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NORTHWEST FLORIDA WATER MANAGEMENT DISTRICT

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DECEMBER 1993

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VOLUME I OF III
WORK PLAN

CORRY STATION
PENSACOLA, FLORIDA

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
CHARLESTON, SOUTH CAROLINA
29411-0068

DRAFT

SOIL AND/OR GROUND WATER CONTAMINATION REMEDIAL INVESTIGATION

NTTC CORRY STATION PENSACOLA, FLORIDA

Contract No. N62467-93-C-0680

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LIST OF ACRONYMS

BLS	Below Land Surface
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CLP	Contract Laboratory Program
CompQAP	Comprehensive Quality Assurance Project Plan
CWA	Clean Water Act
DDT	Dichlor-diphenyl-trichloroethane
DOD	Department of Defense
DQO	Data Quality Objectives
DXF	Drawing Exchange Format
EC	Environmental Coordinator
ECUA	Escambia County Utilities Authority
EIC	Engineer-In-Charge
EQB	Equipment Blanks
FDEP	Florida Department of Environmental Protection
FDER	Florida Department of Environmental Regulation
FS	Feasibility Study
FT	Feet
FGS	Florida Geological Survey
g/L	Grams Per Liter
GAC	Granular Activated Carbon
GIS	Geographic Information System
GC	Gas Chromatograph
GC/MS	Gas Chromatograph/Mass Spectrophotometer
HSP	Health and Safety Plan
I.D.	Inside Diameter
IN	Inch
IR	Installation Restoration
LPZ	Low Permeability Zone
LSD	Land Surface Datum
MCL	Maximum Contaminant Level
MDL	Minimum Detection Limit
µg/kg	Micrograms per Kilogram
mg/kg	Milligrams per Kilogram
µg/L	Micrograms per Liter
mg/L	Milligrams per Liter
MPZ	Main Producing Zone
NAS	Naval Air Station
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEESA	Naval Energy and Environmental Support Activity
NGVD	National Geodetic Vertical Datum

LIST OF ACRONYMS
(continued)

NTTC	Naval Technical Training Center
NWFWMD	Northwest Florida Water Management District
OLF	Outlying Landing Field
ORNL	Oak Ridge National Laboratory
OSHA	Occupational Health and Safety Administration
OVA	Organic Vapor Analyzer
P.G.	Professional Geologist
PCB	Polychlorobiphenyl
PCE	Tetrachloroethylene
PPB	Parts Per Billion
PQL	Practical Quantitation Limit
PVC	Polyvinyl Chloride
PWC	Public Works Center
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RA	Remedial Action
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RFP	Request for Proposal
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
ROICC	Resident Officer in Charge of Construction
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SOP	Standard Operating Procedure
SOUTHDIV	Southern Division
SSHAP	Site-specific Health and Safety Plan
SSQP	Site-Specific Quality Assurance Project Plan
STORET	STORage RETrieval
SZ	Surficial Zone
TBD	To be Determined
TCE	Trichloroethylene
T.D.	Total Depth
TMR	Telescoping Mesh Refinement
TOC	Top of Casing
USEPA	United States Environmental Protection Agency
USN	United States Navy
UST	Underground Storage Tank
VISA	Very Intensive Study Area
VOC	Volatile Organic Compound

1.0 INTRODUCTION

1.1 Project Overview and Approach

The Sand-and-Gravel Aquifer in southern Escambia County is utilized for a variety of uses including public water supply and industrial demands. Traditionally, the availability of water from the aquifer has been more than adequate to meet the water needs of the area. This is attributable to the excellent water-bearing characteristics of the aquifer and the high rate of local rainfall recharge. Unfortunately, these same characteristics allow for rapid infiltration and transport of surface contaminants into the surficial sands, and ultimately into the underlying Main Producing Zone of the Sand-and-Gravel Aquifer, which serves as the primary source of ground water for the area. In recent years, 3 of the area's principal water supply utilities have experienced contamination problems in selected production wells. In all cases, the contamination has been attributed to the transport of surface contaminants through the Surficial Zone (SZ) and Low Permeability Zone (LPZ), and subsequent migration to the public supply wells open to the Main Producing Zone (MPZ).

