 12-3
CHAIN OF CUSTODY RECORD

PAGE _____ OF _____

CLIENT _____
ADDRESS _____
PROJECT NAME/NUMBER _____

PROJECT MANAGER _____
TELEPHONE NO. (901) 372-7962
FAX. NO. (901) 372-2454
SAMPLERS: (SIGNATURE) _____

FIELD SAMPLE NUMBER	DATE	TIME	SAMPLE TYPE	TYPE/SIZE OF CONTAINER	PRESERVATION TEMP.	PRESERVATION CHEMICAL	NO. OF CONTAINERS	ANALYSIS REQUIRED								REMARKS

RELINQUISHED BY:	DATE / TIME	RECEIVED BY:	DATE / TIME	RELINQUISHED BY:	DATE / TIME	RECEIVED BY:	DATE / TIME
SIGNATURE _____		SIGNATURE _____		SIGNATURE _____		SIGNATURE _____	
PRINTED _____		PRINTED _____		PRINTED _____		PRINTED _____	
COMPANY _____		COMPANY _____		COMPANY _____		COMPANY _____	
REASON _____		REASON _____		REASON _____		REASON _____	

METHOD OF SHIPMENT: _____
SHIPMENT NO. _____
SPECIAL INSTRUCTION: _____

COMMENTS: _____

AFTER ANALYSIS, SAMPLES ARE TO BE:
- ☐ DISPOSED OF (ADDITIONAL FEE)
- ☐ STORED (90 DAYS MAX)
- ☐ STORED OVER 90 DAYS (ADDITIONAL FEE)
- ☐ RETURNED TO CUSTOMER

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Laboratory Sample Receipt Procedures

1. A sample custodian accepts custody of the shipped samples from the carrier and enters data about the package into a receipt log, including the status of the custody seals on the coolers.
2. The laboratory sample custodian logs in the sample and opens the shipping coolers, checks the contents, and verifies that the information on the chain-of-custody agrees with samples received.
3. The custodian records information such as shipment, pickup, and courier on the "Remarks" section of the chain-of-custody record. The custodian also documents temperature of the cooler by checking the temperature blank or strip, as well as the general condition of sample containers.
4. The analyst verifies sample preservation before extraction, digestion, or analysis and records pH.
5. If samples are improperly preserved, the laboratory QA coordinator documents this fact, along with the sample identification and other pertinent information, and notifies the task order manager and site manager. All other QA/QC discrepancies are [handled similarly] and must be documented as out-of-control events with the corrective action taken.

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13.0 INVESTIGATION-DERIVED WASTE

All [IDW] solids and liquids are to be handled in a manner consistent with all applicable local, state, and federal waste disposal guidelines. This waste will be containerized in a [U.S. Department of Transportation] (DOT)-approved drum (Type 6B, 6C, 6J, 17C, or 17H). The disposal method will be selected by the Navy based on [waste] classification, [which will be determined by TCLP analysis.] The waste [then] will be disposed of by the Navy in accordance with applicable guidelines for the waste category. All drums will be labeled with the site number, date of collection, and waste category. [Procedures for handling IDW are discussed in detail in a separate IDW plan (E/A&H *in press*).]

13.1 Soil Waste

Soil is considered unclassified waste until analytical data are received. Investigation-derived soil will be drummed, labeled, and transported to a waste storage facility by the Navy. When analytical results are received, the soil will be disposed of properly. Only small quantities of soil will be drummed ([less than] 10 cubic yards). Alternative means of disposing of larger quantities will be addressed [by individual sites].

13.2 Water Waste

All investigationderived water (e.g., decontamination, monitoring well development, and sample purging) will be drummed and labeled as described in the paragraph above. [The drums may be transported] to the Industrial Wastewater Treatment Plant (IWTP) [or to an offsite facility] for disposal.

[Bold items in brackets denote changes to the first draft of document.]

13.3 Isopropyl Alcohol Waste

All investigation-derived isopropyl alcohol waste shall be drummed separately. Navy personnel will transport the drums to a waste storage facility [where] the [contents] will be disposed of properly.

w.4 Personal Protective Equipment Waste

Used personal protective equipment (PPE) will be placed in 55-gallon, DOT-approved drums for disposal by the Navy. Navy personnel will transport the drums to a waste *storage* facility until the [contents] *can* be disposed of properly.

13.5 Disposable Sampling Equipment

All disposable sampling equipment (e.g., plastic sheeting, rope, etc.) will be placed into 55-gallon, DOT-approved drums for disposal by the Navy. Drums will be labeled by *site* number, date of collection, and waste category. Drums will be transported by Navy personnel to a waste storage facility until the *[contents]* can be disposed of properly.

13.6 Documentation

A drum-tracking log will be kept for the convenience of the Navy separate from field logbooks. This log will detail number of drums, site number, waste type, and date filled.

14.0 DATA MANAGEMENT

This section describes the methods to be used throughout the project to document field work and manage [collected] data.

14.1 Field Documentation

The field project manager will be thoroughly familiar with appropriate documentation procedures. He or she will perform or directly oversee completion of the documents accompanying this investigation. Documentation tasks will be performed on a sample-by-sample or item-by-item basis throughout the day. Sample container labels and chain-of-custody forms will be prepared as completely as possible in advance.

General Field Documentation Procedures

- Complete all documentation in waterproof black ink.
- Mark through corrections with a single line, then date and initial the correction.
- Do not destroy or discard serialized documents, even if they are illegible or inaccurate.
- Maintain voided entries within project files.

Field documentation consists of a master site logbook, one or molt site-specific field logbooks, field forms, photographs, sample labels, and chain-of-custody records. This allows detailed data to be recorded in various field logbooks and[/or] forms [and cross-referenced] in the site logbook.

Logbooks: Master site and field logbooks provide a daily handwritten record of all field activities at an investigation site. All logbooks must be permanently bound and have hard covers. Field logbooks must be waterproof. The master site logbook is a master record of all site activities, and entries usually [are] made at the end of each work day. Field logbooks are detailed daily records kept in real time. A field logbook will be assigned to each site at NAS

Pensacola. Additionally, a sample logbook will be prepared detail[ing] the samples collected each day, but in less detail than the chain-of-custody.

Master Site Logbooks: The master site logbook chronicles all field investigation activities, but does not have the same level of detail as the field logbook. It delineates conditions and activities occurring on a given day and refers [to] the appropriate field logbooks and forms for specific information.

The field project manager completes the master site logbook and signs and date[s] the end of each page. Pages should not be removed [and] all partially used pages should be lined through to prevent [later] data entry. The front of the master site logbook [should include] the project name and number, name of subcontractor, service client, contract number, and dates of use.

Master Site Logbook Contents:

- List of all field logbooks and brief outline of their required contents.
- Daily temperature, weather conditions, and names and titles of personnel present.
- Levels of personnel protection and changes, if required.
- Name, title, organization, and purpose of any site visitors.
- Brief outline of site activities and references to the appropriate logbook.
- specific comments on any problems encountered, their resolution, and any impact on the field investigation.
- Any changes and supporting rationale.
- Brief record of all telephone calls and how they affected the investigation.
- Instrument calibration, specifically name(s) of personnel who performed daily calibration.

Field Logbooks: All information required on the cover of the site logbook also must be provided on the cover of each field logbook. In addition, it must list the specific area [to which] it is

assigned. Entries in the field logbook must be made using a 24-hour clock and Signed by the responsible person at the bottom of each page. Unused pages or [unused] portions of pages must be lined out to prevent entry of additional information. Copies of field logbooks will be made [regularly for] backup.

Field Logbook Contents:

- Date and time task *started* and ended; weather conditions, and the names, titles, and organizations of personnel performing the tasks.
- Description of level of [PPE] and *any changes*.
- Description of site activities in specific detail or [forms used].
- Description of field tests performed and [their] results.
- Detailed description of samples collected, and any [QC] samples collected.
- List of the time, equipment type, and procedures followed for decontamination.
- Record of instrument calibration and any failures with a brief description of repairs and/or replacements.

Sample Logbook A sample logbook will compile a record of samples collected and shipped (including QA/QC samples), analyses requested, the airbill number of the shipment, and any pertinent information concerning sample status.

Field Data Record Forms: Forms [to] be used during this investigation include subsurface *boring* logs, monitoring well construction diagrams, monitoring well development forms, sample records, and additional data as *appropriate*. Do not leave blank spaces on completed forms. If information on a form does not apply, mark the space "N/A." Complete all forms in the field as the task is performed. Copy forms regularly for backup. Field farms to be used during this investigation are discussed below.

Sample Labels: Attach completed labels to each sample container immediately after sample collection. Refer to Section 12.3 of this plan for labeling instructions. Sample label information (at least sample identification and time of collection) will be recorded in the field logbook as a cross-reference at the time of collection.

Chain-of-Custody Records: The chain-of-custody record will contain a summary of the contents of the *shipment*, dates, times, sample numbers, number and volume of sample containers; [its purpose is to] document the transfer of sample custody. See Section 12.6 of this *CSAP* for instructions on chain-of-custody [transfer].

Subsurface Boring **Logs:** Soil boring logs will be maintained by a qualified E/A&H geologist. Lithology will be described from split-barrel samples and auger cuttings using the USCS. Subsurface boring logs will be completed as the boring is advanced. Items to be recorded include materials encountered, depth to water, obvious contamination, and any other necessary information.

Monitoring well **Construction Diagrams:** A monitoring well construction diagram will summarize the monitoring well construction. Data to be completed include location, date drilled, drilling method, well depth, screen location, and general construction [details]. A general log will also be recorded in the field logbook as a cross-reference. Monitoring well schematics are found in Section 5 of this CSAP.

Photographs: Photographs will be taken of all pertinent field activities as directed by the Field Project Manager. The information listed below will be recorded in the field logbook:

- Date, time, location, and name of photographer
- Description of photograph and orientation

- Number of photograph on film roll

After the film is developed, transfer this information to the back of each photograph

143 Analytical Data Validation

CLP data should be validated using procedures in *National Functional Guidelines for Organic* Data Review, June 1991 and *National Functional Guidelines for Inorganic Data Review*, July 1988. Data from other analytical methods will be validated by E/A&H. Independent data validation will be conducted on 10 percent of the samples by an independent subcontractor.

14.3 Other Related Data

Other related data will include illustrations, graphs, meeting summaries, audit reports, and laboratory results. This information will be compiled and reviewed for report presentation.

Meeting Summaries, Telephone Conversations, and Notes: These items will be recorded in the field logbooks along with the dates, time, and names of [people] involved. This information will be available for photocopying if requested. Meetings and conversations with a substantial impact on the project will be described in a memorandum to the project manager.

Illustrations, Computations, and *Engineering* Data: Original illustrations and graphics will be initialed and dated by the person originating the document. A second person will check for completeness and accuracy. All *maps*, calculations, and data will be reported or prepared to accepted standards and confidence levels.

Field Change Request Forms: Field change request forms [(see Figure 14-1)] will be submitted when any deviation from the work plan or *SAP* is required [that will adversely affect quality of the data generated, will cause a significant change in the field effort's *cost*, can

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be defined as a major change in the scope of the field effort, or will cause significant delays in the schedule. Examples of this type of change follow:

- **Significantly changing the number of wells**
- **Significantly changing the number of sampling points**
- **Changing decontamination procedures**
- **Changing drilling method or well construction design**
- **Changing sampling methods]**

Information **[should]** include the **nature of the change, reason for the** change, and date it will be **implemented. These** forms will be **submitted** to **the [Engineer in Charge** (EIC) representing the Navy.

[Analytical Results

All data **collected** during **these investigations will** be managed and submitted to the **USEPA** and **FDEP** in **accordance with** the **USEPA Region IV's** data **locational** policy. **The** interchange file format **guidance** is **provided** in **Appendix** F.]

14.4 Reports

Progress Reports: **Monthly progress reports prepared** by the project manager will **include the** number of samples collected, sites **investigated, monitoring** wells **installed,** any deviations from approved field or **laboratory** procedures, **and other appropriate information. These reports will** be directed to the EIC **representing** the Navy.

Final Report: The final **[RI] report** will **be written after sampling and validation of all** laboratory **analyses.** The final **report** will **consolidate and summarize collected** dam and document the unit **evaluation.** An initial **draft report** will be **submitted for comment by the**

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Figure 14-1

NAVY CLEAN
ENSAFE/ALLEN & HOSHALL
(901) 383-9113

FIELD CHANGE REQUEST

E/A&H PROJECT NO. _____ FIELD CHANGE NO. _____

TO _____ LOCATION _____ DATE _____

DESCRIPTION: _____

REASON FOR CHANGE: _____

RECOMMENDED DISPOSITION: _____

FIELD MANAGER(SIGNATURE) _____ DATE _____

DISPOSITION: _____

SITE MANAGER _____ DATE _____

DISTRIBUTION: E/A&H PROJECT MANAGER
QUALITY ASSURANCE MANAGER
NAVY EIC
FIELD MANAGER

OTHERS AS REQUIRED _____

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Navy, and the Technical Review Committee including USEPA (Region IV) and FDEP. Where appropriate, comments will be incorporated into the final document.

Interim reports or technical memoranda will be completed as necessary to describe significant divergence of site conditions from those anticipated, secure concurrence on the need for emergency or interim corrective measures, or to gain regulatory input on unanticipated issues.

Tables and Graphs: Data obtained from sampling and analysis procedures will be summarized and presented in tables. These tables will be supported by raw laboratory reports submitted under separate cover to the EIC. Graphical presentation of sampling results will be in several formats. Isoconcentration maps will be developed for soil and groundwater parameters, if possible. In addition, maps showing sample locations and sampling results [also] will be completed. Groundwater surface contours along with flowdirection and gradient [also] will be displayed on the site base maps. Cross-sectional plots may be used if they would enhance understanding of the site. Forms completed during the investigation will be included in appendices of the report.

Accumulated data and analytical results will be [interpreted] as a project team effort. The expertise of each project team member will be used to develop proper conclusions and recommendations. The final decision about interpretation of data for the report will lie with the task order manager, [the project technical director, and the Florida-registered professional geologist.]

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15.0 QUALITY ASSURANCE PLAN

15.1 Introduction

This section presents policies, project organization, objectives and functional activities, along with QA/QC measures intended to achieve the quality assurance goals of the facility investigation to be performed at NAS Pensacola.

This document is intended to fulfill requirements for ensuring all work [will] be conducted in accordance with QA/QC protocols and field procedural protocols for environmental monitoring and measurement data as established in the following documents.

Applicable Guidance Documents:

- U.S. Environmental Protection Agency. (February 1991). *Standard Operation Procedures and Quality Assurance Manual.* Athens, Georgia.
- Naval Energy and Environmental Support Activity. (June 1988). (NEESA 20.2-047B). *Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program.* Port Heuneme, California.
- Naval Energy and Environmental Support Activity. (February 1985). (NEESA 20.2-031A) *Groundwater Monitoring Guide.* Port Heuneme, California.
- Southern Division Engineering Command, Revision 4. (March 1989). SOUTHNAVFACENGCOM *Guidelines for Groundwater Monitoring Well Installation.*

Before field investigations begin, a site meeting will be conducted at the facility for the task order manager, all field personnel, a representative of the site management, and any subcontractors who will be working [there!]. The meeting['s objectives] will be to familiarize personnel and subcontractors with the site, discuss the logistics with management, and discuss health and safety procedures. The SOUTHNAVFACENGCOM EIC and representatives from

the [FDEP] and USEPA Region IV will be invited. When authorized by the EIC, the investigation [will begin].

15.2 Quality Assurance/Quality Control Objectives

In general, [QA]objectives conducted as part of the Navy technical services contract assess and document the precision, accuracy, representativeness, completeness, and comparability of all sampling and analysis performed. Quality criteria are outlined here to assure suitability for intended use of data obtained during projects, and to meet goals established by NEESA and in the USEPA document, *Data Quality Objectives for Remedial Response Activities Development Process* (March 1987) Office of Solid Waste and Emergency Response (OSWER) Directive 9355.0-7B. NEESA Data Quality Objective (DQO) Level B protocol (USEPA Level II) will be used for the physical surveys. Soil, surface water, sediment, groundwater, and contaminant quantification investigations will be conducted at NEESA DQO Level D protocol (USEPA LEVEL IV). The following discussion presents the project-specific level of effort for [QA] and data quality criteria. [QC] sample collection will follow the frequency presented in Table 15-1.

Table 15-1
Quality Control Sample Collection Frequencies

Trip Blank:	One per sample shipping cooler containing VOC samples
Rinsate Blank:	[One per sampling event (week) per sampled media]; one per 20 soil-gas samples collected
Field Blank:	One per sampling event (week) per source. (Potable Water and Reagent Grade Water—ASTM Type III)
Duplicates:	One per [20] water and soil samples collected; one per 20 soil-gas samples collected
MS/MSD:	One per 20 water and soil samples collected; matrix is to be the same sample used for duplicate analysis
Temperature Blank:	One per sample shipping cooler
Equipment/Material Blanks:	One sample each of filter pack sand, drilling mud, grout, bentonite pellets or powder, used in well construction per material source/site

Notes:
Trip blanks are for volatile organic analysis only.
MS/MSD = Matrix Spike/Matrix Spike Duplicate Samples

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15.2.1 Recision

precision is a measure or estimate of the reproducibility of measurements and methods and is defined for qualitative data as the variability of a *group of* values compared with their average value. [To] assess [the] precision of the measurement systems [being] used in this project, duplicates will be obtained and analyzed with the samples collected. Precision, [to be] used as a criterion for data classification, is *calculated* as a relative percent difference in analytical outcome between a given sample and corresponding duplicate.

The type of duplicates used willdepend on the part of the measurement system tobeevaluated for precision. Field-duplicated samples analyzed by the game *laboratory* will yield information about sampling method precision and matrix homogeneity. Laboratory-duplicated samples give an indication of sample preparation and analytical method precision.

A field duplicate is a sample collected in the field from the exact location as another sample and sent to the laboratory for analysis with another sample. A laboratory duplicate is prepared in the laboratory and consists of a split from a sample sent from the'field to the *laboratory.*

15.2.2 Accuracy

The accuracy of an entire measurement *system,* which [indicates] any bias, is difficult to measure in environmental measurement systems. Sources of error are the sampling process, field and laboratory contamination, preservation, handling, sample matrix, and analysis. *The* accuracy of a method is an estimate of the difference between the true value and the determined mean value. In the field, methods [of] detecting false positive results include [preparing] trip blanks, field blanks, and equipment rinsate blanks. In the laboratory, matrix and surrogate spike samples are used to detect positive and negative bias.

[Per NEESA definitions] field blanks [are] sample containers filled in the field with water from each source used for decontamination. Field blanks are prepared, preserved, and stored in the same manner as the samples. The field blank is analyzed along with the field samples for the constituents of interest to check for contamination imparted to the samples by the water source. Samples of the ASTM Type III water and tap water will be collected weekly.

Trip blanks will be used for volatile constituent measurements. A trip blank consists of a [VOA] sample container filled with organic-free water in the laboratory, traveling unopened with the sample bottles to the field. Trip blanks will be stored with the sample bottles in a contaminant-free area. If trip blanks received from the laboratory contain large air bubbles (pea size), [they] will be discarded and the laboratory contacted. [If not discarded,] the trip blank [then] is shipped back to the laboratory with volatile samples collected in the field. It is opened in the laboratory and analyzed along with the field samples for the volatile constituents of interest. Trip blanks will be submitted to the laboratory with water samples for volatile analysis at a frequency of one per shipping container [of] VOC samples.

An equipment rinsate blank is made by taking ASTM Type III water and placing it in contact with the field sampling apparatus (e.g., bailer, pump, split-barrel sampler, Xi-Tech sampling sleeve) [after equipment is decontaminated]. The water will be collected in the same type of containers as the other samples, preserved in the same manner, and analyzed for the Same parameters of interest. One equipment rinsate blank will be collected [per sampling event (week)] per sampling media. If sampling occurs in the same sample media using different equipment on the same day (e.g., if soil samples are collected with Xi-Tech sampler, split-barrel sampler, and hand auger) a separate rinsate blank will be collected for each [device].

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Matrix spike samples prepared by the laboratory are useful in assessing the [analytical methods'] accuracy, and can detect matrix effects [where] other sample components interfere with the analysis of the contaminant of concern. The method of measuring analytical accuracy is percent recovery.

Analytical matrix spikes will be performed by the laboratory, typically at a frequency of one per 20 samples per matrix. Matrix spike recoveries for inorganic analyses are definitive; therefore, if matrix spike recoveries are outside of control limits, the data will be flagged as quantitatively suspect or estimated. Control limits for laboratory matrix spike recovery are published by USEPA or determined by historical laboratory results. Surrogate spikes, typically prepared from deuterated isomers of selected target compounds, provide an added measure of method accuracy. General precision and accuracy goals for laboratory analytical procedures (NEESA Level D) are as previously provided in Table 10-2. To provide the additional volume needed by the lab for matrix spike and matrix spike duplicate analysis, [double the volume for] the first sample of each 20 soil, water, and sediment samples taken.

An equipment/materials blank shall be collected from the materials and liquids to be used in monitoring well construction at each investigation site.

15.2.3 Representativeness

The goal of this inspection is to delineate the extent of any soil and groundwater contamination, and to determine the most appropriate remedial Option. Soil and groundwater samples will be properly collected and monitoring well parameters will be measured in accordance with NEESA protocol to ensure samples collected during the investigation are representative of the areas of concern.

15.2.4 Completeness

Completeness goals for this project are set at 100 [percent] for laboratory analysis. Data completeness will be expressed as the percentage of total valid tests conducted and as the percentage of the total valid tests required in the scope of work.

Completeness goals of field measurements reflect the ability to re-sample immediately, before declaring well stability, and obtaining samples for laboratory analysis. The completeness goals [consider] unavoidable non-attainment of QA goals during the course of an investigation. Efforts will be made, however, to maintain soil and groundwater data completeness levels above 90 percent for field measurements, if possible.

15.2.5 Comparability

Comparability is assured through the use of established methods of field sampling by experienced field personnel and laboratory analysis as specified by NEESA regulations.

15.3 Experience Requirements

Experienced field personnel shall perform all site activities at NAS Pensacola. Résumés for E/A&H personnel are included in Appendix [G]. Subcontractor résumés will be available onsite.

15.4 Organization and Responsibilities

Overall responsibility for projects conducted in accordance with NEESA regulations will be vested in NEESA (or its approved representatives). Therefore, project coordination responsibilities lie with the SOUTHNAVFACENGCOM EIC. The components of the project chain-of-command will be performed as established in NEESA 20.2-047B. Project oversight will be organized along the following lines of authority.

Naval Energy and Environmental **Support Activity: NEESA** is **responsible** far **ensuring** the quality of **laboratory** analyses performed *during* **the various phases** *of* CLEAN is **acceptable. NEESA** is also responsible **for managing** the **NEESA contract representative** (NCR).

Engineer in Charge: The **EIC** *at* **the engineering** field division provides **the** site information **and history,** provides logistical assistance, specifies the **sites requiring investigation,** and reviews results and recommendations.

The EIC is responsible for coordinating **procurement,** finance, **and** report; **for** ensuring all documents **are** reviewed by the NCR; for communicating comments **from** the **NCR and** other **technical** review **to** the subcontractors; **and for ensuring** the subcontractors address **all** the comments submitted **and** take *appropriate* **corrective actions.**

NEESA Contract Representative: The **NCR is** responsible **for ensuring** each **project bas** appropriate overall **QA. The** NCR reviews *laboratory* **QA** plans **and** work plans, submits performance sample **data,** provides field **and** laboratory audits, **and reviews** data from **the** site. The questions from **subcontractors** and the EIC **regarding specific** field **and** *laboratory* QC **practices are** directed to the NCR, who **also** evaluates **referee** samples.

State or Local Oversight: **This [CSAP]** will **be submitted to the FDEP and the USEPA Region** IV for review and approval. Field **activities and meeting** will **be coordinated** with these agencies **as** required.

Investigation Performance: The following individuals **or** firms will **be responsible** for the **(implementing]** all work activities.

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Engineering Subcontractor: E/A&H will serve as the engineering subcontractor for this project. As the engineering subcontractor, E/A&H is responsible for designing and implementing the RI/FS [and preliminary site characterization] activities.

Analytical Laboratory: [The laboratory to be used will be NEESA-approved. CLP analytical methods using Level IV protocol will be used by the selected laboratory.] The laboratory must adhere to the laboratory requirements in NEESA 20.2-047B. The laboratory must prepare and submit a laboratory QA plan, analyze and submit the results of proficiency testing, submit to an onsite inspection, and correct any deficiencies cited during the inspection by the NCR. The laboratories are required to identify a laboratory QA coordinator (LQAC) responsible for overall quality assurance. The LQAC must not be responsible for schedule, costs, or personnel other than QA assistants. It is preferred the LQAC report to the laboratory director. The LQAC must have the authority to stop work on projects if QC problems arise affecting the quality of the data produced.

In addition to conforming to all NEESA regulations, all work shall be performed in a manner consistent with the regulations listed below.

Applicable Regulations:

- The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as amended.
- The National Oil and Hazardous Substances Pollution Contingency Plan (NCP), Title 40 CFR, Part 300, as amended.
- Other appropriate federal, state, and local guidelines, rules, regulations, and criteria (where applicable).

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17.0 FLORIDA PROFESSIONAL GEOLOGIST SEAL

I have read and approve of the Final Comprehensive Sampling and Analysis Plan for NAS Pensacola and seal it in accordance with Chapter 492 of the Florida Statutes. In sealing this document, I certify the geological information contained in it is true to the best of my knowledge, and the geological methods and procedures included in this plan are consistent with currently accepted geological practices.

Name:	Brian E. Caldwell
License Number:	1330
State:	Florida
Expiration Date:	July 21, 1994

Brian E. Caldwell

Brian E. Caldwell

7/5/94

Date

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APPENDIX A

COMPREHENSIVE *SAMPLING AND ANALYSIS* PLANREVIEW FORM

Orientation *Meeting*

Instructions for Use: Before performing any actions at NAS Pensacola, E/A&H personnel will attend an orientation meeting at which the following requirements will be fully *explained.* Sign and date this form to indicate you have reviewed these requirements.

General Requirements

- ☐ Pensacola map showing locations of NAS Pensacola and selected air courier office
- ☐ Map of NAS Pensacola showing locations of *site office* trailer and site
- ☐ Health & Safety Plan *(see* Health & Safety Officer)

Sampling Requirements

- ☐ Unified Soil Classification System (USCS)
- ☐ Stainless-Steel Sleeves
- ☐ Sample-Numbering System
- ☐ QA/QC Frequency
- ☐ QA/QC Definitions
- ☐ Sample Packaging

Documentation Requirements

- ☐ Field Forms
- ☐ Field Logbooks
- ☐ Photographs

Acceptance

I have reviewed all of the requirements listed above for field activities *at* NAS Pensacola.

_____
Name

_____
Date

APPENDIX B

STANDARD PRACTICE FOR DESCRIPTION AND IDENTIFICATION OF SOILS (VISUAL-MANUAL PROCEDURE) ASTM D2488-90

Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)[1]

This standard is issued under the fixed designation D 2488; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense. Consult the DoD Index of Specifications and Standards for the specific year of issue which has been adopted by the Department of Defense.

1. Scope

1.1 This practice covers procedures for the description of soils for engineering purposes.

1.2 This practice also describes a procedure for identifying soils, at the option of the user, based on the classification system described in Test Method D 2487. The identification is based on visual examination and manual tests. It must be clearly stated in reporting an identification that it is based on visual-manual procedures.

1.2.1 When precise classification of soils for engineering purposes is required, the procedures prescribed in Test Method D 2487 shall be used.

1.2.2 In this practice, the identification portion assigning a group symbol and name is limited to soil particles smaller than 3 in. (75 mm).

1.2.3 The identification portion of this practice is limited to naturally occurring soils (disturbed and undisturbed).

NOTE 1—This practice may be used as a descriptive system applied to such materials as shale, claystone, shells, crushed rock, etc. (See Appendix X2).

1.3 The descriptive information in this practice may be used with *other* soil classification systems or for materials other than naturally occurring soils.

1.4 *This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For specific precautionary statements see Section 8.

1.5 The values stated in inch-pound units are to be regarded as the standard.

2. Referenced Documents

2.1 *ASTM Standards:*

D 653 Terminology Relating to Soil, Rock, and Contained Fluids[2]

D 1452 Practice for Soil Investigation and Sampling by Auger Borings[2]

D 1586 Method for Penetration Test and Split-Barrel Sampling of Soil[2]

D 1587 Practice for Thin-Walled Tube Sampling of Soils[2]

D 2113 Practice for Diamond Core Drilling for Site Investigation[2]

D 2487 Test Method for Classification of Soils for Engineering Purposes[2]

D 4083 Practice for Description of Frozen Soils (Visual-Manual Procedure)[2]

3. Terminology

3.1 *Definitions:*

3.1.1 Except as listed below, all definitions are in accordance with Terminology D 653.

NOTE 2—For particles retained on a 3-in. (75-mm) US standard sieve, the following definitions are suggested:

Cobbles—particles of rock that will pass a 12-in. (300-mm) square opening and be retained on a 3-in. (75-mm) sieve, and

Boulders—particles of rock that will not pass a 12-in. (300-mm) square opening.

3.1.1.2 *clay*—soil passing a No. 200 (75-μm) sieve that can be made to exhibit plasticity (putty-like properties) within a range of water contents, and that exhibits considerable strength when air-dry. For classification, a day is a fine-grained soil, or the fine-grained portion of a soil with a plasticity index equal to or greater than 4, and the plot of plasticity index versus liquid limit falls on or above the "A" line (set Fig. 3 of Test Method D 2487).

3.1.1.3 *gravel*—particles of rock that will pass a 3-in. (75-mm) sieve and be retained on a No. 4 (4.75-mm) sieve with the following subdivisions:

coarse—passes a 3-in. (75-mm) sieve and is retained on a ¾-in. (19-mm) sieve.

fine—passes a ¾-in. (19-mm) sieve and is retained on a No. 4 (4.75-mm) sieve.

3.1.1.4 *organic clay*—a clay with sufficient organic content to influence the soil properties. For classification, an organic clay is a soil that would be classified as a clay, except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

3.1.1.5 *organic silt*—a silt with sufficient organic content to influence the soil properties. For classification, an organic silt is a soil that would be classified as a silt except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

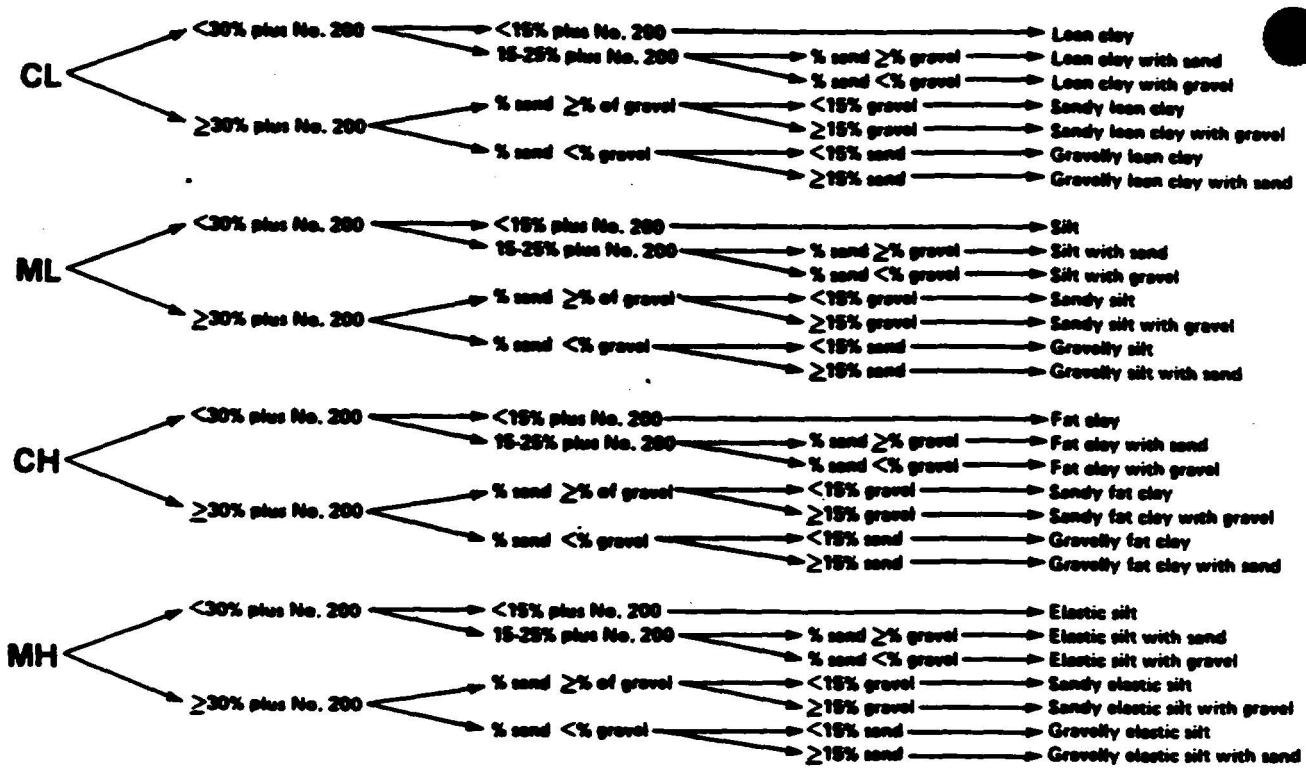
3.1.1.6 *peat*—a soil composed primarily of vegetable tissue in various stages of decomposition usually with an organic odor, a dark brown to black color, a spongy consistency, and a texture ranging from fibrous to amorphous.

3.1.1.7 *sand*—particles of rock that will pass a No.

[1] This practice is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.07 on Identification and Classification of Soils.

Current edition approved June 29, 1990. Published August 1990. Originally published as D 2488 – 66 T. Last previous edition D 2488 – 84[ε1].

[2] *Annual Book of ASTM Standards*, Vol 04.08.



NOTE—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 1a Flow Chart for Identifying Inorganic Fine-Grained Soil (50 % or more fines)

(4.75-mm) sieve and be retained on a No. 200 (75-μm) sieve with the following subdivisions:

coarse—passes a No. 4 (4.75-mm) sieve and is retained on a No. 10 (2.00-mm) sieve.

medium—passes a No. 10 (2.00-mm) sieve and is retained on a No. 40 (425-μm) sieve.

fine—passes a No. 40 (425-μm) sieve and is retained on a No. 200 (75-μm) sieve.

3.1.1.8 *silt*—soil passing a No. 200 (75-μm) sieve that is nonplastic or very slightly plastic and that exhibits little or no strength when air dry. For classification, a silt is a fine-grained soil, or the fine-grained portion of a soil, with a plasticity index less than 4, or the plot of plasticity index versus liquid limit falls below the "A" line (see Fig. 3 of Test Method D 2487).

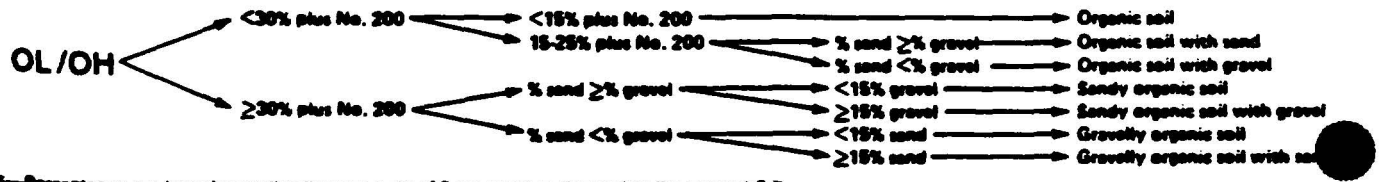
4. Summary of Practice

4.1 Using visual examination and simple manual tests, this practice gives standardized criteria and procedures for describing and identifying soils.

4.2 The soil can be given an identification by assigning a group symbol(s) and name. The flow charts, Figs. 1a and 1b for fine-grained soils, and Fig. 2, for coarse-grained soils, can be used to assign the appropriate group symbol(s) and name. If the soil has properties which do not distinctly place it into a specific group, borderline symbols may be used, see Appendix X3.

