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LONG-TERM MONITORING PLAN FOR OPERABLE UNIT 9 (OU 9) SITE 36 AND SITE 37

NAS CECIL FIELD FL

1/1/2001

TETRA TECH NUS INC

Long-Term Monitoring Plan

Operable Unit 9, Sites 36 and 37

Naval Air Station Cecil Field

Jacksonville, Florida

Southern Division
Naval Facilities Engineering Command

Contract Number N62467-94-D-0888
Contract Task Order 0078

January 2001

LONG-TERM MONITORING PLAN

OPERABLE UNIT 9, SITES 36 AND 37

NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

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ACRONYMS

ARAR	applicable or relevant and appropriate requirements
AS	Air sparging
BCT	BRAC Cleanup Team
bgs	Below ground surface
BRAC	Base Realignment and Closure
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLEAN	Comprehensive Long-Term Environmental Action Navy
COC	chemical of concern
CTO	Contract Task Order
DO	dissolved oxygen
EISOPQAM	Environmental Investigations Standard Operating Procedures and Quality Assurance Manual
FAC	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
FFA	Federal Facilities Agreement
GIS	Geographic Information System
µg/L	Microgram per liter
ID	inside diameter
JPA	Jacksonville Port Authority
mg/L	milligram per liter
mV	millivolt
NAS	Naval Air Station
NCP	National Contingency Plan
NSF	National Sanitation Foundation
NTU	nephelometric turbidity unit
ORP	oxidation/reduction potential
OU	Operable unit
PAH	Polycyclic aromatic hydrocarbon, Polynuclear aromatic hydrocarbon
PRG	Preliminary remedial action goal
PVC	polyvinyl chloride
QA/QC	Quality assurance/quality control
RAO	Remedial Action Objective
RI	Remedial Investigation
SOP	Standard Operating Procedure

SOUTHNAVFACENGCOM	Southern Division Naval Facilities Engineering Command
SWQC	Surface Water Quality Criteria
TCL	target compound list
TRPH	total recoverable petroleum hydrocarbons
TtNUS	Tetra Tech NUS, Inc.
U.S. EPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound

1.0 INTRODUCTION

This Long-Term Monitoring Plan for Operable Unit (OU) 9, Sites 36 and 37, Naval Air Station Cecil Field, Jacksonville, Florida, has been prepared by Tetra Tech NUS, Inc., (TtNUS) for the Southern Division Naval Facilities Engineering Command (SOUTHDIVNAVFACENGCOM) under the Navy Comprehensive Long-Term Environmental Action Navy (CLEAN) Program, Contract Number N62467-94-D-0888, Contract Task Order (CTO) 0078. This plan outlines the requirements and describes the procedures for performing the well installation, sample collection, and analysis for OU 9. It is intended for use in conjunction with the Base-Wide Generic Work Plan for NAS Cecil Field (TtNUS, 1998).

NAS Cecil Field is located in northeastern Florida, in Jacksonville. Most of the base is located in Duval County and a small portion of the base is located in Clay County. The base was closed by the Navy and the flightline was transferred to the Jacksonville Port Authority (JPA) in 1999. The former base is currently known as Cecil Commerce Center. Sites 36 and 37 are located on the north side of the East-West Runways.

1.1 OVERVIEW

Site 36 consists of an extensive groundwater plume contaminated primarily with benzene, xylenes, trichloroethene, and fuel-related compounds. Site 37 also consists of an extensive groundwater plume contaminated primarily with benzene, xylenes, dichloroethene, and fuel-related compounds.

The objective of long-term groundwater monitoring at Sites 36 and 37 is to evaluate the performance, progress, and effectiveness of air sparging (AS) in the source area and natural attenuation in the downgradient area. To achieve this objective, this monitoring plan is designed to determine trends in contaminant levels over time, while also verifying that contaminant reduction is occurring. The monitoring plan includes groundwater sampling and analysis from selected existing and new monitoring wells.

In the event that data collected under this monitoring plan indicate that either AS or natural attenuation is insufficient to protect human health and the environment or to prevent plume expansion, a contingency plan will be developed to augment or replace these remedies.

The monitoring plan also includes a line of sentinel wells located about 400 feet downgradient of the leading edge of the contaminant plume. If an analysis of a groundwater sample collected from the line of sentinel wells indicates that the benzene preliminary remedial action goal (PRG) of 1 µg/L has been exceeded, the following step-by-step actions would be taken:

1. The sentinel well(s) where the exceedance(s) was(were) detected would be re-sampled to verify the exceedance(s).

2. If the exceedance(s) is(are) verified, additional hydrogeological modeling would be performed to determine a revised predicted expansion of the contaminant plume based upon the new monitoring data.

3. Based on the results of the additional modeling, contingency remedies would be developed per the ROD.

The monitoring plan also includes sampling and analysis of dry weather flow water samples from the storm sewer in the vicinity of Site 36. The objective of the sampling is to monitor the concentration of contaminants in the storm water outfall from groundwater that has infiltrated into the sewer.

2.0 FIELD OPERATIONS

2.1 NEW MONITORING WELL INSTALLATION

Four shallow, five intermediate, and one deep well will be installed. These wells are being installed to either monitor the effectiveness of the treatment system, track the contamination in the plume, or supplement natural attenuation monitoring. The locations of these new wells are shown on Figure 2-1. The rationale and purpose of the well locations are described on Table 2-1. The new wells are also summarized in the table below:

Well Number	Depth, feet bgs	Screen length, feet
CEF-36-35S	15	10
CEF-36-36I	60	5
CEF-36-37D	92 (Estimated)	5
CEF-36-38I	45	5
CEF-36-39I	60	5
CEF-36-41I	45	5
CEF-36-40I	45	5
CEF-37-23S	15	10
CEF-37-24S	15	10

All permanent groundwater monitoring wells will be installed and constructed in accordance with all applicable Department of the Navy, Southern Division Naval Facilities Engineering Command, Monitoring Well Design, Installation, Construction, and Development Guidelines, State of Florida Well Standards and Regulations, U.S. EPA Region 4 Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM) (U.S. EPA, 1996), and TtNUS Standard Operating Procedure (SOP) GH-2.8. In some cases, site conditions, geologic settings, or unknown factors, may require slight modifications in well installation and/or construction methods. Modifications from the aforementioned guidance documents will be thoroughly evaluated and reviewed by the on-site senior field geologist. Any deviations or modifications deemed appropriate will be properly documented.

Shallow and intermediate depth wells will be installed using hollow stem auger methods. The deep well will be installed by mud rotary methods. No split spoon sampling is required. All wells will be constructed with certified-clean well construction material. The top of the screened interval for the shallow monitoring wells will be placed approximately 2 feet above the water table, to allow for the measurement, if any, of thickness of free phase petroleum product. Shallow monitoring wells will be constructed of 2-inch inside diameter (ID), flush-threaded polyvinyl chloride (PVC) well screen and compatibly threaded PVC riser.

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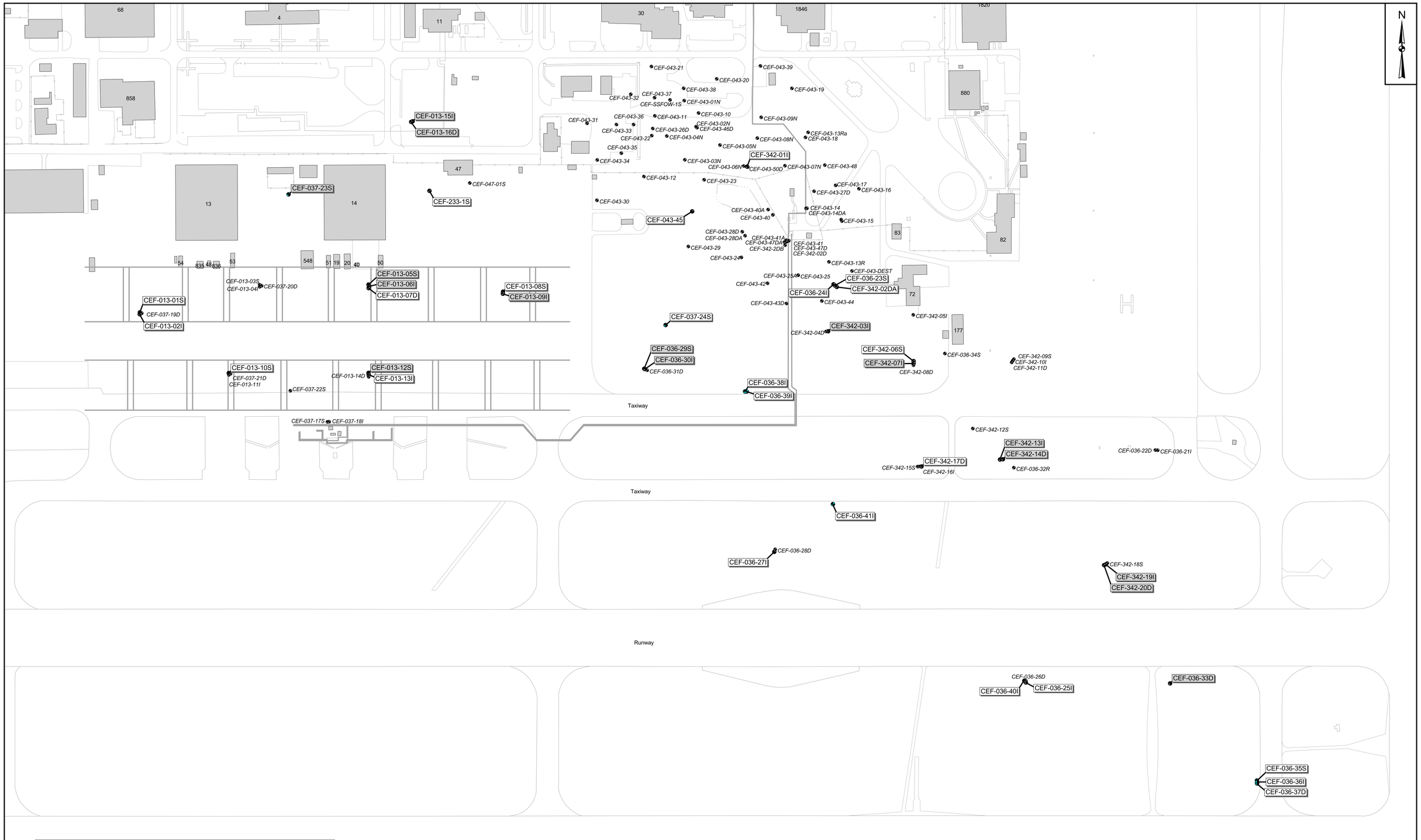