The U.S. Navy operates 10 production wells at Corry Station which supply water to Corry Station and NAS Pensacola. Within the past several years, detectable levels of the insecticide dieldrin have been detected in at least 5 of the Corry Station wells. Dieldrin concentrations range from <0.01 to 1.3 micrograms per liter (μg/L), with an apparent concentration gradient decreasing to the south and west from production well Corry #8 located in the northeast corner of Corry Station (ORNL, 1989). As a result of the dieldrin contamination of the Corry Station wells, the Navy has identified the need to perform a detailed hydrogeologic and water quality site assessment in an effort to characterize the extent of the contamination, determine the potential source(s), identify possible future well locations, and develop a remediation plan for the site. To assist in this endeavor, the U. S. Navy, Southern Division, requested the Northwest Florida Water Management District (NWFWMD) to prepare a work plan to perform the site assessment.

The NWFWMD recently completed a regional assessment of the ground water flow and contaminant transport characteristics of the Sand-and-Gravel Aquifer for several utilities in southern Escambia County. In addition to data collection activities, this project entailed the development of a three-dimensional, finite-element model of the aquifer for use in preparing management plans for the siting of wells, preparation of production well pumping plans, and simulating the migration of contaminants in the subsurface. In preparing the proposal for the Corry Station site assessment, therefore, it was considered essential that the proposed work be performed within the framework of the regional ground water model. In this manner, maximum use can be made of the data collected as part of the regional effort, and the impacts of withdrawals, variations in aquifer parameters, and contamination outside the Corry Station area can be incorporated into the site assessment. The result is an integrated study plan that will provide for a comprehensive site assessment of Corry Station.

The site assessment will be accomplished using a combination of NWFWMD staff and qualified subcontractors for the water quality and soil analyses, and the drilling/field data collection programs. All contractors will be retained under the provisions of Florida Statutes, and selected using standard NWFWMD procedures. These procedures are intended to provide for a competitive process for the selection of contractors in the most cost-effective manner possible, based on the qualifications and experience of the firms.

The NWFWMD would propose to complete the site assessment using a phased approach. In this manner each phase of the project will be used to meet specific project objectives. Phase I consists of this work plan which includes a compilation of existing information pertinent to the site assessment, identification of data deficiencies, and recommendations regarding the minimum amount of field work and data collection necessary to fully meet the project objectives. The compilation of existing information included available data regarding water quality, hydraulic properties, soil analyses, records of ground water withdrawals, and contaminant concentration data. Also of critical importance was the compilation of all available records on pesticide use, handling areas, and disposal areas that were used at Corry Station. This information provided a historical baseline of information on the use of dieldrin at the site, and provided information useful in developing the field data collection requirements for Phase II and Phase III.

Phase II site assessment will be devoted primarily to establishing the distribution of dieldrin in the subsurface, location of the source(s) of dieldrin and gaining insight into the transport mechanisms and movement of dieldrin in the environment. Field data collection, and environmental sampling (water and soils) will be conducted to determine the levels and distribution of dieldrin contamination at and in the immediate vicinity of Corry Station. As presently planned, the data collection will include examination of the contaminant levels in the surface soils, and the Surficial and Main Producing Zones of the Sand-and-Gravel Aquifer in an effort to determine the extent and nature of the contamination (point or nonpoint sources). This will be accomplished through a program of soil borings and installation of monitor wells. A custom water quality sampling plan of selected Corry Station supply wells will provide information on the transport mechanisms controlling the movement of dieldrin in the subsurface.

Application of the ground water flow and contaminant transport model, and analysis of remedial alternatives will be accomplished in Phase III of the project. The Corry Station model will be calibrated and applied as a sub-domain of the previously developed regional model. A telescoping mesh refinement (TMR) technique will be utilized for this purpose, and will allow the results from the regional model to be used as the initial and boundary conditions for the finer scale model of Corry Station. In this manner, external pumping, regional variations in water levels and in aquifer properties can be fully incorporated into the Corry Station analysis.