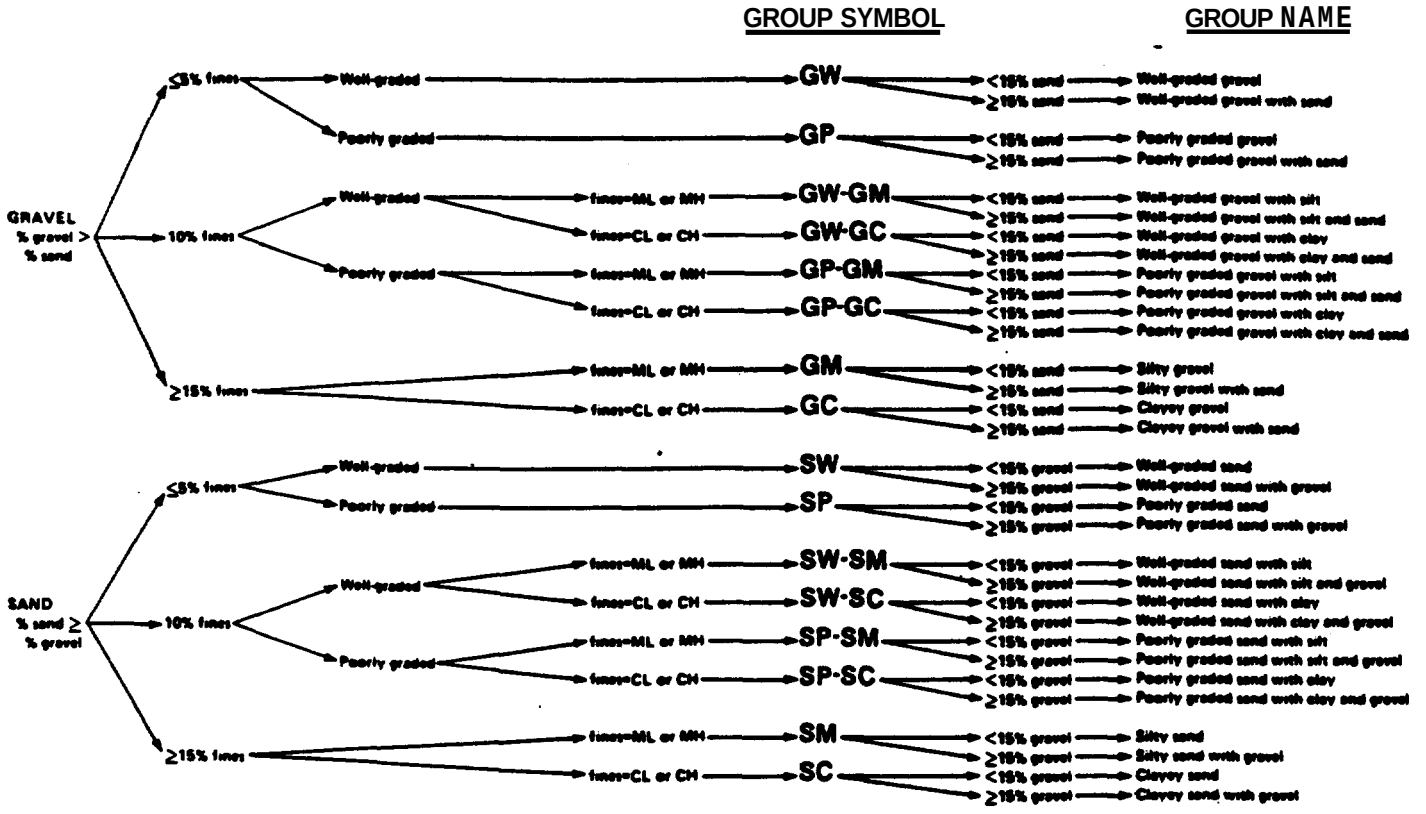
NOTE 3—It is suggested that a distinction be made between *dual symbols* and *borderline symbols*.

Dual Symbol—A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC, CL-ML used to indicate that the soil has been identified as having the properties of a classification in accordance with Test Method D 2487 where two symbols are required. Two symbols are required when the soil has between 5 and 12 % fines or



NOTE—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 1b Flow Chart for Identifying Organic Fine-Grained Soil (50 % or more fines)



NOTE—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 2 Flow Chart for Identifying Coarse-Grained Soils (less than 50 % fines)

when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart.

Borderline Symbol—A borderline symbol is two symbols separated by a slash, for example, CL/CH, GM/SM, CL/ML. A borderline symbol should be used to indicate that the soil has been identified as having properties that do not distinctly place the soil into a specific group (see Appendix X3).

5. Significance and Use

5.1 The descriptive information required in this practice can be used to describe a soil to aid in the evaluation of its significant properties for engineering use.

5.2 The descriptive information required in this practice should be used to supplement the classification of a soil as determined by Test Method D 2487.

5.3 This practice may be used in identifying soils using the classification group symbols and names as prescribed in Test Method D 2487. Since the names and symbols used in this practice to identify the soils are the same as those used in Test Method D 2487, it shall be clearly stated in reports and all other appropriate documents, that the classification symbol and name are based on visual-manual procedures.

5.4 This practice is to be used not only for identification of soils in the field, but also in the office, laboratory, or wherever soil samples are inspected and described.

5.5 This practice has particular value in grouping similar soil samples so that only a minimum number of laboratory tests need be run for positive soil classification.

NOTE 4—The ability to describe and identify soils correctly is learned more readily under the guidance of experienced personnel, but it may also be acquired systematically by comparing numerical laboratory test results for typical soils of each type with their visual and manual characteristics.

5.6 When describing and identifying soil samples from a given boring, test pit, or group of borings or pits, it is not necessary to follow all of the procedures in this practice for every sample. Soils which appear to be similar can be grouped together; one sample completely described and identified with the others referred to as similar based on performing only a few of the descriptive and identification procedures described in this practice.

5.7 This practice may be used in combination with Practice D 4083 when working with frozen soils.

6. Apparatus

6.1 *Required Apparatus:*

6.1.1 *Pocket Knife or Small Spatula.*

6.2 *Useful Auxiliary Apparatus:*

6.2.1 *Small Test Tube and Stopper* (or jar with a Lid).

6.2.2 *Small Hand Lens.*

7. Reagents

7.1 *Purity of Water*—Unless otherwise indicated, references to water shall be understood to mean water from a city water supply or natural source, including non-potable water.

7.2 *Hydrochloric Acid*—A small bottle of dilute hydrochloric acid, HCl, one part HCl (10 *N*) to three parts water (This reagent is optional for use with this practice). See Section 8.

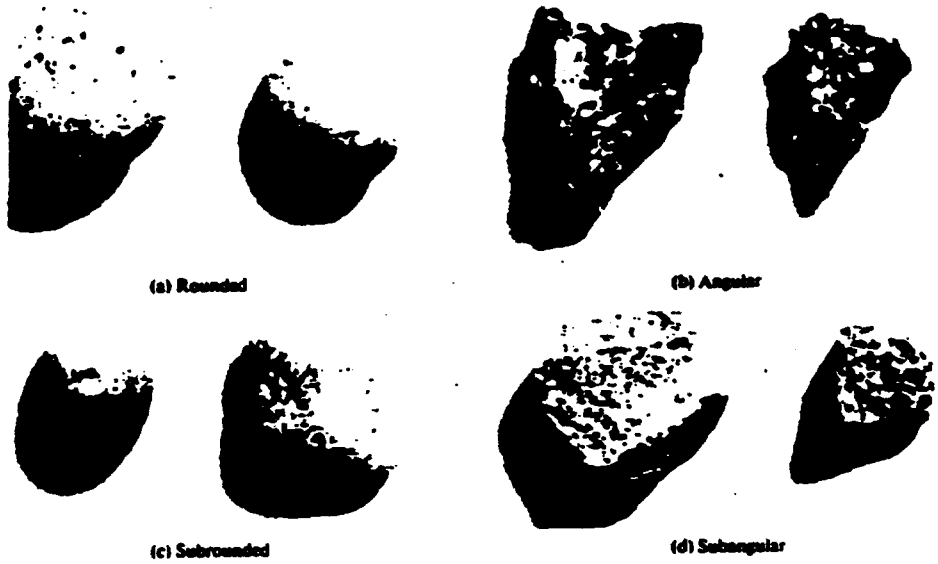


FIG. 3 Typical Angularity of Bulky Grains

8. Safety Precautions

8.1 When preparing the dilute HCl solution of one part concentrated hydrochloric acid (10 *N*) to three parts of distilled water, slowly add acid into water following necessary safety precautions. Handle with caution and store safely. If solution comes into contact with the skin, rinse thoroughly with water.

8.2 **Caution—Do** not add water to acid.

9. Sampling

9.1 The sample shall be considered to be representative of the stratum from which it was obtained by an appropriate, accepted, or standard procedure.

NOTE 5—Preferably, the sampling procedure should be identified as having been conducted in accordance with Practices D 1452, D 1587, or D 2113, or Method D 1586.

9.2 The sample shall be carefully identified as to origin.

NOTE 6—Remarks as to the origin may take the form of a boring number and sample number in conjunction with a job number, a geologic stratum, a pedologic horizon or a location description with respect to a permanent monument, a grid system or a station number and offset with respect to a stated centerline and a depth or elevation.

9.3 For accurate description and identification, the minimum amount of the specimen to be examined shall be in accordance with the following schedule:

Maximum Particle Size, Sieve Opening	Minimum Specimen Size, Dry Weight
4.75 mm (No. 4)	100 g (0.5 lb)
9.5 mm (⅜ in.)	200 g (0.5 lb)
19.0 mm (¾ in.)	1.0 kg (2.2 lb)
38.1 mm (1½ in.)	8.0 kg (18 lb)
75.0 mm (3 in.)	60.0 kg (132 lb)

NOTE 7—If random isolated particles are encountered that are significantly larger than the particles in the soil matrix, the soil matrix can be accurately described and identified in accordance with the preceeding schedule.

9.4 If the field sample or specimen being examined is smaller than the minimum recommended amount, the report shall include an appropriate remark.

TABLE 1 Criteria for Describing Angularity of Coarse-Grained Particles (see Fig. 3)

Description	Criteria
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces
Subangular	Particles are similar to angular description but have rounded edges
Subrounded	Particles have nearly plane sides but have well-rounded corners and edges
Rounded	Particles have smoothly curved sides and no edges

10. Descriptive Information for Soils

10.1 *Angularity*—Describe the angularity of the sand (coarse sizes only), gravel, cobbles, and boulders, as angular, subangular, subrounded, or rounded in accordance with the criteria in Table 1 and Fig. 3. A range of angularity may be stated, such as: subrounded to rounded.

10.2 *Shape*—Describe the shape of the gravel, cobbles, and boulders as flat, elongated, or flat and elongated if they meet the criteria in Table 2 and Fig. 4. *otherwise*, do not mention the *shape*. Indicate the fraction of the particles that have the shape, such as: one-third of the gravel particles are flat.

10.3 *Color*—Describe the color. Color is an important property in identifying organic soils, and within a given

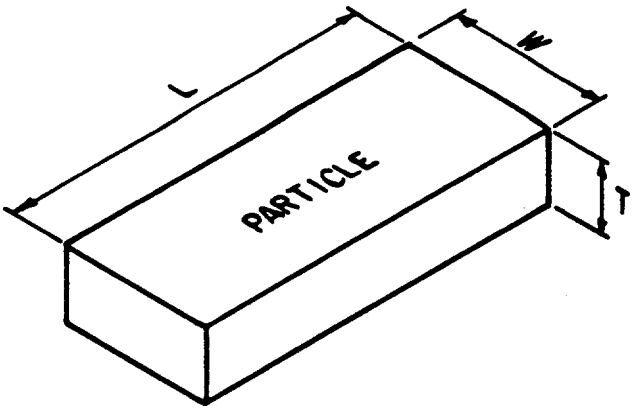
TABLE 2 Criteria for Describing Particle Shape (see Fig. 4)

The particle shape shall be described as follows where length, width, and thickness refer to the greatest, intermediate, and least dimensions of a particle, respectively.

Flat	Particles with width/thickness > 3
Elongated	Particles with length/width > 3
Flat and elongated	Particles meet criteria for both flat and elongated

PARTICLE SHAPE

W = WIDTH
T = THICKNESS
L = LENGTH



FLAT: W/T > 3
ELONGATED: L/W > 3
FLAT AND ELONGATED:
– meets both criterio

FIG. 4 Criteria for Particle Shape

TABLE 3 Criteria for Describing Moisture Condition

Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

locality it may also be useful in identifying materials of similar geologic origin. If the sample contains layers or patches of varying colors, this shall be noted and all representative colors shall be described. The color *shall* be described for moist samples. If the color represents a *dry* condition, this shall be stated in the report.

10.4 *Odor—Describe* the odor if organic or unusual. Soils containing a significant amount of organic material usually have a distinctive odor of decaying vegetation. This is especially apparent in fresh samples, but if the samples are dried, the odor may often be revived by heating a moistened sample. If the odor is unusual (petroleum product, chemical, and the like), it shall be described.

10.5 *Moisture Condition*—Describe the moisture condition as dry, moist, or wet, in accordance with the criteria in Table 3.

10.6 *HCl Reaction*—Describe the reaction with HQ as none, weak, or strong, in accordance with the criteria in Table 4. Since calcium carbonate is a common amenting agent, a report of its presence on the basis of the reaction with dilute hydrochloric acid is important.

TABLE 4 Criteria for Describing the Reaction With HCl

Description	Criteria
None	No visible reaction
Weak	Some reaction, with bubbles forming slowly
Strong	Violent reaction, with bubbles forming immediately

TABLE 5 Criteria for Describing Consistency

Description	Criteria
Very soft	Thumb will penetrate soil more than 1 in. (25 mm)
Soft	Thumb will penetrate soil about 1 in. (25 mm)
Firm	Thumb will indent soil about ¼ in. (6 mm)
Hard	Thumb will not indent soil but readily indented with thumbnail
Very hard	Thumbnail will not indent soil

10.7 *Consistency*—For intact fine-grained soil, describe the consistency as very soft, soft, firm, hard, or very hard, in accordance with the criteria in Table 5. This observation is inappropriate for soils with significant amounts of gravel.

10.8 *Cementation*—Describe the cementation of intact coarse-grained soils as weak, moderate, or strong, in accordance with the criteria in Table 6.

10.9 *Structure*—Describe the structure of intact soils in accordance with the criteria in Table 7.

10.10 *Range of Particle Sizes*—For gravel and sand components, describe the range of particle sizes within each component as defined in 3.12 and 3.16. For example, about 20 56 fine to *coarse* gravel, about 40 % fine to coarse sand.

10.11 *Maximum Particle Size*—Describe the maximum particle size found in the sample in accordance with the following information:

10.11.1 *Sand Size*—If the maximum particle size is a sand size, describe as fine, medium, or coarse as defined in 3.1.6. For example: maximum particle size, medium sand.

10.11.2 *Gravel Size*—If the maximum particle size is a gravel size, describe the maximum panicle size as the smallest sieve opening that the particle will pass. For example. maximum particle size, 1½ in. (will pass a 1½-in. square opening but not a ¼-in. square opening).

10.11.3 *Cobble or Boulder Size*—If the maximum particle size is a cobble or boulder size, describe the maximum dimension of the largest particle. For example: maximum-dimension, 18 in. (450 mm).

10.12 *Hardness*—Describe the hardness of coarse sand and larger particles as hard, or state what happens when the particles are hit by a hammer, for example, gravel-size particles fracture with considerable hammer blow, some gravel-size particles crumble with hammer blow. "Hard" means particles do not *crack*, fracture, or crumble under a hammer blow.

10.13 Additional comments shall be noted, such as the presence of roots or root holes, difficulty in drilling or augering hole. caving of trench or hole, or the presence of mica.

10.14 A local or commercial name or a geologic interpre-

TABLE 6 Criteria for Describing Cementation

Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

TABLE 7 Criteria for Describing Structure

Description	Criteria
Stratified	Alternating layers of varying material or color with layers at least 6 mm thick; note thickness
Laminated	Alternating layers of varying material or color with the layers less than 6 mm thick; note thickness
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided	Fracture planes appear polished or glossy, sometimes striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness
Homogeneous	Same color and appearance throughout

tation of the soil, or both, may be added if identified as such.

10.15 A classification or identification of the soil in accordance with *other* classification systems may be added if identified as such.

11. Identification of Peat

11.1 A sample composed primarily of vegetable tissue in various stages of decomposition that has a fibrous to amorphous texture, usually a *dark* brown to black color, and an organic odor, Shall be designated as a highly organic soil and shall be identified is peat, PT, and not subjected to the identification procedures described hereafter.

12. Preparation for Identification

12.1 The soil identification portion of this practice is based on the portion of the soil sample that will pass a 3-in. (75-mm) sieve. The larger than 3-in. (75-mm) particles must be removed. manually. for a loose sample, *or* mentally, for an intact sample before classifying the *soil*.

12.2 Estimate and note the percentage of cobbles and the percentage of boulders. Performed visually, these estimates will be on the basis of volume percentage.

NOTE 8—Since the percentages of the particle-size distribution in Test Method D 2487 are by dry weight, and the estimates of percentages for gravel, sand, and fines in this practice are by *dry* weight, it is recommended that the report state that the percentages of cobbles and boulders are by volume.

12.3 Of the fraction of the soil smaller than 3 in. (75 mm), estimate and note the percentage, by *dry* weight, *of* the gravel, sand, and fines (see Appendix X4 for suggested procedures).

NOTE 9—Since the particle-size components appear visually on the basis of volume, considerable experience is required to estimate tbr percentages on the basis *of* dry weight. Frequent comparisons with laboratory particle-size analyses should be made.

12.3.1 The percentages shall k estimated to the closest 5 %. The percentages of gravel, sand, and fines must add up to 100 %.

12.3.2 If one of the components is present but not in sufficient quantity to be considered 5 % of the smaller than 3-in. (75-mm) portion, indicate its presence by the term *trace*, for example, trace of fines. A trace is not *to* be considered in the total of 100 % for the components.

13. Preliminary Identification

13.1 The soil is *fine grained* if it contains 50 % or more fines. Follow the procedures for identifying fine-grained soils of Section 14.

13.2 The soil is *coarse grained* if it contains less than 50 % fines. Follow the procedures for identifying coarse-grained soils of Section 15.

14. Procedure for Identifying Fine-Grained Soils

14.1 Select a representative sample *of* the material for examination. Remove particles larger than the No. 40 sieve (medium sand and larger) until a specimen equivalent to about a handful of material is available. Use this specimen for performing the *dry* strength, dilatancy, and toughness tests.

142 *Dry Strength:*

14.2.1 From the specimen, select enough material to mold into a ball about 1 in. (25 mm) in diameter. Mold the material until it has the consistency of putty, adding water if necessary.

14.2.2 From the molded material, make at least three test specimens. A test Specimen shall be a ball of material about ½ in. (12 mm) in diameter. *Allow* the test specimens to dry in *air*, *or* sun, or by artificial means, as long as the temperature does not exceed 60°C.

142.3 If the test *Specimen* contains natural *dry* lumps, those that are about ½ *in.* (12 mm) in diameter may be used in place of the molded balls.

NOTE 10—The process of molding and drying usually produces higher strengths than are found in natural dry lumps of soil.

14.2.4 Test the strength of the dry balls or lumps by crushing between the fingers. Note the strength as none, low, medium, *high*, or very high in accorance with the criteria in Table 8. If natural dry lumps are used, do not use the results of any of the lumps that are found to contain particles of coarse sand.

142.5 The presence of high-strength water-soluble cementing materials, such is calcium carbonate, may cause exceptionally high dry strengths. The presence of calcium carbonate can usually be detected from the intensity of the reaction with dilute hydrochloric acid (see 10.6).

14.3 *Dilatancy:*

14.3.1 From the specimen, select *enough* material to mold into a ball about ½ in. (12 mm) in diameter. Mold the material, adding water if necessary, until it bas a soft, but not sticky, consistency.

14.32 Smooth the soil ball in the palm of one hand with the blade of 8 knife *or* small spatula. Shake horizontally, striking the side of the hand vigorously against the other hand several times. Note the reaction of water appearing on

TABLE 8 Criteria for Describing Dry Strength

Description	Criteria
None	The dry specimen crumbles into powder with mere pressure of handing
Low	The dry specimen crumbles into powder with some finger pressure
Medium	The dry specimen breaks into pieces or crumbles with considerable finger pressure
High	The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between thumb and a hard surface
Very high	The dry specimen cannot be broken between the thumb and a hard surface

TABLE 9 Criteria for Describing Dilatancy

Description	Criteria
None	No visible change in the specimen
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing

TABLE 10 Criteria for Describing Toughness

Description	Criteria
Low	Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft
Medium	Medium pressure is required to roll the thread to near the plastic limit. The thread and the lump have medium stiffness
High	Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness

the surface of the soil. Squeeze the sample by closing the hand or pinching the soil between the fingers, and note the reaction as none. slow, or rapid in accordance with the criteria in Table 9. The reaction is the speed with which water appears while shaking, and disappears while squeezing.

14.4 Toughness:

14.4.1 Following the completion of the dilatancy test, the test specimen is shaped into an elongated pat and rolled by hand on a smooth surface or between the palms into a thread about 1/8 in. (3 mm) in diameter. (If the sample is too wet to roll easily, it should be spread into a thin layer and allowed to lose some water by evaporation.) Fold the sample threads and reroll repeatedly until the thread crumbles at a diameter of about 1/8 in. The thread will crumble at a diameter of 1/8 in. when the soil is near the plastic limit. Note tbe pressure required to roll the thread near the plastic limit. Also, note the strength of the thread. After the thread crumbles, the pieces should be lumped together and kneaded until the lump crumbles. Note the toughness of the material during kneading.

14.4.2 Describe the toughness of the thread and lump as low, medium. or high in accordance with the criteria in Table 10.

14.5 *Plasticity*—On the basis of observations made during the toughness test, describe the plasticity of the material in accordance with the criteria given in Table 11.

14.6 Decide whether the soil is an inorganic or an organic fine-grained soil (see 14.8). If inorganic, follow the steps given in 14.7.

14.7 *Identification of* Inorganic Fine-Grained *Soils:*

TABLE 11 Criteria for Describing Plasticity

Description	Criteria
Nonplastic	A 1/8-in. (3-mm) thread cannot be rolled at any water content
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit

14.7.1 Identify the soil as a *lean clay*, CL, if the soil has medium to high dry strength, no or slow dilatancy, and medium toughness and plasticity (see Table 12).

14.7.2 Identify the soil as a *fat clay*, CH, if the soil has high to very high dry strength, no dilatancy, and high toughness and plasticity (see Table 12).

14.7.3 Identify the soil as a *silt*, ML, if the soil has no to low dry strength, slow to rapid dilatancy, and low toughness and plasticity, or is nonplastic (see Table 12).

14.7.4 Identify the soil as an *elastic silt*, MH, if the soil has low to medium *dry* strength, no to slow dilatancy, and low to medium toughness and plasticity (see Table 12).

NOTE 11—These properties are similar to those for a lean clay. However. the silt will dry quickly on the hand and have a smooth, silky feel when dry. Some soils that would classify as MH in accordance with the criteria in Test Method D 2487 are visually difficult to distinguish from lean clays, CL. It may be necessary to perform laboratory testing for proper identification.

14.8 *Identification of Organic Fine-Grained Soils:*

14.8.1 Identify the soil as an *organic soil*, OL/OH, if the soil contains enough organic particles to influence the soil properties. Organic soils usually have a dark brown to black color and may have an organic odor. Often, organic soils will change color, for example, black to brown, when exposed to the air. Some organic soils will lighten in color significantly when air dried. Organic soils normally will not have a high toughness or plasticity. The thread for the toughness test will be spongy.

NOTE 12—In some cases, through practice and experience, it may be possible to further identify the organic soils as organic silts or organic clays, OL or OH. Correlations between the dilatancy, dry strength, toughness tests, and laboratory tests can be made to identify organic soils in certain deposits of similar materials of known geologic origin.

14.9 If the soil is estimated to have 15 to 25 % sand or gravel, or both, the words "with sand" or "with gravel" (whichever is more predominant) shall be added to the group name. For example: "lean clay with sand, CL" or "silt with gravel, ML" (see Figs. 1a and 1b). If the percentage of sand is equal to the percentage of gravel, use "with sand."

14.10 If the soil is estimated to have 30 % or more sand or gravel, or both, the words "sandy" or "gravelly" shall be added to the group name. Add the word "sandy" if there appears to be more sand than gravel. Add the word "gravelly" if there appears to be more gravel than sand. For example: "sandy lean clay, CL", "gravelly fat clay, CH", or "sandy silt, ML" (see Figs. 1a and 1b). If the percentage of sand is equal to the percent of gravel, use "sandy."

15. Procedure for Identifying Coarse-Grained Soils (Contains less than 50 % fines)

15.1 The soil is a *gravel* if the percentage of gravel is estimated to be more than the percentage of sand.

TABLE 12 Identification of Inorganic Fine-Grained Soils from Manual Tests

Soil Symbol	Dry Strength	Dilatancy	Toughness
ML	None to low	Slow to rapid	Low or thread cannot be formed
CL	Medium to high	None to slow	Medium
MH	Low to medium	None to slow	Low to medium
CH	High to very high	None	High

15.2 The soil is a *sand* if the percentage of gravel is estimated to be equal to or less than the percentage of sand.

15.3 The soil is a *clean gravel* or *clean sand* if the percentage of fines is estimated to be 5 % or less.

15.3.1 Identify the soil as a *well-graded gravel*, GW, or as a *well-graded sand*, SW, if it has a wide range of particle sizes and substantial amounts of the intermediate particle sizes.

15.3.2 Identify the soil as a *poorly graded gravel*, GP, or as a *poorly graded sand*, SP, if it consists predominantly of one size (uniformly graded), or it has a wide range of sizes with some intermediate sizes obviously missing (gap or skip graded).

15.4 The soil is either a *gravel with fines* or a *sand with fines* if the percentage of fines is estimated to be 15 % or more.

15.4.1 Identify the soil as a *clayey gravel*, GC, or a *clayey sand*, SC, if the fines are clayey as determined by the procedures in Section 14.

15.4.2 Identify the soil as a *silty gravel*, GM, or a *silty sand*, SM, if the fines are silty as determined by the procedures in Section 14.

15.5 If the soil is estimated to contain 10 % fines, give the soil a dual identification using two group symbols.

15.5.1 The first group symbol shall correspond to a clean gravel or sand (GW, GP, SW, SP) and the second symbol shall correspond to a gravel or sand with fines (GC, GM, SC, SM).

15.5.2 The group name shall correspond to the first group symbol plus the words "with clay" or "with silt" to indicate the plasticity characteristics of the fines. For example: "well-graded gravel with clay, GW-GC" or "poorly graded sand with silt, SP-SM" (see Fig. 2).

15.6 If the specimen is predominantly sand or gravel but contains an estimated 15 % or more of the other coarse-grained constituent, the words "with gravel" or "with sand" shall be added to the group name. For example: "poorly graded gravel with sand, GP" or "clayey sand with gravel, SC" (see Fig. 2).

15.7 If the field sample contains any cobbles or boulders, or both, the words "with cobbles" or "with cobbles and boulders" shall be added to the group name. For example: "silty gravel with cobbles, GM."

16. Report

16.1 The report shall include the information as to origin, and the items indicated in Table 13.

NOTE 13—*Example: Clayey Gravel with Sand and Cobbles, GC*—About 50 % fine to coarse, subrounded to subangular gravel; about 30 % fine to coarse, subrounded sand; about 20 % fines with medium plasticity, high dry strength, no dilatancy, medium toughness; weak reaction with HCl; original field sample had about 5 % (by volume) subrounded cobbles, maximum dimension, 150 mm.

In-Place Conditions—Firm, homogeneous, dry, brown

Geologic Interpretation—Alluvial fan

NOTE 14—Other examples of soil descriptions and identification are given in Appendixes X1 and X2.

NOTE 15—If desired, the percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages, as follows:

Trace—Particles are present but estimated to be less than 5 %
Few—5 to 10 %
Little—15 to 25 %
Some—30 to 45 %
Mostly—50 to 100 %

TABLE 13 Checklist for Description of Soils

1. Group name
2. Group symbol
3. Percent of cobbles or boulders, or both (by volume)
4. Percent of gravel, sand, or fines, or all three (by dry weight)
5. Particle-size range:
   Gravel—fine, coarse
   Sand—fine, medium, coarse
6. Particle angularity: angular, subangular, subrounded, rounded
7. Particle shape: (if appropriate) flat, elongated, flat and elongated
8. Maximum particle size or dimension
9. Hardness of coarse sand and larger particles
10. Plasticity of fines: nonplastic, low, medium, high
11. Dry strength: none, low, medium, high, very high
12. Dilatancy: none, slow, rapid
13. Toughness: low, medium, high
14. Color (in moist condition)
15. Odor (mention only if organic or unusual)
16. Moisture: dry, moist, wet
17. Reaction with HCl: none, weak, strong

For intact samples:

18. Consistency (fine-grained soils only): very soft, soft, firm, hard, very hard
19. Structure: stratified, laminated, fissured, slickensided, lensed, homogeneous
20. Cementation: weak, moderate, strong
21. Local name
22. Geologic interpretation
23. Additional comments: presence of roots or root holes, presence of mica, gypsum, etc., surface coatings on coarse-grained particles, caving or sloughing of auger hole or trench sides, difficulty in augering or excavating, etc.

16.2 If, in the soil description, the soil is identified using a classification group symbol and name as described in Test Method D 2487, it must be distinctly and clearly stated in log forms, summary tables, reports, and the like, that the symbol and name are based on visual-manual procedures.

17. Precision and Bias

17.1 This practice provides qualitative information only, therefore, a precision and bias statement is not applicable.

18. Keywords

18.1 classification; clay; gravel; organic soils; sand; silt; soil classification; soil description; visual classification

APPENDIXES

(Nonmandatory Information)

X1. EXAMPLES OF VISUAL SOIL DESCRIPTIONS

XI. I The following examples show how the information required in 16.I can k reported. The information that is included in descriptions should be based on individual circumstances and need.

XI. 1.1 *Well-Gmded Gravel with Sand (GW)*—About 75 % fine to coarse, hard. subangular gravel; about 25 96 fine to *coarse,* hard. subangular sand trace of fines; maximum *size,* 75 mm, brown, dry; no reaction with HCl.

X1.1.2 *Silty Sand with Gravel (SM)*—About 60 % predominantly fine sand; about 25 % silty fines with low plasticity, low dry strength. rapid dilatancy, and low toughness: about I5 % fine. hard. subrounded gravel. a few gravel-size panicles fractured with hammer blow maximum size, *25* mm; no reaction with HCl (Note—Field sample size smaller than recommended).

In-Place Conditions—Firm. stratified and contains lenses of silt I to 2 in. (25 to 50 mm) thick. moist. brown to gray; in-place density 106 lb/ft³; in-place moisture 9 %.

X1.1.3 *Organic Soil (OL/OH)*—About 100 % fines with low plasticity, slow dilatancy, low dry strength, and low toughness; wet, dark brown, organic odor. weak reaction with HCl.

X1.1.4 *Silty Sand with Organic Fines (SM)*—About 75 % fine to coarse, hard, subangular reddish sand; about 25 % organic and silty dark brown nonplastic fines with no dry *strength* and slow dilatancy; wet; maximum *size. coarse* sand; weak reaction with HQ.

X1.1.5 *Poorly Graded Gravel* with *Silt. Sand. Cobbles and Boulders (GP-GM)*—About 75% fine to coarse, hard, subrounded to subangular gravel; about 15 % fine, hard, subrounded to tubangular sand; about 10 96 silty nonplastic fines: moist. brown: no reaction with HCI: original field sample had about 5 % (by volume) hard. subrounded cobbles and a trace of hard. subrounded boulders, with a maximum dimension of 18 in. (450 mm).

X2. USING THE IDENTIFICATION PROCEDURE AS A DESCRIPTIVE SYSTEM FOR SHALE, CLAYSTONE, SHELLS. SLAG, CRUSHED ROCK, AND THE LIKE

X2.1 The identification procedure may k used as a descriptive system applied to materials that exist in-situ as shale, claynone. sandstone. siltstone, mudstone, etc., but convert to soils after field or laboratory processing (crushing. slaking, and the like).

X2.2 Materials such as shells. crushed rock. slag, and the like, should be identified as such. However. the procedures used in this practice for describing the particle size and plasticity characteristics may be used in the description of the material. If desired, an identification using a group name and symbol according to this practice may be assigned to aid in describing the material.

X2.3 The group symbol(s) and group names should be placed in quotation marks or noted with some type of distinguishing symbol. See examples.

X2.4 Examples of how group names and symbols can be incororated into a descriptive system for materials that are not naturally occurring soils are as follows:

X2.4.1 Shale *Chunks*—Retrieved as 2 to 4-in. (50 to 100-mm) pieces of shale from power auger hole. dry, brown, no reaction with HCI. After slaking in water for 24 h, material identified as "Sandy Lean Clay (CL)"; about 60 % fines with medium plasticity, high dry strength, no dilatancy, and medium toughness; about 35 % fine to medium, hard sand about 5 % gravel-size pieces of shale.

X2.4.2 *Crushed Sandstone*—Product of commercial crushing operation: 'Poorly Graded Sand with Silt (SP-SM)"; about 90 % fine to medium sand: about 10 % nonplastic fines: dry. reddish-brown, strong reaction with HCI.

X2.4.3 *Broken Shells*—About 60 % gravel-site broken shells: about 30 % sand and sand-size shell pieces; about 10 % fines: 'Poorly Graded Gravel with Sand (GP)."

X1.4.4 *Crushed Rock*—Processed from gravel and cobbles in Pit No. 7; 'Poorly Graded Gravel (GP)"; about 90 96 fine, hard. angular gravel-size particles; about 10 % coarse, hard. angular sand-size particles; dry, tan: no reaction with HCl.

X3. SUGGESTED PROCEDURE FOR USING A BORDERLINE SYMBOL FOR SOILS WITH TWO POSSIBLE IDENTIFICATIONS.

X3.1 Since this practice is based on estimates of particle size distribution and plasticity characteristics. it may be difficult to clearly identify the soil as belonging to one category. To indicate that the soil may fall into one of *two* possible basic groups. a borderline symbol may be used with the two symbols separated by a slash. For example: SC/CL or CL/CH.

X3.1.1 A borderline symbol may be used when the

percentage of fines is estimated to be between 45 and 55 %. One symbol should be for a coarse-grained soil with fines and the other for a fine-grained soil. For example: GM/ML or CL/SC.

X3.1.2 A borderline symbol may be used when the percentage of sand and the percentage of gravel are estimated to be about the same. For example: GP/SP, SC/GC, GM/SM. It is practically impossible to have a soil that would have a borderline symbol of GW/SW.

X3.1.3 A borderline symbol may be used when the soil could be either well graded or poorly graded. For example: GW/GP, SW/SP.

X3.1.4 A borderline symbol may be used when the soil could either be a silt or a clay. For example: CL/ML, CH/MH, SC/SM.

X3.1.5 A borderline symbol may be used when a fine-grained soil has properties that indicate that it is at the boundary between a soil of low compressibility and a soil of high compressibility. For example: CL/CH, MH/ML.

X3.2 The order of the borderline symbols should reflect similarity to surrounding or adjacent soils. For example: soils in a borrow area have been identified as CH. One sample is considered to have a borderline symbol of CL and CH. To show similarity, the borderline symbol should be CH/CL.

X3.3 The group name for a soil with a borderline symbol should be the group name for the first symbol, except for:

CL/CH lean to fat clay
ML/CL clayey silt
CL/ML silty clay

X3.4 The use of a borderline symbol should not be used indiscriminately. Every effort shall be made to first place the soil into a single group.

X4. SUGGESTED PROCEDURES FOR ESTIMATING THE PERCENTAGES OF GRAVEL SAND, AND FINES IN A SOIL SAMPLE

X4.1 *Jar Method*—The relative percentage of coarse- and fine-grained material may be estimated by thoroughly shaking a mixture of soil and water in a test tube or jar, and then allowing the mixture to settle. The coarse particles will fall to the bottom and successively finer particles will be deposited with increasing time: the sand sizes will fall out of suspension in 20 to 30 s. The relative proportions can be estimated from the relative volume of each size separate. This method should be correlated to particle-size laboratory determinations.

X4.2 *Visual Method*—Mentally visualize the gravel size particles placed in a sack (or other container) or stacks. Then, do the same with the sand size particles and the finer. Then, mentally compare the number of stacks to estimate the percentage of plus No. 4 sieve size and minus No. 4 sieve size present. The percentages of sand and fines in the minus sieve size No. 4 material can then be estimated from the wash test (X4.3).