LEGEND

- DPT Location
- Monitoring Well
- Aviation Fuel Piping

CEF-013-15I Sample for Natural Attenuation Parameters and Contaminants specified in Table 2-1

CEF-013-03S Sample Contaminants specified in Table 2-1 only

150 0 150 Feet

P:\GIS\NAS_CecilField\site-3637_naturalattenuationsampling.apr
04Jan01 MJJ Sample Locations Layout

DRAWN BY	DATE
MJJ	15Oct98
CHECKED BY	DATE
—	—
	DATE
	—
SCALE	
AS NOTED	

MONITORING WELL SAMPLE LOCATIONS
SITES 36 AND 37
NATURAL ATTENUATION SAMPLING
NAS CECIL FIELD
JACKSONVILLE, FLORIDA

CONTRACT NO.	
0039	
OWNER NO.	
—	
APPROVED BY	DATE
—	—
DRAWING NO.	REV.
FIGURE 2-1	1

TABLE 2-1

MONITORING WELLS AND SAMPLING RATIONALE
LONG-TERM MONITORING
SITES 36 AND 37
NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

Monitoring well No.	Depth Interval	Depth, Ft	Site	Existing/New	Analytes	Rationale and Comments
CEF-37-23S	S	15	37	N	NA, V	Upgradient, shallow, 5' west of 37-024A
CEF-37-24S	S	15	37	N	V	Monitor west end of HS, 250' SE of 36-27B
CEF-36-35S	S	15	36	N	V	Sentinel, shallow, 450' SE of 36-33D
CEF-36-36I	I	60	36	N	V	Sentinel, intermediate, 450' SE of 36-33D
CEF-36-37D	D	92**	36	N	V	Sentinel, deep, 450' SE of 36-33D
CEF-36-38I	UI	45	36	N	V	Monitor plume, UI, 200' E of 36-006A
CEF-36-39I	LI	60	36	N	V	Monitor plume, LI, 200' E of 36-006A
CEF-36-41I	UI	45	36	N	V	Monitor plume, UI, 200' NW of 36-016A
CEF-36-40I	UI	45	36	N	V	Monitor migration, UI, 10' E of CEF- 36-25I
CEF-13-1S	S	14.5	37	E	V	Monitor migration, shallow
CEF-13-2I	I	39	37	E	V	Monitor migration, intermediate
CEF-13-15I	I	44	37	E	NA, V	Common upgradient, intermediate
CEF-13-16D	D	82	37	E	NA, V	Upgradient, deep
CEF-233-1S	S	13	37	E	V, P, T	Shallow, side of plume
CEF-13-6I	I	39	37	E	NA, V, M	Source, intermediate, HS
CEF-13-5S	S	14	37	E	NA, V, P, M	Source, shallow, HS
CEF-13-7D	D	87	37	E	V	Monitor, deep
CEF-13-8S	S	14	37	E	V, P, T	Monitor, shallow, HS
CEF-13-9I	I	44	37	E	NA, V	Down plume, intermediate, HS
CEF-13-10S	S	14	37	E	V	Shallow, edge of plume, migration
CEF-13-12S	S	15	37	E	NA, V	Down plume, shallow
CEF-13-13I	I	43	37	E	V	Intermediate, edge of plume, migration to depth
CEF-43-45	S	15*	36	E	V, T	Monitor, shallow
CEF-36-29S	S	14	37 (36)	E	NA, V	Downgradient, shallow
CEF-36-30I	I	60	37 (36)	E	NA, V	Downgradient, intermediate
CEF-36-24I	I	60	36	E	V, T	Monitor, intermediate, HS
CEF-36-23S	S	15	36	E	V	Monitor for migration, shallow, HS
CEF-342-1I	I	45	36	E	NA, V, P	Upgradient, interemediate
CEF-342-2DA	D	86	36	E	V	Monitor, source area
CEF-342-3I	I	45	36	E	NA, V, P, T	Source, intermediate, HS
CEF-342-6S	S	15	36	E	V	Shallow, HS
CEF-342-7I	I	45	36	E	NA, V	Source, intermediate, chlorinated, HS
CEF-342-17D	D	84	36	E	V	Monitor historic chlorinated hit, HS
CEF-342-13I	I	44.5	36	E	NA, V	Down plume, intermediate, HS
CEF-342-14D	D	87	36	E	NA, V	Source, deep, chlorinated, HS
CEF-36-27I	LI	57	36	E	V	Monitor plume
CEF-342-19I	I	45	36	E	NA, V	Downgradient, intermediate
CEF-342-20D	D	85	36	E	NA, V	Down plume, deep
CEF-36-25I	I	57	36	E	V	Monitor migration

TABLE 2-1

MONITORING WELLS AND SAMPLING RATIONALE
LONG-TERM MONITORING
SITES 36 AND 37
NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

Monitoring well No.	Depth Interval	Depth, Ft	Site	Existing/New	Analytes	Rationale and Comments
CEF-36-33D	D	92	36	E	NA, V	Downgradient, deep
CEF-342-5I	I	45	36	E	WL	Water level only
CEF-36-31D	D	90	36	E	WL	Water level only
CEF-37-21D	D	95	37	E	WL	Water level only
CEF-AOI31-1S	S	15*	37	E	WL	Water level only
CEF-37-19D	D	84	37	E	WL	Water level only
CEF-13-11I	I	42.5	37	E	WL	Water level only
CEF-14-1S	S	13	37	E	WL	Water level only
CEF-13-3S	S	15	37	E	WL	Water level only
CEF-13-4I	I	39	37	E	WL	Water level only
CEF-37-20D	D	98	37	E	WL	Water level only
CEF-37-22S	S	14.5	37	E	WL	Water level only
CEF-37-18I	I	60	37	E	WL	Water level only
CEF-13-14D	D	93	37	E	WL	Water level only
CEF-342-8D	D	84	36	E	WL	Water level only
CEF-342-11D	D	80	36	E	WL	Water level only
CEF-342-12S	S	15	36	E	WL	Water level only
CEF-342-18S	S	15	36	E	WL	Water level only
CEF-36-26D	D	88.5	36	E	WL	Water level only
CEF-36-21I	I	54	36	E	WL	Water level only
CEF-36-22D	D	88	36	E	WL	Water level only

NOTES:
S - Shallow
I - Intermediate
D - Deep
LI - Lower intermediate
UI - Upper intermediate
N - New
E - Existing
NA - Natural attenuation parameters
V - VOCs by 8260B
P - PAHs by 8310
T - TRPH by FL-PRO
M - Iron and manganese (total and dissolved) by 6010B
WL - Water Levels only
HS - "Hot Spot" monitoring for progress of active treatment
X - is a temporary number, number to follow sequence after approval.
New Site 36 numbers start at -35#, Site 37 wells start at -23#.
* - to be field checked
** - estimated, set at bottom of surficial sand unit.

PVC shall meet National Sanitation Foundation (NSF) Standard 14 as specified in U.S. EPA Region 4 EISOPQAM (U.S. EPA, 1996).

Intermediate and deep monitoring wells will also be constructed of 2-inch ID, flush-threaded PVC well screen and compatibly threaded PVC riser.

Boreholes for deep monitoring wells will be advanced to the base of the sand unit of the surficial aquifer system, a depth of approximately 90 feet bgs. The upper-rock aquifer consists of limestone and sands. The bottom of the screened interval for the deep monitoring well will be placed even with, or slightly below, the clay layer that overlies the top of the upper-rock aquifer. Deep monitoring wells will be constructed of 2-inch ID, flush-threaded PVC well screen and PVC well casing riser.

Well screens for shallow monitoring wells will be 10 feet long with 0.010-inch openings. The top of the screen will be set about 2 feet above the water table. Intermediate and deep well screens will be 5 feet long with 0.010-inch openings.

For all monitoring wells, a primary filter pack of clean, silica sand will be installed 0.5 feet below the bottom of the well screen to a minimum of 2 feet above the top of the well screen. A sand passing U.S. Standard Sieve No. 20-30 will be used. A 2 foot thick secondary filter pack of very fine sand passing U.S. Sieve No. 30 (30/65 sand) will be used as a seal. The annular space above the seal will be grouted with neat cement or a bentonite/cement mixture from the top of the seal to within 2 feet of ground surface. The concrete used to form the pad will fill the remaining annular space. The concrete pad and protective well cover will not be installed for a minimum of 24 hours following the installation of the cement grout seal. Figure 2-2 of the Base-Wide Generic Work Plan, Project Operations Plan, Volume II (TtNUS, 1998b) illustrates a typical monitoring well construction.