As part of Phase III the NWFWMD currently anticipates the need to perform 2 multi-well aquifer tests to obtain information on the hydraulic properties of the Surficial Zone, Low Permeability Zone, and Main Producing Zone. This information is currently lacking, and is required for the development of the local ground water flow and contaminant transport model. Following calibration and verification of the model, simulations will be made of the contaminant plume with emphasis on the future movement of the contamination, the rate of movement, and an evaluation of alternatives for remediation of the contamination. In the third phase, the NWFWMD will also prepare a final report providing full documentation of the model calibration and application, the results and interpretation of all model simulations, and recommendations for future actions.

Timely completion of all projects in the most cost-effective manner possible is a high priority for the NWFWMD. For this reason, the NWFWMD has established procedures for tightly controlling project schedules and expenditures. In addition to these procedures, the NWFWMD would propose that frequent workshops be held with Navy personnel to review the status of the project, and to discuss any modifications to the work schedule and technical components of the project that may be necessary based on completed work. The NWFWMD would also propose that detailed progress reports be submitted on a quarterly basis and supplemented with reports prepared at the completion of each major study phase. This project management plan is intended to provide for completion of the project on schedule and within budget, while also maintaining the appropriate level of communication between the Navy and NWFWMD staff.

2.0 FACILITY DESCRIPTION

The NTTC Corry Station is located in southwestern Escambia County, Florida, approximately 1.5 miles (mi) west of the City of Pensacola and 2.5 mi north of NAS Pensacola (Figure 2-1). The station has an area of approximately 604 acres (ac) (NEESA, 1992) and presently hosts 4 principal facilities: the Naval Technical Training Center (NTTC); the Naval Hospital; the Navy Shopping Mall; and Corry Family Housing. The NTTC is the station's primary mission and provides Navy personnel with training in cryptology, electronic warfare, photograph, and optical and instrument repair (SOUTHDIV, 1989). This activity encompasses most of the station's surface area (413.5 ac). The Naval Hospital occupies 42.5 ac; Corry Family Housing occupies 88.5 ac; and the Navy Shopping Mall occupies 41.7 ac (SOUTHDIV, 1989).