X4.3 *Wash Test (for relative percentages of sand and fines)*—Select and moisten enough minus No. 4 sieve size material to form a 1-in (25-mm) cube of soil. Cut the cube in half, set one-half to the side and place the other half in a small dish. Wash and decant the fines out of the material in the dish until the wash water is clear and then compare the two samples and estimate the percentage of sand and fines. Remember that the percentage is based on weight, not volume. However, the volume comparison will provide a reasonable indication of grain size percentages.

X4.3.1 While washing, it may be necessary to break down lumps of fines with the finger to get the correct percentages.

X5. RATIONALE

X5.1 This practice was significantly revised in the D 2488 – 84 version from the previous version D 2488 – 69 (1975). The revisions are documented in the literature.[3]

X5.2 Changes in this version from the previous version include rewording of 1.2.3 to say (disturbed and undisturbed), the addition of 5.7 to refer to the practice for describing frozen soils, and the addition of Appendix X5 on Rationale.

[3] Howard, A. K. "The Revised ASTM Standard on the Description and Identification of Soils (Visual-Manual Procedure)," *Geotechnical Testing Journal*, GTJODJ Vol. 10, No. 4, December 1987.

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This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, 1916 Race St., Philadelphia, PA 19103.

APPENDIX C

OPERATING MANUAL FOR HYDROLAB DATASONDE 3 DATALOGGER

Hydrolab Operating Procedures

The Hydrolab Datasonde 3 (DS3) Multiparameter Water Quality Datalogger is an online transmitter of in-situ water quality measurements. The device measures temperature, pH, dissolved oxygen (DO), conductivity, salinity, depth, and [oxidation-reduction potential] (Redox) readings in lakes, streams, estuaries, or other large or small water bodies. The DS3 is designed for multi-mode operation. Data output can be continuously monitored, or the unit can operate remotely with data stored on board until downloading. Its digital output can be displayed, logged, and downloaded to a personal computer, or remotely transmitted through a modem or communications link. The device is built for operation in abusive field conditions.

DS3 Data Display Variables (Accuracy)

- Temperature in [°]C/F (±0.15°C)
- pH in units (±0.2 units)
- Redox in millivolts [(mv)] (±20 mV)
- DO in [milligrams per liter] (mg/L) or % Saturation (DO, ±0.2mg/L)
- Conductivity in milliSiemens/[centimeter] ([ms]/cm), microSiemens/cm [(μS/cm)], K ohms/cm, or resistivity (±1 [percent] of range)
- Salinity in [parts per thousand] (ppt) or total dissolved solids (TDS) (±0.2ppt)
- Depth (feet or meters) in level or total level (±0.45m)

The DS3's waterproof cylindrical core is constructed of durable plastic and contains a battery pack, a real-time clock, a solid-state memory package, and logging software. Attached to the lower end of the core is a multiprobe unit containing a temperature sensor, a specific conductance/salinity sensor, a pH glass electrode, a Redox sensor, a DO sensor, and a depth sensor. The lower end also contains the unit's sensor guard and ballast weight, or stirrer assembly. The upper end of the DS3 unit contains an RS-232 data output port, and a stainless-steel anchoring bail.

Standard Operating Mode

Once communication is established between the DS3 and computer, the following introductory heading will appear on-screen:

HYDROLAB Datasonde 3 VX.YZ
(C)opyright 1990 Hydrolab Corporation

Time	Temp	pH	SpCond	Salin	DO	DO	Redox	Depth	Batt

HHMSS deg C units ms/cm ppt %Sat mg/L mv meters volts

This header appears only if the header function of the Variables Menu is enabled. The header denotes the DS3's software version, its alpha-numeric name, measurement parameters currently enabled, and the current measurement variables selected for those parameters. If these features are *changed* after the program is entered, the new alpha-numeric name and parameters will be displayed when communication with the unit is re-initiated. Immediately following the *appearance* of the header, the DS3 will enter its Standard Operating Mode (SOM), whereby row after row of parameters will appear on screen. The third and fourth lines of the introductory header will be reprinted once every 24 lines so the columns can be identified once the initial header has scrolled off-screen.

The Basic Menu

The Basic Menu is accessed from the SOM by hitting the space bar. The following then appears on-screen:

HYDROLAB Datasonde 3 V X.YZ

- (P)arameters
- (C)alibrate
- (V)ariables
- (L)ogging
- (H)eader
- (M)easure
- (I)dentity
- or (Escape or Ctrl X to cancel)

Typing any of the letters in parentheses will [select] the menu of interest. Each entry within a menu results in the program returning to the SOM. The menu selection must therefore be re-accessed via the Basic Menu after each entry is made.

- **Parameters**

Typing a "P" will access the Parameters Menu, providing the following display:

- (p)H
- Specific (C)onductivity/Resistivity
- (S)alinity/TDS
- (%)Sat
- D(O)
- (R)edox
- (D)epth/Level

— (B)attery
— (A)ll
— or (Escape or Ctrl X to cancel)

Selecting the letter in parentheses allows individual parameters to be enabled or disabled from this menu. Care should be taken when using this function, as certain parameters depend u p others. For instance, disabling all forms of specific conductance will automatically disable DO, or enabling DO will automatically enable specific conductance. Time and temperature cannot be disabled.

- Variables

Typing a "V" from the Basic Menu will access the Variable Menu, which allows default Settings to be made for measurement variables. The Variable menu appears as follows:

— (T)emperature
— Specific (C)onductance/Resistivity
— (%) Sat
—
— (D)epth/Level
— (A)utolog
— SDI-12 Addr(e)ss
— SDI-12 De(l)ay
— (H)eader
— (B)uzzer
— (S)tirrer
— E(x)pert
— Ba(u)d Rate
or (Escape or Ctrl X to cancel)

Typing any letter in parentheses will [select] a particular feature from the Variable Menu.

Temperature

This feature allows the temperature variable to be manipulated. Either the Centigrade or Fahrenheit scales are selected for temperature measurement.

Specific Conductance/Resistivity

This feature allows either specific conductance or resistivity to be selected as a measurement value, and permits additional attributes to be adjusted. Succeeding choice of measurement value, the presentation of this value is selected in either milliSiemens/cm or microSiemens/cm. Following selection of presentation format, the type of cell block is selected (freshwater if specific conductances between 0 [and] 10 mS/cm are anticipated, seawater if specific

conductances greater than 10 mS/cm are anticipated). The specific conductance measuring range is then chosen. The measuring range can be automatic, or readings can be made in the high, medium, or low range. The next item selected is for salinity to be measured, or TDS. The final item selected is for specific conductance/resistivity and salinity/TDS readings to be compensated or uncompensated for temperature.

% Sat

This feature allows a barometric pressure that is different from the calibration value to be entered, if necessary.

DO

This feature allows certain aspects of the DO measurements to be specified. Standard or Hydrolab LoFlow membranes are selected, as are whether readings are to compensate for salinity, or [be] uncompensated.

Depth/Level

This feature [manipulates] the depth/level variable. Either meters or feet are chosen as an expression of depth. Following selection of the variable, either "depth" or "level" is chosen, depending on how the DS3 is equipped. If the unit is equipped with a depth transducer (having a range of 0 [to] 100 meters), depth is chosen for this expression. If the unit has a level transducer (having a range of 0 [to] 10 meters), level is chosen for this expression. The transducer type is printed on the DS3's label.

Autolog

This feature allows access to Autolog. This function enables or disables the automatically started logging sequence, which provides a record of all parameters once each hour. An enabled autolog can provide backup data for situations where the starting time or date, stopping time or date, or interval time has been incorrectly specified. Also, if for some reason there is a reset of transmitter electronics (power fluctuations, etc.), Autolog is set by default to be enabled.

SDI-12 Address

This feature allows the unit to be personalized. The SDI-12 address that the user wishes to assign a particular DS3 is entered.

SDI-12 is an interface bus designed to [connect] a wide variety of transducers without having to worry about incompatible sensor outputs. It sends information to a single data recorder (the SDI-12 controller) with a single cable bus.

SDI-12 Delay

This feature [incorporates] a measurement delay (normally 30 or 120 seconds).

Header

This feature [enables or disables] the display of header information. If enabled, header information is included in the data lines.

Buzzer

This feature [enables or disables] the buzzer function. If enabled, a buzzer sounds each time a reading is made.

Stirrer

This feature [enables or disables] the stirrer function. Once enabled, the DS3 automatically actuates the stirrer for each logging run.

Expert

This feature enables or disables the expert function, which abbreviates items appearing on the menu screen and data printout.

Baud Rate

This feature allows the unit to be set to a different baud rate before dumping a memory file. The DS3 starts up at 1,200 baud. However, 1,200 baud is not fast enough to keep up with a DS3 during recovery of logged data. The Baud Rate feature allows selection from [five] available baud rates (9,600, 44,800, 2,400, 1,200, or 300). The communications program for the computer will need to be set to the selected baud rate.

Report

This feature provides a report of all of the default settings currently selected from the Variable Menu.

- **Calibration**

[Before deploying] the DS3, the unit should be checked for calibration and operation. Calibration also should be checked periodically when the unit is deployed in the field for extended periods. The unit is calibrated by pouring a calibration standard into the calibration cup [that] comes with the apparatus. Alternately, the entire unit can be immersed in a bucket of calibration standard.

Typing a "C" from the Basic Menu will access tk Calibrate Menu, which is displayed as follows:

— (p)H
— Specific (C)onductivity/Resistivity
— (S)alinity/TDS
— (%)Sat
— D(O)
— (R)edox
— (D)epth/Level
— (L)abel
— (T)ime
— (I)nterval
— (M)essage
— or (Escape or Ctrl X to cancel)

Typing any of the letters in parentheses will allow calibration of that particular function. Temperature is permanently set at the factory and cannot be field calibrated.

pH

[The] pH calibration is initiated by using a 7-buffer solution to first adjust the pH system's zero. Subsequently, a slope buffer solution is used to adjust the pH system's slope. The unit will accept any pH value between 6.8 and 7.2 for the zero setting. Typing in the value of the buffer automatically calibrates the pH system to zero. To adjust pH slope, the calibration procedure is repeated with the slope buffer solution. The slope buffer value must be below 6.8 or higher than 7.2 for proper adjustment.

Specific Conductance/Resistivity

Specific conductance calibration is initiated by monitoring readings until they have stabilized for the standard solution, and them entering the value for the standard. If the default setting has been set to measure resistivity, the resistivity value for the standard is entered.

Salinity/TDS

Salinity calibration is initiated by accessing the salinity/TDS function. If the default setting is set for salinity, the value of the salinity calibration standard in parts per thousand at 25°C is entered. If TDS is the default selection, the TDS for the calibration standard is entered.

Dissolved Oxygen

DO calibration can be set for % saturation or for mg/L. Type "%" to calibrate for % saturation. Once into this function, enter the local barometric pressure (in millimeters of mercury). This adjusts calibration for both DO mg/L and DO % saturation (calibration should

be 100.0 for the standard membrane, or 102.5 for the Hydrolab LoFlow membrane). Alternatively, type "O" to calibrate for DO mg/L. Enter the local barometric pressure as before, subsequently entering the DO concentration of the calibration standard as measured via Winkler titration or other instrumentation.

Redox

The Redox value of the calibration standard can be entered upon access to the Redox function.

Depth/Level

Depth calibration can be zeroed in air, at or near the surface of the water to be sampled, or at a known water depth. The depth is entered in either meters or feet, depending upon the default variable.

Additional Features of the Calibrate Menu

Entering the Label function allows the name of the transmitter to be changed (up to 12 characters). Accessing the Time function, allows the month/day/year/time to be entered. The military-time format is used (HHMMSS). The Interval function allows the time to be set for the data printing interval. The Message Interval allows notes to be entered into the data record being created, if necessary, to help maintain clarity of the record.

- **Logging**

The Logging Menu allows the set up of a logging routine for automatic, unattended monitoring. The DS3 transmitter can log in two forms of memory, depending upon the configuration of the unit. Standard memory can log up to 32,000 readings (allowing all parameters to be logged twice an hour for approximately 60 days). Extended memory can log up to 70,000 readings.

If information is downloaded to a [personal] computer (PC), [it] must be IBM compatible, possess a serial or COMM port, have DOS version 2.0 or higher installed, and be compatible with a DB25F to DB25M adapter cable. The PROCOMM Plus Software Terminal Emulator Program is required to properly interface the PC with the DS3. To communicate with a PC, make sure the baud rates for both DS3 and computer are compatible. The unit's default setting is 1200 baud, but can be changed through the Variable Menu. An interface cable, underwater cable, or calibration cable can be used to connect the DS3 to the computer. Since the DS3 needs to be powered during the logging sequence, sufficient battery power needs to be available. Once connected, if the DS3 and computer are properly interfaced, pressing the space bar accesses the SOM/Basic Menu.

Typing an "L" from the Basic Menu allows access to the Logging Menu, which is displayed as follows:

- (D)ump
- (E)rase
- (S)etup
- S(t)atus
- (R)eview
- (A)nnotate
- St(o)re
- or (Escape or Ctrl X to cancel)

Typing any of the letters in parentheses will allow entry into that particular logging function.

Dump

This feature allows the user to erase files no longer needed. Logging runs can be set up, and data files can be reviewed. Data storage on the manual file can be initiated, or this file can be annotated. Data can be dumped as "printer ready" if it is to be used for disk archiving or for word processing. Data also can be dumped into a pre-formatted file for a spreadsheet.

The Dump function allows selection of different configurations of variables/calibrations:

- Variables/calibrations in effect when the logging run was setup can be used.

- If re-calibration took place at any time during a run, data can be adjusted to reflect the calibration changes as they took place.

  The variables/calibrations current at the time of data dump can be used.

This feature allows comparison of readings for an indication of calibration drift. If improper variables were set, (cell block type, DO membrane type, etc.) corrections can be made by re-dumping with those variables changed to a proper Setting.

Selecting the Printer Ready function allows automatic statistical work to be done. Statistics are compiled for each parameter in the form of the number of readings taken, the number of readings taken that were out of the parameter's measurement range, minimum and maximum readings, maximum rate of change between measurements, and mean/standard deviation. Daily statistics, total statistics, both daily/total statistics, or no statistics can be chosen.

If any parameter values are accompanied by an asterisk (*), that value is based on a default calibration setting. This means that the DS3 has forgotten the calibration information provided for the sensor measuring that parameter, and has replaced it with a nominal calibration setting. The affected sensor needs re-calibration, and if the parameter affects other parameters, these will

also appear with asterisks (i.e., specific conductance, which affects salinity, DO, and depth readings).

Selecting the Spreadsheet Importable function pre-formats data for spreadsheet distribution, quoting all text. This download is accomplished via an X-modem transfer. The Spreadsheet Importable function does not compute any statistics, however.

Erase

The erase function allows a file to be erased to regain use of the memory space occupied by that file.

Setup

This function allows a logging run to be set up. [Before] staring the logging run, the status of all enabled/disabled parameters should be checked, as well as the status of the stirrer and buzzer. The stirrer and buzzer cannot be altered during a logging run, while calibration and variables *can* be changed during a run.

To set up a run, the menu *calls* for the name of the logging run to be entered. It then asks for entry of commencement date/time (in MMDDYY/HHMMSS, and stopping date/time (in MMDDYY/HHMMSS). The program then asks for the time between logging scans (in HHMMSS), and if a warm up is desired [before beginning] the run. The warmup function allows the DS3 to warm up for 2 minutes [before] the logging run, recommended if a stirrer is used or if DO-pH-Redox sensors are not continuously polarized. Power consumption must be considered. This 2-minute warmup is not necessary if the DO-pH-Redox internal polarizing batteries *are* used. These batteries continuously power the pH and Redox amplifiers, and the DO sensor, doing away with their 2-minute warmup requirement. A possible shortened life *span* for the DO sensor must be considered. Even if no warmup is chosen, the DS3 automatically warms up for 30 seconds [before beginning] a logging *scan.*

Once a logging run has been set up, the DS3 is disconnected from the interface cables. The transmitter will activate automatically when the logging run starts. It will continue to activate until logging is scheduled to stop, the power supply is depleted, or the memory is full.

Status

This function displays a logging status *report.* The name and number of each logging run is listed (start/stop/interval). Remaining memory (number of scans/readings based on current parameters) is listed, and remaining battery time (% battery life) is *estimated.*

Review

This function allows stored data to be scanned without dumping the *entire* file. The *scan can* begin at the beginning of a file, the end of a file, or at a specific date and time.

Annotate

This function allows a 49-character annotation to be entered in a text format adjacent to a particular file. The note then will be downloaded along with the file.

Store

This function allows [data to be entered manually] for a particular situation. If during a survey, the readings for a particular station have stabilized, the data *can* be immediately stored as a manual file.

- Header

Typing an "H" from the Basic Menu allows access to the Header Menu. This causes the header to be printed, and is useful if the Header function has been disabled through the Variables Menu.

The header will appear as:

ABCDEF123456

Time	Temp	pH	SpCond	Salin	DO	DO	Redox	Depth	Batt
HHMSS	deg C	units	ms/cm	ppt	%Sat	mg/l	mv	meters	volts

- **Measure**

Typing an "M" from the Basic Menu allows access to the Measure Menu. *Actuating* this feature will cause *one* line *of* data to be printed immediately. This is useful if the user wants to take occasional discretionary readings.

- **Identify**

Actuating this feature from the Basic Menu causes the DS3 to print its software version and parameters that the unit will currently support. It will appear as:

Hydrolab DS3 VX.YZ TPCS%ORDB

Power Supply

The internal *battery* pack uses 10 "AA" batteries, which are contained in the upper part of the unit. The internal *battery* pack will support a unit for 20 days (stirrer used) or 30 days (no stirrer used). A *submersible* external battery pack also can be used, and will support the DS3 for up to 140 days, but cannot be used with a stirrer. Power can also be furnished by cable. The power source must remain connected to *the* transmitter during the logging function.

Unit Configuration

Configuration of a DS3 should be carefully considered. If the Hydrolab LoFlow DO sensor is used, internal polarizing batteries are necessary. This is because the LoFlow DO sensor requires a 5-minute warmup period, and should therefore be continuously powered. If the standard membrane DO sensor is used, a stirrer is necessary unless a flow rate of 25 cm/sec is maintained past the sensor. The two minute warmup is sufficient for the standard DO membrane. If the LoFlow DO sensor is used, the weighted sensor guard is used over the multiprobe unit. The stirrer replaces the sensor guard when used, and also provides sensor protection and negative buoyancy.

Deployment

The DS3 is anchored by tying a rope or chain to the stainless-steel bail at the top of the unit. The device should be fixed either upright or level. The unit should be protected from floating debris, and should not be deployed in a location that makes it a navigation hazard. If marked with a buoy, it should not be made attractive to vandals. It is recommended that the multiprobe weighted sensor guard or stirrer be installed, as well as the DO sensor guard. The pH reference electrode should be uncapped. Be prepared to re-calibrate as necessary. The DO membrane may require changing after only a few days. If the unit is stationed in shallow water, them is a danger it could be hit by boats or outboard motor propellers.

DS3 Maintenance

Contaminated or worn out sensors will produce unreliable data. The maintenance manual provides instructions on replacing or servicing worn sensors. This requires careful disassembly of some of the sensors, and re-calibration. A maintenance schedule needs to account for periodic downtime for each unit.

APPENDIX D

OPERATING MANUAL FOR THE NISKIN WINGED CURRENT METER

GENERAL OCEANICS

MODEL 6011 MkII

NISKIN WINGED CURRENT METER

OPERATING MANUAL
RAM MEMORY

MARCH 1991

Preliminary

YOUR CURRENT METER SHOULD BE RECEIVED WITH THE FOLLOWING ITEMS. PLEASE CHECK WHEN UPACKING TO BE SURE THEY ARE INCLUDED.

1. 6011MK2 CURRENT METER
2. VISIBLE SENSORS, PRESSURE & CONDUCTIVITY
3. WIRE MOORING STANDOFF FRAME (W/ANODES) AND WIRE STOP
* 4. RAM MEMORY CARTRIDGE
5. OPERATORS MANUAL

*RAM MEMORY CARTRIDGES AND RAM READER KITS ARE PRICED SEPARATELY

IF *ANY* OF THE ITEMS ARE MISSING, PLEASE CONTACT G.O. ASAP

INC. • 1295 N.W. 163rd Street, Miami, Florida 33169-9922 • Tel.: (305) 621-2882 Telex: 80-8247 Fax: (305) 621-17

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Low-Speed Fin with Conductivity

Fig. 8 Calibration Curve
Standard Fin: No Environmental Sensors

Fig. 9 Calibration Curve
Standard Fin with Conductivity

Fig. 10 Calibration Curve
High-Speed Fin: No Environmental Sensors

Fig. 11 Calibration Curve
High-Speed Fin with Conductivity

1 INTRODUCTION

The General Oceanics model 6011 MkII is a battery-powered RAM recording current meter. It measures current by measuring the angle of tilt of its own housing when suspended from a suitable mooring. Wings on the housing orient the meter with the current, the direction of which is then determined by a solid-state flux-gate compass. The absence of rotors and other delicate external sensors, together with its extremely low power consumption, make the meter ideal for long term deployments in the deep ocean, while its small size and ease of handling make it the choice for much inshore work.

The meter incorporates a real-time clock. This means that Universal Coordinated Time (GMT) is recorded with each data point on the RAM cartridge. Log keeping and data analysis are thereby simplified and there is less chance of ambiguity in interpreting the data record. The real-time clock is powered by its own battery, which is separate from the meter's main power battery, and which has a five-gear lifetime.

The basic meter records temperature as well as the data for current speed and direction. Sensors to measure conductivity and pressure are also available as options.

In the "Vector-Averaging" mode, the internal microprocessor computes the average east and north components of current from a number of individual readings and records only those averages on the RAM cartridge, a data compression technique which increases the effective capacity of the cartridge by up to thirty-two times. The microprocessor also computes and records the standard deviation of the averages to provide information on the noise environment of the meter. Vector-averaging is the preferred mode of operation. It provides the maximum amount of data and requires the least amount of post-deployment data processing.

After the meter has been recovered the RAM cartridge must De processed. General Oceanics offers the service of reading RAM cartridges and supplying a complete range of data products. Alternatively, the user can acquire a model 6011RR RAM reader to interface with any one of a range of desk-top computers, which allows the user to process the data himself.

General Oceanics can supply auxiliary hardware to facilitate deployment of the model 6011 current meter in a wide range of situations. Deployment from a fixed structure such as an oil rig or harbor pier is the easiest to set up. For near-bottom measurements, a "gallows" frame is available which provides a fixed point mooring at a known height in the water. Most deployments use a wire mooring with either a surface or sub-surface float. For this application a "stand-off" is used, which can be clamped to the wire at any depth without cutting or damaging the wire in any way. The stand-off not only keeps the

meter clear of the wire, but also de-couples the meter from mooring motion. Both a standoff and a wire stop are supplied with the meter.

The design of the stand-off and the operating principle of the meter itself both help to simplify mooring design. Being able to clamp the stand-off at any point along the wire makes it easy to re-configure a mooring to meet changing operational requirements Also, since the meter takes up an angle of tilt determined only by the current, the tilt of the mooring itself is a secondary consideration. This means that, particularly in high current regimes, buoyancy requirements and anchor weights can be greatly reduced.

The meter is normally supplied with a standard fin which covers the speed range zero to 225 cm/sec. For greater resolution at low speeds or to estend the range to higher speeds, low-speed and high-speed fins are available.

2 PRINCIPLES OF OPERATION

2.1 Basis

The Model 6011 MK II current meter is a microprocessor controlled data logger which captures data from a number of sensors and then records them on a RAM cartridge. The overall operation of the meter is best explained by the simplified program flow chart shown in Fig. 1.

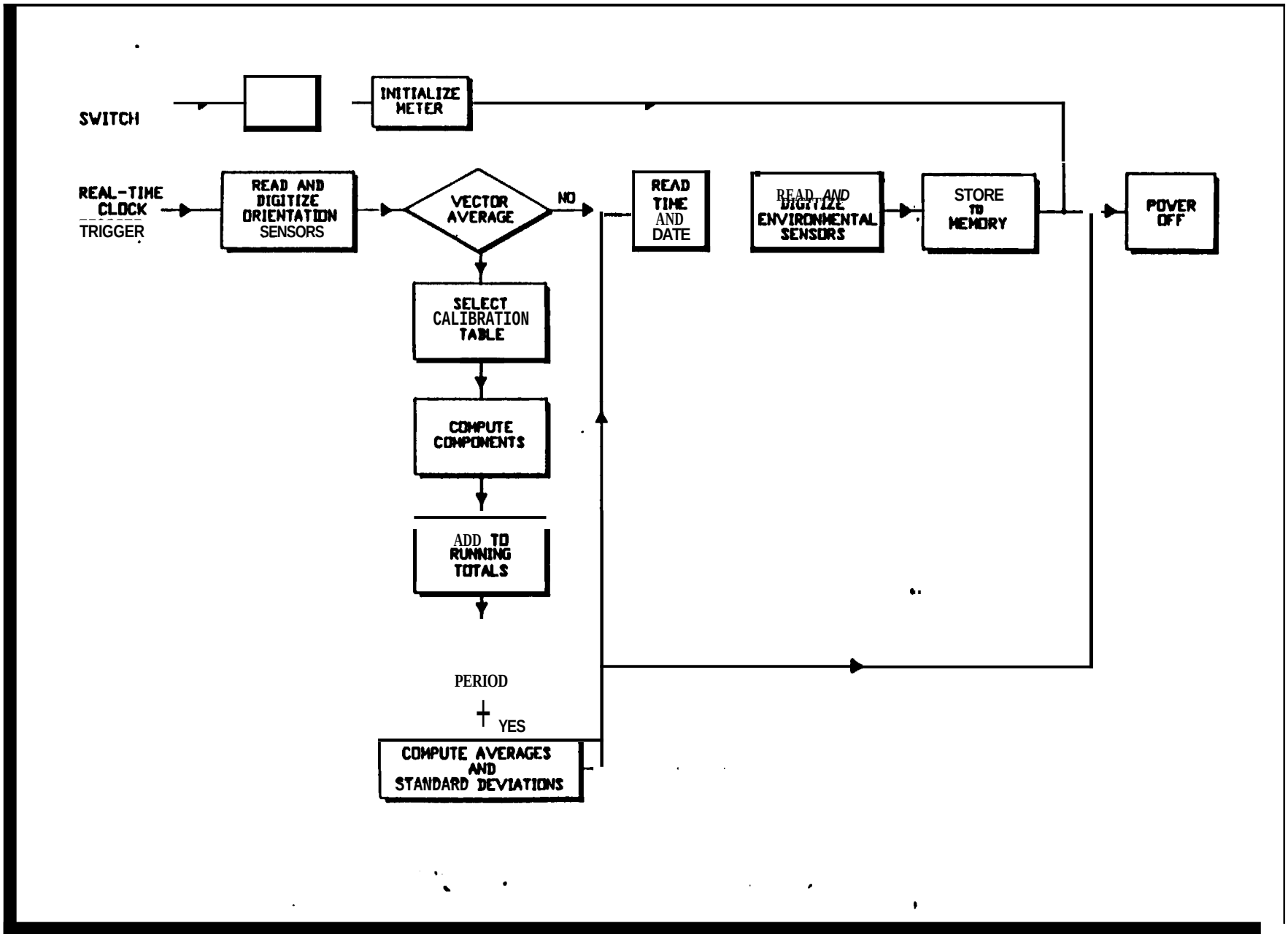

Fig.1 Simplified Program Flow Chart

2.2 Vector Averaging

In the vector-averaging mode, the microprocessor proceeds to compute the north and east components of current immediately after is has read the orientation sensors. To compute the components it needs to know which of the three fins are fitted to the meter. This information is provided by the setting of the mode selector switch: positions 2, 3 and 4 for vector averaging with low, standard and high speed fins. The number of samples over which the average is taken is determined by the setting of the samples-per-burst switch on the real-time clock board. As shown in Fig. 2, a line called "burst status" .remains low during the burst period. All the time the status line is low, each component is added to a running. total. If it is high, signalling the end of the averaging period, the running :total is divided by the number of samples to arrive at the average. Standard deviation is treated in a similar way. The meter then goes on to read the real-time clock and the outputs of the environmental sensors. Each reading is tagged with time and recorded to RAM. Finally the meter is powered down. This means that battery power to the sensors and any other high current components is switched off; only the essential time-keeping components and some of the data memory remain operating. Hence, current consumption between samples is reduced to a few microamps, allowing the meter to operate for up to one year on a single batter. One can see from the last part of the flow chart that time, date and the readings of the environmental sensors that are recorded correspond to the LAST of the samples used to form the vector averages of current, a point that may significant in data interpretation.

Calibration tables for all three fins are stored in the meter so that if a fin is changed it is necessary to set the mode selector switch to the new position. The tables for meters fitted with pressure and conductivity sensors are slightly differenl from those without.

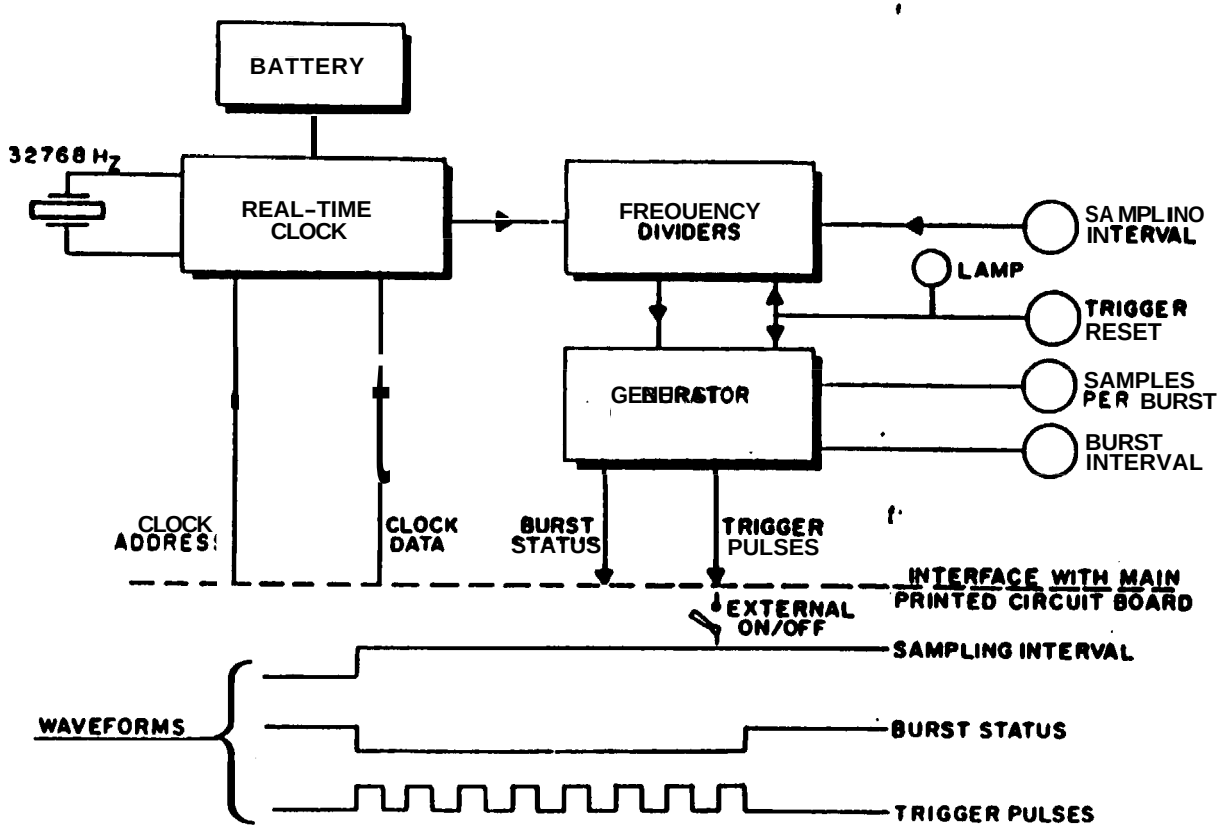

Fig. 2 Real-Time Clock. Block Diagram

2.3 Self test

An external ON/OFF switch is mounted on the end cap of the meter's pressure housing. As the hardware block diagram in Fig. 2 indicates, when the switch is in the ON position trigger pulses from the real-time clock are allowed to reach the power control circuitry and the meter cycles through its measuring and recording functions as already described. In the OFF position the meter remains in the quiescent, low power, condition. Turning the switch from OFF to ON triggers a self-test and initialization sequence.

3 CONTROLS AND INDICATORS

3.1 User Operated Controls

The Model 6011 Mk II current meter has a number of user-operated controls which select the various operating modes and sampling intervals. Most of the controls are mounted on the main printed circuit boards (see Fig.3) and are accessible only when the meter is withdrawn from its pressure case. The one esternal switch is mounted on the end cap opposite to the swivel end. Conductivity and pressure sensors, when fitted, are mounted on the same end cap.

3.2 External ON/OFF Switch

This rotary action switch controls the flow of trigger pulses from the clock board to the main board. In the OFF position no pulses get through and the meter remains in its standby state drawing minimum battery current. In the ON position the meter is triggered into operation at the rate set by the sampling-interval and burst-sampling switches. If the meter is out of its pressure case, the successful progress of the routine can be followed by counting the eight flashes of the self-test lamp.

Normally, this switch will be turned ON or OFF once or twice as part of the check out procedure and then left OFF until just before deployment.

3.3 Sampling Interval

This switch sets the basic sampling interval of the meter in all its operating modes. Operated with the aid of a small screwdriver, this 10-position switch selects intervals from 7.5 seconds to 60 minutes. See SPECIFICATIONS for the full range of available intervals.

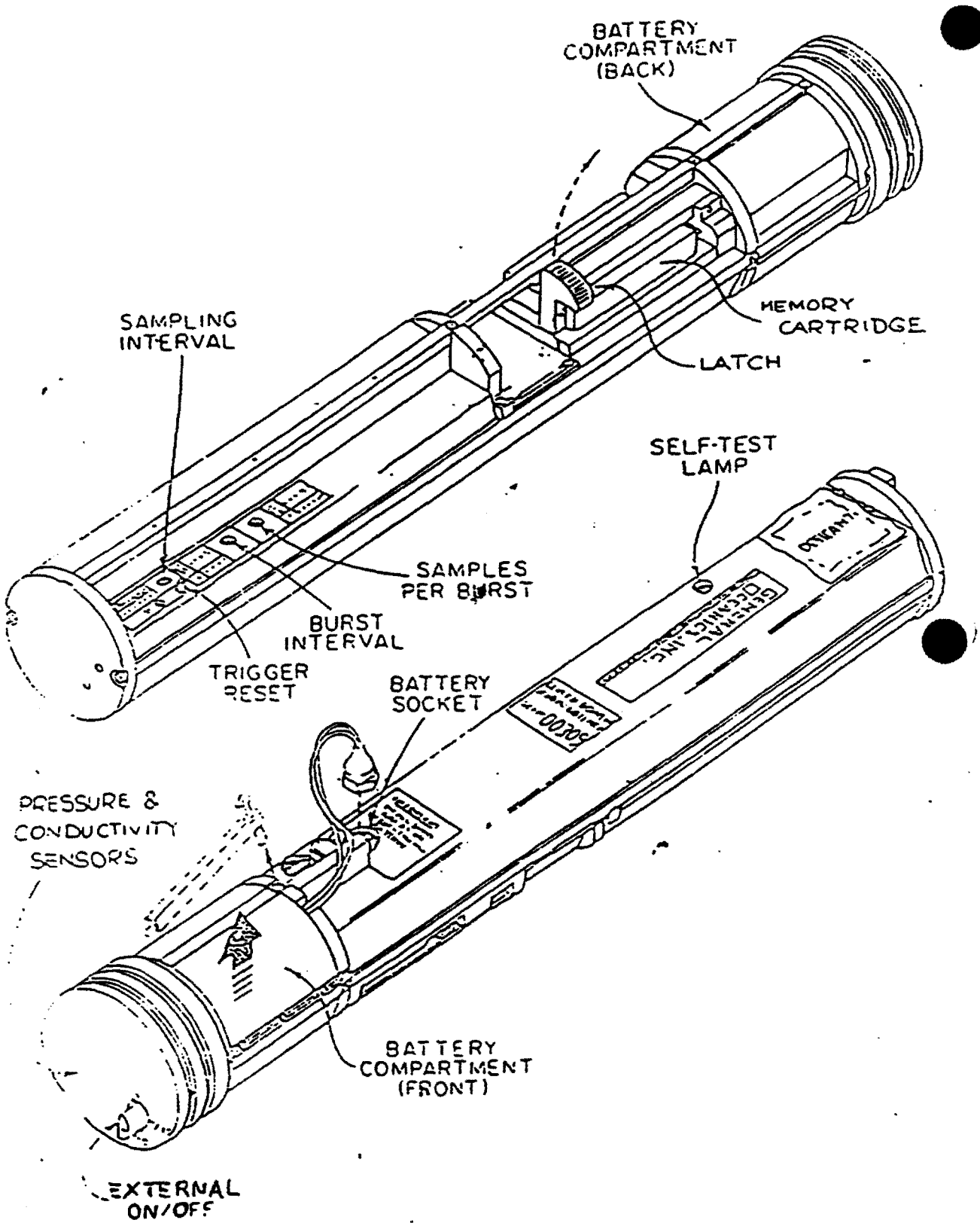

Fig.3 Layout of main features and controls

3.4 Burst Length

A 6-position switch selects the number of samples in a burst. The numbers available are one to 32 in 1:2 steps. This switch selects the number of samples over' which the average is taken. In position six, for example, a burst of 32 samples will be averaged before being recorded as a single value. With the switch in position one, the burst length is a single sample.