All monitoring wells will be completed with an 8-inch diameter, flush grade, and protective steel casing with bolt-on cover. A 2.5-foot- by 2.5-foot-wide by 6-inch-thick concrete surface pad shall be placed flush with the ground surface. In areas where the well was constructed by advancing through existing concrete pavement (approximately 12 to 18-inches thick), square well pads will not be installed. Instead, a 12-inch diameter hole will be cored through the concrete. The protective steel cover will be set in neat cement grout, and the cover will be placed so the top of the cover is flush with the existing concrete surface. This will allow for minimal disturbance of existing concrete surfaces and will hold-up to heavy traffic due to the minimal surface exposure of the well cover. Because most wells will be installed within or adjacent to the flightline, no bumper guards will be installed.

All wells will be properly identified by installing a permanent 4-inch by 4-inch aluminum tag identification plate. This identification plate will be installed inside the flush grade cover by affixing the plate to the protective cover metal sleeve with either rivets or self-tapped screws. The well identification plate will be affixed to the protective well cover prior to installing the well cover and neat cement grout seal. Each well identification plate will contain, at a minimum, the following information.

(a) Well identification number
(b) Date of construction
(c) Drilling contractor and certification number
(d) Depth of well
(e) Screened interval
(f) Static water level
(g) Casing depth and inside diameter
(h) Northing and easting coordinates

Prior to development, a hydrocarbon interface probe will be used (if necessary) to determine the potential presence of both light and dense free product in the well. Groundwater monitoring wells with free product will not be developed.

Monitoring wells will be developed in accordance with the TtNUS SOP GH-2.8 no sooner than 24 hours nor longer than 7 days after well completion to remove fine material from the area around the monitored interval of the well. Wells are developed by bailing, pumping, or surging, as determined by the field geologist. The pH, temperature, turbidity, and specific conductivity measurements are collected from the purged water after each borehole volume is removed or at predetermined intervals.

A minimum of 5 times the standing water volume in the well casing plus 5 times the water volume in the saturated gravel pack (assume 30 percent porosity) will be removed. Turbidity will be measured during well development. An attempt will be made to develop the well to a turbidity of 10 nephelometric turbidity units (NTU). The wells will be developed until the discharge water is visibly clear, and temperature, pH, and specific conductivity have stabilized to within 5 percent variance for three consecutive measures, or as determined by the TtNUS field geologist.

Water-quality stabilization is determined using the following criteria: temperature ±1.0°C, pH ±0.1 unit, and specific conductivity ±5 percent. If a value of less than 10 NTUs cannot be achieved, attempts to stabilize the turbidity at a constant value will be made. All water quality measurements and the volumes removed will be recorded for each well on the well development form.

2.2 EXISTING MONITORING WELLS

All existing wells are constructed of flush joint, threaded, 2-inch ID Schedule 40 PVC. Well screens are 0.010-inch slot size. Shallow well screens are 10 feet long, and intermediate and deep well screens are 5 feet long. The wells were installed with a typical sand pack consisting of 20-40 grade silica sand, pure sodium bentonite or 30/65 sand seal, and grouted annulus. The soil boring logs and monitoring well construction diagrams are found in the Remedial Investigation (RI) Report (TtNUS, 1999).

The locations of the existing wells are shown on Figure 2-1, and the rationale for the selection of the wells for sampling is described in Table 2-1. Figures 2-2 through 2-5 shows the locations of the wells to be sampled relative to the plume outlines, hot spots, and proposed sparge wells.

2.3 LONG-TERM SAMPLING AND ANALYSIS

The monitoring wells that have been selected to monitor the effectiveness of AS/VE in the source area and immediate vicinity and to monitor the effectiveness of natural attenuation in the area downgradient of the source are shown on Table 2-1. This table also lists the analyses that are to be performed on samples from each well.

Groundwater will be sampled and analyzed to verify that the contaminant mass and mobility are being effectively reduced. Water-level measurements will also be performed during each sampling event at the monitoring wells to be sampled, plus several additional wells. The wells where only the water level will be measured are included on Table 2-1. Samples will be collected and analyzed in accordance to the “Remedial Investigation Field Sampling Plan for Site 36 – Control Tower TCE Plume and Site 37 – Hangars 13 and 14 DCE Plume, NAS Cecil Field, Jacksonville, Florida” (TtNUS, 1998a). Samples from wells denoted with “V”, “P”, “T” and "M" on Table 2-1 will be analyzed for VOCs, polycyclic aromatic hydrocarbons (PAHs), TRPH, and specific metals (total and dissolved), respectively, as shown on Table 2-2. Samples from wells denoted with “NA” on Table 2-1 will be analyzed for natural attenuation parameters, as shown on Tables 2-3 and 2-4. Natural attenuation parameters were selected based on the results of previous natural attenuation analyses (TtNUS 1999, and HLA 1998).

Note that samples for dissolved metal analysis are to be filtered through a 1-micron cartridge filter.

TABLE 2-2

SUMMARY OF CHEMICALS OF CONCERN ANALYTICAL REQUIREMENTS
LONG-TERM MONITORING
SITES 36 AND 37
NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

Parameter	Sample Container	Container Volume	Preservation[1]	Maximum Holding Time	Analytical Methodology
TCL VOCs	Glass, black phenolic plastic screw cap, Teflon-lined	2x40 mL	Cool to 4°C, dark, HCl to pH < 2	14 days	SW-846 8260B
PAHs	Amber glass, Teflon-lined cap	1000 mL	Cool to 4°C	Extraction 7 days; analysis within 40 days	SW-846 8310
TRPH	Amber glass, Teflon-lined cap	1000 ml	Cool to 4ºC	Extraction 7 days; analysis within 40 days	FL-PRO
Iron and Manganese (total and dissolved)	Glass or polyethylene	1000 ml	Cool to 4°C, HNO_3 to pH <2	180 days to analysis	SW-846 6010B

NOTES:

1 Preservation agents: HCl = Hydrochloric acid

TABLE 2-3

NATURAL ATTENUATION PARAMETERS
FIELD ANALYTICAL METHODS
LONG-TERM MONITORING
SITES 36 AND 37
NAVAL AIR STATION CECIL FIELD, JACKSONVILLE, FLORIDA

Parameter	Method[2]/ Reference	Data Use	Sample Volume, Container, & Preservation
Temperature	Direct-reading thermometer	Biological processes are temperature dependent.	100-250 ml in glass or plastic container. Analyze immediately
Dissolved Oxygen	CHEMetrics ampoule kits	Concentration of less than 1 mg/L indicates anaerobic conditions.	Follow test kit instructions. Analyze immediately to nearest 0.2 mg/L
pH	Direct-reading meter	Biological processes are pH sensitive.	100-250 ml in glass or plastic container. Analyze immediately
Conductivity	Direct-reading meter	General water quality parameter used to verify that site samples are obtained from the same groundwater system.	100-250 ml in glass or plastic container. Analyze immediately
Alkalinity	HACH Test Kit Number AL-DT - Digital Titration - Phenolphthalein and Total Method (HACH Method 8203)	Total alkalinity provides an indication of the amount of CO_2 generated during aerobic or anaerobic reduction of a hydrocarbon.	Follow test kit instructions. Analyze immediately to determine carbonate, bicarbonate, and hydroxide ions to the nearest 10 mg/L
Ferrous Iron (Fe^{+2})	HACH Test Kit Number IR-18C - Color Disc - 1,10 Phenanthroline Method	Presence of ferrous iron may indicate presence of an anaerobic degradation process due to depletion of oxygen, nitrate, and manganese.	Follow test kit instructions. Analyze immediately to nearest 0.2 mg/L
Hydrogen Sulfide (H_2S)	HACH Test Kit Number HS-C - Color Chart - Effervescence of H_2S	Provides evidence of sulfate-based anaerobic degradation. May also indicate natural H_2S production.	Follow test kit instructions. Do not aerate or agitate. Analyze immediately. Analyze to nearest 0.1 mg/L
Sulfide	HACH DR-850	Provides evidence of sulfate-based anaerobic degradation.	Follow kit instructions. Analyze immediately.
Oxidation-Reduction Potential (ORP)	Direct-Reading Meter	ORP provides information on RE/DOX conditions and to interpret the nature and state of chemical compounds and biological conditions. ORP typically ranges from +200mV in normal aerobic, oxidizing conditions to -400mV in strongly anaerobic, reductive conditions.	10-250 ml in glass container filling from the bottom. Do not aerate or agitate. Analyze immediately.