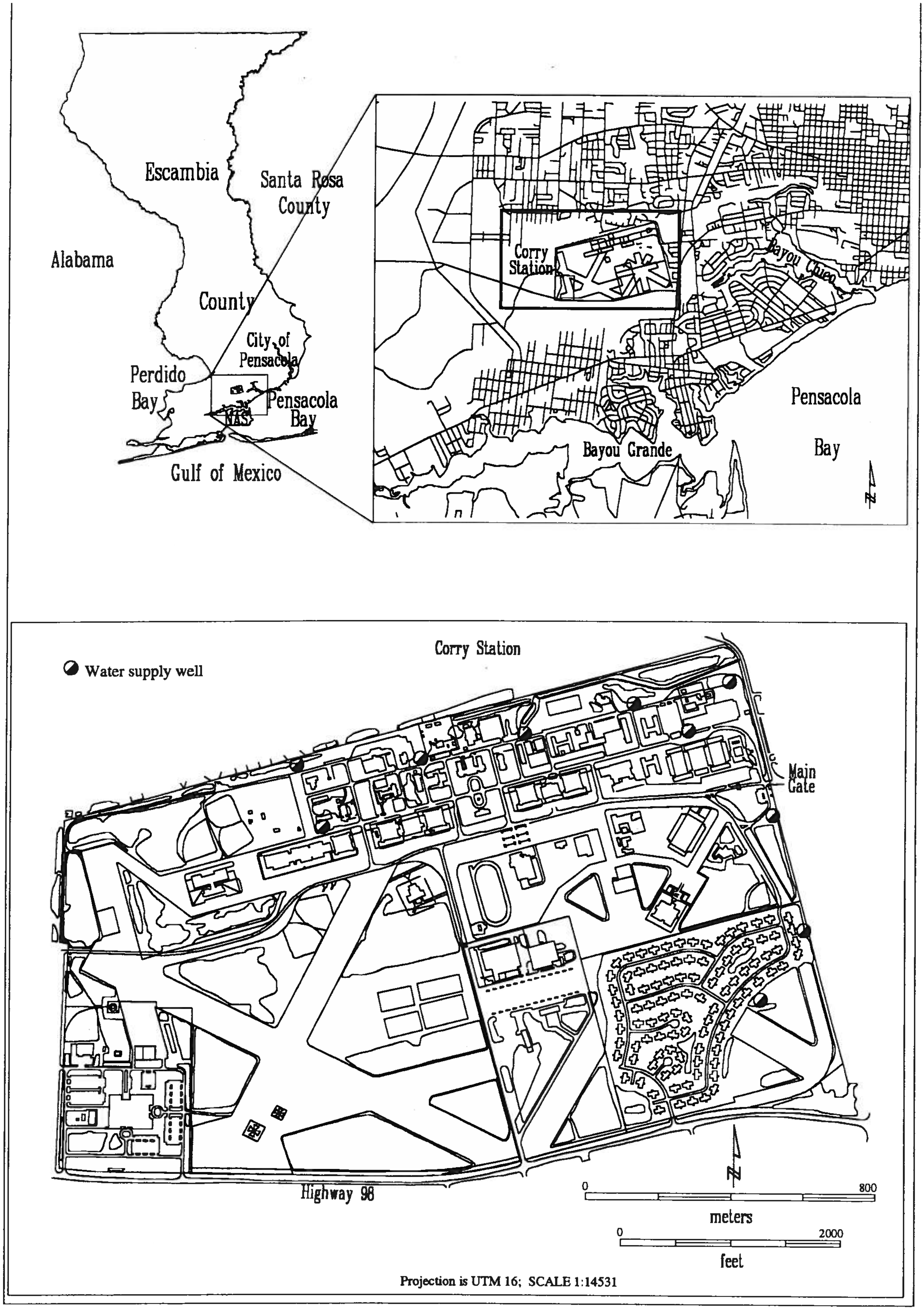


Figure 2-1. Corry Station in Southwestern Escambia County, Florida

3.0 SITE HISTORY

Historically, Corry Station has served two major functions during the past 65 years. The station was originally commissioned as an Outlying Landing Field (OLF) in 1928 (SOUTHDIV, 1989). Corry Station served this function for a period of 30 years, until 1958, at which time the OLF was decommissioned. In 1961, the station was recommissioned as a training center. Approximately 12 years later in 1973, the station was re-designated as NTTC, with the addition of electronic warfare training and the Naval School of Photography (SOUTHDIV, 1989).

4.0 CLIMATOLOGY

NTTC Corry Station is located in an area that typically experiences a mild, subtropical climate. This climate is a result of the latitude (approximately 30° North) and the stabilizing effect of the adjacent Gulf of Mexico. January is typically the coolest month of the year with normal daily maximum and minimum temperatures of 32.2° C and 23.5° C respectively. The lowest temperature of record is -15° C, which occurred in January 1985. The highest temperature of record, 41.1° C, occurred in July 1980. On average, there are 58 days per year when the temperature exceeds 32.2° C and 16 days when the temperature falls below 0° C.

The mean annual precipitation is 60.4 inches (in) per year. Mean monthly rainfall ranges from a high of 7.53 in (July) to a low of 3.69 in (November). The wettest month of record is July 1979 (20.36 in). The driest month of record is October 1978, when no rain was recorded. The maximum 24-hour rainfall was 11.10 in (March 1979). On average, rain falls on about 1 day in 3 and typically 109 days per year experience rainfall. There is sunshine approximately 60 percent of the time. Thunderstorms are a regular occurrence with an average of 69 storms per year while snowfall is rare. Hurricanes and tornadoes are infrequent but can cause substantial damage to the area. Six hurricanes have passed within 50 miles of Pensacola since 1980. Table 4-1 presents the aggregate weather measurements for Pensacola and vicinity.

Relative humidity is high. On average, humidities peak around sunrise at 85 percent, declining to a low of 60 percent around midday.