3.5 Burst Interval

A 4-position switch determines the interval between the samples to be used in a vector average. Thus, if a burst of eight samples and an interval of four seconds are selected, the effective averaging period will be 32 seconds.

3.6 Trigger Reset

Pressing this button resets the counting circuitry so that trigger pulses can be made to occur at a known time in each hour. The general rule is that the first trigger pulse occurs at a time one half of the selected sampling interval after pressing the reset button. If a sampling interval of one minute has been selected; for example, then the first trigger will occur 30 seconds after pressing the trigger reset button, the next at one minute and thirty seconds, the nest at two minutes and 30 seconds and so on. The general rule does not apply for the 30 and 60 minute sampiing intervals. In both cases the first trigger occurs 22.5 minutes after reset; all the following ones are at the selected intervals.

The red indicator lamp next to the button provides a positive indication that reset has occurred.

The push-button has no effect on the setting of the real-time clock.

3.7 Mode Selector

This switch, mounted on the opposite side of the meter from the other four controls, determines the vector-averaging mode. Position 1 is for factory use. Positions 2, 3 and 4 select the vector averaging mode. Position 2 should be used if a low-speed fin is fitted to the meter, 3 for a standard fin and 4 for a high-speed fin. When computing the vector averages, the microprocessor examines the switch setting in order to select the correct fin calibration look-up table.

3.8 Self-Test Lamp

When the meter self-test is triggered by actuating the external ON/OFF switch, this lamp flashes at the rate of eight times in three seconds as the test proceeds.

4 RAM MEMORY OPERATION

4.1 Introduction

RAM Memory is a solid-state memory system which replaces the more traditional tape recorder and data cassette for long term storage of the data gathered by the current' meter. It makes use of a removable data cartridge containing its own 10-year battery power source. The cartridge is smaller than a standard audio cassette, offers up to twice the data capacity, and can be quickly and conveniently changed in the field with no external equipment.

The design of the RAM Memory incorporates a number of features to ensure that recording will take place reliably during a deployment and that data cannot be accidentally erased after a recovery of the meter. For instance, a mechanical interlock prevents the user closing the pressure housing if the cartridge is incorrectly seated in its holder and a self test procedure warns if' the cartridge's internal battery has run down. After recovery, a write-protect switch on the cartridge can be set, thus making it. almost impossible to inadvertently erase the stored data.

A simple reader is available (6011RR) which plugs into an expansion slot of an I.B.M.* P.C. or PC/XT desktop computer. This, together with software which is supplied by General Oceanics, allows the user to read and process the data stored in the cartridge.

*Registered trademark of International Business Machines Corporation.

4.2 Cartidge Data Capacity

Cartridges are available in nominal capacities of 64, 128, 256 and 512 kilobytes. Each data record in the meter is stored as a 13-byte word. In addition, 13 bytes are used to store the instrument serial number together with some information used internally by the meter itself. Taking as an example a 128 kbyte cartridge, we can now calculate its capacity in terms of data records. The actual size of the cartridge is 131,072 bytes. This leaves 131,059 bytes for useful data, which is equivalent to

10,081 complete data records. The corresponding figures for the other sizes are 5,040, 20,163 and 40,328 data records. The largest capacity cartridge, therefore, allows recording once every ten minutes for almost a full year.

5 INSTRUMENT PREPARATION

5.1 Battery Capacity

First check that there is sufficient battery capacity remaining to run the instrument for the planned deployment period. The only way to be sure of this is by keeping an accurate record of battery use on the label provided on the side of the battery. If there is any doubt, use a new battery. (Refer to section 6.3.1 Battery Life.)

5.2 Battery Replacement

The actual removal and replacement of the battery is very straight forward. The grey plastic battery holder is held in place by a short retaining bar which is secured with a single captive screw. Battery connection is via the blue 5-pin connector at the end of the short pigtail. As the battery holder is being slid into position, take care to guide the pigtail into the slot provided.

5.3 Switch Settings

First select the mode, selector switch. If vector averaging then make sure the switch points to the correct fin . Then set the burst-interval and samples-per-burst switches for the desired averaging period. Thirdly, bearing in mind the constraints pointed out in paragraph 8., select the sampling interval to match the planned deployment period. Finally, press the trigger reset button to lock the triggering seyuence in the right phase with the real-time clock.

Again, for many applications, averaging over 32 samples at 2-second intervals (Samples-per-Burst=32: Burst Interval=2sec.) provides good coverage. The sampling interval can be set anywhere between 2 minutes and 30. minutes, depending on the duration of the deployment.

When the instrument has been prepared as just described, activate the external ON/OFF switch to trigger the self test sequence (eight flashes of the self test lamp). Some practice may be needed in positioning the meter so that the self-test lamp can be observed while activating the external switch. If all is well at this stage the switch should be turned off and the meter sealed in its pressure housing.

5.4 Sealing Up

The iaportant points at this stage are (1) place a desiccant bag in the pressure housing, and (2) make sure that the single O-ring seal, and its mating surface, are clean, lightly greased and undamaged. **CHECK THAT THE SERIAL NUMBER OF THE HOUSING MATCHES THAT OF THE METER'S ELECTRONICS.** Slide the meter carefully into the housing, checking that the battery pigtail is tucked out of the way. Turn the meter so that the alignment hole in the end cap matches the one in the housing. As the meter is driven home, the pin at the end of the meter should engage the locating hole in the far end cap. Secure the meter using the thick nylon monofilament locking cord. It should .slide into the matching half-grooves in the end cap and the pressure housing until only the L-shaped termination is exposed. The short end of the L is then pressed into the aligned holes. This ensures that the meter's internal sensors are lined up with the center line of the fin.

5.5 Deployment

After the meter has been prepared as described in the foregoing paragraphs, all that remains is to TURN THE EXTERNAL SWITCH ON and attach the meter to the mooring.

5.6 Fin Change

If the meter is to be used in areas where very high or very low currents are expected, the standard fin can be replaced by one with the appropriate range (see SPECIFICATIONS for ranges available). The fin is secured by two cable ties which rest in grooves in the pressure housing (see section 12.3 for part numbers of replacement ties). The fin is aligned with the meter's direction sensors by the nylon bolt at the swivel end of the housing; the bolt is in turn secured by a locking screw in one of the lugs of the end cap. Note that although the fin can be changed, THE PRESSURE HOUSING AND ELECTRONICS PACKAGE MUST STAY TOGETHER AS A PAIR TO PRESERVE THE ACCURACY OF CALIBRATION.

6 DEPLOYMENT

6.1 Preparing for Deployment

In preparing a meter the user should, in general, follow the procedures detailed in Section 5 (INSTRUMENT PREPARATION) of the Operating Manual.

The rode selector switch (described in section 3.7) should be set to position 2, 3, or 4 depending on whether a low, standard or high speed fin is fitted to the meter.

Fig.1 shows the RAM Memory cartridge in place in the current meter. To plug in the cartridge simply lift the latch, turn the cartridge so the write-protect switch faces outwards, and insert it into the 30-pin socket. If the cartridge is not properly seated, the latch will not spring back to its fully closed position and it will be impossible to slide the meter into the pressure housing.

Finally, set the write-protect switch .on the cartridge to OFF, plug in the battery, and turn on the external ON/OFF switch. The meter will then go through a self-test routine as indicated by the Self-Test lamp flashing eight times. If the lamp does not flash, check that the cartridge is properly plugged in with the write-protect-switch off.

6.2 Unplugging the Cartrige

When the current meter is recovered at the end of a deployment it will be necessary to remove the cartridge from the meter in order to read it. The cartridge is so designed that is very difficult to lose or alter the stored data while unplugging it. However, to be absolutely sure, the following procedure should be followed:

a) As-the meter arrives on deck set the External ON/OFF switch to the OFF position and note the time.
b) Rinse with fresh water and dry the meter as usual.
c) Remove the meter from the pressure housing.
d) Set the write-protect switch on the RAM cartridge to the ON position.
e) Unplug the battery.
f) Lift the latch (see Fig 1) and remove the cartridge from its socket.

All the time the cartridge is out of the meter the write-protect switch should be left in the ON position.

6.3 Other Notes

6.3.1 Battery Life

RAM Memory draws less power from the battery allowing more readings to be taken. For instance, when taking 32-sample averages, the battery has enough energy for 40,000 32-sample averages. So, the maximum deployment time is one year OR the time to record 40,000 32-sample averages OR *80,000* 16-sample averages OR 160,000 8-sample averages, whichever is the shortest. Note that the 40,000 averages could be recorded in a single deployment using a 512 kbyte cartridge or in a series of deployments using a 128 kbyte cartridge several times.

6.3.2 Last Record Data Loss

The RAM Memory system can loose some data as a result of the averaging process itself. For example in the process of assembling a 32-reading average, the meter is switched off just before taking the 32nd reading 31 data points have been lost.

6.3.3 Monitor Connector

The monitor connector is disabled except for the manufacturers use. To check out a meter, it is a simple matter to record a few minutes' worth-of data and then read the cartridge.

6.3.4 Serial Number Record

The first two bytes in the RAM Memory cartridge are used to record the meter's full serial number.

6.3.5 Data Format

Data within the meter are handled as binary numbers, each having sufficient bits to match the required precision. As the data are prepared for recording the individual numbers are stacked end to end to form a string 104 bits long. During the recording process itself the string of bits is stored in the RAM Memory cartridge eight bits at a time as 13 bytes. The bits for each record are organized as follows in the order shown:

Data	Number of Bits
Month	4
Day	5
Hour	5
Minute	6
Pressure	12
Temperature	12
Conductivity	12
East current component	12
West current component	12
Standard deviation in east component	12
Standard deviation in west component	12
Total	104

The way in which each piece of data is encoded and the significance of each bit in the record are as follows:

Number of bits	Vector Averaging
1	1
7	Serial Number
4	Month
5	Day
5	Hour
6	Minute
12	Pressure
12	Temperature
12	Conductivity
12	East Component
12	North Component
12	E. Std. Deviation
12	N. Std. Deviation
112	

7 BATTERY

7.1 Battery Safety

Lithium batteries store a large amount of energy in a small volume so they should always be handled with care. The following rules should be followed:

DO NOT incinerate, short circuit, puncture, crush or disassemble the battery.
DO NOT attempt to re-charge the battery.
DO NOT store or use the battery at temperatures above 72 deg. C.

8 CAUTIONARY NOTES

8.1 Choice of Sampling Interval

When vector averaging, the sampling interval rust be long enough to allow the meter to complete its cycle of operation. For example, if a burst length of 32 samples is selected together with a burst interval of two seconds the cycle takes almost 64 seconds to complete. In this case the sampling interval should be no less than two minutes
(since the next shortest interval, one minute, is insufficient to accommodate the complete cycle).

If too short an interval is inadvertently selected the meter automatically compensates, for many combinations of burst length and burst interval, by ignoring the intermediate trigger pulses. However, at best, this can only complicate later interpretation of the data record.

9 SPECIFICATIONS

Speed:
Sensor: Force-balance tilt sensor.
Range: 0 to 300 cm/sec. (with appropriate fin)
Accuracy: +/- 1 cm/sec.
Resolution: +/- 1 cm/sec.

Direction:
Sensor: Three-axis flux-gate compass
Accuracy: +/- 2 degrees.
Resolution: +/- 1 degree.

Temperature:
Sensor: Aged linear thermistor
(Yellow Springs Instrument Co. Type 44202).
Range: -5 to +45 degrees C.
Accuracy: +/- 0.25 Degree C.
Resolution: +/- 1/64 Degree C.
Thermal time constant: < 2 MINUTES

Conductivity:
Sensor: Inductive Toroid
Range: 0 to 75 mS/cm.
Accuracy: +/- 2.5 mS/cm.
Resolution: +/- 0.1 mS/cm.

Pressure:
Sensor: Strain gauge.
Range: 0 to 10,000 p.s.i.
Accuracy: +/- 0.5%
Resolution: +/- 0.1%

Internal clock:
Type: Quartz crystal.
Accuracy: +/- 0.1 second/day
Outputs: Trigger pulses. Date and time information.
Power: Lithium battery independent of meter's main battery. Battery life: 5 years.

Sampling interval:
Selected by 10-position switch.
Available intervals: 7.5, 15, 30, 60 seconds,
2, 5, 10, 20, 30, 60 minutes.

Burst sampling:
Samples per burst selected by 6-position switch;
2, 4, 8, 16, 32 samples per burst.
Burst interval selected by 4-position switch;
2, 4, 8, and 16 seconds.

Data capacity:
Cartridges are available in nominal capacities of 64, 128, 256 and 512 kilobytes. Each data record in the

meter is stored as a 13-byte word. In addition, 13 bytes are used to store the instrument serial number together with some information used internally by the meter itself. Taking as an example a 128 kbyte cartridge, we can now calculate its capacity in terms of data records. The actual size of the cartridge is 131,072 bytes. This leaves 131,059 bytes for useful data, which is equivalent to 10,081 complete data records. The corresponding figures for the other sizes 5,040, 20,163 and 40,328 data records. The largest capacity cartridge, therefore, allows recording once every ten minutes for almost a full year.

Data translation:
Using Model 6011RR reader with desk-top computer (e.g., I.B.N. *P. C. or compatible).

Battery:
Two D-size lithium cells with capacity of 14 amp-hours.
Output: 7.8 volts
Life: up to one year, depending on operating mode.

Pressure case dimensions:
Length: 54.9 cm. Diameter: 10.5 cm.

Weights:
In air: 9/0 Kg. In water: 4.5 Kg.

Pressure Seal:
Single O-ring.
Tool-free opening and closing using General Oceanics' standard plastic cord sealing system.

Exposed material:
Plastic and hard-coat anodized dichromate sealed aluminum.

Wing characteristics:
Low speed: 0 to 70 cm/sec.
Standard: 0 to 225 cm/sec.
High speed: 0 to 300 cm/sec.

10 MOORING METHODS

Figs. 4 and 5 illustrate possible ways of deploying the Model 6011 MkII current meter. Its lightness and compactness considerably ease the expense and difficulty of designing moorings. In deep-sea moorings, especially, the savings are enhanced by the reduced requirements in flotation, anchor weight and cable size.

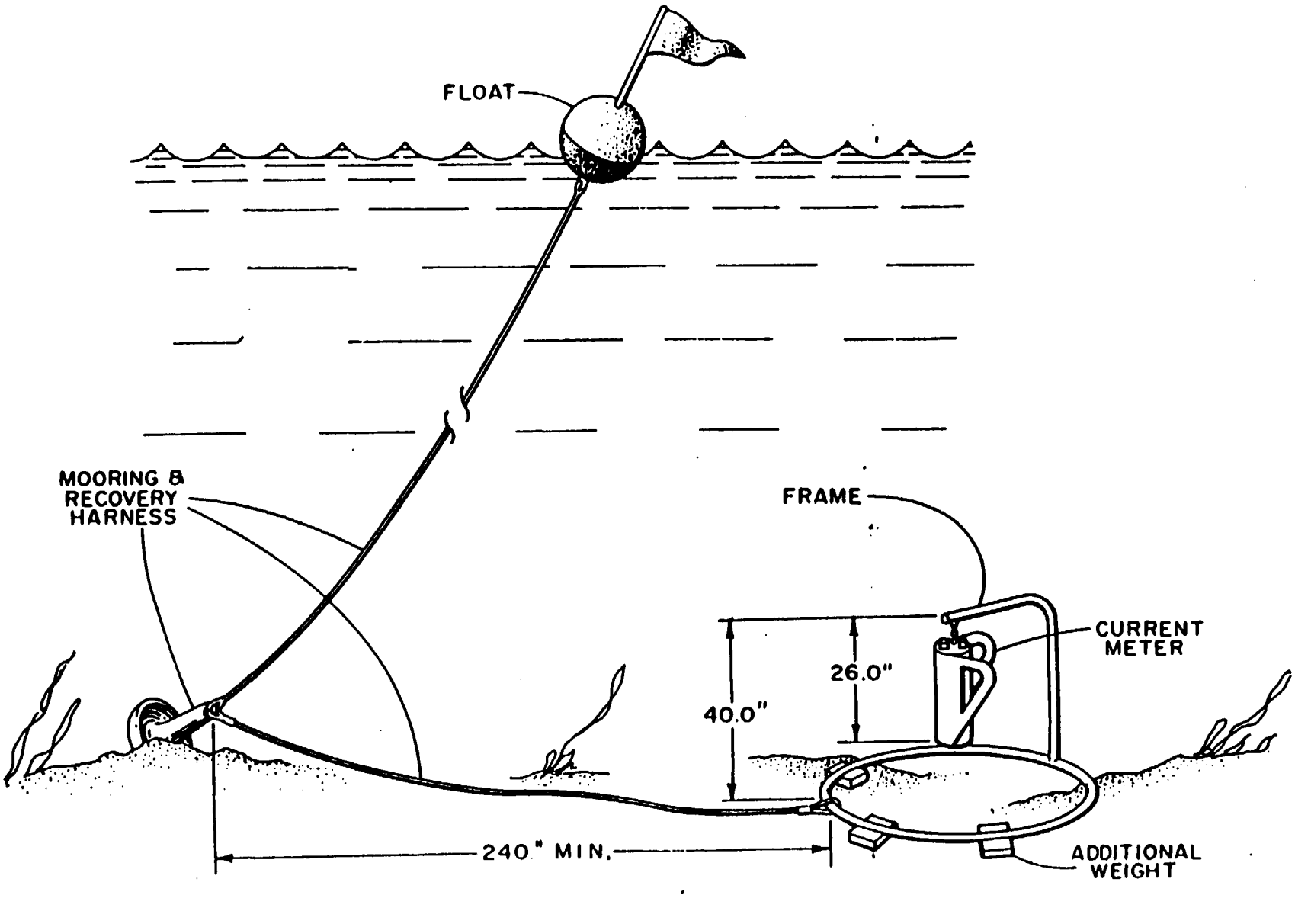

Fig. 4 Deployment for Near-Bottom Measurements

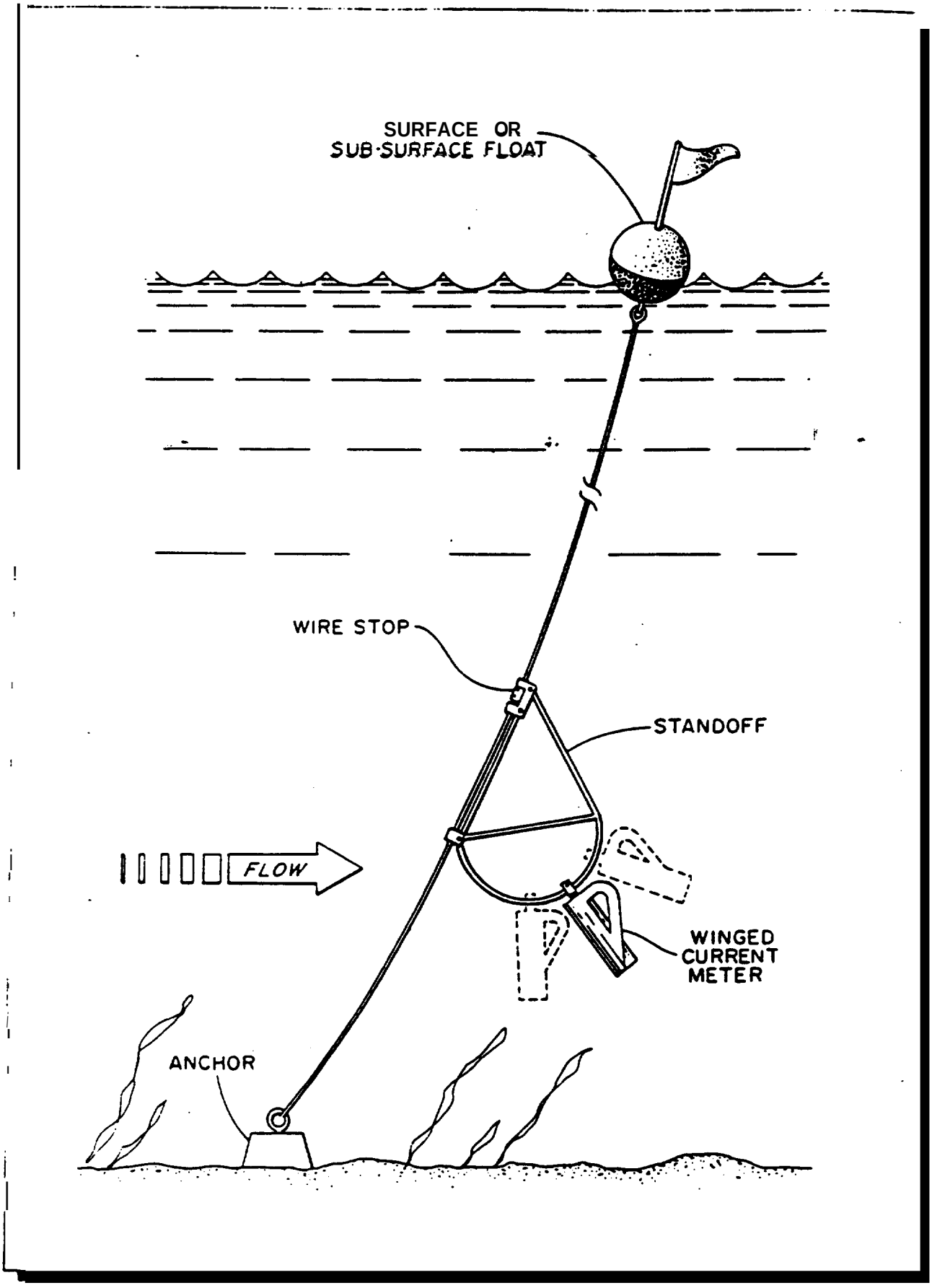

Fig.5 Typical Deep-Sea Deployment

11 CALIBRATION CURVES

On the following pages are six calibration curves showing tilt angle as a function of current speed for the low-speed, standard and high-speed fins.. For each speed there are two curves. One is for meters that have no environmental sensors the other is for meters fitted with a conductivity sensor. The addition of a pressure sensor does not change either calibration curve. A temperature sensor is fitted to all model 6011 meters but since it is buried in the end cap, it *too has* no effect on the calibration curves.