TABLE 2-3

NATURAL ATTENUATION PARAMETERS
FIELD ANALYTICAL METHODS
LONG-TERM MONITORING
SITES 36 AND 37
NAVAL AIR STATION CECIL FIELD, JACKSONVILLE, FLORIDA

Parameter	Method[2]/ Reference	Data Use	Sample Volume, Container, & Preservation
Carbon Dioxide (CO_2)	HACH Test Kit Number CA-DT - Digital Titration - Sodium Hydroxide & Phenolphthalein Method (HACH Method 8205)	May be compared with background values as an indication of aerobic and anaerobic process. Is produced during aerobic respiration as well as anaerobic processes. Is utilized during methanogenesis.	Follow test kit instructions. Do not aerate or agitate. Analyze immediately. Analyze to nearest 0.1 mg/L

NOTES:

1 Table adapted from overview of the Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater (U.S. EPA, 1998).
2 Method refers to U.S. EPA test methods. Standard Methods are based on Standard Methods for the Examination of Water and Wastewater (Clesceri, et al, 1992)

TABLE 2-4

NATURAL ATTENUATION PARAMETERS
FIXED-BASED LABORATORY METHODS
LONG-TERM MONITORING
SITES 36 AND 37
NAVAL AIR STATION CECIL FIELD, JACKSONVILLE, FLORIDA

Parameter	Method[2]/ Reference	Data Use	Sample Volume, Container, & Preservation
Alkalinity	EPA 310.1. Manual titrimetric	General water quality parameter used to verify that site samples are obtained from the same groundwater system and to measure the buffering capacity of the groundwater.	100-250 ml in glass or plastic container. Cool to 4°C. Analyze within 14 days.
Iron (Dissolved)	SW-846 6010B	Iron can act as electron acceptors during biodegradation.	250 ml in plastic container. Collect filtered and unfiltered aliquots. HNO_3 to pH <2. Cool to 4°C. Analyze within 6 months.
Nitrate (NO_3^-)	EPA 300	Potential substrate for microbial respiration. May compete as an electron acceptor if present at moderate concentrations (>1 mg/L).	250 ml in plastic container. Cool to 4°C. Analyze within 48 hours.
Nitrite (NO_2^-)	EPA 300	Provides additional information on microbial and geochemical conditions.	250 ml in plastic container. Cool to 4°C. Analyze within 48 hours.
Orthophosphate (PO_4)	EPA 300	Potential substrate for microbial respiration. Provides additional information on microbial and geochemical conditions.	250 ml in plastic container. Filter if turbid. Cool to 4°C. Analyze within 48 hours.
Sulfate (SO_4^{-2})	EPA 300	Potential substrate for microbial respiration. May compete as an electron acceptor if present at moderate concentrations (>20 mg/L).	250 ml in plastic container. Cool to 4°C. Analyze within 28 days.
Chloride (Cl^-)	EPA 300	Provides direct evidence of dechlorination. Provides additional information on geochemical conditions.	250 ml in plastic container. Cool to 4°C. Analyze within 28 days.
Dissolved Sulfide (S^{-2})	EPA 376.1	Provides evidence of sulfate-based anaerobic degradation.	1 liter in plastic container. NaOH to pH >9. Cool to 4°C. Analyze within 7 days.

TABLE 2-4

NATURAL ATTENUATION PARAMETERS
FIXED-BASED LABORATORY METHODS
LONG-TERM MONITORING
SITES 36 AND 37
NAVAL AIR STATION CECIL FIELD, JACKSONVILLE, FLORIDA

Parameter	Method[2]/ Reference	Data Use	Sample Volume, Container, & Preservation
Methane, Ethane, Ethene	RSK SOP-147 & 175	Presence of methane indicates biological degradation via an anaerobic pathway utilizing CO_2 as an electron acceptor. Ethane and ethene also indicate biological degradation of chlorinated VOCs.	40 ml in volatile organic analyte (VOA) vial with Teflon lined septum. HCl to pH <2. Cool to 4°C. Analyze within 14 days.
Total Organic Carbon (TOC)	E 415.1	Indicates if the groundwater has a sufficient supply of carbon to act as the primary substrate. Collect from well located upgradient of site.	125 ml HDPE. H_2SO_4 to pH < 2.0. Cool to 4°C. Analyze within 28 days.

NOTES:

1 Table adapted from overview of the Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater (U. S. EPA, 1998).
2 Method refers to U.S. EPA test methods. Standard Methods are based on Standard Methods for the Examination of Water and Wastewater (Clesceri, et al, 1992)

DRAWN BY MJJ	DATE 15Oct98	MONITORING WELL SAMPLE LOCATIONS WITH PLUMES AND PROPOSED SPARGE WELLS - SHALLOW ZONE SITES 36 AND 37 NATURAL ATTENUATION SAMPLING NAS CECIL FIELD JACKSONVILLE, FLORIDA	CONTRACT NO. 0039
CHECKED BY	DATE		OWNER NO.
	DATE		APPROVED BY / DATE
SCALE AS NOTED			DRAWING NO. FIGURE 2-2 / REV. 1

LEGEND

- DPT Location
- Monitoring Well
- Aviation Fuel Piping
- Air Sparge Radius of Influence
- "Hot-Spot" No. 1 - (Intermediate)
- "Hot-Spot" No. 2 - (Deep)
- "Hot-Spot" No. 3 - (Shallow/Intermediate)
- Benzene 1 ppb
- TCE 3 ppb
- PCE 3 ppb
- Vinyl Chloride 1 ppb
- DCE 3 ppb
- 1,1,2-TCE 3 ppb

CEF-013-15I Sample for Natural Attenuation Parameters and Contaminants specified in Table 2-1

CEF-013-03S Sample Contaminants specified in Table 2-1 only

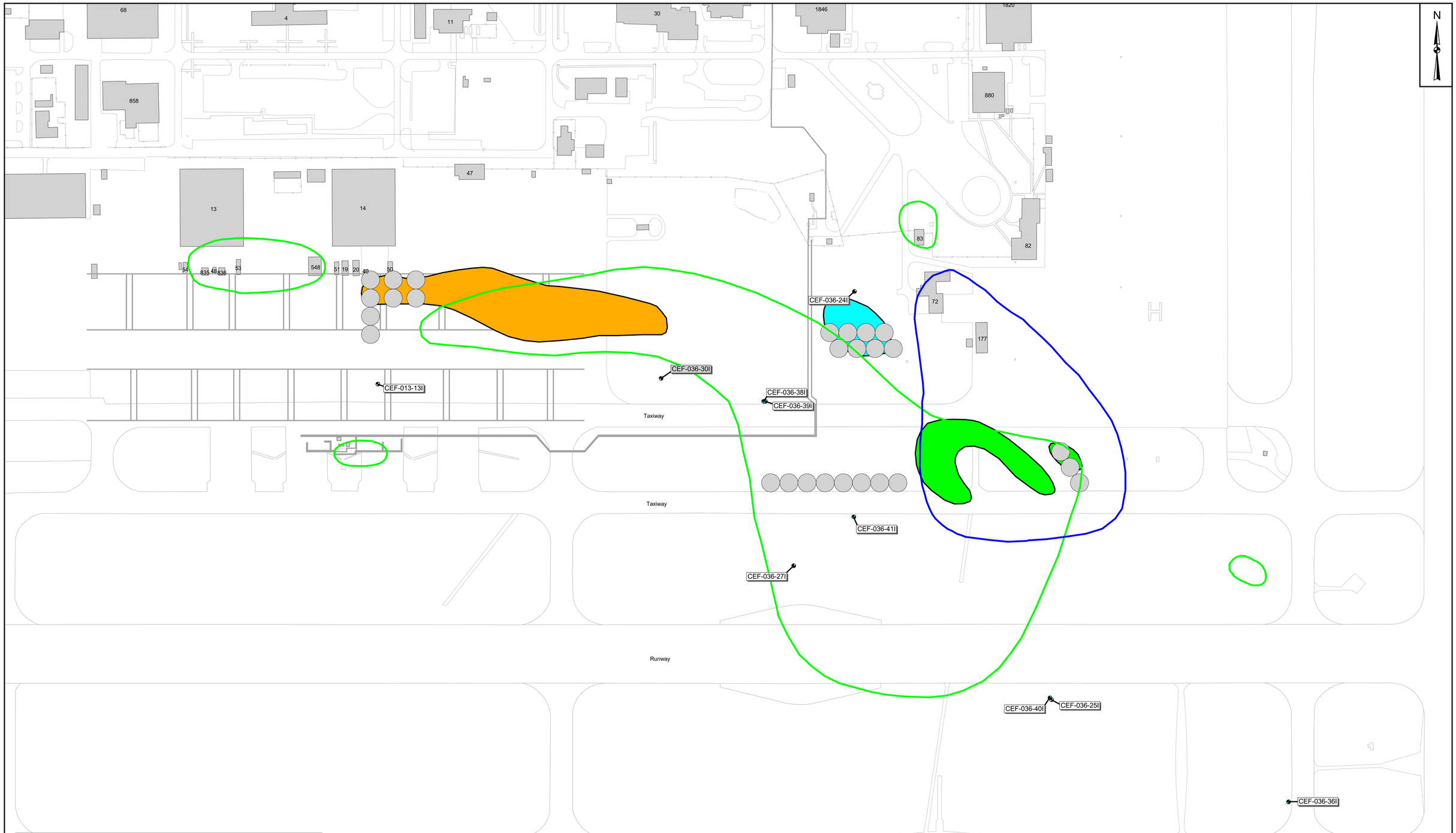
150 0 150 Feet

P:\GIS\NAS_CecilField\site-3637_naturalattenuationsampling.apr
13Dec00 MJJ Sample Locations Layout2 - Inter1

DRAWN BY MJJ	DATE 15Oct98
CHECKED BY	DATE
	DATE
SCALE AS NOTED	

MONITORING WELL SAMPLE LOCATIONS WITH PLUMES AND PROPOSED SPARGE WELLS - UPPER INTERMEDIATE ZONE
SITES 36 AND 37
NATURAL ATTENUATION SAMPLING
NAS CECIL FIELD
JACKSONVILLE, FLORIDA

CONTRACT NO. 0039	
OWNER NO.	
APPROVED BY	DATE
DRAWING NO. FIGURE 2-3	REV. 1



DRAWN BY MJJ	DATE 15Oct98	MONITORING WELL SAMPLE LOCATIONS WITH PLUMES AND PROPOSED SPARGE WELLS - LOWER INTERMEDIATE ZONE SITES 36 AND 37 NATURAL ATTENUATION SAMPLING NAS CECIL FIELD JACKSONVILLE, FLORIDA	CONTRACT NO. 0039
CHECKED BY —	DATE —		OWNER NO. —
	DATE —		APPROVED BY — / DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 2-4 / REV. 1

DRAWN BY MJJ	DATE 15Oct98	MONITORING WELL SAMPLE LOCATIONS WITH PLUMES AND PROPOSED SPARGE WELLS - DEEP ZONE SITES 36 AND 37 NATURAL ATTENUATION SAMPLING NAS CECIL FIELD JACKSONVILLE, FLORIDA	CONTRACT NO. 0039
CHECKED BY	DATE		OWNER NO.
	DATE		APPROVED BY / DATE
SCALE AS NOTED			DRAWING NO. FIGURE 2-5 / REV. 1

The frequency of sampling and analysis for the wells (except as noted below) is as follows:

Year	Frequency
1	Quarterly
2-3	Semi-Annual
3+	Annual

The frequency of sampling for CEF-36-35S, 36-36I, and 36-37D will be semiannual.

The analyses, wells, and sampling frequency may be changed over the course of the monitoring program. Changes in the monitoring program will be considered at least annually based on evaluation of the data and concurrence by the BRAC Cleanup Team (BCT). However, it is anticipated that the number of wells sampled in future sampling events may be reduced, depending on the results of the first year of monitoring. The selection of wells for future monitoring will depend on the concentrations of natural attenuation parameters and contaminants in the early rounds. Following the review of the results of the future sampling events, it may be possible to reduce the number of wells to a representative set that will be retained for monitoring for the duration of the project. The representative set of wells for each monitoring year will be refined based on the locations where indications of biodegradation natural attenuation (contaminant concentrations and natural attenuation parameters) are strongest from the previous events.

Monitoring results will be tabulated and presented to the BCT in annual reports. If natural attenuation is determined to be occurring at an unacceptable rate, then further remedial measures may be considered.

During the first 5-year period, sampling and analysis of the long-term monitoring well network will be conducted quarterly for the first year, semiannually for the next two years, and annually thereafter. The first year quarterly sampling events will be conducted in order to determine if there are significant temporal changes as a result of seasonal influences. If the data collected during this initial period supports the observed efficiency of natural attenuation (documentation that the plume is either in a steady-state condition or declining), the monitoring frequency may be reduced. If data collected at any time during the monitoring program indicate plume migration or a risk to human health and the environment, the sampling frequency may be adjusted accordingly and a contingency plan will be developed.

2.4 STORM SEWER SAMPLING AND ANALYSIS

Storm sewer locations that are to be sampled to monitor the characteristics of the dry weather flow in the storm sewer are shown on Figure 2-6. The sample locations and analyses are summarized on Table 2-5.

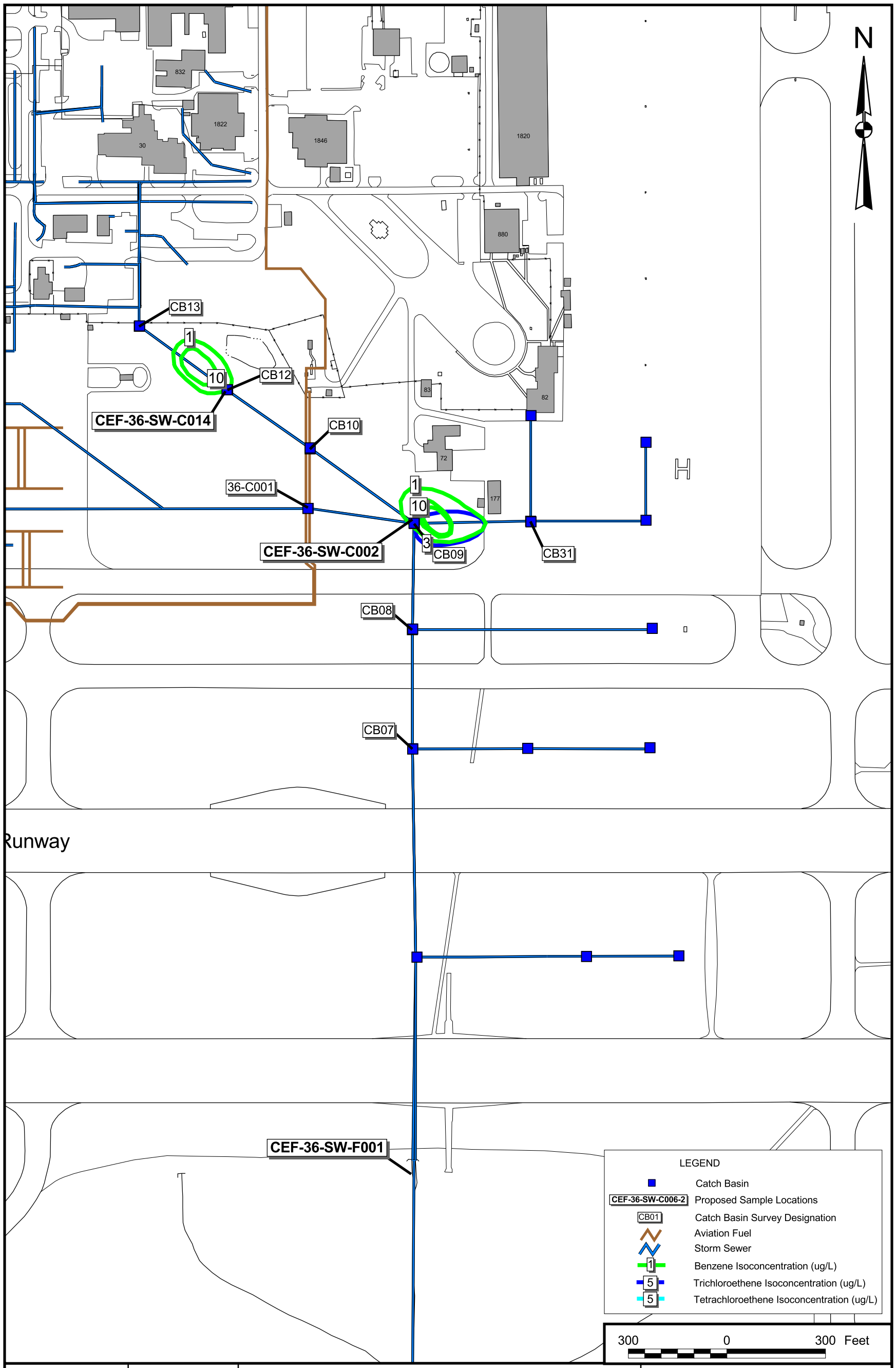
TABLE 2-5

STORM SEWER SAMPLING
LONG-TERM MONITORING
SITES 36 AND 37
NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

Sampling Location No.	Analyses	Notes
CEF-36-SW-F001	V, P, T	Also known as Outfall 11
CEF-36-SW-C002	V, P, T	Also known as CB09
CEF-36-SW-C014	V, P, T	Also known as CB12

NOTES:
V – VOCs by 8260B
P – PAHs by 8310
T – TRPH by FL-PRO

P:\GIS\CECIL\site3637_DesignBasis.apr 26Dec00 MJJ Figure 3 Layout



DRAWN BY MJJ	DATE 27Nov00	STORM SEWER SAMPLE LOCATIONS SITE 36 NATURAL ATTENUATION SAMPLING NAS CECIL FIELD JACKSONVILLE, FLORIDA	CONTRACT NUMBER 0039
CHECKED BY	DATE		APPROVED BY — DATE —
COST/SCHEDULE-AREA			APPROVED BY — DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 2-6 REV 0

Dry weather storm water flow will be sampled and analyzed to verify that the introduction of contaminants into the surface water by way of infiltration into the storm sewers is being reduced, and to confirm that the concentrations of contaminants at the outfall are less than FDEP Surface Water Quality Criteria (SWQC) for Class III Surface Waters, as listed in FAC 62-302. Samples will be collected and analyzed in accordance to the "Remedial Investigation Field Sampling Plan for Site 36 – Control Tower TCE Plume and Site 37 – Hangars 13 and 14 DCE Plume, NAS Cecil Field, Jacksonville, Florida" (TtNUS, 1998a). Samples as denoted with "V", "P", and "T" on Table 2-6 will be analyzed for VOCs, PAHs, and TRPH, respectively.

Surface water samples will be collected as grab samples either by submerging the sampling bottle (except for bottles that contain a chemical preservative) into the water, using a bailer or dipper to obtain the sample, or using a peristaltic pump. Samples will only be collected during dry weather conditions, preferably at least 72 hours after the last rainfall. Prior to sampling, the flow upstream from catch basin CB13 will be checked to confirm that no water is entering the system from upstream sources. Samples will be collected in a downstream to upstream sequence. The catch basins have been previously sampled, and therefore no surveying is needed. Note that each catch basin has both a sample location designation from the RI (e.g., 36-C015) and a designation from the survey (e.g., CB13). The RI designation does not match the survey designation.

The sampling events will coincide with the monitoring well sampling events, at a frequency relative to the start-up of the air sparging (AS) system, noted below.

Year, relative to AS Start-up	Frequency
1, first month after AS start-up	Every two weeks
1, second and third month after start-up	Monthly
1, remaining 9 months after start-up	Quarterly
2-3	Semi-Annual
3+	Annual

The analyses, sample locations, and sampling frequency may be changed over the course of the monitoring program, based on the analytical results. Changes in the monitoring program will be considered at least annually based on evaluation of the data and concurrence by the BCT.

Monitoring results will be tabulated and presented to the BCT in annual reports. The results will be compares to the FDEP SWQC for Class III Surface Waters, as listed in FAC 62-302.