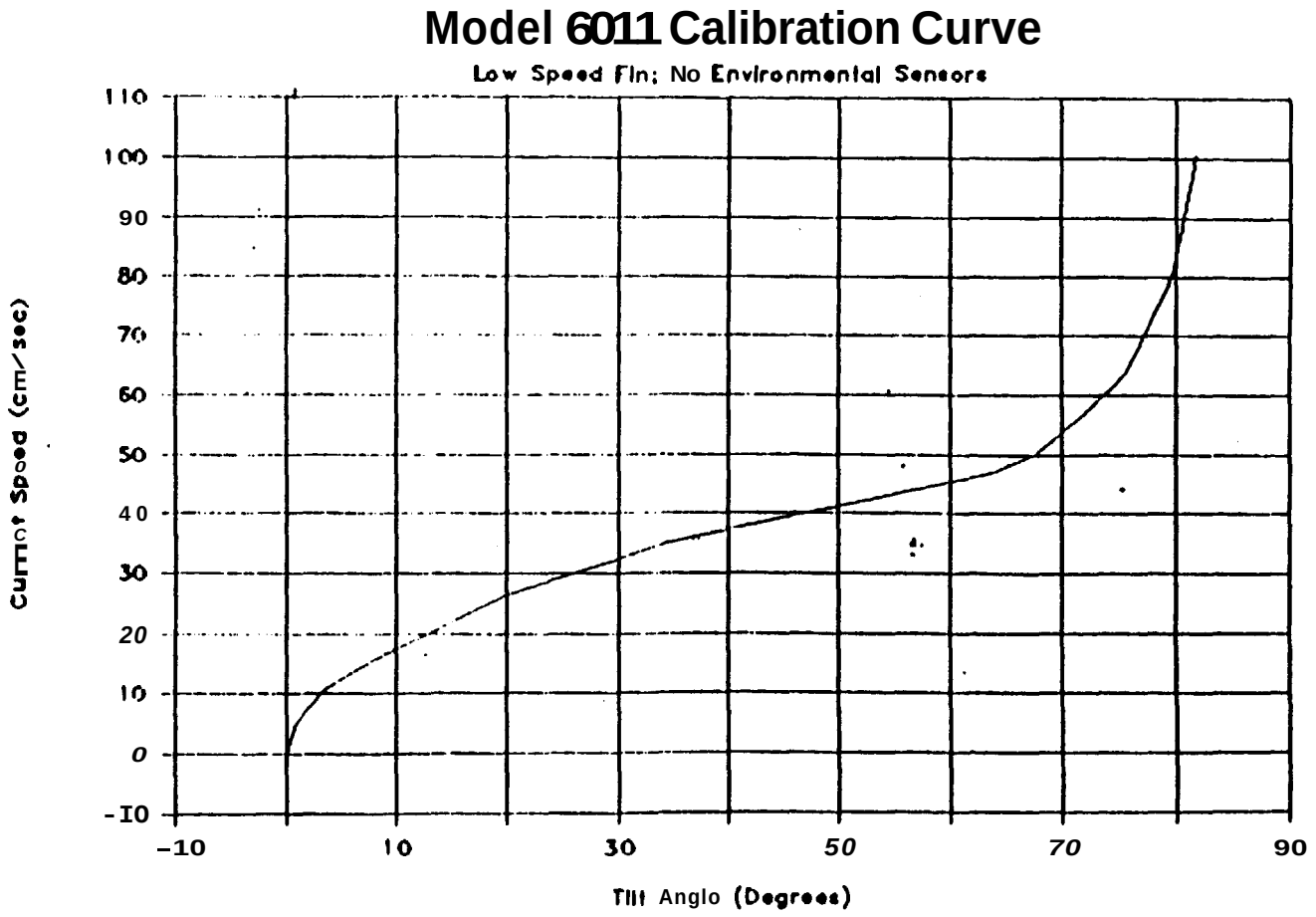

Fig.6 Calibration Curve
Low-Speed Fin: No Environmental Sensors

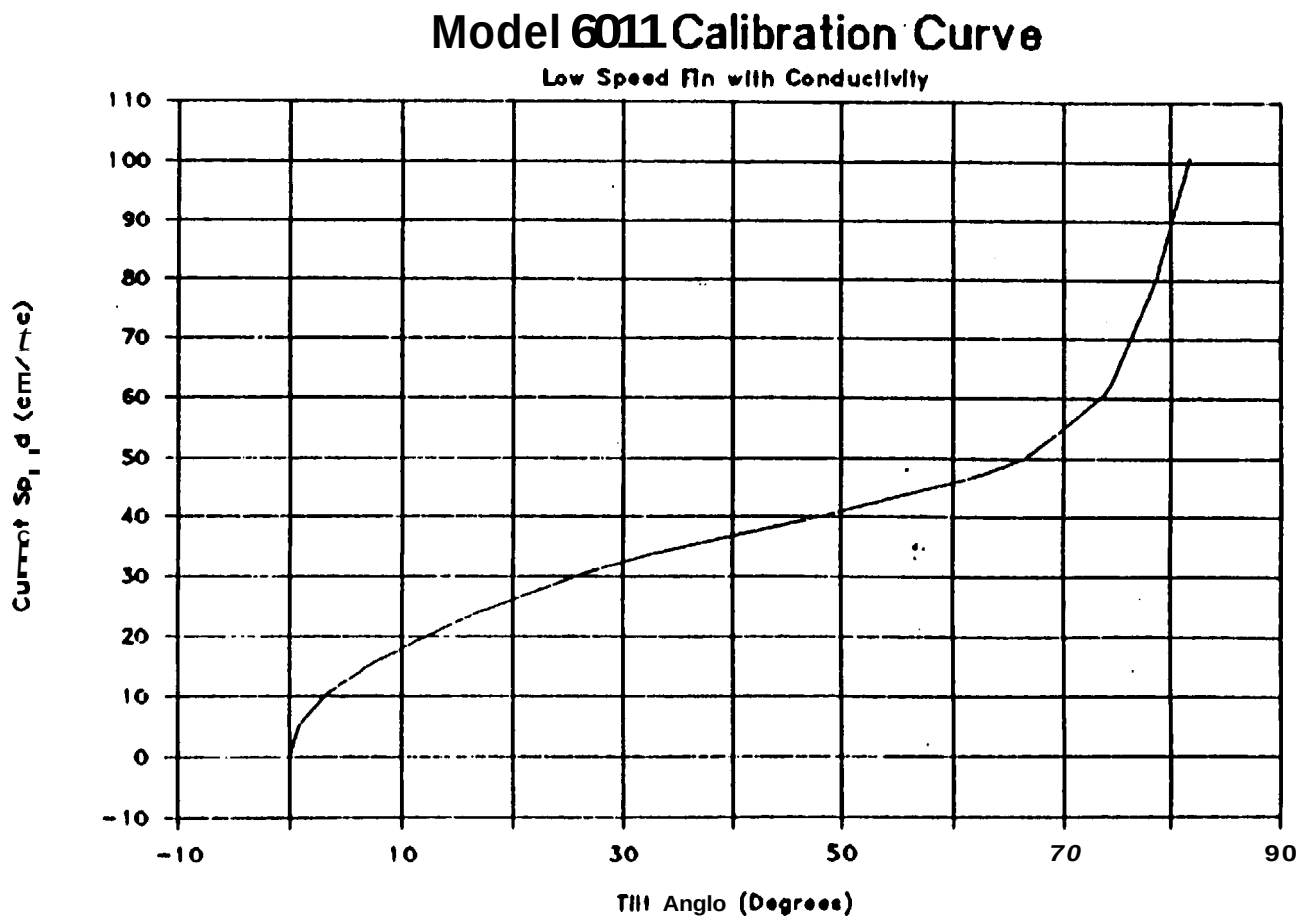

Fig.7 Calibration Curve
Low-Speed Fin with Conductivity

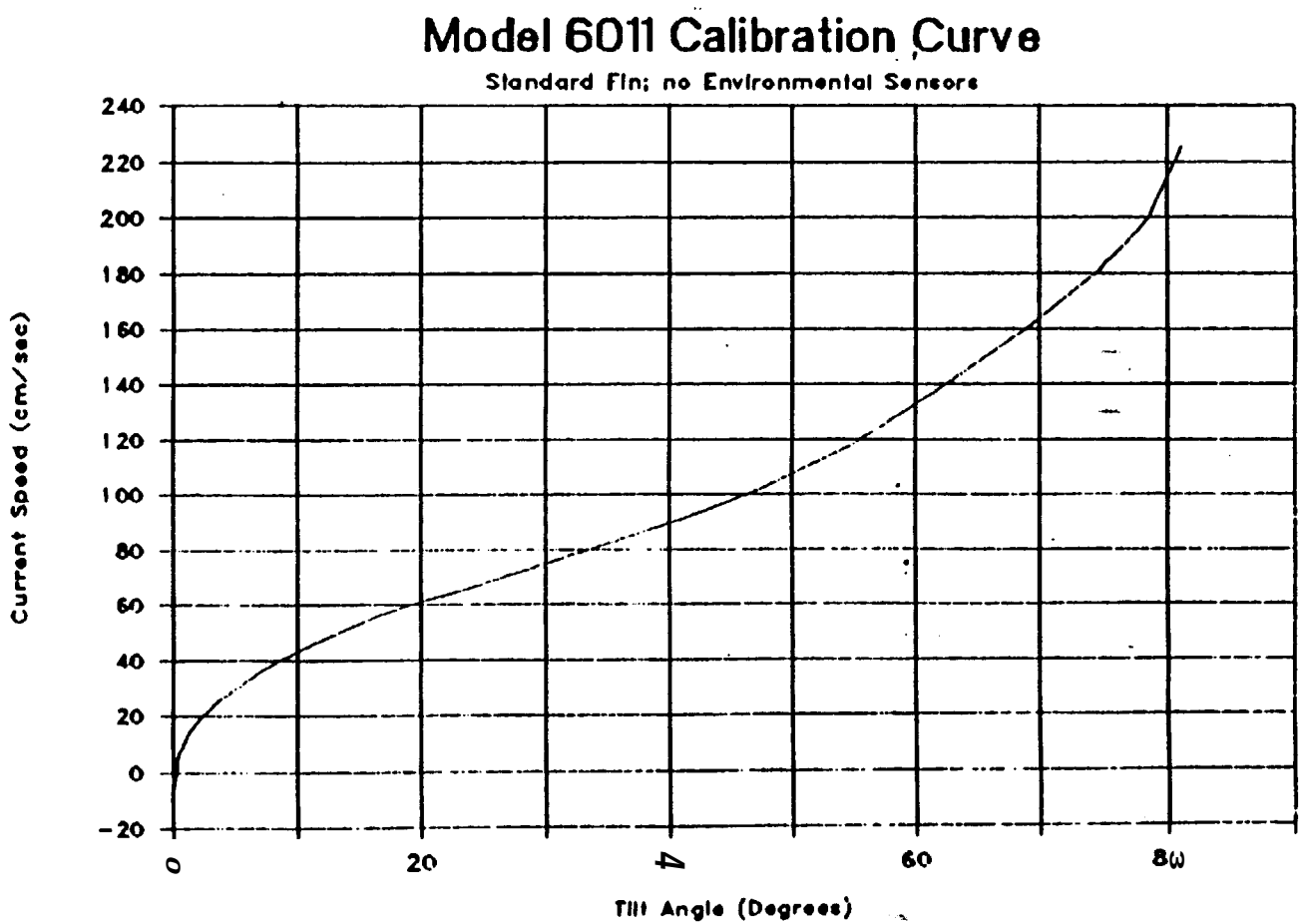

Fig.8 Calibration Curve
Standard Fin: No Environmental Sensors

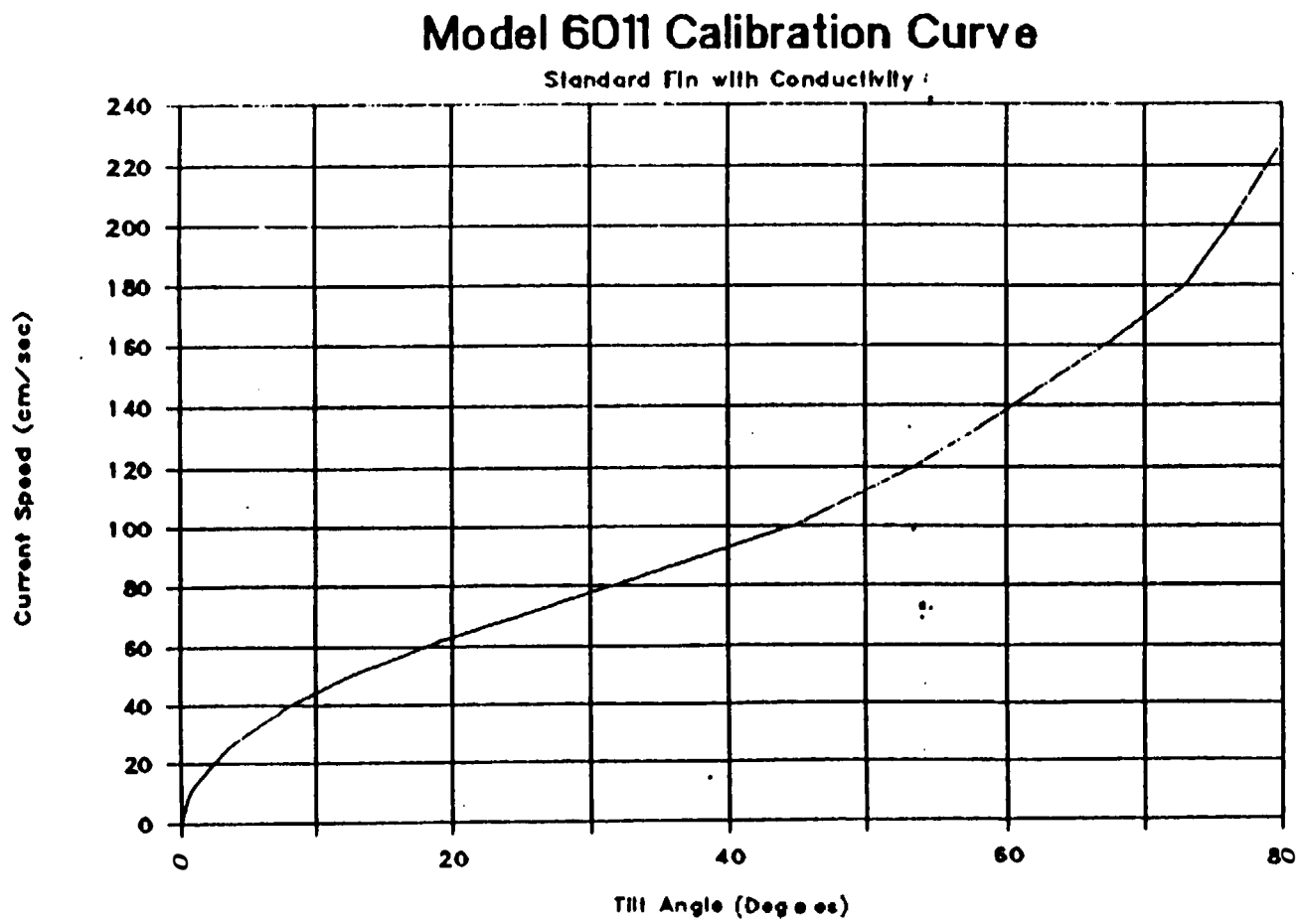

Fig. 9 **Calibration Curve**
Standard Fin nith Conductivity

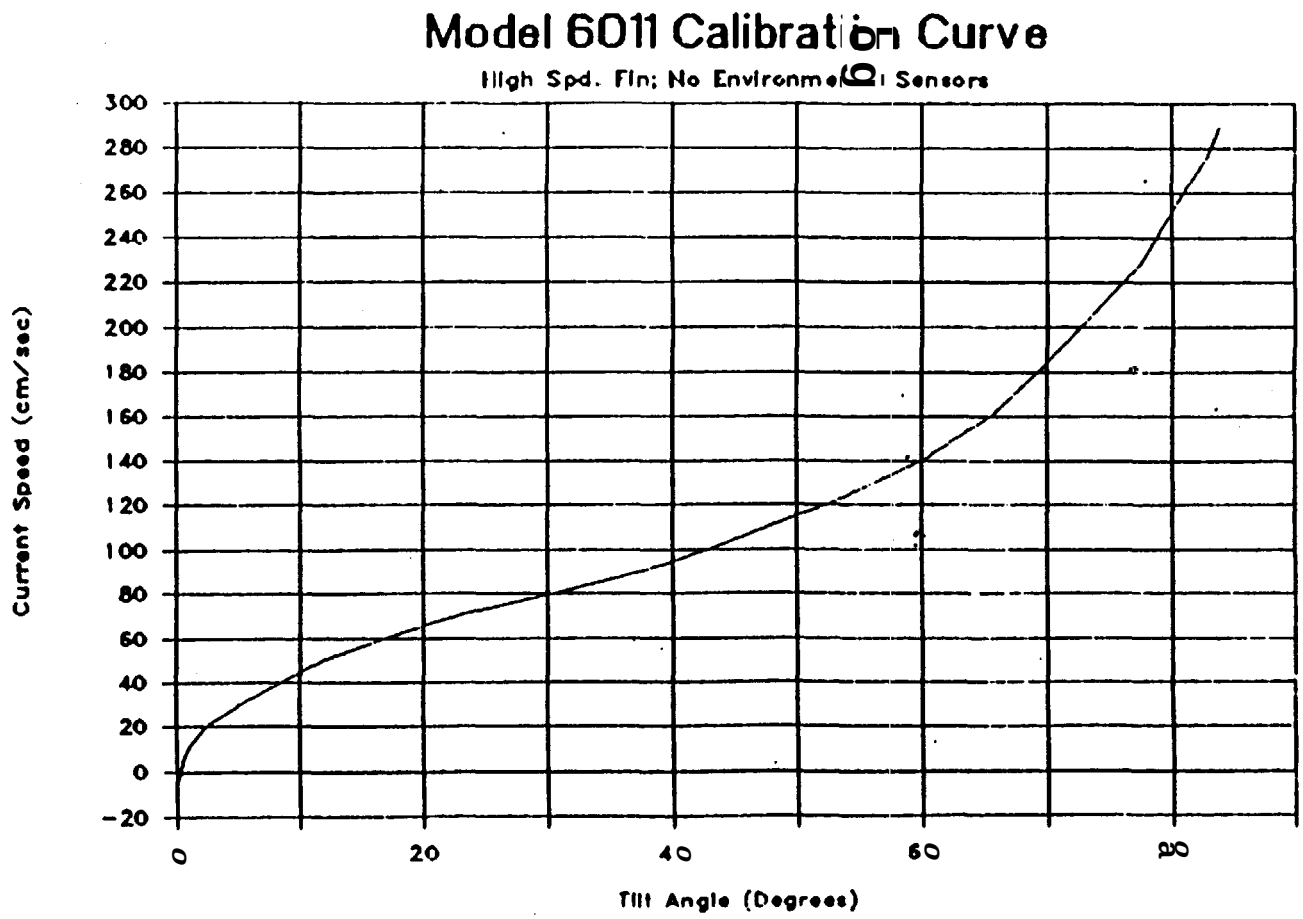

Fig. 10 Calibration Curve
High-speed Fin: No Environmental Sensors

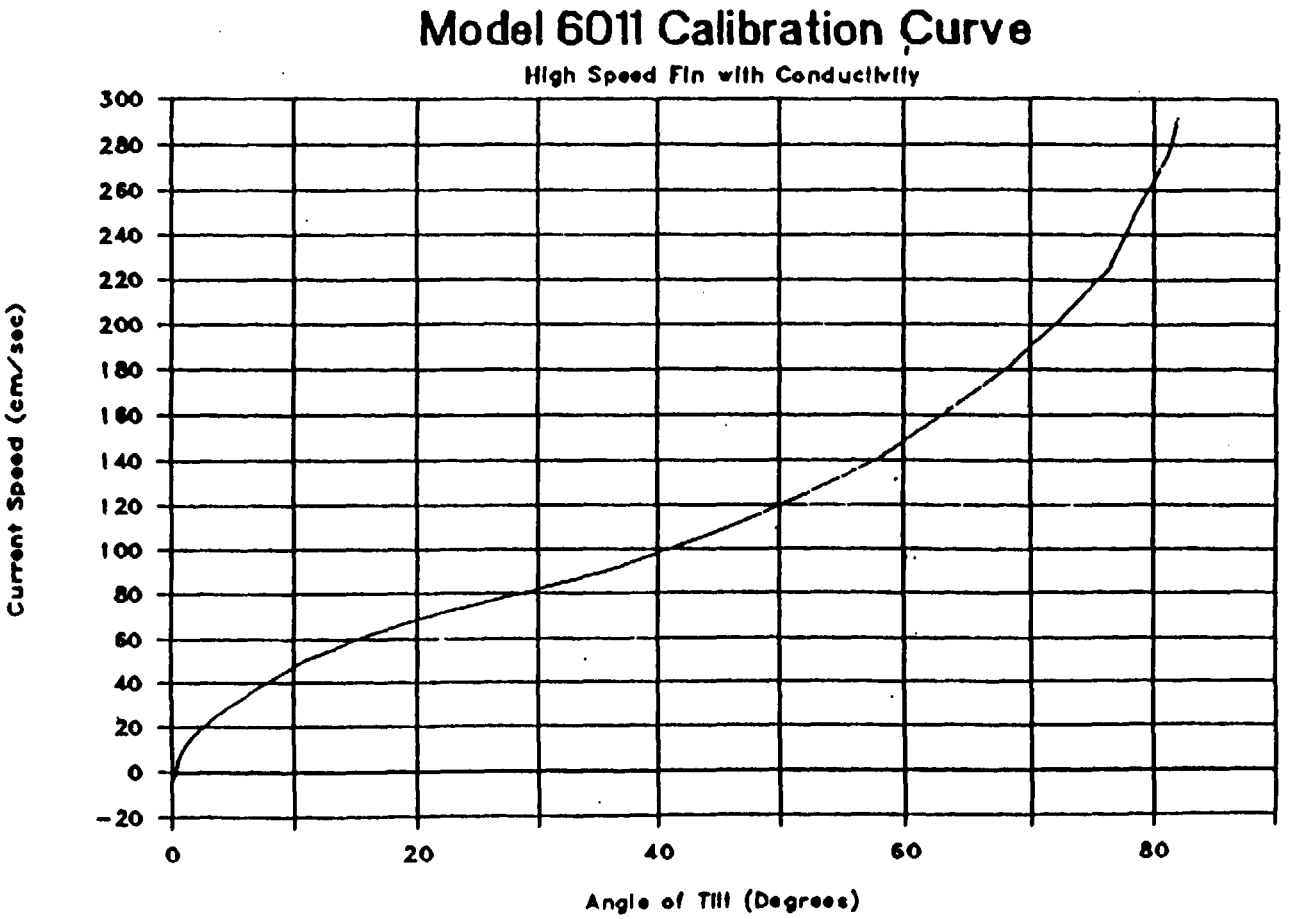

Fig. 11 Calibration Curve
High-speed Fin with Conductivity

12 MAINTENANCE

12.1 Routine Care

Because of its simple design, the Model 6011 requires very little in the way of routine maintenance. The main battery should be replaced as recommended in section 6.3.1 of this manual. The batteries in the real-time clock have a life of five years. Changing these batteries entails removing the protective covers and re-setting the clock using special equipment available only at the factory. For this reason, it is recommended that meters be returned to General Oceanics, Inc. when the clock batteries become due for replacement.

Before each deployment, lightly grease the O-ring seals and check them for damage. If there is any doubt about their integrity, they should be replaced. After a deployment, remove any marine growth, exercising special care in the region of the conductivity and pressure sensors, and thoroughly rinse the meter in fresh water. Remove the main battery and store it separately if the meter is left unused for more than a few weeks.

12.2 Antifouling Treatment

To protect it against marine growth during extended deployments, the meter can be treated with anti-fouling paint. The following procedure uses material which are readily available at boat supply stores and which are compatible with the aluminum of the pressure case and the plastics of the fins. The layers of paint have a negligible effect on meter calibration.

Step 1: Clean housing thoroughly with hot, soapy water and rinse. Allow to dry and wipe thoroughly with acetone to degrease surface.

Step 2: Remove the ABS wing from the current meter pressure housing. Then apply two thin coats of Pettit Metal Primer to the pressure housing, allowing at least 2 hours drying time between coats.

Step 3: Apply two thin coats of Pettit Vinyl Red Undercoater. This forms the prime barrier to protect the aluminum. It is important that two thin coats, instead of one thick one, be used to ensure total coverage of the aluminum. Also apply two coats of undercoater to the ABS wing to ensure better adhesion of the antifouling coating. Remember to leave at least 2 hours between coats. If possible, apply the undercoater with a sprayer. For thinning and cleaning use Pettit # 140 Vinyl Thinner.

Step 4: Applying the antifoulant. Pettit Alumiguard is recommended because of its compatibility with aluminum. The current meter may be painted then shelved for up to 3 months without the treatment loosing its effectiveness. Two or more

thin coats should be applied; if expected use is in a high growth area put on up to 5 thin coats. Recoat time is from 1 to 4 hours. Wait at least 16 hour8 after the last coat before immersion. Remember to coat the wing when using the antifoulant. Pettit # 140 Vinyl Thinner is used to thin the paint and for cleanup.

12.3 Spare Parts

The following are the General Oceanics reference numbers to the more frequently used spare parts.

Item	G.O. Reference #
Standoff	6011SO
Wire Stop	6011WS
O-ring	81-0153
Desiccant bag	99-0611
Cable tie - fin	48-1225
High-speed wing	6011000004
Low-speed wing	6011000003
Standard wing	6011000002
Battery	6011BL

GENERAL OCEANICS

MODEL 6011 RR

RAM READER

OPERATING MANUAL

JANUARY 1991

A COPY OF THIS MANUAL IS INCLUDED ON YOUR FLOPPY DISK

INC. • 1295 N.W. 163rd Street, Miami, Florida 33169-9922 • Tel.: (305) 621-2882 Telex: 80-8247 Fax: (305) 621-1

GENERAL OCEANICS

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1 INTRODUCTION

1.1 Function

The General Oceanics Model 6011RR RAW Reader is designed to read the data cartridges used on the 6000 series of oceanographic recording instruments. These data cartridges contain banks of CMOS memory chips together with a lithium battery which allows them to retain recorded data for over ten years. The Reader plugs into an IBM PC/XT, or compatible, desktop computer. Data are taken from the cartridge, displayed on the computer screen, and recorded on a disk file. The user can then access the file and carry out any further processing he wishes.

2 INSTALLATION

2.1 Component Parts

The Model 6000RR is shipped as a package of four items:

1. The RAM Reader main unit. This holds the socket into which is plugged the data cartridge.

2. An interface card which plugs into one of the expansion slots in the IBM PC/XT. (MetraByte Corp. Yodel PIO-12)

3. A ribbon cable with 37-pin connectors to connect items 1 and 2.

4. The floppy disk containing the operating and installation software.

2.2 Hardware Installation

2.2.1 Base Address Selection

The IBM PC/XT accesses the interface card by way of four consecutive address locations in the PC 1/0 address space. These addresses start at a base address which is selected by an 8-position DIP switch (see Fig.1). The base address can in theory be placed anywhere in the 1/0 address space, but base addresses below FF hex (255 decimal) should be avoided as this address range is used by the internal 1/0 of the computer. The 200-3FF hex (512-1023) address range provides extensive unused areas of 1/0 space, though you should check with page 2-23 of the "Technical Reference Manual" for possible conflicts with commonly installed peripherals.

```
      9 8 7 6 5 4 3 2
     ----------------
ON       * * * * * *
/\    ! ! ! ! ! ! ! !
||    * *
     ----------------
```

Fig.1 Base address switch setting for 300 hex (768 decimal)

TABLE I. Switch Position Address Equivalents.

Switch posn.	Address line	Decimal equivalent
9	A9	512
a	A8	256
7	A7	128
6	A6	64
5	AS	32
4	A4	16
3	A3	a
2	A2	4

·Switches have decimal values as shown above, in the "off" 'position. In the "on" position the decimal value is zero.

Conflict with other peripherals that may be installed often manifests itself as erratic data displayed on the screen, in which case a different base address should be selected.

2.2.2 PIO Card Installation

Turn off the computer, disconnect the power cords, and move it so that you can work on it from the back. Open the computer and remove the screw holding the filler plate that is in line an empty expansion slot. Remove the filler plate and plug the interface card into the slot making sure it is seated firmly in the connector. Finally, secure the card bracket with the screw that was removed earlier, and return the computer to its case. You can now proceed to install the software.

2.2.3 System Assembly

Position the RAM Reader main unit alongside the computer for convenient access. Use the 37-way ribbon cable to connect it to the interface card in the computer.

2.3 Software Installation

2.3.1 Introduction

The diskette supplied with the RAM Reader contains a number of programs and files. MANUAL.DOC contains the test for this manual. The second is a program labelled SETUP; it allows the user to select which disk drive will be used to store the data that is read from the RAM cartridge. It also tells the actual reading programs the base address that has been selected on the interface card. The remaining files contain the programs which control the reader and format the data (e.g. RDCM will read the RAM cartridge from a MKII Current Meter). These programs are all very similar and differ only because different instruments in the 6000 series use slightly different data formats (see Section 3).

2.3.2 Running SETUP

First you should make a working copy of the software disk supplied, using the normal DOS commands. The original disk can then be stored as a back-up.

At this stage it is worth giving some thought to the general arrangement of your data handling system. The overall aim is to transfer data from the RAM cartridge to a disk file on either a floppy or hard disk. Once in a disk file the data can be accessed much more quickly and conveniently than by re-reading the cartridge. For a system with two floppy disks, it will normally be most convenient to run the program disk in drive A: and to store the transcribed data on a separate disk in drive B:. With a

hard disk system, running the program on the hard disk - drive C: - and storing data on a floppy disk in A: may be best.

Whatever arrangement you use, transfer all the files on the General Oceanics disk to the selected drive, either by inserting the floppy disk in the drive or by copying them to drive C:. Then make the selected drive the default drive (e.g. if C: then type 'C:' followed by RETURN). Then type 'SETUP' followed by RETURN. After a few seconds you will see the introductory banner followed by a prompt to select the data storage disk drive. Hake your selection, following the guidelines in the opening remarks of this section.

The next prompt calls for the entry of the base address which you have already selected on the DIP switch on the interface card. Enter this address as a decimal number.

Once you have entered these two pieces of information they are stored in a file SETUP.DAT on the default drive. There is no need to run the SETUP program again unless you wish to change these initial conditions.

2.3.3 Reading Data

To read data, type the appropriate program name followed by RETURN. The program name can be found in Section 3, DATA FORMAT, under the name of the instrument on which the data were recorded. For example, if data were recorded on a Model 6011 MK II current meter, then the program to use is RDCM.

The program will start by displaying the following information:

a. The serial number of the recording instrument.

b. The number of samples stored in the cartridge.

c. The disk drive being used for data storage.

The program will issue a warning if you attempt to read data without a cartridge plugged into the reader, or if the reading program does not match the recording instrument i.e. if you try to read Current meter data with the Inclinometer program.

To proceed, follow the prompts as they appear on the screen. Reading will continue until all the samples have been read or until you reach the last address in the cartridge.

The default read operation will display the date/time group and the orientation sensor data on the screen along with the number of samples. Using the "h" key to halt the process other options become available.

They include:

"s" - to start the read process at the beginning of the cartridge (re-starting will write over previously stored file!) ;
"c" - to continue process at present position (always continues in default mode);
"o" - to display the environmental sensors (instead of orientation data) continuing from present position;
"b" - blanks the screen while processing (speeds up operation considerably);
"e" - terminate processing at present position.

Since the generated file is an ASCII delimited file it can reach quite a size with respect to the number of bytes. If you have designated a floppy drive as the storage drive then the program will pause after each group of 5000 readings to allow you to change diskettes if necessary. Hard disks 'C' through 'F' will continue to write the data until the cartridge end is reached.

The following table will help to determine the correct floppy disk size and whether to replace it or to continue:

Cartridge Size	Readings Available	Size of file (bytes)	Disk size
64K	5,000	300,000	360K min.
128K	10,000	600,000	720K min.
256K	20,000	1,200,000	1.2Meg. min.
512K	40,000	2,400,000	10Meg. Hard drive

(The above examples are for a MKII Current Meter which averages about 60 bytes per reading).

2.3.4 Examining Data

The data file (e.g. CM2DAT.DAT) can be viewed using a number of different methods. DOS utilities MORE, TYPE, EDLIN and PRINT are bottom line methods of viewing, editing and printing the data. Any word processor capable of handling ASCII files can be used also. The file can also be imported into any number of spreadsheet and database environments available commercially.

Section 3 of this manual gives the data format and respective column designations for instruments in this series.

3 DATA FORMAT

3.1 Common Features

The format of the data displayed on the screen will vary from instrument to instrument. However, certain features remain common through out the range. Columns 1 through 4 are used to display the month, day, hour and minute recorded by the instrument's real-time clock. The last column is the sequential sample number. The columns in between display data as described in the sub-sections relating to each instrument.

Data are recorded on the disk file in essentially the same format as the display except that there are no spaces and no column headings. Data values are separated by commas and each line is terminated by a carriage return.

3.2 Model 6011U Inclinometer

The program to read data from Model 6011U Inclinometers is RDINC. For a Hodel 6011UP (an inclinometer fitted with a pressure sensor) use RDINCP.

The file used to store cartridge data is INCDAT.DAT.

Data are stored on disk as twelve columns. The first four and the twelfth are as described in Section 3.1. Column 5 is used to store pressure as a percentage of the sensor's full scale reading. Column 6 stores temperature in degrees Centigrade. Column 7 represents conductivity in units of milliseimans/meter.

Columns 8 and 9 are used to store tilt angle (relative to the vertical) and tilt direction (relative to magnetic north), both in degrees.

Alternatively, columns 8 and 9 can be used to store tilt information in Cartesian form as easterly and northerly components. These components are derived, in principle, as follows. First the tilt angle is converted to its trigonometric sine - a number in the range zero to 1. Then, this number is

multiplied by the sine of the direction angle to obtain the easterly component. Similarly, the northerly component is sin(tilt) multiplied by cos(direction). We end up, therefore, with numbers in the range -1 to +1. On this scale -1 in the column 9 would represent 90 degrees of tilt to the south. The Cartesian representation has an advantage, in some applications, of allowing tilt angles to be handled vectorially.

The tenth and eleventh columns are values of the standard deviations of the two tilt components.

If conductivity or pressure sensors are not fitted to the inclinometer, dummy data will be stored in the corresponding columns on the disk.

3.3 Model 6011 MkII Current Meter

The program to read data from the Model 6011 MkII Current Meter is RDCM.

The file used to store cartridge data is CM2DAT.DAT.

Data are displayed in 12 columns as follows:

Column	Data
1	Month
2	Day
3	Hour
4	Minute
5	Pressure (as % FSD of sensor)
6	Temperature (deg. C.)
7	Conductivity (mS/m)
8	East-West current (cm./sec.)
9	North-South current (cm./sec.)
10	E-W Std. Devn. (cm./sec.)
11	N-S Std. Devn. (cm/sec.)
12	Sample Number

3.4 Model 6070 Thermograph

The program to read data from the Model 6070 Thermograph is RDPTC.

The file used to store cartridge data is DATLOG.DAT

Data are displayed in 8 columns as follows:

Column	Data
1	Honth
2	Day
3	Hour
4	Minute
5	Pressure
6	Temperature
7	Conductivity
8	Sample Number

3.5 Model 6051 Pressure Gauge

The program used to read cartridges from the Model 6051 Pressure Gauge is RDPG.

Data are stored in DATLOG.DAT.

APPENDIX E

ANALYTICAL METHODS, SAMPLE CONTAINERS, PRESERVATION, AND HOLDING TIMES

Table 1
Analytical Methods, Sample Containers, Preservation, and Holding Times

Parameter	Analytical Method	Extraction Method	Sample Matrix	Minimum Container Size / Material[a]	Sample Preservation[b]	Holding Times
Hardness	EPA 130.1	N/A	Water	(1) 500-ml Plastic Jar	Chill, 4° C, H_2SO_4 pH < 2 (.25 ml)	28 days after sampling
Total Suspended Solids, non-filterable	EPA 160.2	N/A	Water	(1) 1-liter Amber Glass Jar with Teflon-lined septum[c]	Chill, 4° C	7 days until analysis
Alkalinity	EPA 310.1	N/A	Water	(1) 1-liter Amber Glass Jar with Teflon-lined septum[c]	Chill, 4° C	14 days until analysis
Nitrate-N	EPA 352.1	N/A	Water	(1) 1-liter Amber Glass Jar with Teflon-lined septum	Chill, 4° C	2 days until analysis
		N/A	Soil	(1) 4-oz Glass Jar (1) 1-liter Glass Jar	Chill, 4 C	2 days until analysis
Total Kjeldahl Nitrogen	EPA 351.4	N/A	Water	(1) 1-liter Amber Glass Jar with Teflon-lined septum	Chill, 4° C, H_2SO_4 pH < 2 (.25 ml)	28 days until analysis
		N/A	Soil	(1) 4-oz Glass Jar (1) 1-liter Glass Jar	chin, 4° C	28 days until analysis
Total Phosphorus	EPA 365.3	N/A	Water	(1) 1-liter Amber Glass Jar with Teflon-lined septum[c]	H_2SO_4 pH < 2	Analyze within 28 Days
		N/A	Soil	(1) 4-oz Glass Jar (1) 1-liter Glass Jar	Chill, 4° C	Analyze within 28 Days

Table 1
Analytical Methods, Sample Containers, Preservation, and Holding Times

Parameter	Analytical Method	Extraction Method	Sample Matrix	Minimum Container Size / Material[a]	Sample Preservation[b]	Holding Times
Biological Oxygen Demand (BOD)	EPA 406.1	NIA	Water	(1) 1-liter Amber Glass Jar with Teflon-lined septum	chill, 4° C	Start analysis within 48 hours
Chemical Oxygen Demand (COD)	EPA 410.1	NIA	Water	(1) 500-ml Plastic Jar	Chill, 4° C, H_2SO_4 pH < 2 (.25 ml)	28 days until analysis
Total Organic Carbon (TOC)	EPA 415.1, 416.2	NIA	Water	(1) 1-liter Amber Glass Jar with Teflon-lined septum	Chill, 4° C, H_2SO_4 pH < 2 (.25 ml)	28 days until analysis
		NIA	Soil	(1) 4-oz Glass Jar (1) 1-liter Glass Jar	Chill 4° C	28 days until analysis
Cation Exchange Capacity (CEC)	EPA 9081	NIA	Soil	Shelby Tube	None	None
Heterotrophic Plate Count	SM 92166	NIA	Water	(1) 1-liter Amber Glass Jar with Teflon-lined septum	Chill, 4° C	Not to exceed 24 hours
		N/A	Soil	(1) 4-oz Glass Jar (1) 1-liter Glass Jar	Chill. 4° C	14 days
Metals + Cyanide (filtered)	TAL	CLP	Water	(2) 500-ml HOPE Jar for metals + (1) 1-liter Amber Glass Jar for Cyanide	chill, 4° C Metals - HNO_3 pH < 2 Cyanide - NaOH pH > 12	Metals - 6 months Mercury - 26 days Cyanide - 12 days
		CLP	Soil	(1) 4-oz Glass Jar (1) 1-liter Glass Jar	Chill, 4° C	Metals - 6 months Mercury - 26 days Cyanide - 12 days

Table 1
Analytical Methods, Sample Containers, Preservation, and Holding Times

Parameter	Analytical Method	Extraction Method	Sample Matrix	Minimum Container Size / Material[a]	Sample Preservation[b]	Holding Times
Metals + Cyanide (unfiltered)	TAL	CLP	Water	(2) 500-ml HDPE Jar for metals + (1) 1-liter Amber Glass Jar for Cyanide	Chill, 4° C Metals - HNO_3 pH < 2 Cyanide - NaOH pH > 12	Metals - 6 months Mercury - 26 days Cyanide - 12 days
		CLP	Soil	(1) 4-oz Glass Jar (1) 1-liter Glass Jar	Chill, 4° C	Metals - 6 months Mercury - 26 days Cyanide - 12 days
Volatile Organic Compounds (VOC)	CLP	CLP	Water	(3) 40-ml VOA Vials with Teflon-lined septa	chill, 4° C, HCl pH < 2, store in dark	10 days until analysis', 5 days if unpreserved
		CLP	Soil	(1) 4-oz Glass Jar (1) 1-liter Glass Jar	chill, 4° C, store in dark	10 days until analysis[f]
Semivolatile Organic Compounds (Base-Neutral/Acid Extractables)	CLP	CLP	Water	(2) 1-liter Amber Glass Jars with Teflon-lined septa	chill, 4° C[e]	Extract within 5 days, analyze within 40 days'
		CLP	Soil	(1) 4-oz Glass Jar (1) 1-liter Glass Jar	Chill, 4° C	Extract within 10 days, analyze within 40 days[f]

Table 1
Analytical Methods, Sample Containers, Preservation, and Holding Times

Parameter	Analytical Method	Extraction Method	Sample Matrix	Minimum Container Size / Material[a]	Sample Preservation[b]	Holding Times
Pesticides/PCBs	CLP	CLP	Water	(2) 1-liter Amber Glass Jar with Teflon-lined septum	chill, 4° C, 5 ≤ pH ≤ 9, store in dark	Extract within 5 days, analyze within 40 days[f]
		CLP	Soil	(1) 4-oz Glass Jar (1) 1-liter Glass Jar	Chill, 4° C, store in dark	Extract within 10 days, analyze within 40 days[f]
Hexavalent Chromium	EPA 218.4	N/A	Water	(1) 1-liter Plastic	chill 4° C	24 hours
		N/A	Soil	(1) 4-oz Glass Jar (1) 1-liter Glass Jar	Chill 4° C	None specified
Percent Moisture	ASTM D-2216-80	N/A	Soil	Shelby tube	None	None
Bulk Density	ASTM D-4263	N/A	Soil	Shelby tube	None	None
Porosity	ASTM D-4645	N/A	Soil	Shelby tube	None	None
Grain Size	ASTM D-2434	N/A	Soil	Shelby tube or Stainless-Steel Sampling Sleeve	None	None
Specific Gravity	ASTM D-864	N/A	Soil	Shelby tube	None	None
Permeability	ASTM D-2434	N/A	Soil	Shelby tube	None	None

Notes:

CLP analyses performed in accordance with Statement of Work (SOW) 3/90.

a Soil samples collected with split-barrel samplers shall be submitted to the laboratory in stainless-steel sampling sleeves [or jars].

b Any preserving agents used must be ACS Certified Reagent Grade.

c Hardness and chemical oxygen demand (COD) will be collected in same sample container.

d Total suspended solids, sulfate, orthophosphate, and alkalinity will be collected in same sample container.

e Sodium thiosulfate ($Na_2S_2O_3$), 0.008%, should be added in the presence of free or combined chlorine.

f CLP holding times are from Validated Time of Sample Receipt (VTSR).

N/A = Not applicable. Extraction is not required or is part of the analytical method.
[HDPE = high density polyethylene]

APPENDIXF

INTERCHANGE FILE FORMAT

FOR ELECTRONIC DATA REPORTS

INTERCHANGE FILE FORMAT
FOR
ELECTRONIC DATA REPORTS

Thir document establishes, for EPA Region IV, the required format for electronic reporting of monitoring data.

Data will be transported a8 a ret of four ASCII filar:

STATION.DAT	Contains baric information about monitoring rtation location and type.
WELL.DAT	Containr detailed information about construction and charactoristics of groundwater monitoring stationr.
SAMPLE. DAT	Containr baric information about the collection and characterirticr of samples.
PARM. DAT	Contains measured valuer and reporting units for specific parameters.

The first line of EACH of the four filer MUST contain the following text starting with position one: 19901001

These files are to be transmitted in ASCII format using 5.25 inch flexible dirk, nine-track magnetic tape (1600 or 6250 bpi) or, in the future, via communications channels yet to be defined. **Hardcopy reporting** requirements will continuo ar currently required until further notice. Additional filer may be defined in the future for non-groundwater station types should the need arise.

Several of there filer will contain data that is usually static in nature. For example, the basic information contained in STATION.DAT will not normally change for any ringle station; therefore, once the data has been submitted for a particular rtation, it will not be required to resubmit that information. If, however, the station record is updated or corrected, the record would have to be resubmitted. After the initial report then, STATION.DAT would be submitted

only when now stations are created, or when an old station record is modified, and need only continue the new or modified records. The same is true of file WELL.DAT. SAMPLE.DAT would, of course, k submitted each *time* one or more *new* samples were to be reported, or any sample record required updating. Again, the file need only contain tho new or updated records. PARM.DAT is expected to be submitted at each required reporting interval, since it will contain the analytical results needed to determine compliance. It must contain all new results for: the reporting interval, and may contain corrections and updates to older records. As may k observed, the format allows for synchronous reporting, provided that no sample may be reported before the station with which it is associated, and no parametric record before it8 sample record.

For each file described in the appendices, all field8 must be reported. Tho null, or "no data", value for all field. is the pound sign (#), and must appear in the first column position of its field. Field values may k listed on per line in the export file, or multiple values may be reported on a single line, provided that field values are reported in the specified order, and each value is terminated by a comma (,). Lines containing multiple values may not exceed *80* characters in length, including the delimiters.

DO NOT CREATE LINES LONGER THAN 80 CHARACTERS! EVEN THOUGH LONGER RECORDS MAY APPEAR TO LIST PROPERLY ON THE SCREEN, LINES LONGER THAN 80 CHARACTERS WILL NOT BE ACCEPTED BY THE IFF POST PROCESSOR!

Since the comma is used am a delimiter for data values, the values themselves may not contain any comma, even though the value may be a text stream.

Datafile STATION.DAT

Field No.	Field Name	Field Description
1	STATION_KEY	Unique station identifier. Consists of a twenty-seven character ALPHANUMERIC field, left justified, containing:

Column:	Description:
01-12	Unique site identifier as assigned by EPA. Must be ALPHANUMERIC.
13-17	Unique solid waste management unit designator. Must be ALPHANUMERIC.
18	Media status indicator:. Must contain one of the following: C - Compliance monitoring B - Baseline monitoring station A - Ambient monitoring station
19-27	Unique rtation identifier. Must be ALPHANUMERIC. If this data is to be used with tho Region IV Query Menu, tho naming convention recommended for stations is as follow. Monitoring wells should contain "MW, test pits 'TP', bore holes 'BH', surface soils 'SS'.

2	TYPE	Type of monitoring rtation. Consists of a four character

		ALPHANUMERIC field, left justified, containing one of the following: AIR, SWTR, GWTR, SOIL, SED, and SLDG. Tho meanings of these abbreviations are as follows: AIR - Air sampling station SWTR - Surface water sampling station GWTR - groundwater sampling station SOIL - Soil sampling station SED - Stream bed sediment SLDG - Process sludge sampling
3	LATITUDE	Geographic position of the station in degrees north of equator. Must be in the format DDMMSS.xxxx. where DD represents degrees, MM represents minutes, and SS.xxxx represents seconds, with available precision to four decimal places.
4	LONGITUDE	Geographic position of tho rtation in degrees west of the Prime Meridian. Must bo in the format DDDMMSS.xxxx, where DDD represents degrees, MM represents minutes, and SS.xxxx represents seconds, with available precision to four decimal places.
5	LSDAT	Elevation in feet (MSL) of land surface at tho location of the monitoring station. Must bo a DECIMAL NUMERIC field with a maximum of twelve characters (including the decimal point) and may have up to two digits after the decimal point.
6	RFDAT	Elevation in foot (MSL) of the point from which height above ground, water level and sampling depth measurements are taken. DECIMAL NUMERIC field with a maximum of twelve characters (including tho decimal point) and

may have up to two digit8 after the decimal point.

7	CONDT	Date construction of the station was completed. Eight character integer field consisting of:

COLUMNS	CONTENT
1-4	Yoar including century, e.g. 1989
5-6	Numeric month
7-8	Numeric day of month

Column numbers are relative to tho beginning of the CONDT field. Each subfield described above must be right justified, and may contain leading zeros.

8	ACCUR	Estimated accuracy for the reported latitude and longitude, in motors. DECIMAL NUMERIC fiald with a maximum of six characters (including tho decimal point) and may havo up to two digits after the decimal point.
9	LLMETH	One character ALPHANUMERIC field which indicate8 the method used to determine the latitude and longitude. Contains one of the following:

C - Calculated from map
D - Digitized from a map
G - Global Positioning System
L - Loran-C
U - Unknown
O - Other method not listed above

10	OMETH	Any method for which there is no Code. This field consists of 32 character ALPHANUMERIC field, loft justified. This field is REQUIRED if 'O' is entered in the method field above.
11	COMMENT	Any additional information tho user

feels is necessary, which may not be accommodated in a defined field. Must be ALPHANUMERIC consisting of up to 40 characters.

Datafile WELL.DAT

FIELD no.	FIELD NAME	FIELD DESCRIPTION
1	STATION_KEY	Unique rtation identifier. Consists of a twenty-seven character ALPHANUMERIC field, loft justified, containing:

COLUMN	DESCRIPTION
01-12	Unique site identifier ai assigned by EPA. Must be ALPHANUMERIC.
13-17	Unique solid waste management unit designator. Must be ALPHANUMERIC.
18	Media status indicator. Must contain one of tho following: C - Compliance monitoring station. B - Baseline monitoring station. A - Ambient monitoring station.
19-27	Unique station identifier. Must be ALPHANUMERIC.

2	AQNAM	USGS Aquifer Code for aquifer from which samples are obtained. ALPHANUMERIC field with up to eight characters.
3	TOTDP	Total depth to which the hole was drilled, bored or dug in fwt below land surface datum. DECIMAL NUMERIC field with a maximum of twelve characters (including the decimal point) and may have up to two digits after tho decimal point.