2.5 SAMPLE NUMBERS

Each sample is to be assigned a unique sample identification number. Sample numbers will use the following convention that has been established for NAS Cecil Field and is similar to that used for the RI.

The nomenclature established for this investigation is as follows:

1		2		3		4
AAA-NN	-	AA	-	EEEE	-	NN
Site Location and Site Number		Media		Sample Location		Sample Depth or Round

1 Site Location:

CEF- NAS Cecil Field

Site Number:

36 - Site 36

37 - Site 37

2 Media types:

GW - Groundwater

GF - Groundwater Filtered (applies to filtered metals only)

DU - Duplicate

DF - Filtered Groundwater Duplicate

SW – Surface Water (storm sewer samples)

3 Sampling location by media type:

For existing monitoring wells, EEEE = AEEA with the first A as a specific letter code to identify the site number of the existing well number, below, and EEA as the number and depth designation in the existing well identification number. Note that samples from wells that are already designated by a “36” or “37” do not have a prefix letter code. These codes are consistent with those used in the RI.

Well Prefix Code (First “A” and site number)

A - AOI31

F - 043

H - 13

T - 342

R - 233

For the storm sewer samples, EEE is the existing sampling station designation from the RI and as shown on Table 2-5. An example is C002.

4 Monitor well or storm sewer sampling event, NN is as follows:

11 = Event one

12 = Event two, etc.

The sample event number is being started at 11 to distinguish the samples from the RI samples.

Table 2-6 summarizes the general sample numbers to be used for each well.

TABLE 2-6

MONITORING WELL SAMPLE NUMBERS
LONG-TERM MONITORING
SITES 36 AND 37
NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

Monitoring well No.	Site	General Sample No.	Analytes
CEF-37-23S	37	CEF-37-GW-23S-NN	NA, V
CEF-37-24S	37	CEF-37-GW-24S-NN	V
CEF-36-38I	36	CEF-36-GW-38I-NN	V
CEF-36-39I	36	CEF-36-GW-39I-NN	V
CEF-36-41I	36	CEF-36-GW-41I-NN	V
CEF-36-40I	36	CEF-36-GW-40I-NN	V
CEF-36-35S	36	CEF-36-GW-35S-NN	V
CEF-36-36I	36	CEF-36-GW-36I-NN	V
CEF-36-37D	36	CEF-36-GW-37D-NN	V
CEF-13-15I	37	CEF-37-GW-H15I-NN	NA, V
CEF-13-16D	37	CEF-37-GW-H16I-NN	NA, V
CEF-233-1S	37	CEF-37-GW-R01S-NN	V, P, T
CEF-13-1S	37	CEF-37-GW-H1S-NN	V
CEF-13-2I	37	CEF-37-GW-H2I-NN	V
CEF-13-6I	37	CEF-37-GW-H6I-NN	NA, V, M
CEF-13-5S	37	CEF-37-GW-H5S-NN	NA, V, P, M
CEF-13-7D	37	CEF-37-GW-H7D-NN	V
CEF-13-8S	37	CEF-37-GW-H8S-NN	V, P, T
CEF-13-9I	37	CEF-37-GW-H9I-NN	NA, V
CEF-13-10S	37	CEF-37-GW-H10S-NN	V
CEF-13-12S	37	CEF-37-GW-H12S-NN	NA, V
CEF-13-13I	37	CEF-37-GW-H13I-NN	V
CEF-43-45	36	CEF-36-GW-F45-NN	V, T
CEF-36-29S	37 (36)	CEF-36-GW-29S-NN	NA, V
CEF-36-30I	37 (36)	CEF-36-GW-30I-NN	NA, V
CEF-36-24I	36	CEF-36-GW-24I-NN	V, T
CEF-36-23S	36	CEF-36-GW-23S-NN	V
CEF-342-2DA	36	CEF-36-GW-T2DA-NN	V
CEF-342-3I	36	CEF-36-GW-T3I-NN	NA, V, P, T
CEF-342-6S	36	CEF-36-GW-T6S-NN	V
CEF-342-7I	36	CEF-36-GW-T7I-NN	NA, V
CEF-342-1I	36	CEF-36-GW-T1I-NN	NA, V
CEF-342-17D	36	CEF-36-GW-T17D-NN	V
CEF-342-13I	36	CEF-36-GW-T13I-NN	NA, V
CEF-342-14D	36	CEF-36-GW-T14D-NN	NA, V
CEF-36-27I	36	CEF-36-GW-27I-NN	V
CEF-342-19I	36	CEF-36-GW-T19I-NN	NA, V
CEF-342-20D	36	CEF-36-GW-T20D-NN	NA, V
CEF-36-25I	36	CEF-36-GW-25I-NN	V
CEF-36-33D	36	CEF-36-GW-33D-NN	NA, V
duplicate at 36	36	CEF-36-DU-##-NN	NA, V, P, T
duplicate at 37	37	CEF-37-DU-##-NN	NA, V, P, T

NN - round number, starting at 11 for the first round
- duplicate number for the event, 01, 02, etc.
S - Shallow
I - Intermediate
D - Deep
NA - Natural attenuation parameters
V - VOCs by 8260B
P - PAHs by 8310
T - TRPH by FL-PRO
M - Iron and manganese (total and dissolved) by 6010B
WL - Water Levels only
New Site 36 numbers start at -35#, Site 37 wells start at -23#.

3.0 QUALITY ASSURANCE/QUALITY CONTROL

To reduce sources of error during the implementation of the work outlined in this document, as well as during long-term monitoring, all activities will be carried out in accordance with the Base-Wide Generic Work Plan (TtNUS, 1998b) for NAS Cecil Field.

Quality Assurance/Quality Control samples that are typically collected have been modified for Cecil Field. Specifically, no trip blanks, field blanks, or rinseate blanks are required. Duplicates are to be collected at a rate of 10% of the total samples collected. Matrix spike and matrix spike duplicate (MS/MSD) samples are to be collected at a rate of 5% of the total samples collected.

4.0 EVALUATION CRITERIA

4.1 GROUNDWATER

The primary evaluation criterion to determine the effectiveness of AS and natural attenuation will be a decrease in the concentrations of COCs detected in the groundwater, particularly benzene, xylenes, and TCE. Remediation will be deemed to have been achieved when the concentrations of all contaminants have reached the cleanup goals.

In addition, testing results for the parameters listed in Tables 2-3 and 2-4 will be used to verify whether natural attenuation is occurring and to evaluate the possibility of reaching cleanup goals. The following guidelines will be used for this evaluation:

Oxidation/Reduction Potential (ORP): Dechlorination of chlorinated VOCs generally requires reductive conditions. ORP values of less than +50 millivolts (mV) indicate that reducing conditions are possible, and values of less than –100 (mV) indicate a high possibility of reducing conditions.

Dissolved Oxygen (DO): Values of 0.5 milligrams per liter (mg/L) or greater indicate aerobic conditions; unfavorable conditions for reductive dechlorination for TCE and 1,1-DCE. However, if values exceed 1.0 mg/L, certain chlorinated VOCs, such as vinyl chloride, and many nonhalogenated hydrocarbons may be aerobically degraded.

Nitrates (NO_3^-): Values of 1.0 mg/L or greater indicate that reductive dechlorination may be inhibited.

Ferrous Iron (Fe^{2+}): Values greater than 1.0 mg/L indicate that reductive dechlorination is possible and that anaerobic processes are favorable.

Sulfates (SO_4^{2-}): Values greater than 20 mg/L indicate that reductive dechlorination may be inhibited.

Sulfides (S^{2-}): Values greater than 1.0 mg/L indicate that reductive dechlorination is possible and that anaerobic processes are favorable.

Methane (CH_4): Values greater than 0.5 mg/L indicate that reductive dechlorination and anaerobic processes are potentially occurring but that vinyl chloride may accumulate.

Carbon Dioxide (CO_2), Chlorides (Cl^-), Alkalinity (as $CaCO_3$): Values greater than twice background levels indicate that complete degradation of organic COCs may be occurring.

4.2 STORM SEWER

The results of the storm sewer outfall sampling will be compared to FDEP Surface Water Quality Criteria (SWQC) for Class III Surface Waters, as listed in FAC 62-302. Historically, the only COC measured at the outfall has been benzene. The SWQC for benzene is 71.28 µg/L as an annual average.

5.0 LONG-TERM MONITORING REPORTS

Upon completion of each round of sampling, a brief data summary report will be prepared for the BCT documenting the investigative activities that were performed and presenting the analytical data generated during that sampling event. A comprehensive annual monitoring report will be prepared that presents the nature and extent of chemical and geochemical (when applicable) results and recommendations for the next year's sampling program.

The annual reports will also evaluate the source area contaminant removal achieved by AS, score the natural attenuation process for the downgradient area, and provide conclusions and recommendations for future actions, as required. Initially, scoring of the natural attenuation process will be performed in accordance to the Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater (U.S. EPA, 1998). Scoring protocol will be regularly updated based upon review of the most recent literature. If scoring shows limited evidence (6 to 14 points) or inadequate evidence (0 to 5 points) for natural attenuation of chlorinated organic compounds, and it appears that contaminant reduction is not occurring or contamination is migrating, a recommendation will be made that the selected remedy be reevaluated.

The results of the storm sewer samples and an evaluation of the results will also be included with the groundwater reports. If the results show COC concentrations greater than SWQC values, a recommendation will be made to reevaluate the monitoring program and consider repairing portions of the storm sewer system to minimize infiltration.

Analytical results will be put into the NAS Cecil Field GIS database.

6.0 INSTITUTIONAL CONTROLS

Institutional controls will consist of administrative measures taken to prevent exposure of human receptors to the groundwater in the surficial aquifer. A notification will be made to the agencies administrating the well installation permit program in Duval County to not issue permits for installation of drinking water wells that would pump water from the surficial aquifer.

7.0 FIVE-YEAR REVIEWS

Five-year reviews will be conducted at Sites 36 and 37, Operable Unit 9 (OU 9) in accordance with CERCLA, Section 121(c) and the NCP, Section 300.430(f)4(ii).

7.1 BACKGROUND

Five-year reviews are conducted at sites where remedial action results in hazardous substances, pollutants, or contaminants remaining on site. Remedial action at OU 9 does not immediately remove all contaminants from the site; therefore, residual contaminants will remain on site until the AS/VE and natural attenuation have been successfully completed.

Typically U.S. EPA conducts 5-year reviews. However, remedial action at NAS Cecil Field is being implemented under a Federal Facility Agreement (FFA) and, as such, the Navy is responsible for conducting these reviews. The next review is scheduled for 2004.

7.2 PURPOSE

Five-year reviews are conducted to evaluate whether or not the remedies selected in the Record of Decision (ROD) remain protective of human health and the environment.

7.3 EXECUTION

The 5-year review process will consist of the following:

- Review of background documents concerning OU 9, including long-term monitoring reports;
- Identification and review of new regulatory standards as may have been promulgated since the signing of the ROD or since the previous 5-year review;
- Site visit to conduct a visual inspection;
- Preparation of a 5-year review report, including conclusions and recommendations for future actions as may be required.

7.4 REPORTING

A report will be prepared at the end of each 5-year review period. The 5-year review reports will include the following elements:

- An introduction, including a summary of site characteristics;
- A brief discussion of Remedial Action Objectives (RAOs) and discussion of the applicable or relevant and appropriate requirements (ARARs);
- A description of monitoring and maintenance activities at the site;
- A presentation of monitoring results, including an evaluation of changes in monitoring parameters;
- An evaluation of how well the selected remedy has protected human health and the environment, including a formal statement of protectiveness of human health and the environment, a determination of remaining risks, and an analysis of potential deterioration of the remedy;
- A presentation of cost incurred;
- A summary description of the site visit;
- Documentation of areas of noncompliance, as may apply;
- Recommendations for future response actions, as may be required.

The 5-year review reports will be submitted to the Navy, U.S. EPA Region IV, and Florida Department of Environmental Protection (FDEP).

8.0 REFERENCES

HLA (Harding Lawson Associates), 1998. Site Assessment Report, Day Tank 2, Facility 342, Prepared for SOUTHDIVNAVFACENGCOM, North Charleston, South Carolina, July.

TtNUS (Tetra Tech NUS), 1998a. Remedial Investigation Field Sampling Plan for Site 36 – Control Tower TCE Plume and Site 37 – Hangars 13 and 14 DCE Plume. Prepared for SOUTHDIVNAVFACENGCOM, North Charleston, South Carolina, August.

TtNUS, 1998b. Base-Wide Generic Work Plan for Naval Air Station Cecil Field, Jacksonville, Florida. Prepared for SOUTHDIVNAVFACENGCOM, North Charleston, South Carolina, October.

TtNUS, 1999. Remedial Investigation Report for Site 36 – Control Tower TCE Plume and Site 37 – Hangars 13 and 14 DCE Plume. Prepared for SOUTHDIVNAVFACENGCOM, North Charleston, South Carolina, August.

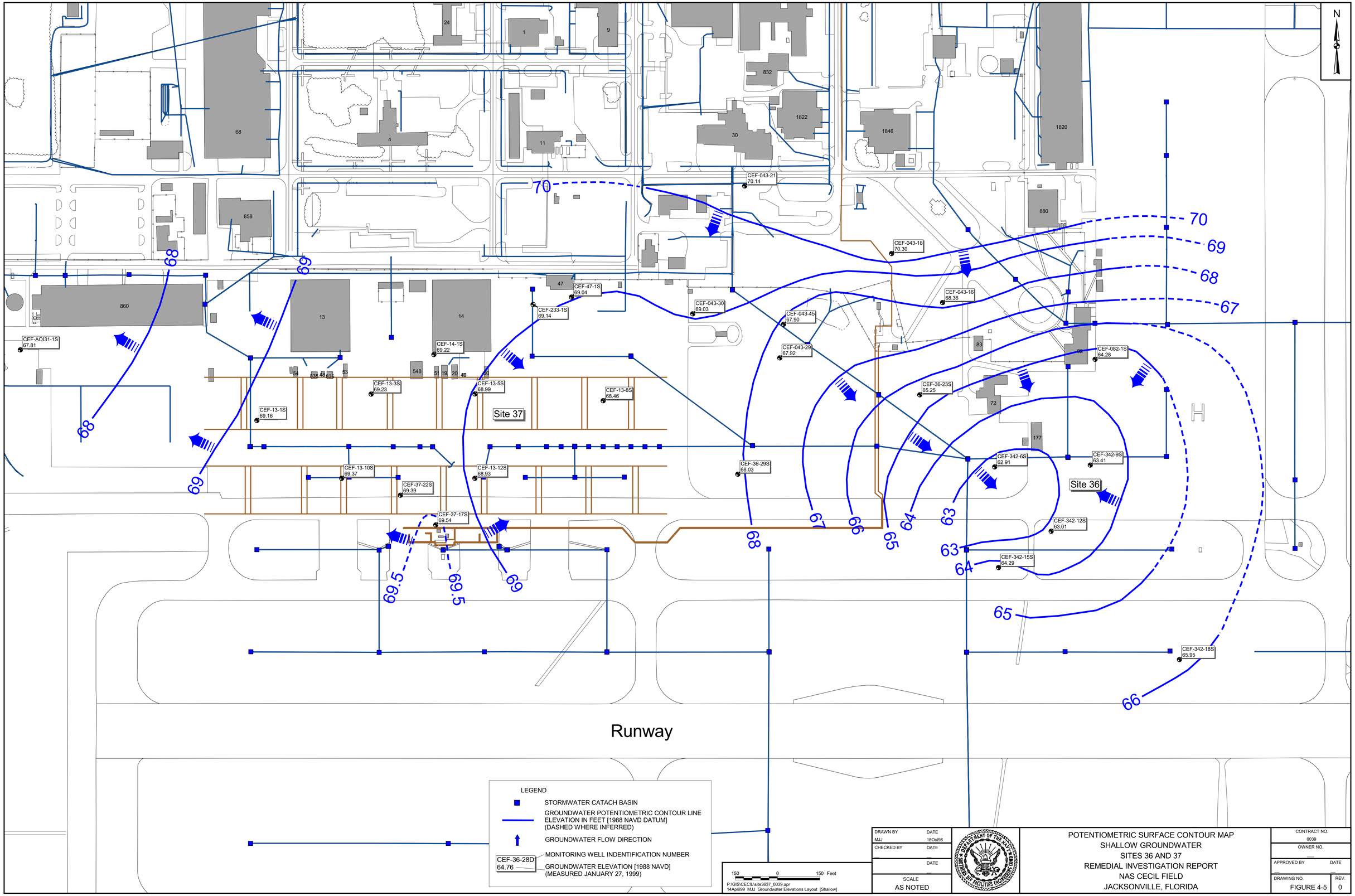
TtNUS, 2000. Feasibility Study Report for Site 36 – Control Tower TCE Plume and Site 37 – Hangars 13 and 14 DCE Plume. Prepared for SOUTHDIVNAVFACENGCOM, North Charleston, South Carolina, September.