4	DRMTH	Method by which well was conrtructed. Must be ALPHANUMERIC, consisting of a single character. The character must be one of the following: H - Hollow stem auger C - Cable tool V - Reverse rotary J - Water jot S - Solid stem auger R - Rotary D - Dug A - Air percussion O - Other
5	DRFLD	Fluid used to lubricate cutting tool &/or remove materials from hole. Must be ALPHANUMERIC, consisting of a single character. Tho character: must be o m of the following: A - Air B - Bentonite W - Water M - Other Mud N - None O - Other fluid
6	DVMTH	Method by which well war developed. Must be ALPHANUMERIC, consisting of a single character. The character must be one of the following: A - Air lift pump B - Bailed C - Compressed air J - Jetted P - Other pump S - Surged Z - Other method N - None
7	DVHRS	Time in hours during which well was developed. Must be INTEGER NUMERIC, consisting of up to 5 digits.

8	SPLTRT	Any special treatment that was applied during the well development process. Must be ALPHANUMERIC, consisting of a single character, which must be one of tho following: C - Chemicals D - Dry ice E - Explosives F - Deflocculant H - Hydrofracturing M - Mechanical Z - Other N - None
9	LIFT	Type of lift indicator. Must be ALPHANUMERIC, consisting of a single charactor. The character must be one of the following: A - Air lift B - Bucket C - Centrifugal pump J - Jet pump P - Pirton pump R - Rotary pump S - Submersible pump T - Turbine U - unknown Z - Other
10	NOSEG	Number of bore hole sections. A bore hole section is defined a8 a length of bora hole of constant diameter. Bore hole sections are designated numerically from top to bottom of bora hole. INTEGER NUMERIC fimld containing a value of one, two, or throe.
11	SGDIA1	Diameter of first bora hole section, in inches.
12	SGDIA2	Diameter of second bore hole section, in inches.
13	SGDIA3	Diameter of third bore hole section. in inches.

		Each of the SGDIAx fields is DECIMAL NUMERIC, containing up to twelve characters (including the decimal point), and may have up to two digits following tho decimal point.
14	STELV1	The depth to the top of the first boro bolo section.
15	STELV2	Tho dopth to the top of tho second boro hole section.
16	STELV3	Tho dopth to the top of tho third boro hole section.
		Each of tho STEW% fields is DECIMAL NUMERIC With a maximum of twelve characters (including the decimal point), and may have up to two digits after the decimal point. These depths are measured relative to land surface datum.
17	SBELV1	Tho depth to the bottom of the first bore hole section.
18	SBELV2	Tho dopth to tho bottom of the second boro hole section.
19	SBELV3	Tho dopth to the bottom of the third bore hole section.
20	NOCAS	Number of casing sections. A casing section is defined an a length of casing of constant diameter and uniform material. Casing sections are designated numerically from top to bottom of well. INTEGER NUMERIC field containing a value of one, two, or three.
21	TCELV1	Tho dopth to the top of the first section of casing (in feet).
22	TCELV2	The depth to the top of the second section of casing (in feet).

23	TCELV3	The depth to the top of the third section of caaing (in feet).
		The TCELVx fields are DECIMAL NUMERIC, each with a maximum of twelve characters (including the decimal point) and may ham up to two digits after tho decimal point. These depths are measured relative to land surface datum.
24	BCELV1	The depth to the bottom of the first section of caaing, in feet.
25	BCELV2	The depth to the bottom of tho second section of casing, in feet.
26	BCELV3	Tho depth to'the bottom of tho third section of caring, in feet.
		The BCELVx fields are DECIMAL NUMERIC, each with a maximum of twelve characters (including the decimal point) and may have up to two digits aftor tho decimal point. These depths are measured relative to land surface datum.
27	CIDIA1	Inside diameter of the first section of casing, in inches.
20	CIDIA2	Inside diameter of tho second section of casing, in inches.
29	CIDIA3	Inside diameter of tho third section of caaing, in inches. The CIDIAx fields are DECIMAL "" ERIC, each with a maximum of twelve characters (including the decimal point) and may have up to two digits after the decimal point.
30	CODIA1	Outside diameter of the first section of caaing, in inches.
31	CODIA2	Outride diameter of the second section of casing, in inches.

32 **CODIA3** Outside diameter of the third section of caring, in inches.

Tho CODIAx fields are DECIMAL NUMERIC, each with a maximum of twelve characters (including tho decimal point) and may have up to two digits after tho decimal point.

33 **CMATR1** Description or name of caring material from which the first section of cuing ir made.

34 **CMATR2** Description or name of caring material from which the second section of casing is made.

3s **CMATR3** Doscription or name of casing material from which tho third section of casing is made.

Tho CMATRx fields are ALPHANUMERIC, each with a maximum of eight characters.

OPEN INTERVAL - Any portion of the well *in* which the interior of the well is not isolated from tho **surrounding soil and** rock **by unbreached casing.**

36 OPTYP Indicator of the type of opening in tho open interval. The field is ALPHANUMERIC, consisting of a single character. The character must be one of the following:

O - Open end
P - Puforatod or slotted
S - Screened
T - Sand point
W - Walled
X - Open holo
Z - Other

37 **TOELV** The depth to tho top of tho open interval. The TOELV field is DECIMAL NUMERIC with a maximum of twelve characters (including the

decimal point) and may have up to two digit8 after the decimal point. Measured relative to land surface.

38 **BOELV** The depth to the bottom of the open interval. The BOELV field is DECIMAL NUMERIC with a maximum of twelve characters (including the decimal point) and may have up to two digit8 after the decimal point. Measured relative to land surface.

39 **OMATR** Description or name of material used to screen the open interval. Tho OMATR field is ALPHANUMERIC with a maximum of eight characters.

40 **OWIDT** Width or short dimension of slot or mesh of screen material for tho open interval, in inches. The OWIDT field is DECIMAL NUMERIC with up to twelve characters (including the decimal point), and may have up to three digit8 following the decimal point.

41 **OLENG** Length os long dimension of slot or mesh of screen material for the open interval, in inches. The OLENG field is DECIMAL NUMERIC with up to twelve characters (including the decimal), and may have up to three digits following tho decimal point.

FILTER PACK - Material placed in the annulus of the well between the bore hole wall and the well screen to prevent formation material from entering through the well screen.

42 **FPMTH** Indicator for method of filter pack placement. Must be ALPHANUMERIC consisting of a single character. The character must be one of the following:

A - dropping material down the hole and tamping

B - dropping material down hollow-stem auger
T - Tremie pipe
0 - Other

43 **FPMAT** Description or name of the material which forms the filter pack. Must be ALPHANUMERIC, consisting of up to eight characters.

44 **FPGRN** Grain size of the material which forms the filtor pack, in m8h gauge. Must be INTEGER NUMERIC, with up to four characters.

45 **TFELV** The depth to tho top of the filtor pack. The TFELV field is DECIMAL NUMERIC with tho maximum of twelve characters (including tho decimal point) and may have up to two digits after the decimal point. Measured relative to land surface.

46 **BFELV** The depth to tho bottom of the filtor pack. The BFELV field is DECIMAL NUMERIC with a maximum of twelve characters (including the decimal point) and may have up to two digits aftor the decimal point. Measured relative to land surface.

ANNULAR SEALANT - Material used to seal the space between the bore hole and the casing of the well. The annular sealant is placed directly above the filter pack to prevent the migration of contaminants to the sampling zone from the surface or intermediate zones and prevent cross contamination between strata.

47 **SLMTH** Indicator for method of sealant placement. Must be ALPHANUMERIC consisting of a single charactor. The character must be one of the following:

A - dropping material down the hole and tamping

B - dropping material down hollow-stem auger
T - tremie pipe
O - other

40	SLMATR	Description or name of the material which forms tho seal above the filter pack against entry of surface water. Must k ALPHANUMERIC, consisting Of a single charactor. The charactor must k one of the following: B - Bentonite C - Clay G - Cement Z - Other N - None
49	TSLELV	The depth to tho top of tho annular seal. Tho TSLELV field is DECIMAL NUMERIC with a maximum of twelve charactera (including the decimal point) and may have up to two digit8 after the decimal point. Measured relative to land surface.
50	BSLELV	The depth to tho bottom of the annular seal. Tho BSLELV field is DECIMAL NUMERIC with a maximum of twelve charactors (including the decimal point) and may have up to two digits aftor tho decimal point. Measured relative to land surface.
51	SRFSL	Surface meal indicator. Indicates whether or not tho upper portion of the bore hole is sealed to prevent inflow of surface water. Single charactor ALPHANUMERIC, containing "Y" if well is sealed. Otherwise, contains "N".
52	DNGRAD	Downgradient indicator. Indicate8 whether or not tho well ha8 k e n installed hydraulically downgradient of tho source of potential groundwater pollution,

		and is capable of detecting the migration of contaminants. Single character ALPHANUMERIC containing "Y" if well is downgradient from waste disposal site. Otherwise, contains "N".
S3	DRLOG	Drillers log indicator. Indicates availability of drillers log. Single character ALPHANUMERIC, containing "Y" if log is available. Otherwise, contains "N".
54	LTHLG	Lithologic log indicator. Lithologic log shows distribution of lithology with depth in the bore hole. Single character ALPHANUMERIC, containing 'Y' if log is available. Otherwise, contains "N".
55	WLUSE	Well use indicator. Must be ALPHANUMERIC, consisting of a single character. The character must be one of the following: D - Domestic (private) water supply I - Indurtrfal water supply M - Monitoring well P - Public water supply O - Other
56	COMMENT	Supplemental information as needed. May contain up to 80 ALPHANUMERIC charactors.

Datafile SAMPLE.DAT

FIELD NO.	FIELD NAME	FIELD DESCRIPTION
1	SAMPLE_KEY	Unique sample identifier. Conrirtr of forty-two charactu field, left justified, containing:

COLUMN	DESCRIPTION
01-12	Unique site identifier as assigned by EPA. Must be ALPHANUMERIC.
13-17	Unique solid waste management unit designator. Must be ALPHANUMERIC.
18	Media status indicator. Must contain one of tho following: C - Compliance monitoring rtation B - Baseline monitoring rtation A - Ambient monitoring rtation
19-27	Unique rtation identifier. Must be ALPHANUMERIC.
28-42	Unique sample identifier. Must be ALPHANUMERIC.

2	DELTH	Vertical displacement of sample from the reference elevation (in feet) of tho sampling rtation. For surface water, soils, and groundwater stations, this wuld be the depth of the sample and for air monitoring stations, tho height above ground. Must be DECIMAL NUMERIC consisting of a maximum of six characters (including the decimal) and may have up to two

17

digits after the decimal point.

3 **DATE** Date of sample collection. Eight character integer field consisting oft

COLUMNS	CONTENT
1-4	Year, including century, e.g. 1989
5-6	Numeric month
7-8	Numeric day of month

Column n e s s at. relative to the beginning of tho field. Each subfield described above must be right justified, and may contain loading zeros.

4 **TIME** Time (in military format) of sample collection. INTEGER NUMERIC consisting of four characters.

5 **SSTAT** Station status of condition. Used primarily for groundwater monitoring stations. ALPHANUMERIC consisting of one character. The character must be one of the following*t*

D - Dry
F - Flowing
O - Obstructed
P - Pumping
W - Destroyed
S - Surficial inflow
Z - Other

FIELD MEASUREMENTS

6 **TEMP** Sample temperature in degrees Celsius. DECIMAL NUMERIC consisting of six characters (including tha decimal) and may nave up to two digits after +ne

		decimal point.
7	PH	Sample pH in rtandard units. DECIMAL NUMERIC consirting of six characters (including the decimal) and may have one digit after the decimal point.
8	COND	Specific Conductance in uMhos. INTEGER NUMERIC consisting of a maximum of six characters.
9	TURB	Turbidity. INTEGER NUMERIC consisting of a maximum of eight characters. May be reported in JTU or NTU, as required by program.
10	WLEVEL	Well water level, or stream gage height, in feet. Measured relative to the reference datum. Item is DECIMAL "ERIC consisting of a maximum of six characters (including the decimal) and may have up to two digits following the decimal point.
11	WINDSP	Wind speed in km/h. DECIMAL NUMERIC consisting of a maximum of six characters (including the decimal), and may have up to two digit6 after the decimal point.
12	WINDIR	Wind direction in degrees. INTEGER NUMERIC consirting of a maximum of four characters.
13	SAMMETH	Method used to collect sample. ALPHANUMERIC field, left justified, consisting of up to 20 characters.
14	SAMPLER	Name of agency or organization that collected the sample. Must be ALPHANUMERIC consisting of up to 20 characters.
15	COMMENT	*Any* additional information the user feels necessary, which may not be accommodated in a defined field.

Must be ALPHANUMERIC consisting of up to 40 characterr.

Datafile PARM.DAT

FIELD NO.	FIELD NAME	FIELD DESCRIPTION
1	PARAM_KEY	Unique data record identifier. Consists of fifty-four character field, left justified, containing:

COLUMN	DESCRIPTION
01-12	Unique site identifier as assigned by EPA. Must be ALPHANUMERIC.
13-17	Unique solid waste management unit designator. Must be ALPHANUMERIC.
18	Media status indicator. Must contain one of the following: C - Compliance monitoring station B - Baseline monitoring station A - Ambient monitoring station
19-27	Unique station identifier. Must be ALPHANUMERIC.
28-42	Unique sample identifier. Must be ALPHANUMERIC.
43-54	Parameter identifier. For chemical constituents for which CAS numbers exist, the CAS number will be the identifier. For other constituents, the identifier will be determined on an as-needed basis.

	s5-se	Replicate number. Identifies the value as one of two or more analytical results for tho same parameter on the same sample. INTEGER NUMERIC, right justified, up to four characters. Not used unless replicate results are reported.
2	QUALF	Qualifier field, ALPHANUMERIC, may contain up to four STORET qualifier codes.
3	VALUE	**The reported analytical result for the chemical. Must be DECIMAL NUMERIC, consisting of up to twelve characters (including the decimal), and may have up to four digits after the decimal point.**
4	UNITS	**The units of measurement in which analytical results are reported. ALPHANUMERIC, consisting of up to six characters.**
5	METHOD	Tho name or code of tho analytical method or technique used to obtain the reported value. ALPHANUMERIC, containing up to fourteen characters.
6.	DATE	Date of analysis. Eight character INTEGER field consisting of:

COLUMN	CONTENT
1-4	Year, including century, e.g. 1989
5-6	Numeric month
7-8	Numeric day of month

Column numbers are relative to the beginning of tho DATE field. Each subfield described *above* must be

		right justified, and may contain leading zeros.
7	DETLIM	Detection limit. Must be in same units a8 the reported value. Must be DECIMAL NUMERIC, consisting of up to twelve characters (including the decimal), and may have up to four digit8 after the decimal point.
8	LAB	Name of lab that performed the analysis. ALPHANUMERIC field containing up to 28 characters.
9	COMMENT	*Any* additional information the user feels necessary, which may not be accommodated in a defined field. Must bo ALPHANUMERIC consisting of up to 40 characters.

IFF FIELD WORKSHEET

Sample Station Information

1. Site Identification lo. _|_|_|_|_|_|_|_|_|_|_|_|_|
2. Waste Management Unit _|_|_|_|_|
3. Compliance, Baseline, or Ambient Monitoring (C, B, or A) _|
4. Unique station identifier _|_|_|_|_|_|_|_|_|
5. Unique sample identification _|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|
6. Type of media collected _|_|_|_|

   AIR - Air sample station
   SWTR - Surface water station
   GWTR - Ground water station
   SOIL - Soil sampling station
   SED - Sediment sampling station
   SLDG - Process sludge station
   OTHR - Other type of sample station

7. Latitude _|_|_|_|_|_|_|_|.|_|_|_|_|
8. Longitude _|_|_|_|_|_|_|_|.|_|_|_|_|
9. Elevation of land surface _|_|_|_|_|_|_|_|_|_|.|_|_|
10. Reference elevation (i.e top of casing) _|_|_|_|_|_|_|_|_|_|.|_|_|
11. Date of station installation _|_|_|_|_|_|_|_|
    y y y y m m d d
12. Estimated accuracy of the longitude and latitude _|_|_|_|.|_|_|
13. Method used to determine longitude or latitude _|

    C - Calculated from map
    U - unknown
    G - Global positioning system
    O - Other method not listed
    L - Loran-C
    D - Digitized from map
    S - Field survey

Site ID #_____
Waste Man unit_____
Station ID_____
Sample ID_____

14. Any method for which there is no listed code _|_|_|_|_|_|_|_|_|_|_|_|_|

15. Additional comments _|_|_|_|_|_|_|_|_|_|_|_|_|

16. Vertical displacement of sample from reference datum _|_|_|._|_|

17. Date sample was collected _|_|_|_|_|_|_|_|
y y y y m m d d

18. Time (military) sample was collected _|_|_|_|

19. Condition of sample location _|

D - Dry
O - Obstructed
W - Destroyed

F - Flowing
P - Pumping
Z - Other

20. Temperature _|_|_|._|_|

21. pH _|_|._|

22. Specific conductivity in uMhos _|_|_|_|_|_|

23. Sample turbidity _|_|_|_|_|_|_|_|

24. Well water level (or stream gage height) _|_|_|._|_|

25. Wind speed _|_|_|._|_|

26. Wind direction _|_|_|_|

27. Sample collection method _|_|_|_|_|_|_|_|_|_|_|_|_|

28. Name of organization collecting samples _|_|_|_|_|_|_|_|_|_|_|_|_|

29. Comment field. May be up to 40 alphanumeric characters _|_|_|_|_|_|_|_|_|_|_|_|_|

Site ID #_____
Waste Man Unit_____
Station ID_____
Sample ID_____

Well Installation Information

30. Aquifer name _|_|_|_|_|_|_|_|_|

31. Total depth of boring _|_|_|_|_|_|_|_|_|_|.|_|

32. Drilling method _|

H - Hollow stem	S - Solid stem
C - Cable tool	R - Rot —
V - Reverse rotary	D - Dug
J - Water jet	A - Air percussion
O - Other	

33. Lubricating fluid _|

A - Air	M - Mud other than bentonite
B - Bentonite	N - None
W - Water	O - Other fluid

34. Method of development _|

A - Air lift	B - Bailed
C - Compressed Air	J - Jetted
P - Other pump	S - surged
Z - Other	N - None

35. Hours of development _|_|_|_|_|

36. Special treatment of well during drilling or development _|

C - Chemicals	D - Dry ice
E - Explosives	F - Deflocculant
H - Hydrofracture	M - Mechanical
Z - Other	N - None

37. Type of lifting mechanism _|
(This field is used to record the well setup. For instance, a domestic well may have a permanently installed pump.)

A - Air lift	R - Rotary pump
B - Bucket	S - Submersible pump
C - Centrifugal pump	T - Turbine
J - Jet pump	U - Unknown
P - Piston pump	Z - Other

Site ID #_____
Waste Man Unit_____
Station ID_____
Sample ID_____

38. Number of borehole sections _|

39. Diameter of first borehole _|_|_ _|_|_|_|_|_|_|._|_|

40. Diameter of second borehole _|_|_ _|_|_|_|_|_|_|._|_|

41. Diameter of third borehole _|_|_ _|_|_|_|_|_|_|._|_|

42. The depth to the top of the first borehole section, measured from ground surface _|_|_|_|_|_|_|_|_|_|._|_|

43. The depth to the top of the second borehole section _|_|_|_|_|_|_|_|_|_|._|_|

44. The depth to the top of the third borehole section _|_|_|_|_|_|_|_|_|_|._|_|

45. The depth to the bottom of the first borehole _|_|_|_|_|_|_|_|_|_|._|_|

46. The depth to the bottom of the second borehole _|_|_|_|_|_|_|_|_|_|._|_|

47. The depth to the bottom of the third borehole _|_|_|_|_|_|_|_|_|_|._|_|

48. Number of casing sections _|

49. The depth to the top of the first section of casing _|_|_|_|_|_|_|_|_|_|._|_|

50. The depth to the top of the second section of casing _|_|_|_|_|_|_|_|_|_|._|_|

51. The depth to the top of the third section of casing _|_|_|_|_|_|_|_|_|_|._|_|

52. The depth to the bottom of the first section of casing _|_|_|_|_|_|_|_|_|_|._|_|

53. The depth to the bottom of the second section of casing _|_|_|_|_|_|_|_|_|_|._|_|

54. The depth to the bottom of the third section of casing _|_|_|_|_|_|_|_|_|_|._|_|

55. Inside diameter of the first section of casing _|_|_|_|_|_|_|_|_|_|._|_|

Site ID #_____
Waste Man Unit_____
Station ID_____
Sample ID_____

56. Inside diameter of the second section of casing _|_|_|_|_|_|_|_|_|_|_|.|_|_|

57. Inside diameter of the third section of casing _|_|_|_|_|_|_|_|_|_|_|.|_|_|

58. Outside diameter of the first section of casing _|_|_|_|_|_|_|_|_|_|_|.|_|_|

59. Outside diameter of the second section of casing _|_|_|_|_|_|_|_|_|_|_|.|_|_|

60. Outside diameter of the third section of casing _|_|_|_|_|_|_|_|_|_|_|.|_|_|

61. Casing material of first section of casing material _|_|_|_|_|_|_|_|_|

62. Casing material of second section of casing material _|_|_|_|_|_|_|_|_|

63. Casing material of third section of casing material _|_|_|_|_|_|_|_|_|

64. Type of screen _|

O - Open hole
S - Screened
E - Hydropunch
Y - Other
P - Perforated or slotted
W - Well point
Z - Piezometer

65. Depth to the top of the open or scrrened section _|_|_|_|_|_|_|_|_|_|_|.|_|_|

66. Depth ot the bottom of the open or screened section _|_|_|_|_|_|_|_|_|_|_|.|_|_|

67. Screen material _|_|_|_|_|_|_|_|_|

68. Screen or slot size _|_|_|_|_|_|_|_|_|.|_|_|_|

69. Reserved field _|_|_|_|_|_|_|_|_|.|_|_|_|

70. Filter pack placement method _|

A - Dropping material down the hole
B - Dropping material down hollow stem auger
T - Tremie pipe
O - Other

Site ID #_____
Waste Man Unit_____
Station ID_____
Sample ID_____

71. name of filter pack material _|_|_|_|_|_|_|_|_|

72. Filter pack grain size _|_|_|_|_|_|_|_|_|

73. The depth to the top of the filter pack _|_|_|_|_|_|_|_|_|_|_|.|_|_|

74. The depth to the bottom of the filter pack _|_|_|_|_|_|_|_|_|_|

75. Method of sealant placement _|

A - Dropping material down the hole
B - Dropping material through hollow stem auger
T - Tremie pipe
O - Other

76. Description of sealant material _|

B - Bentonite
G - Cement
Z - Other
N - None

77. Depth to the top of the annular seal _|_|_|_|_|_|_|_|_|_|_|.|_|_|

78. Depth to the bottom of the annular seal _|_|_|_|_|_|_|_|_|_|_|.|_|_|

79. Surface seal indicator _|

80. Downgradient indicator _|

D = Downgradient
U = Upgradient

81. Driller's log indicator _|

82. Lithologic log indicator _|

83. Well use indicator _|

D - Domestic
M - Monitoring well
O - Other
I - Industrial
P - Public

Site ID #_____
Waste Man Unit_____
Station ID_____
Sample ID_____

84. Supplemental commments

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APPENDIX *G*

ENSAFE/ALLEN & HOSHALL RÉSUMÉS

JAMES N. SPEAKMAN, Ph.D., P.E.
VICEPRESIDENT OF ENGINEERING

Education: Ph.D., Environmental and Water Resources Engineering, Vanderbilt University/1971
M.S., Sanitary Engineering, Vanderbilt University/1968
B.S., Civil Engineering, Tennessee Technological University/1966

Certifications: Professional Engineer

Experience:

- Manager of hazardous waste facility design projects for container storage facilities in South Carolina, Florida, Texas, and Tennessee.

- Manager of tank storage design and permitting projects at two (2) U. S. Navy torpedo fuel facilities. Project involved coordinated closure of existing tanks under Federal and state (VA and SC) regulations.

- Managed five (5) open-end hazardous waste compliance contracts for NAVFACENGCOM; four (4) for SOUTHDIV and one (1) for LANTDIV. Projects included development of hazardous waste management plans, hazardous material spill prevention control and countermeasure plans, comprehensive hazardous waste and hazardous materials surveys and preparation of fifteen permanent status permit applications. He prepared the first RCRA Part B Permit application submitted by the U.S. Navy.

- Directed underground tank assessment/closure/removal/remediation projects involving benzene, acetone, toluene, naptha, and petroleum fuels at Santa Anna, CA; Charleston, SC; Lawrenceburg and Memphis, TN; Dallas, TX, and Yorktown, VA. Projects involved removal of as many as six (6) tanks concurrently.

- Managed site remediation projects and hazardous waste facility closures involving heavy metals, volatile organics and PCBs. Developed remediation plans and had responsible charge of their implementation.

- Directed Resource Conservation and Recovery Act (RCRA) Permanent Status Permit applications for the Lake City (Independence, MO), Holston (Kingsport, TN) and Milan, TN Army Ammunition Plants. Those facilities operate multiple hazardous waste storage and treatment facilities, i.e., container storage buildings, surface impoundments, waste piles, incinerators, and treatment units; handling corrosive, reactive (including explosive), ignitable and toxic wastes.

PAUL V. STODDARD, C.P.G.
VICE PRESIDENT, GEOLOGICAL SERVICES

EDUCATION M.S., Geology, Memphis State University/1983
B.S., Geology, Memphis State University/1982
B.S., Biology, Memphis State University/1980

CERTIFICATION: Certified professional Geologist

EXPERIENCE:

- Generated stratigraphic correlations of upper Cretaceous and Tertiary trends of South Texas with concentration in the Wilcox and Frio formations. Responsible for regional correlations of E-logs, preparation of stratigraphic cross sections, development and updating of structure maps, and well spotting and digitizing.

- Conducted remedial site investigations at facilities for sites with potential soil and/or groundwater contamination involving chlorinated hydrocarbons and petroleum products. Field assessments included in-situ monitoring of organic vapors utilizing an organic vapor detector and/or a scanning infrared spectrophotometer.

- Responsible for the design and implementation of "preconveyance" investigations to determine potential soil contamination at various sites being considered for commercial development.

- Field supervision and implementation of closure plans for hazardous waste facilities at Charleston, SC Naval Shipyard. Tasks included removal of hazardous waste inventories, decontamination of tanks, confirmation sampling of decontamination solutions and soil sampling at container storage compounds operated by the Shipyard and Defense Reutilization and Marketing Office.

- Sampled groundwater monitoring wells for hazardous substance contamination and supervised well drillers at Shelby County, TN state Superfund site.

- Conducted a study of pesticide contamination in groundwater at an industrial facility in Missouri. Field Investigation included soil boring, monitoring well installation, determination of hydraulic gradients, data reduction and analyses, and report generation.

- Implemented groundwater investigation for photosensitive hazardous substance contamination at NPL site.

- Field supervision and implementation of closure plans for removal of underground waste oil storage tanks and investigation of potential contamination in soils and groundwater from tank releases.

- Field supervision and implementation of sampling plan for hazardous waste facilities at NAS Memphis. Task included Level B inspection of former waste plating treatment storm sewer, and the sampling of soils associated with defective joints. The task also included the sampling of a former salvage yard for petroleum hydrocarbons and lead.

- Field supervision and implementation of underground storage tank removal investigations. Field assessments include soil sampling and/or monitoring well installation with groundwater sampling and assessment of hydrogeologic conditions.

- Project geologist for interior survey of 120 acre underground room and pillar mine. Additional tasks included surface investigation of karst features, monitoring well installation, interpretation of borehole geophysics, and subsequent groundwater sampling and data reduction.

- Project geologist for hydrogeologic assessment of RCRA facilities. Tasks include site selection and installation of groundwater monitoring networks, slug tests, and subsequent data evaluation.

- Project geologist for MCAS Cherry Point, RFI. Tasks included design and implementation of Field Sampling Plan, including soil borings, monitoring well installation, groundwater sampling, slug tests, hydrogeologic characterization – including diurnal and tidal influences on the shallow aquifer and subsequent data reduction and report generation.

- Project geologist for hydrogeologic assessment of a proposed TN state Superfund site. Investigation included step drawdown and constant rate aquifer pump test for design and installation of a groundwater treatment system.

- Project manager for CERCLA Remedial Investigation/Feasibility Study for a former pesticide manufacturing facility. Tasks included the design and implementation of geologic/hydrogeologic assessment for volatile organic and pesticide contamination, subsequent data reduction, and report generation. Project management included cost tracking, scheduling, and continued regulatory compliance (i.e. Administrative Order).

- Project manager for CERCLA RI/FS for an industrial manufacturing facility. Related tasks included the design and implementation of geologic/hydrogeologic assessments for chlorinated solvent contamination in soils and groundwater. Investigation included monitor well installations, soil vapor extraction, borehole and surface geophysics, and a constant rate aquifer pump test, with subsequent data reduction and interpretation and RI report generation. Project management duties included community relations, maintaining data quality objectives, scheduling, waste disposal, and meeting Administrative order Requirements.

- Supervised and directed remedial investigations (RI) per CERCLA requirements at multiple NPL sites, Region 3, Region 4, Region 5 and Region 6. Investigations included, but were not limited to, soil analyses, monitor and recovery well installation, sampling and analyses of groundwater, aquifer tests, borehole geophysics, surface geophysics and data interpretation, including preparation and presentation of assessment reports.

BRIAN E. CALDWELL,
HYDROGEOLOGIST

EDUCATION: M.S., Geology, Florida State University, 1992
B.S., Geology, Florida State University, 1984
B.A., Psychology, Mars Hill College, 1978

CERTIFICATION Professional Geologist - TN, FL, WY

EXPERIENCE:

- Responsibility and experience includes project development, project management, and detailed tracking of project costs and task execution; primary client and regulatory agency contact for both project development and management.

- Project manager for several underground storage tank sites at Ft. McClellan in Anniston, Alabama and Tyndall Air Force Base in Panama City, Florida.

- Hydrogeologic responsibilities and experience include extensive field oriented projects; the design, installation, and sampling of monitoring well networks; multi- and single well aquifer testing; the perfoxmance of geophysical (magnetometer, ground-penetrating radar, electromagnetic conductivity, and seismic refraction) surveys; and sampling of soil, sediment, and surface water.

- In-house experience includes the incorporation of field and analytical results to site characterizations; statistical and mathematical analysis of hydrogeologic and geochemical data, delineation of the nature, magnitude and pathways of surface and subsurface contamination; computer simulations of single and multiaquifer groundwater systems, and assisting with the development of site-specific remedial measures.

- Project Manager for the installation and quarterly sampling of monitoring wells at a U.S. Navy facility regulated under RCRA in Pensacola, Florida.

- Project Manager for the design, installation, and sampling of a complex multiaquifer groundwater monitoring network and consequent site assessment at a site contaminated with chlorinated semivolatiles in Warrington, Florida.

- Project Field Manager for characterization of hazardous waste sites at the U.S. Naval Air Station in Pensacola, Florida, under the Naval Installation Restoration Program.

HENRY H. BEIRO
SENIOR GEOLOGIST

EDUCATION B.S., Geology, 1981
B.S., Biology, 1982

CERTIFICATION: 1989, Professional Geologist

EXPERIENCE

- Completed a $1.5 million project at the Y-12 weapons plant in Oak Ridge, TN involving soil borings, groundwater well installation, and sampling.

- Review and writing Quality Assurance/Quality Control documents, work plans and field sampling plans for military installations in the US with Martin Marietta Energy System's Hazardous Waste Remedial Action Program (HAZWRAP).

- Designed the Tuskeegee, AL Landfill, installed monitoring wells and trained operators.

- Conducted and managed field gas chromatography for soil gas investigations, the most recent was Phelps Collins ANG, Alpena, MI in October 1991.

- Mauaged and supervised core drilling, rotary drilling, auger drilling and chum drilling operations at various sites.

David L. Trimm,
SENIOR ECOLOGIST

EDUCATION: **M.S.,** Invertebrate Zoology, **Southwest** Texas **State University/1981**
B.S., Biology/Chemistry, **Southwest** Texas State University/1977
Graduate **Studies, Marine Ecology,** University of **Texas Marine** Science **Institute/1978-1979**

CERTIFICATION:

EXPERIENCE:

- Senior Ecologist for ecological assessments of **terrestrial,** aquatic, marine and wetland **resources** located **on** Naval *Air* **Station Pensacola.** **Work** Conducted under Comprehensive Long-Term Environmental *Action* Navy ***(CLEAN)*** **contract.** Duties included plan development, site sampling strategies, **data** analyses and **impact** determination.

- Senior Scientist involved in **wetlands** mitigation plan development **as** a result of possible impacts, by a proposed products pipeline, **to** 404 jurisdictional areas in southeast Texas. Mitigation package resulted in purchase of property and establishment of **trusteeship to** private organization involved in waterfowl habitat management.

- **Project** Manager for an environmental assessment of a proposed railroad right-of-way. Project included field assessment of vegetation community **types,** sensitive plant **species** identification, threatened/endangered **species** investigation and **wetlands** delineation. Several proposed mutes were **inspected** for feasibility of rail **construction impacts.**

- **Project** manager for a two-year, three-phase vegetation recovery study in a Texas saltwater marsh habitat **as** a result of pipeline crude **oil** spill and subsequent cleanup bum. **Work** involved the delineation of sample ***strata,*** random sampling methodology, determination of initial background biomass **at** reference sites and statistical interpretation of data.

- Project Manager for wetlands determination of a 76-acre piece ***of*** property. Involved vegetation community identifkation, **soil type analyses, National** Wetlands Inventory Map review and field determination of wetland areas **based on COE techniques.**

- Assistant **Project** Manager for program development of **initial ecological response** to **an oil spill** into riverine/wetland habitat **along** the **Neches** River, ***texas.*** **This** involved client liaison with Natural **Resource Trustees** for development **and** implementation of wildlife, vegetation and water sampling plan designed **to** assess impacts **in affected area. Sampling** plans and protocol were directed **at** obtaining NRDA defensible **data.**

- Finfish Program Manager for Galveston **Bay,** Texas. Supervised **the collection** of fishery data **from** the Galveston Bay Complex. **Analyzed data** for use in management directives

and decisions. Published and presented data results at conferences and public forums. State appointee to Galveston Bay Marine Advisory Council. Reviewed COE 404 permit applications for impacts to fishery related issues.

ALLISON LEIGH D E N "
GEOLOGIST

EDUCATION: **M.S.,** Geology, Memphis State University/1990
B.S., Geology, Memphis State University/1986

CERTIFICATIONS: Registered Geologist TN0788

RELEVANT EXPERIENCE:

- Project Geologist
  Authored a Sampling and Analysis Plan for a Remedial Investigation at an Industrial Wastewater Treatment facility for the U.S. Navy.

- Project Geologist
  Performed contaminated assessment for leaking UST site in Kingsville, Texas.

- Assistant Project Manager for tank closures, site investigations, and remedial activities for 16 underground storage tank sites. Coordinated two field geologists, drill crews, and sampling technicians. Assimilated raw field data and analytical data into final technical reports.

- **Project Coordinator** and **Hydrogeologist** for the Tellijohn Sanitary Landfill, LeSueur, Minnesota. Authored a workplan, performed hydrogeologic investigation, authored a technical report with groundwater monitoring protocol and coordinated quarterly sampling at the landfill in accordance with Minnesota Solid Waste Rules.

- Hydrogeologist for the Northeast Otter Tail Sanitary Landfill, New York Mills, Minnesota. Authored a Groundwater Monitoring System Workplan in accordance with Minnesota Solid Waste Rules.

- Project Geologist for monitoring well installations and soil boring investigation, Laidlaw Sanitary Landfill, Terre Haute, Indiana.

- Project Geologist for geophysical and subsurface investigation at an archaeological site in Keokuk, Iowa.

- Project Geologist
  Designed a corrective action plan for an underground storage tank site, Bingham Lake, Minnesota.

- Project Geologist for the Motley By-Pass Superfund Site, Minneapolis, Minnesota. Performed hydrogeologic investigation to delineate the extent of contamination.

- Performed numerous Phase 1 site assessments for real estate transactions.

PUBLICATIONS

Dennen, A. L., et *al.*, 1991, An Investigation of Loess Craters on the Bluffs of the Mississippi River, Northwestern Tennessee: Geological Society of America Abstracts with Programs, vol. 3, no. 4.