U. S. EPA Region IV, 1996. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, May.

U. S. EPA, 1998. Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater, EPA/600/R-98/128, September.

APPENDIX A

GROUNDWATER POTENTIOMETRIC SURFACE MAPS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Site 37
Site 36
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CEF-043-18 70.30
CEF-043-30 69.03
CEF-043-45 67.90
CEF-043-29 67.92
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CEF-36-29S 68.03
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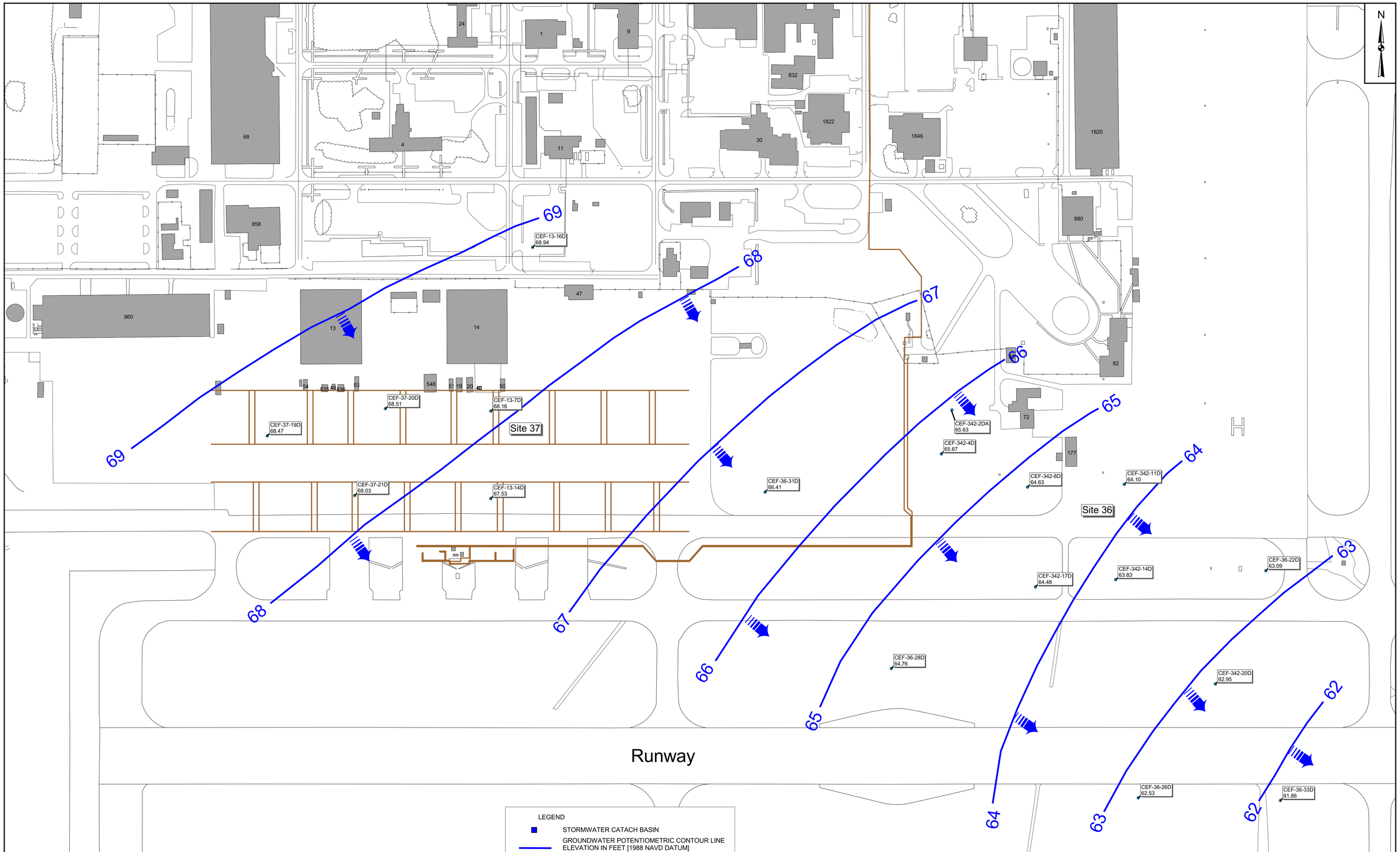
CEF-342-6S 62.91
CEF-342-9S 63.41
CEF-342-12S 63.01
CEF-342-15S 64.29
CEF-342-18S 65.95
CEF-082-1S 64.28
LEGEND
STORMWATER CATACH BASIN
GROUNDWATER POTENTIOMETRIC CONTOUR LINE ELEVATION IN FEET [1988 NAVD DATUM] (DASHED WHERE INFERRED)
GROUNDWATER FLOW DIRECTION
CEF-36-28D 64.76
MONITORING WELL INDENTIFICATION NUMBER
GROUNDWATER ELEVATION [1988 NAVD] (MEASURED JANUARY 27, 1999)
150 0 150 Feet
P:\GIS\CECIL\site3637_0039.apr
14Apr1999 MJJ Groundwater Elevations Layout [Shallow]
DRAWN BY MJJ
DATE 15Oct98
CHECKED BY
DATE
SCALE AS NOTED
POTENTIOMETRIC SURFACE CONTOUR MAP
SHALLOW GROUNDWATER
SITES 36 AND 37
REMEDIAL INVESTIGATION REPORT
NAS CECIL FIELD
JACKSONVILLE, FLORIDA
CONTRACT NO. 0039
OWNER NO.
APPROVED BY
DATE
DRAWING NO. FIGURE 4-5
REV. 0


N
Site 37
Site 36
Runway
CEF-13-16D 68.94
CEF-37-20D 68.51
CEF-13-7D 68.16
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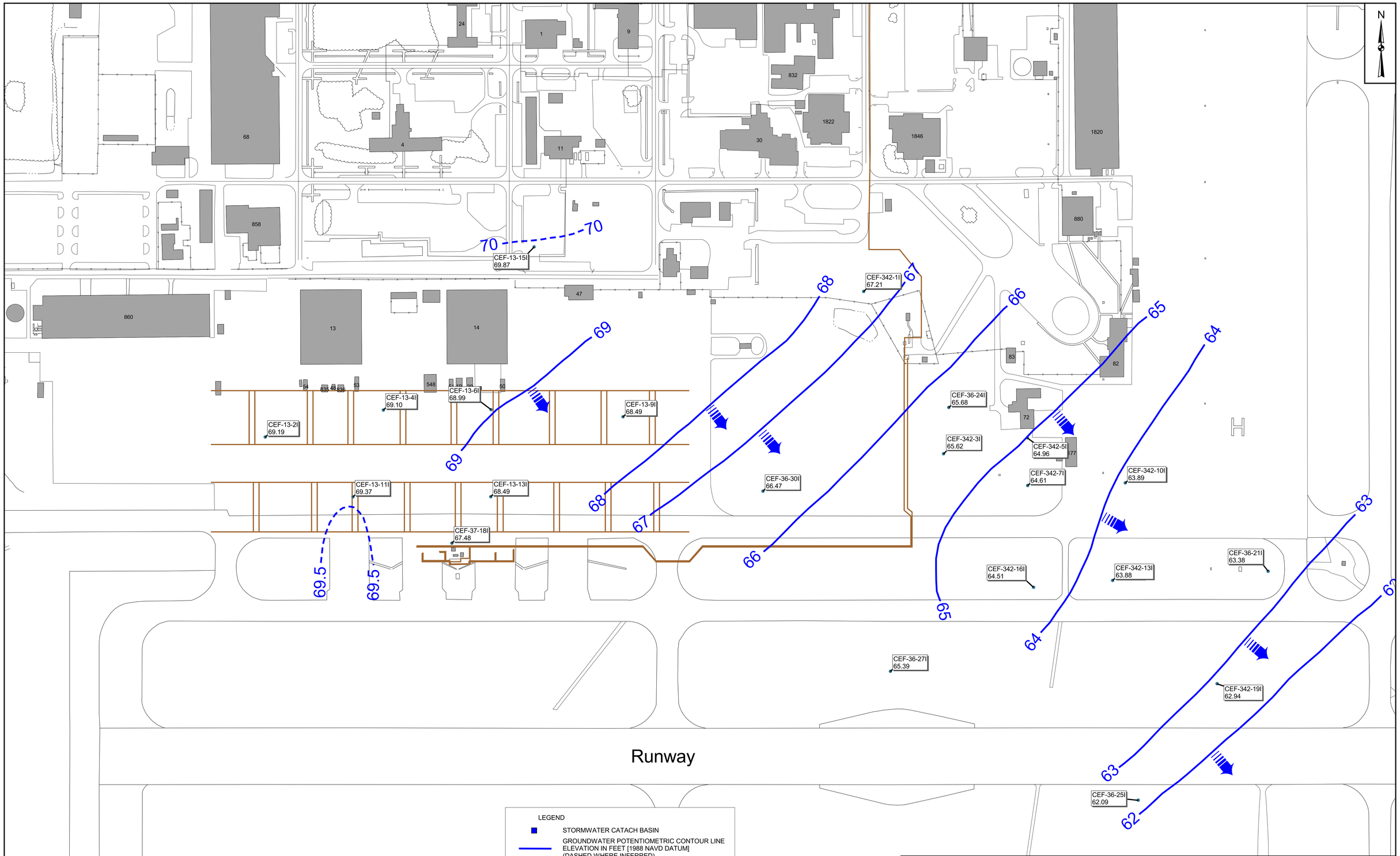
CEF-37-21D 68.03
CEF-13-14D 67.53
CEF-36-31D 66.41
CEF-342-2DA 65.63
CEF-342-4D 65.67
CEF-342-8D 64.63
CEF-342-11D 64.10
CEF-342-17D 64.48
CEF-342-14D 63.83
CEF-36-22D 63.09
CEF-36-28D 64.76
CEF-342-20D 62.95
CEF-36-26D 62.53
CEF-36-33D 61.86
69
68
67
66
65
64
63
62
LEGEND
STORMWATER CATACH BASIN
GROUNDWATER POTENTIOMETRIC CONTOUR LINE ELEVATION IN FEET [1988 NAVD DATUM] (DASHED WHERE INFERRED)
GROUNDWATER FLOW DIRECTION
CEF-36-28D
MONITORING WELL INDENTIFICATION NUMBER
64.76
GROUNDWATER ELEVATION [1988 NAVD] (MEASURED JANUARY 27, 1999)
150 0 150 Feet
P:\GIS\CECIL\site3637_0039.apr
26April99 MJJ Groundwater Elevations Layout [Deep]
DRAWN BY MJJ
DATE 15Oct98
CHECKED BY
DATE
DATE
SCALE
AS NOTED
POTENTIOMETRIC SURFACE CONTOUR MAP
DEEP GROUNDWATER
SITES 36 AND 37
REMEDIAL INVESTIGATION REPORT
NAS CECIL FIELD
JACKSONVILLE, FLORIDA
CONTRACT NO.
0039
OWNER NO.
APPROVED BY
DATE
DRAWING NO.
FIGURE 4-6
REV.
0



DRAWN BY	DATE
MJJ	09August99
CHECKED BY	DATE
	DATE
SCALE	
AS NOTED	

POTENTIOMETRIC SURFACE CONTOUR MAP
INTERMEDIATE GROUNDWATER
SITES 36 AND 37
REMEDIAL INVESTIGATION REPORT
NAS CECIL FIELD
JACKSONVILLE, FLORIDA

CONTRACT NO.	
0039	
OWNER NO.	
APPROVED BY	DATE
DRAWING NO.	REV.
FIGURE 4-7	0