Doran, F. J., Dennen, A. L., et *al.*, 1992, Investigation and Remediation of a Superfund Site in Minneapolis, Minnesota: Geological Society of America Abstracts with Programs, vol. 24, no. 3.

LIST OF PLATES

Plate 1	Site Location Map
Plate 2	Site 41 Location Map

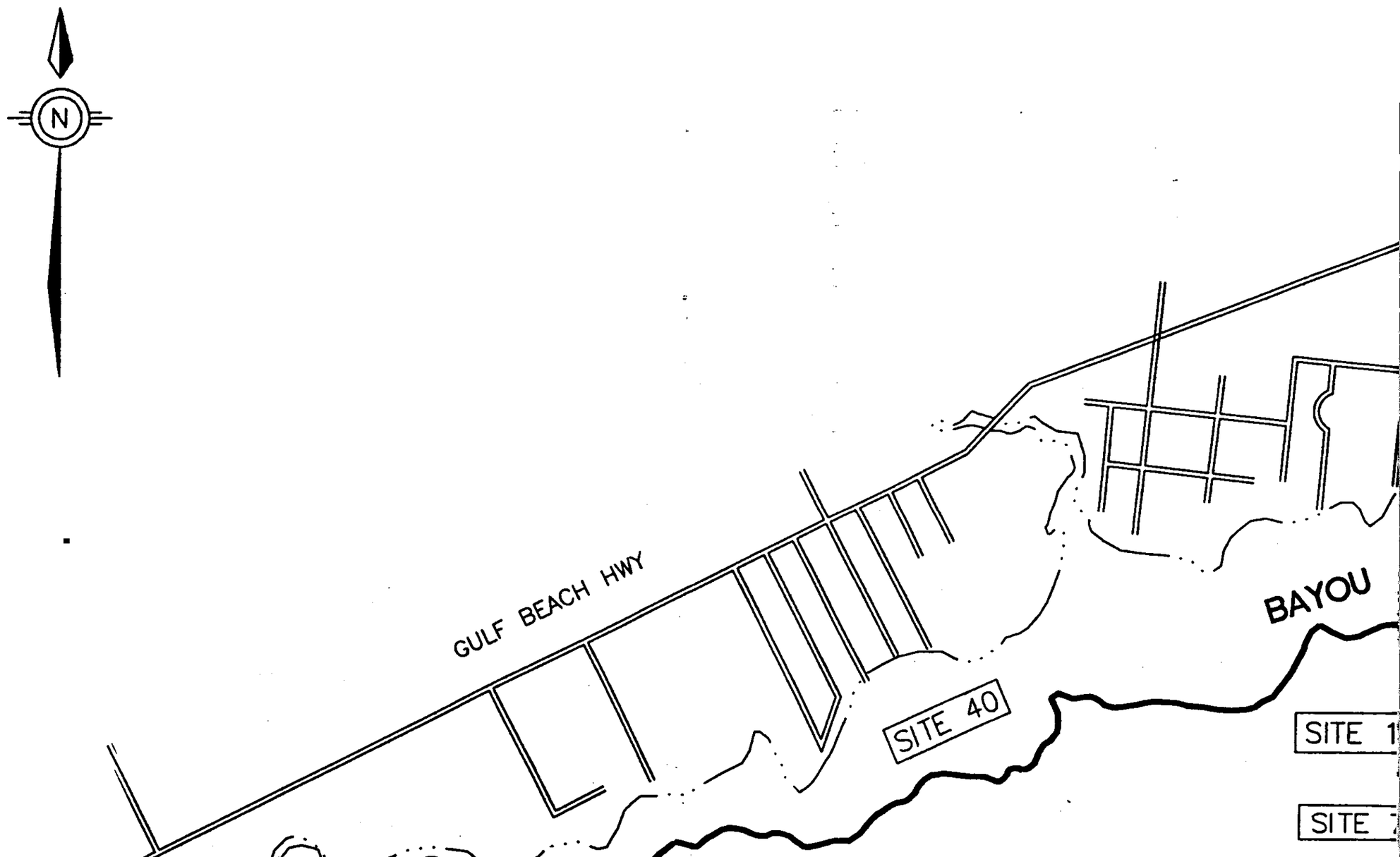
OVERSIZED PAGE

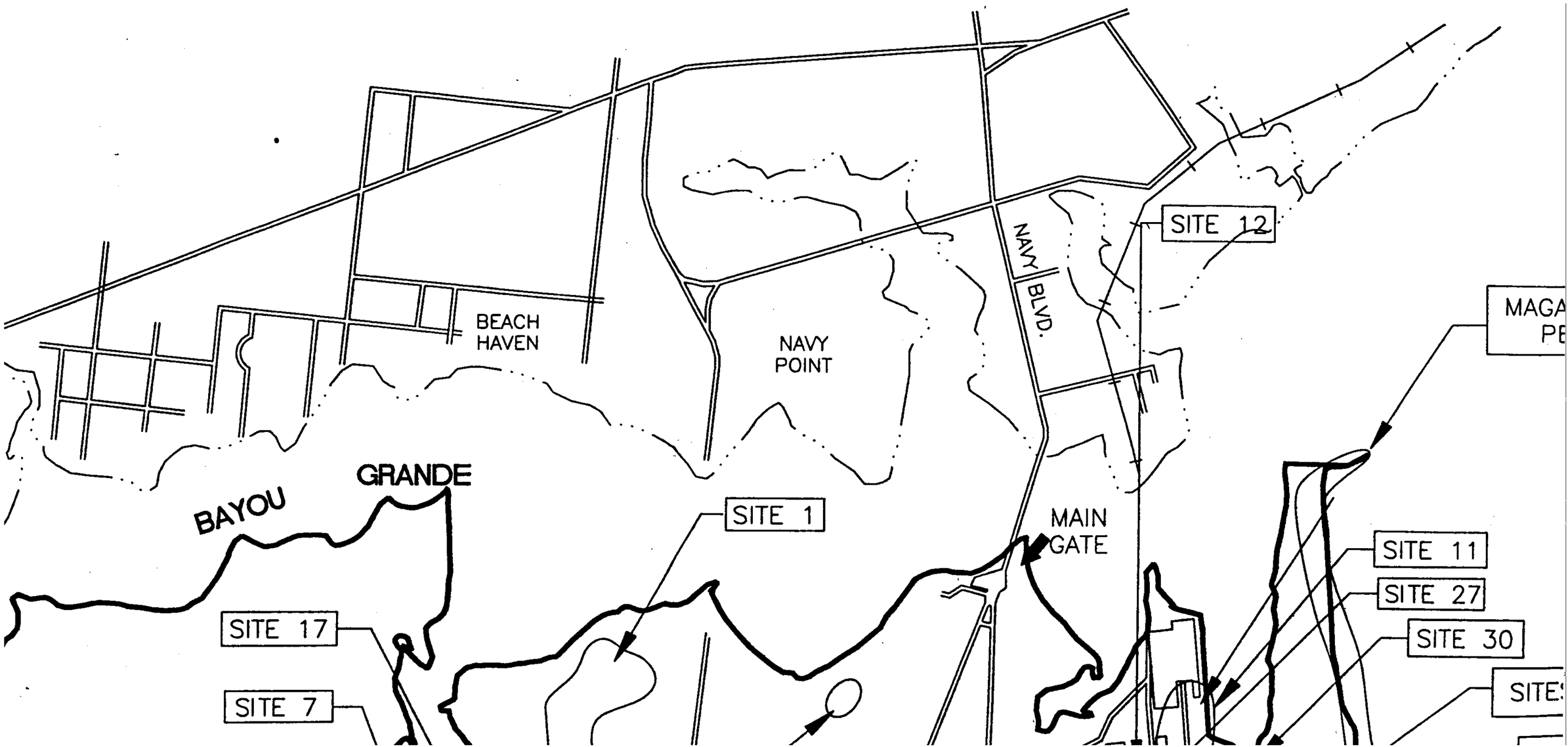
SCANNED IN SECTIONS

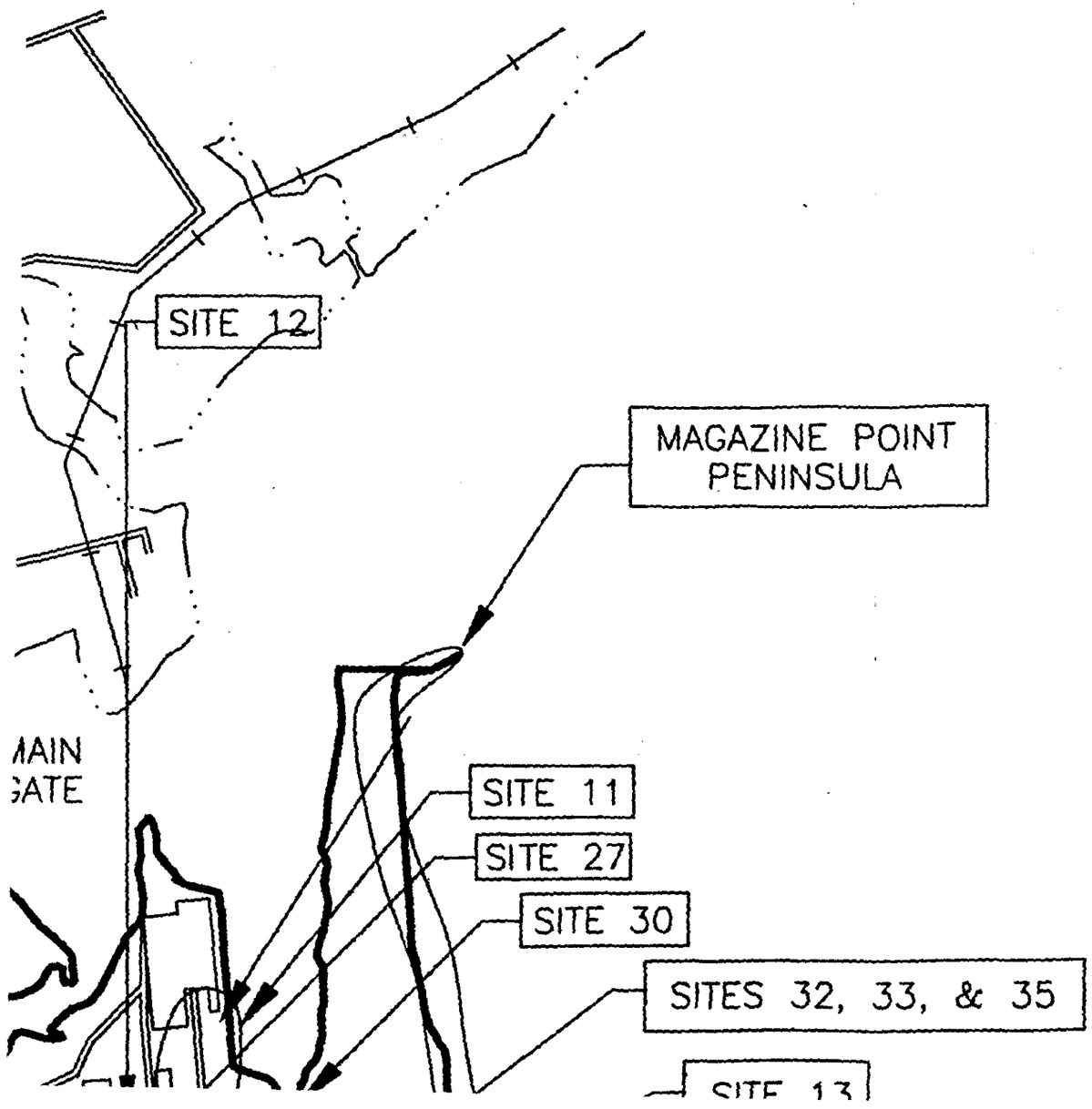
TO FOLLOW

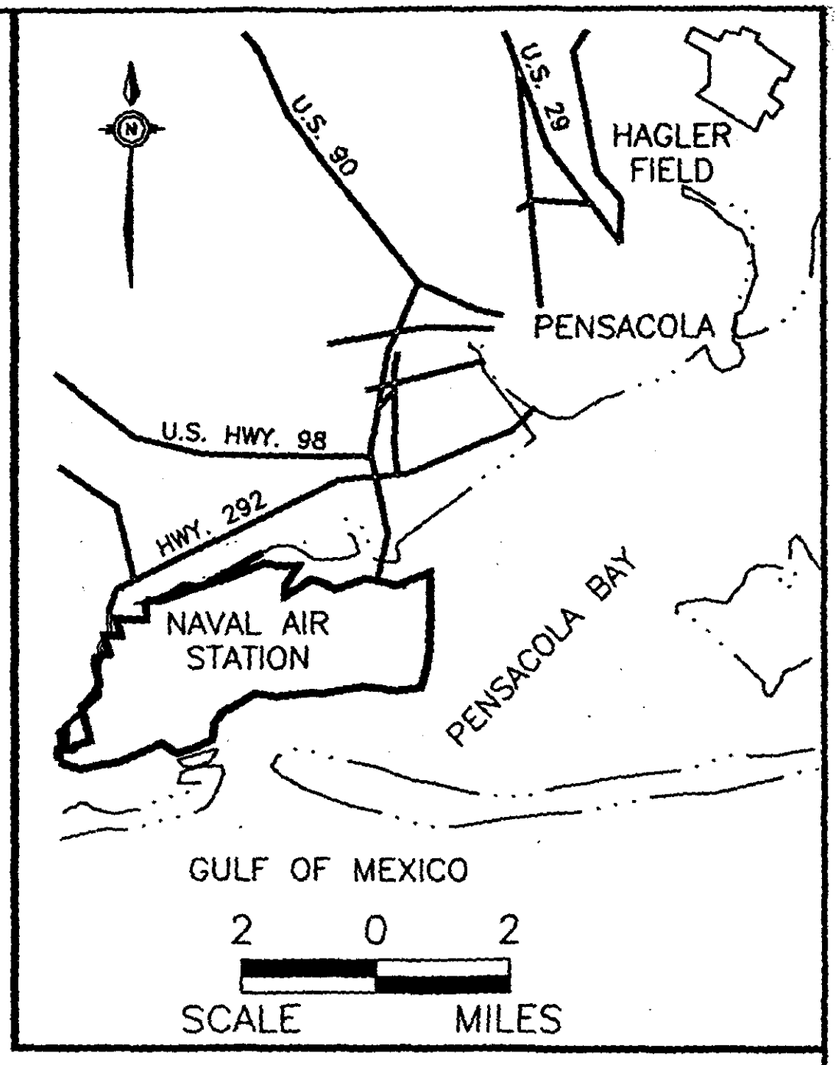
ON SUBSEQUENT IMAGES

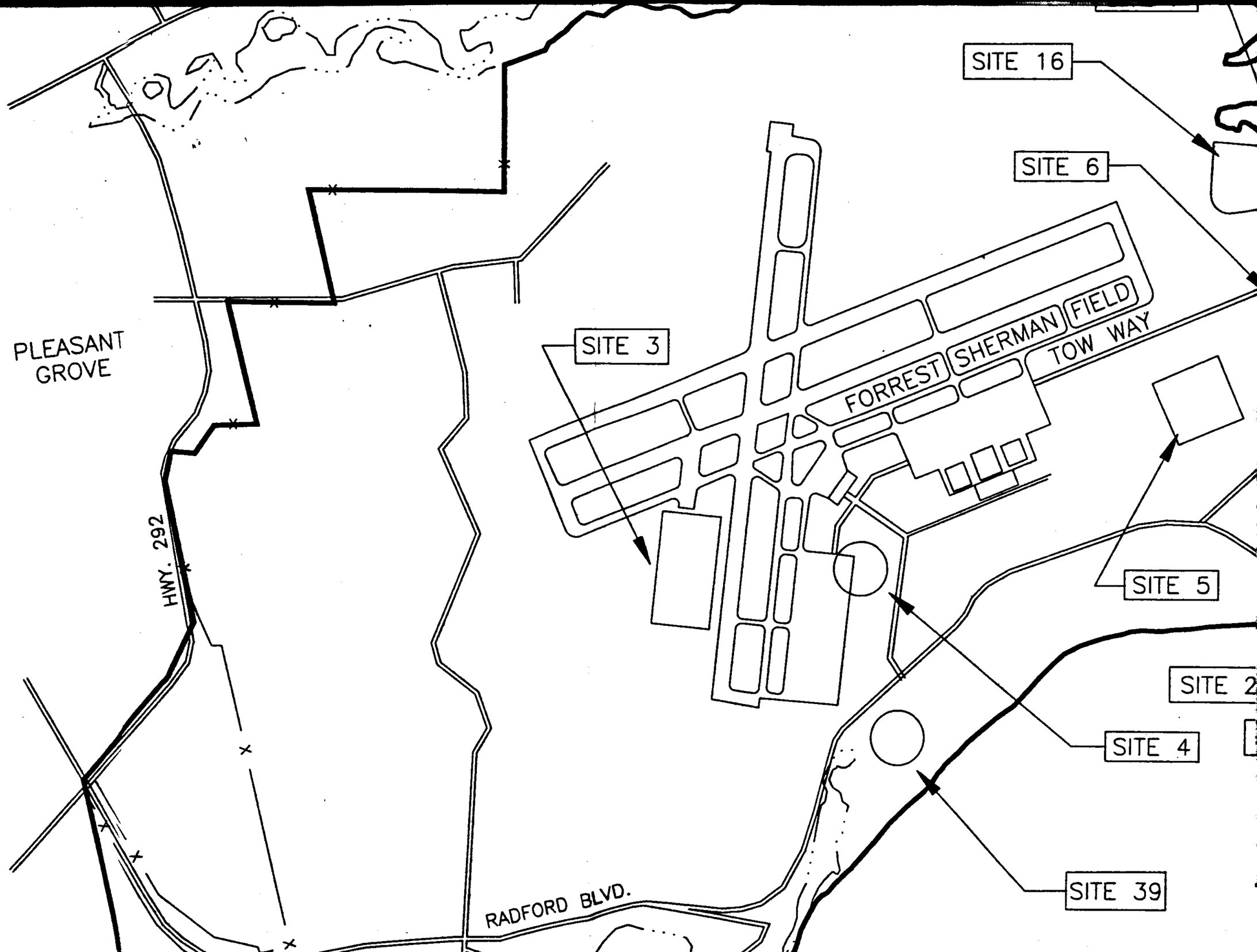
Attachment A

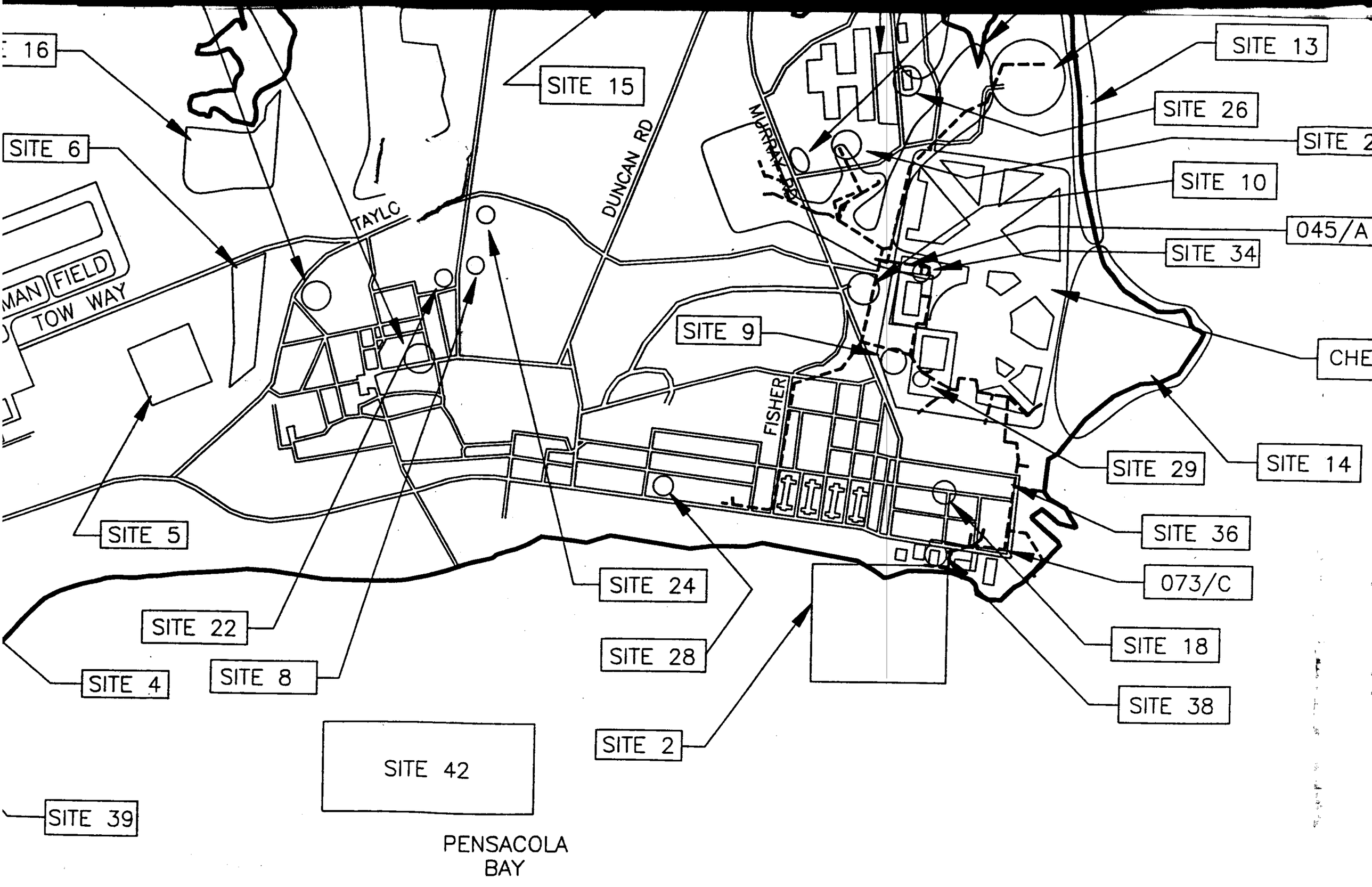

N
GULF BEACH HWY
BAYOU
SITE 40
SITE 1
SITE

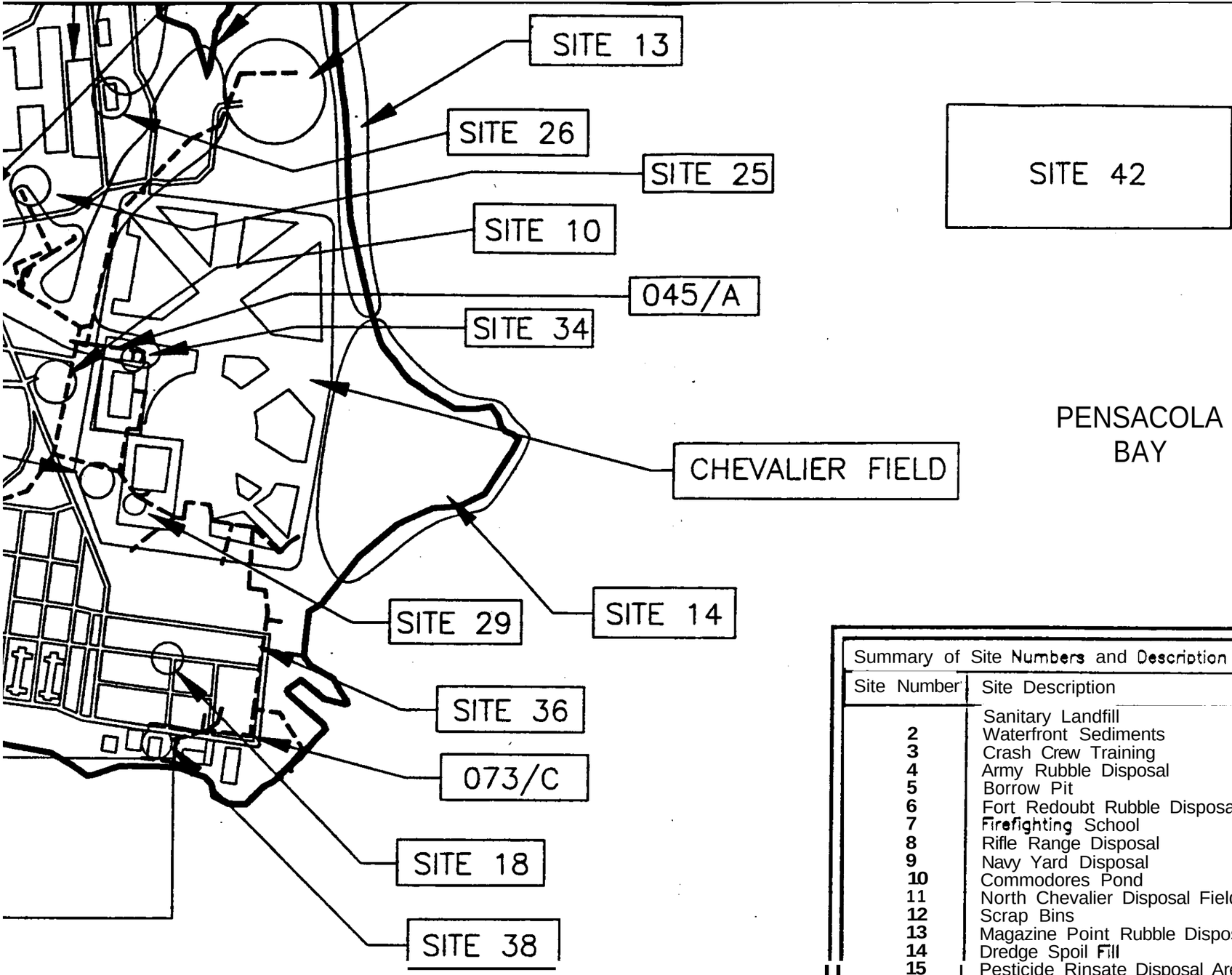

BEACH
HAVEN
NAVY
POINT
NAVY
BLVD.
SITE 12
MAGA
PE
BAYOU
GRANDE
SITE 1
MAIN
GATE
SITE 11
SITE 27
SITE 30
SITE 17
SITE 7
SITE


SITE 12
MAGAZINE POINT PENINSULA
MAIN GATE
SITE 11
SITE 27
SITE 30
SITES 32, 33, & 35
SITE 13


N
U.S. 90
U.S. 29
HAGLER FIELD
PENSACOLA
U.S. HWY. 98
HWY. 292
NAVAL AIR STATION
PENSACOLA BAY
GULF OF MEXICO
2 0 2
SCALE MILES

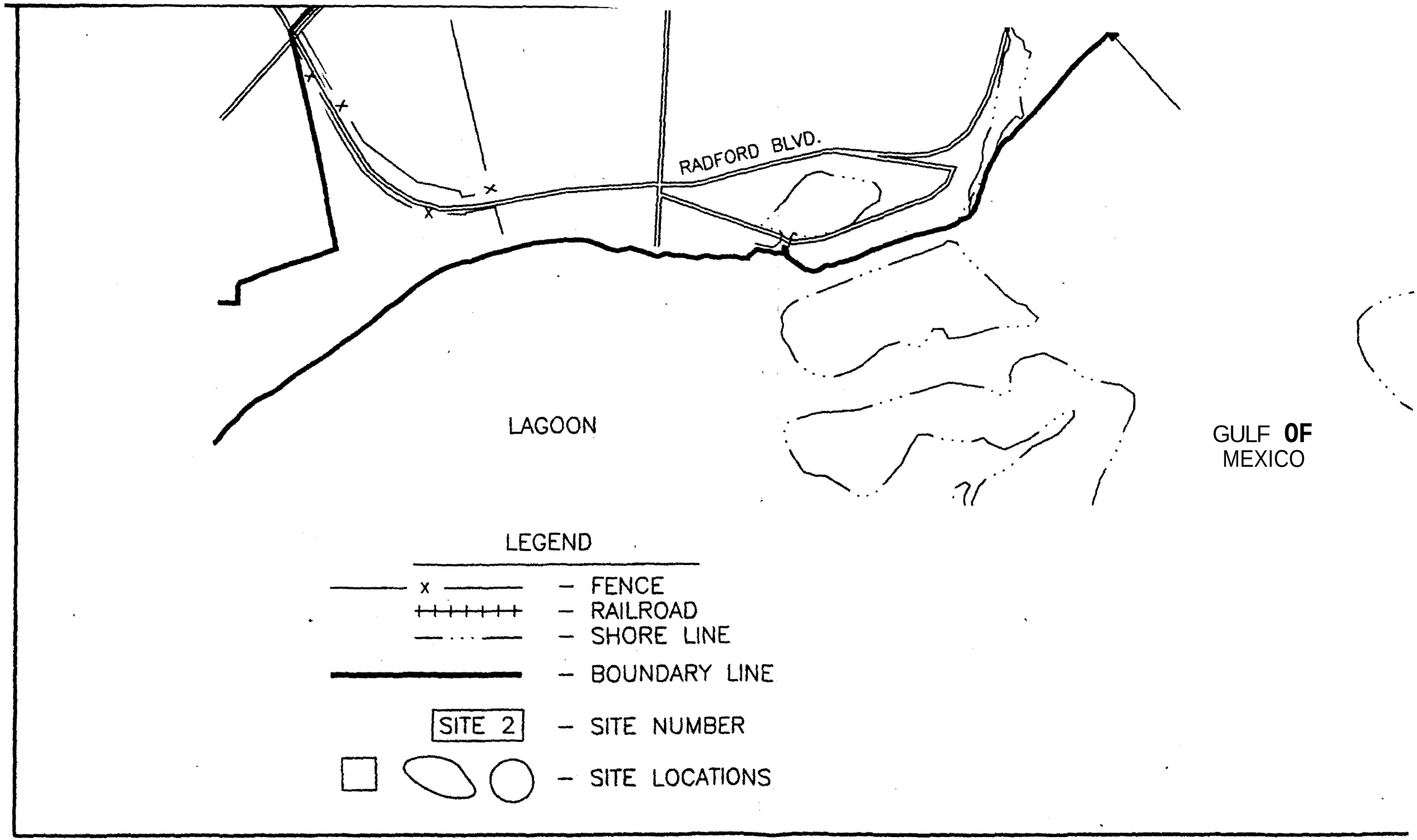

SITE 16
SITE 6
SITE 3
PLEASANT GROVE
FORREST
SHERMAN
FIELD
TOW WAY
HWY. 292
SITE 5
SITE 4
SITE 39
RADFORD BLVD.

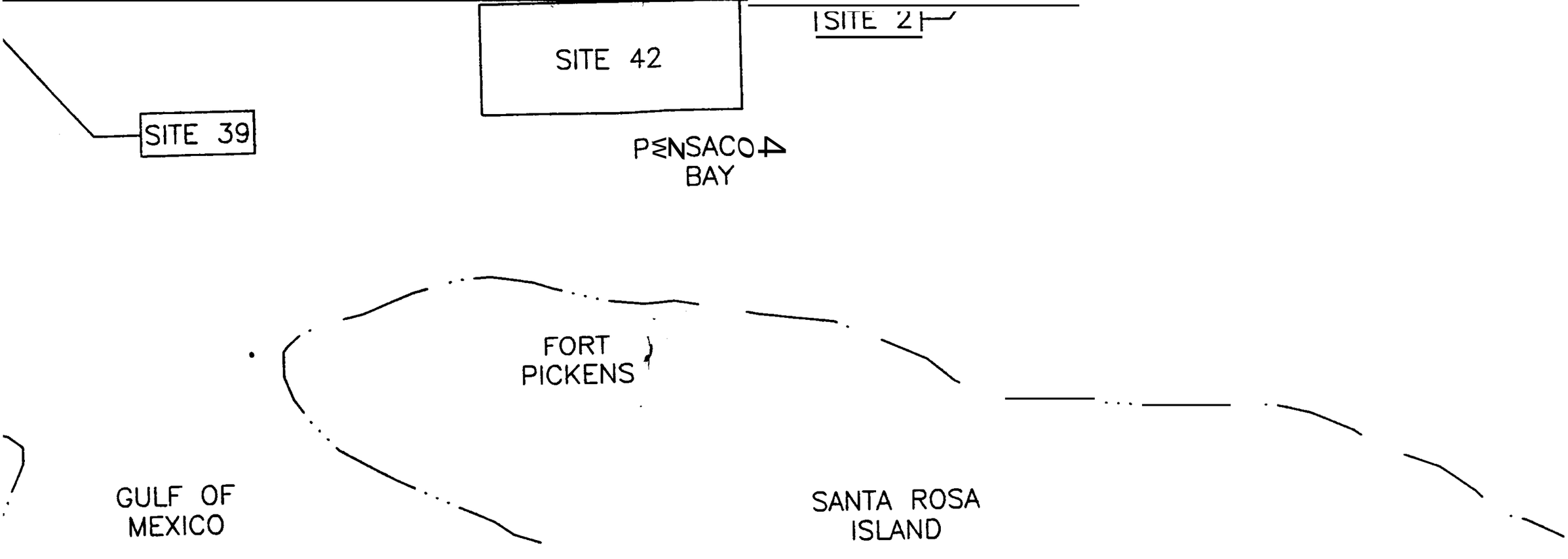

16
SITE 6
SITE 15
DUNCAN RD
TAYLC
MAN FIELD
TOW WAY
SITE 13
SITE 26
SITE 2
SITE 10
045/A
SITE 34
SITE 9
CHE
FISHER
SITE 29
SITE 14
SITE 5
SITE 36
SITE 24
073/C
SITE 22
SITE 28
SITE 18
SITE 4
SITE 8
SITE 38
SITE 2
SITE 42
SITE 39
PENSACOLA
BAY



Summary of Site Numbers and Description

Site Number	Site Description
	Sanitary Landfill
2	Waterfront Sediments
3	Crash Crew Training
4	Army Rubble Disposal
5	Borrow Pit
6	Fort Redoubt Rubble Disposal
7	Firefighting School
8	Rifle Range Disposal
9	Navy Yard Disposal
10	Commodores Pond
11	North Chevalier Disposal Field
12	Scrap Bins
13	Magazine Point Rubble Disposal
14	Dredge Spoil Fill
15	Pesticide Rinsate Disposal Area
16	Brush Disposal Area
17	Transformer Storage Yard
18	PCB Spill Area
19*	Fuel Farm Pipeline Leak
20+	Pier Pipe Leak
21+	Sludge at Fuel Tanks
22	Refueler Repair Shop
23*	Chevalier Field Leak
24	DOT Mixing Area
25	Radium Spill Site
26	Supply Department Outside Storage
27	Radium Dial Shop Sewer
28	Transformer Accident


RADFORD BLVD.
LAGOON
GULF OF MEXICO
LEGEND
– FENCE
– RAILROAD
– SHORE LINE
– BOUNDARY LINE
SITE 2
– SITE NUMBER
– SITE LOCATIONS


SITE 2
SITE 42
SITE 39
PENSACOLA BAY
FORT PICKENS
GULF OF MEXICO
SANTA ROSA ISLAND

NOTE: SITE

17	Transformer St
18	PCB Spill Area
19*	Fuel Farm Pipeline Leak
20+	Pier Pipe Leak
21+	Sludge at Fuel Tanks
22	Refueler Repair Shop
23+	Chevalier field Leak
24	DDT Mixing Area
25	Radium Spill Site
26	Supply Deportment Outside Storage
27	Radium Dial Shop Sewer
28	Transformer Accident
29	Soil South of Building 3460
30	Buildings 649 and 755 Building 648 (previously PSC 31) Sewer Line TL 045/A north to IWTP
32	IWTP Sludge Drying Beds
33	WWTP Ponds
34	Solvent North of Building 3557
35	Miscellaneous IWTP SWMUs
36	IWTP Sewer Line (See Plate 2 for Details)
37+	Sherman Field Fuel Farm
38	Building 71 Sewer Line TL 073/C southwest to the end
39	Oak Grove ,Campground Site
40	Bayou Grande Area
41	NAS Pensacola Wetlands (See Plate 3 for Details)
42	Pensacola Bay

Notes:

- Sites ore under the jurisdiction of the Florida Deportment of Environmental Protection UST Program and are not shown on Plate.

1000 0 1000

SCALE FEET

1 INCH = 1000 FEET

PENSACOLA, FLORIDA

PLATE 1
SITE LOCATIONS

NOTE: SITE 41 SHOWN ON PLATE 2.

Dr by: E.GRIGGS	Tr by: C.TRIPLETT	
Ck by: A.DENNEN	App by: A.DENNEN	Sheet 1
Date: 03/09/95	DWG Name: 38CSAP1	Of 1

OVERSIZED PAGE

SCANNED IN SECTIONS

TO FOLLOW

ON SUBSEQUENT IMAGES

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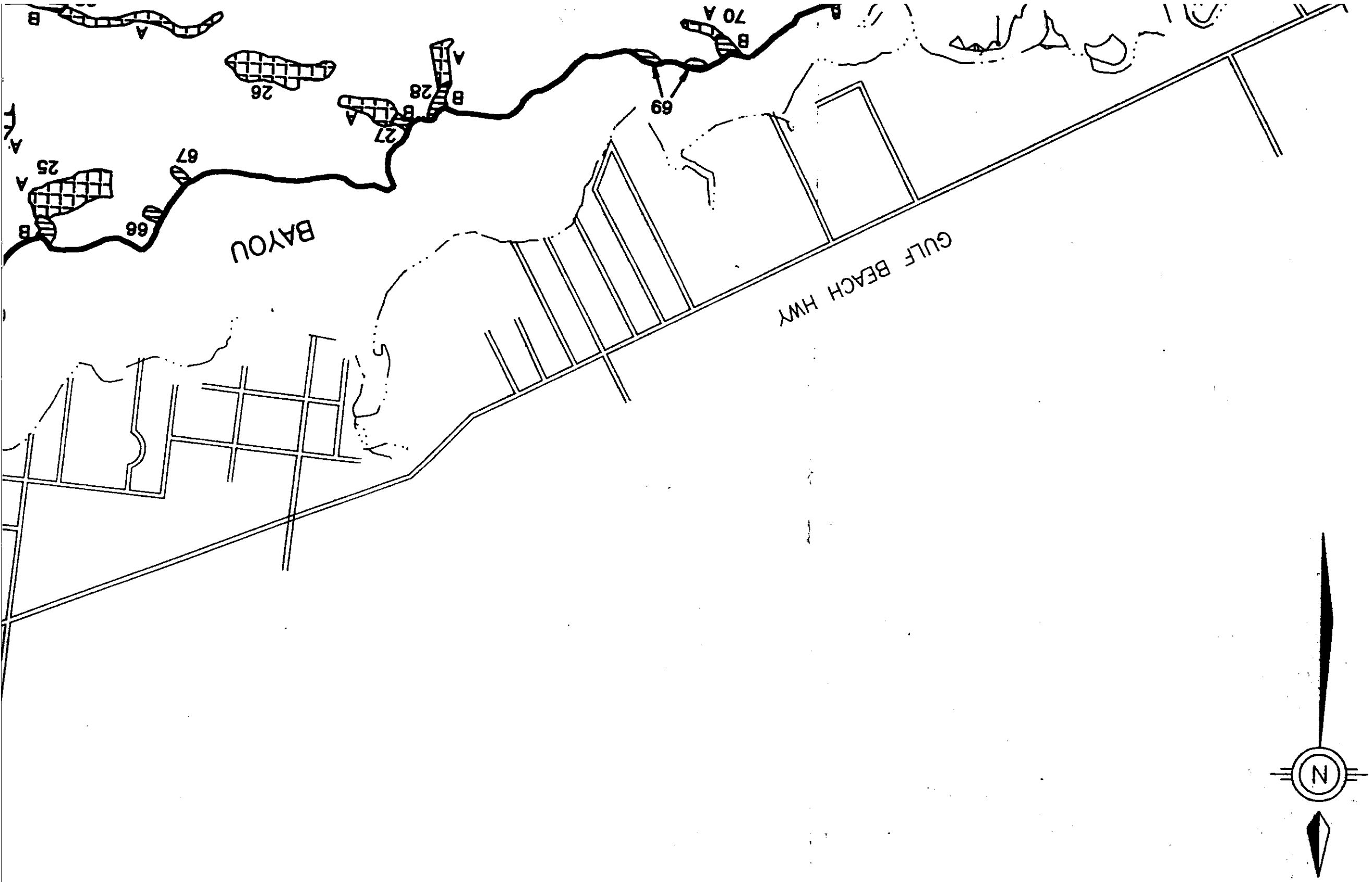
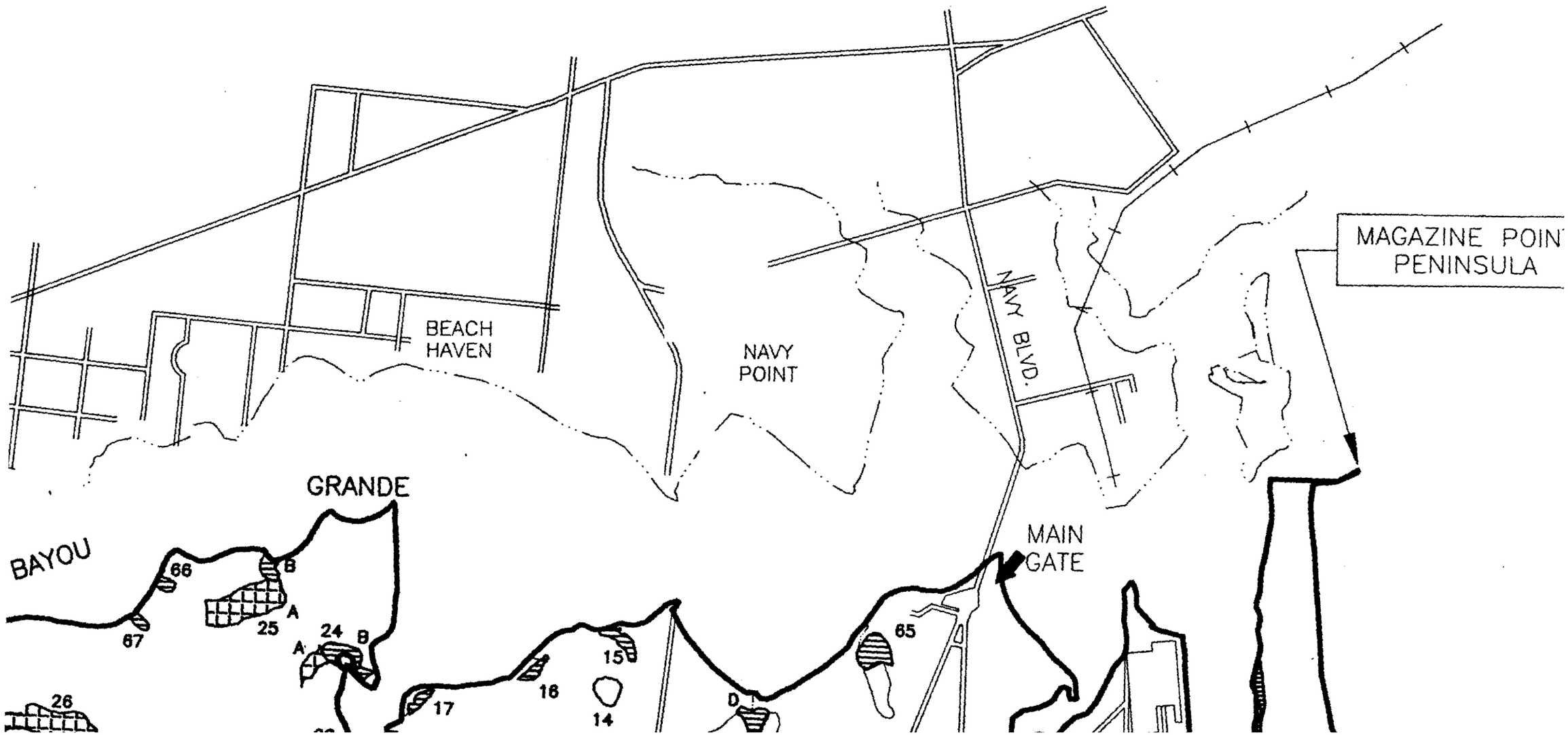
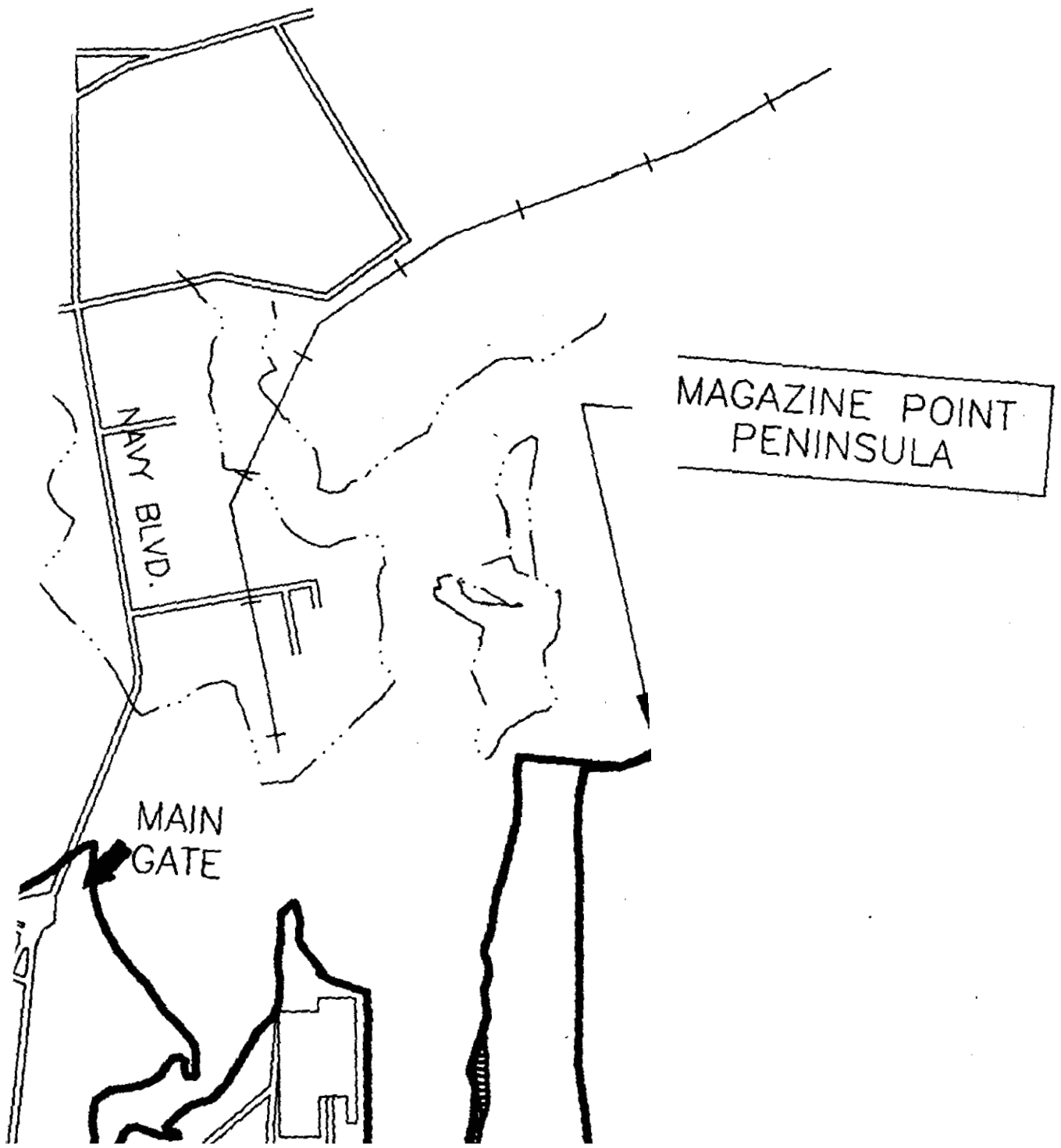
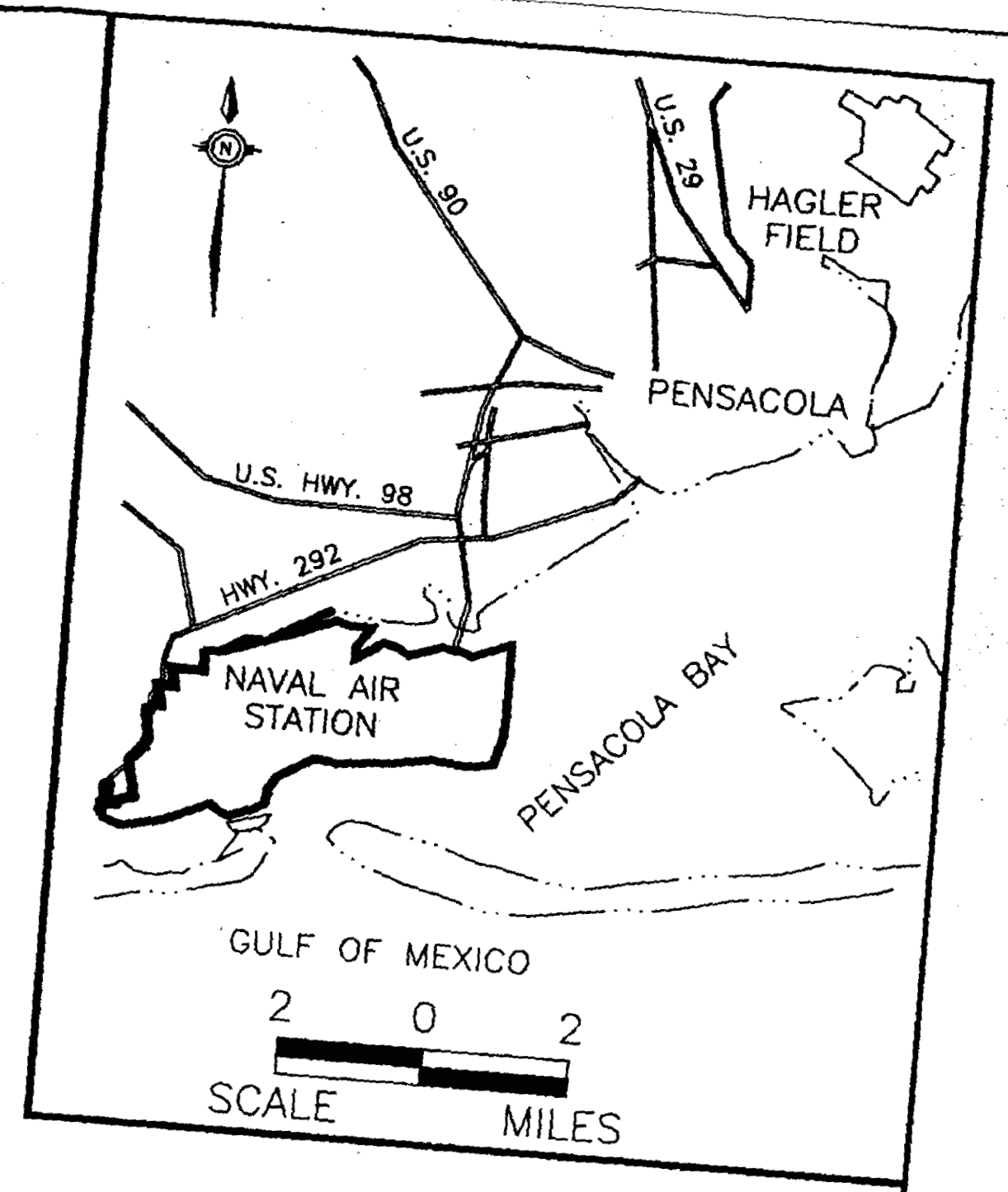
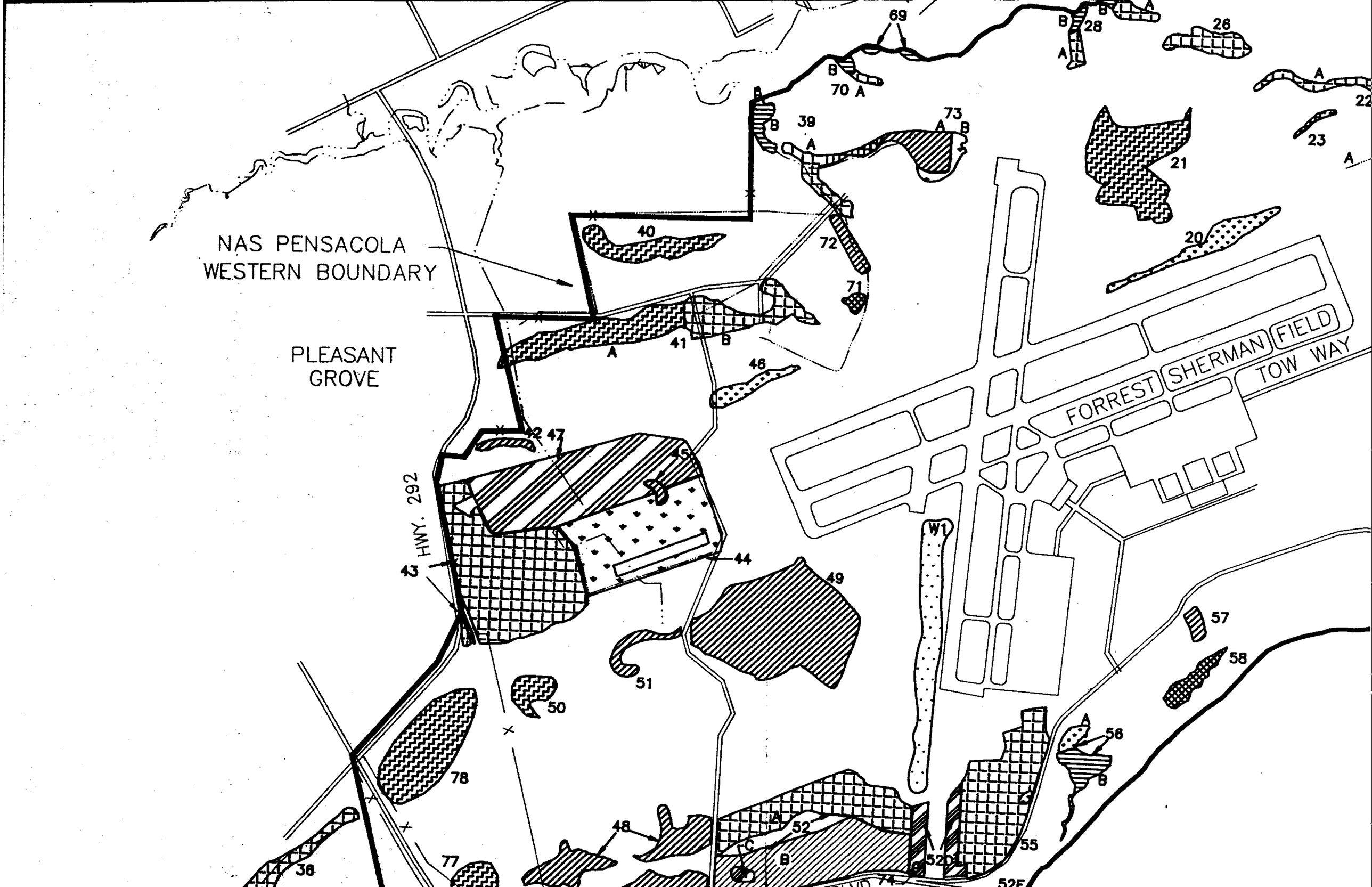

GULF BEACH HWY
BAYOU
N


MAGAZINE POIN
PENINSULA
BEACH
HAVEN
NAVY
POINT
NAVY BLVD.
GRANDE
BAYOU
MAIN
GATE
66
67
B
A
25
24
A
B
15
16
17
14
D
65
26


MAGAZINE POINT
PENINSULA
NAVY BLVD.
MAIN
GATE


N
U.S. 90
U.S. 29
HAGLER
FIELD
PENSACOLA
U.S. HWY. 98
HWY. 292
NAVAL AIR
STATION
PENSACOLA BAY
GULF OF MEXICO
2
0
2
SCALE
MILES


NAS PENSACOLA
WESTERN BOUNDARY
PLEASANT
GROVE
HWY. 292
FORREST
SHERMAN
FIELD
TOW WAY
69
70 A
B
28
26
A
22
23
39
73
21
20
40
72
71
41
46
42 47
45
44
43
49
W1
57
58
51
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56
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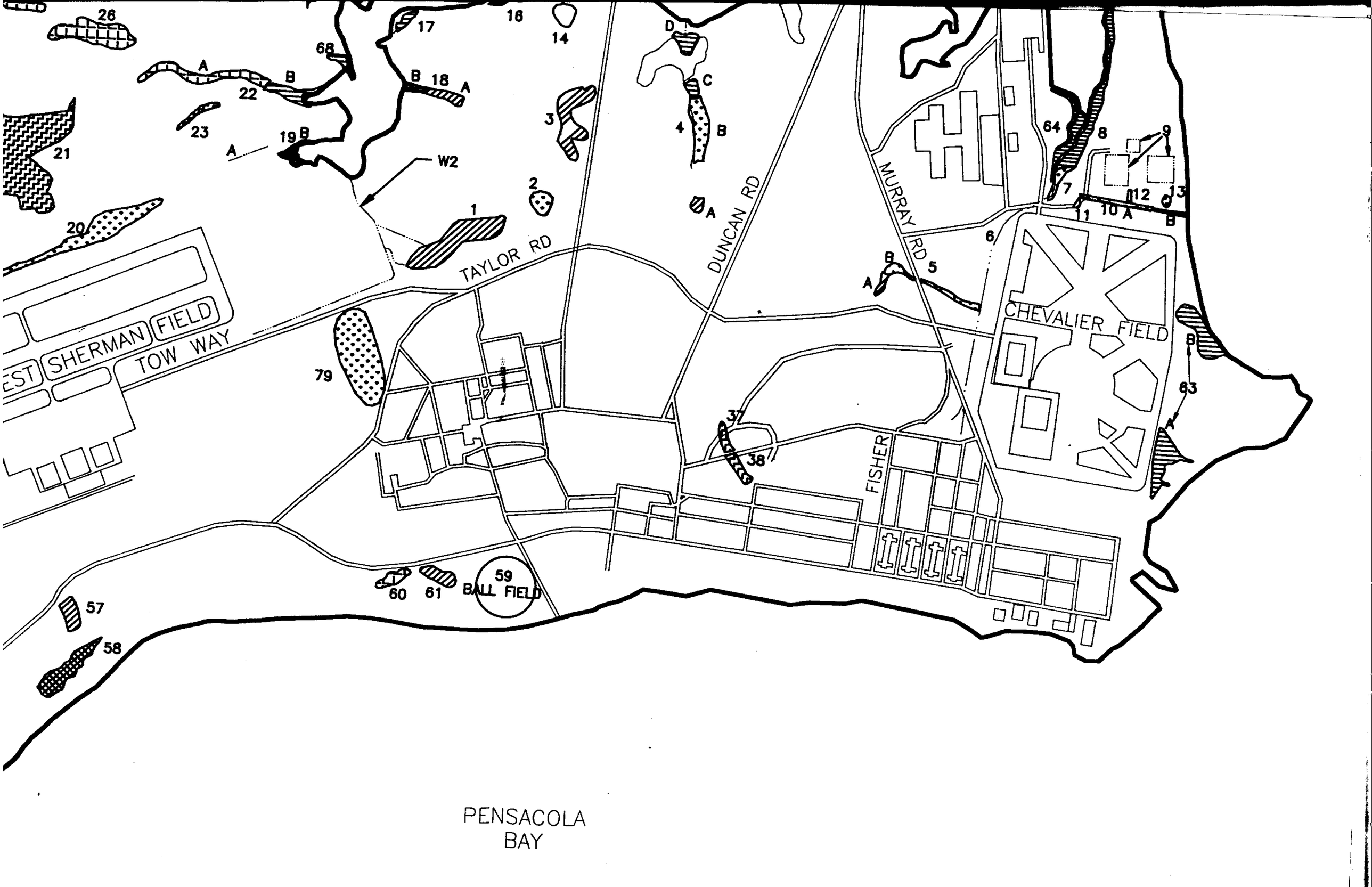
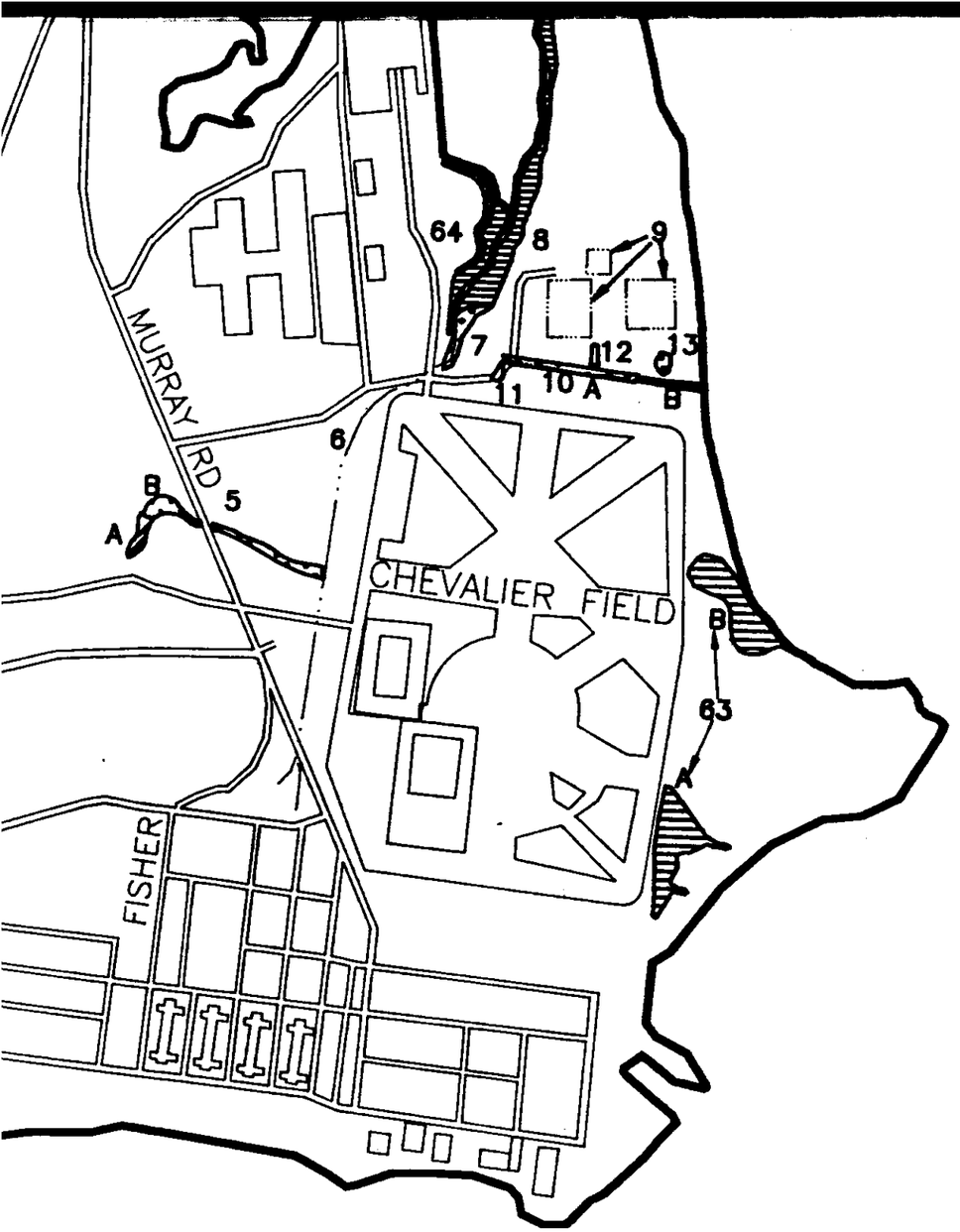
48
52
55
77
36

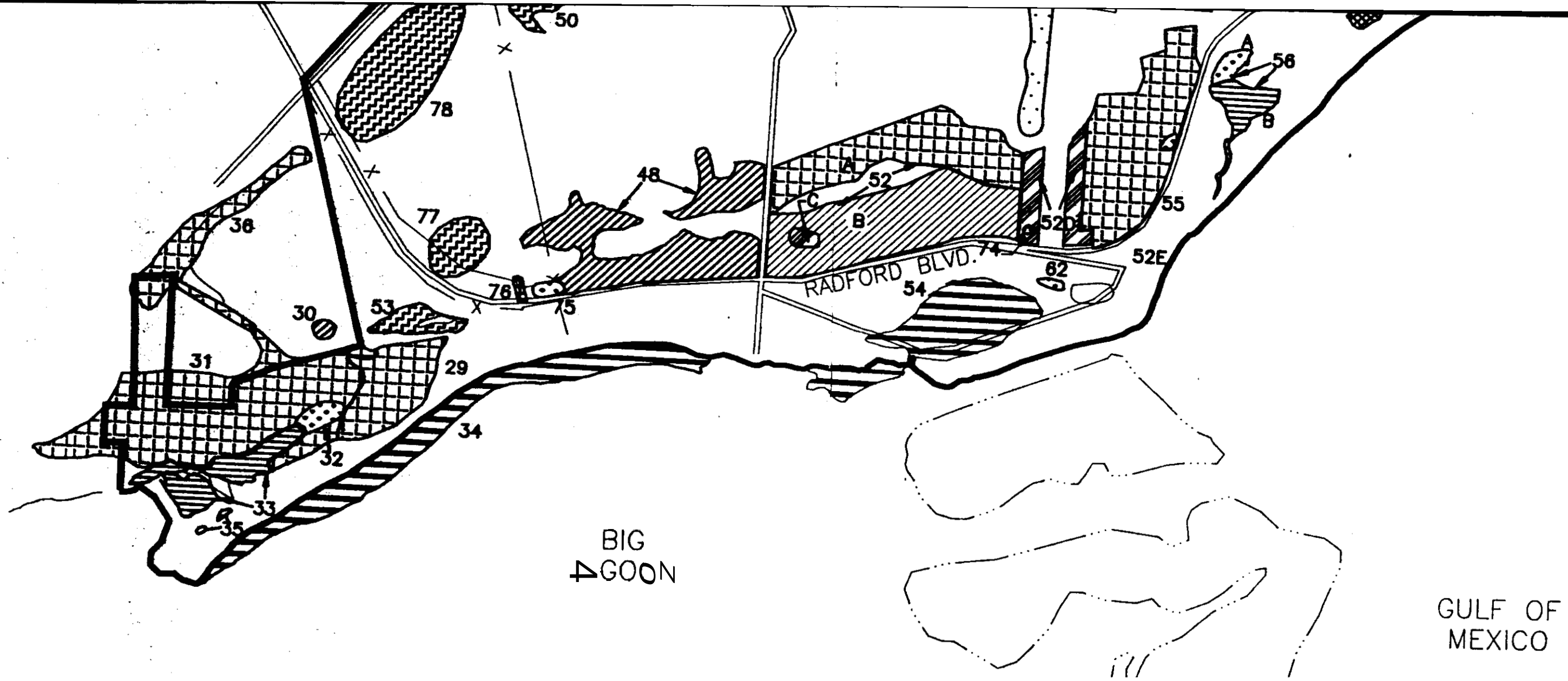

26
68
17
16
14
D
A
B
22
B
18
A
C
3
4
B
23
19
B
A
W2
21
2
1
A
20
TAYLOR RD
DUNCAN RD
MURRAY RD
64
8
9
7
12
13
11
10
A
B
6
B
5
A
SHERMAN FIELD
TOW WAY
EST
CHEVALIER FIELD
B
79
63
37
38
FISHER
59
BALL FIELD
60
61
57
58
PENSACOLA
BAY



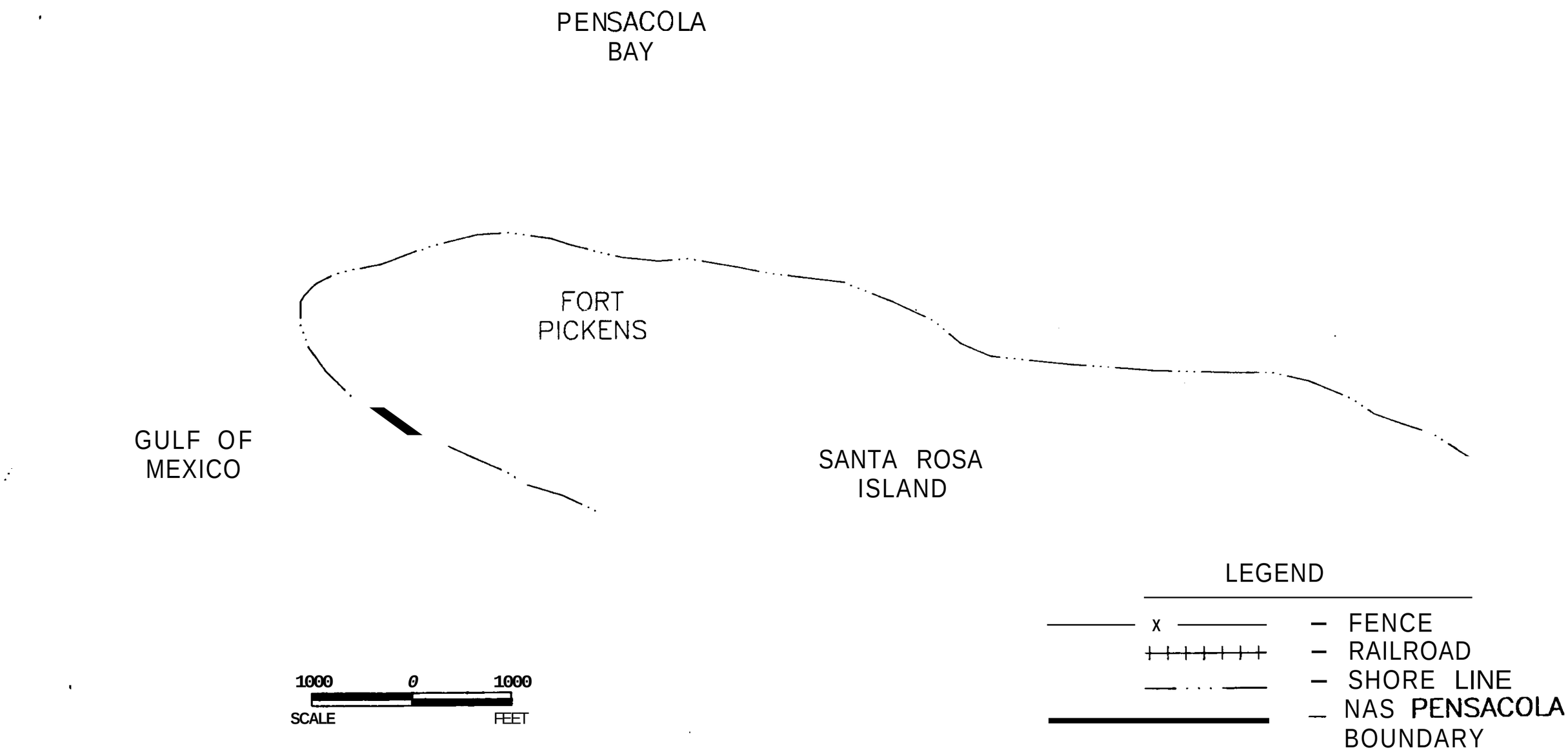
PENSACOLA
BAY

WETLANDS LEGEND

- = PALUSTRINE FORESTED
- = PALUSTRINE FORESTED/EMERGENT
- = PALUSTRINE SCRUB SHRUB
- = PALUSTRINE FORESTED/SCRUB SHRUB
- = PALUSTRINE SCRUB SHRUB/EMERGENT
- = PALUSTRINE EMERGENT



SOURCE: PARSONS AND PRUIOT 1991


PENSACOLA
BAY
FORT
PICKENS
GULF OF
MEXICO
SANTA ROSA
ISLAND
LEGEND
FENCE
RAILROAD
SHORE LINE
NAS PENSACOLA
BOUNDARY
1000
0
1000
SCALE
FEET

PALUSTRINE SCRUB SHRUB

= PALUSTRINE FORESTED/SCRUB SHRUB

= PALUSTRINE SCRUB SHRUB/EMERGENT

= PALUSTRINE EMERGENT

= ESTUARINE EMERGENT

= ESTUARINE AQUATIC BED

1 = WETLAND INDENTIFICATION NUMBER

A = WETLAND SUBDIVISION

LEGEND

- FENCE
- RAILROAD
- SHORE LINE
- NAS PENSACOLA BOUNDARY

COMPREHENSIVE SAMPLING AND ANALYSIS P U N
NAS--PENSACOLA
PENSACOLA, FLORIDA

PLATE 3
STE 41 LOCATION MAP

Dr by: E.GRIGGS	Tr by: E.GRIGGS	
Ck by: A.DENNEN	App by A.DENNEN	Sheet 1
Date: 10/22/93	DWG Name: 36CSAP3	Of 1