TABLE 4-1

Aggregate Weather Measurements for Pensacola and Vicinity
(years between 1962 and 1991, NOAA)

RI Investigation
NTTC Corry
Pensacola, Florida

Measurement	Unit	Value
TEMPERATURE		
January		
Daily Maximum	C	15.9
Daily Minimum	C	5.9
July		
Daily Maximum	C	32.2
Daily Minimum	C	23.6
Annual Extremes		
Length (yrs)		28
Record Highest	C	41.1
Record Lowest	C	-15
NORMAL HEATING DEGREE DAYS		
January	days	445
Seasonal	days	1571
WIND SPEED (MPS)		
Mean Speed		
January	m/sec	4.6
July	m/sec	3.6
RELATIVE HUMIDITY (percent)		
January		
7 a.m. EST	%	82
1 p.m. EST	%	62
7 p.m. EST	%	71
July		
7 a.m. EST	%	88
1 p.m. EST	%	64
7 p.m. EST	%	71

Measurement	Unit	Value
PRECIPITATION (millimeters)		
Normal		
Wettest Month	mm	182
Driest Month	mm	87
Annual	mm	1552
Extremes		
Wettest Month	mm	517
Driest Month	mm	0
Maximum in 24 hours	mm	282
SUNSHINE (% possible)		
January	%	48
July	%	57
ANNUAL MEAN NUMBER OF DAYS		
Sunrise to Sunset		
Clear	days	106
Partly Cloudy	days	122
Cloudy	days	137
Precipitation		
0.25 mm or more	days	109
Thunderstorms	days	69
Heavy Fog	days	35
Temperature		
>32.2 C	days	58
<= 0 C	days	16
<= -17.9 C	days	0

5.0 PHYSIOGRAPHY AND SURFACE WATER HYDROLOGY

Corry Station lies within the Bayou Chico watershed in southwestern Escambia County, Florida (Figure 5-1). The Bayou Chico watershed has an area of approximately 6,630 ac (10.35 square miles (mi^2)). The watershed lies mostly within unincorporated Escambia County. Land surface elevations in the watershed range from sea level to a maximum of approximately 90 ft above sea level. Bayou Chico itself, which lies to the east of Corry Station, has a surface area of approximately 215 ac (0.34 mi^2). Land surface elevations are highest in the northern portion of the watershed (in the vicinity of New Warrington Road and Mobile Highway). Here, elevations range from 70 to 90 ft above sea level with a relatively flat surface topography. This area corresponds to the highest of several relict marine terraces found within the watershed. Moving south of this terrace, in the direction of Corry Station, land surface drops sharply along an east-west trending escarpment. Approximately one quarter of the watershed lies northward of this topographic feature. One of the principal watershed drainage features and a portion of Bayou Chico are found at the foot of this escarpment. Jackson Branch, which heads on the north side of Corry Station, drains from west to east and discharges in the upper arm of Bayou Chico. Jackson Branch lies near and parallels the northern boundary of Corry Station.

Another principle drainage feature, Jones Creek, lies just to the south of Corry Station. Jones Creek also drains from west to east and discharges into the lower arm of Bayou Chico. The creek lies in a broad, shallow swale between 2 of the low coast-wise ridges. This swale extends eastward into Bayou Chico, becoming one of its principal arms. Along Jones Creek is a wetland within the Bayou Chico watershed. Low, wet pine flatwoods are common to the south and west of Corry Station.

Corry Station, therefore, sits on a topographic high between 2 generally parallel, west-to-east flowing streams. Land surface at the station is generally flat, with elevations reaching a maximum of approximately 40 ft above sea level. Lowest station elevations are found along the northern and southern station boundaries with elevations of less than 20 ft above sea level. The original topographic expression of the station has long since been blurred by development. It has been estimated that approximately half of Corry Station lies within the Jackson Branch subwatershed while the other half lies within the Jones Creek subwatershed.

There are no naturally occurring perennial streams on Corry Station. However, there is at least one, artificial modified intermittent stream located in the northern portion of Corry Station which drains surface water from the station. Much of the surface water drainage from the Corry Station can be contributed to runoff from the paved runways on-site. The runoff leaves the site to the south via culverts that convey the surface water southward under the Highway 98. The majority of culverts that cross under this highway are located downgradient of Corry Station. On the southside of Highway 98, these culverts are connected to the Jones Creek wetland by ditches.

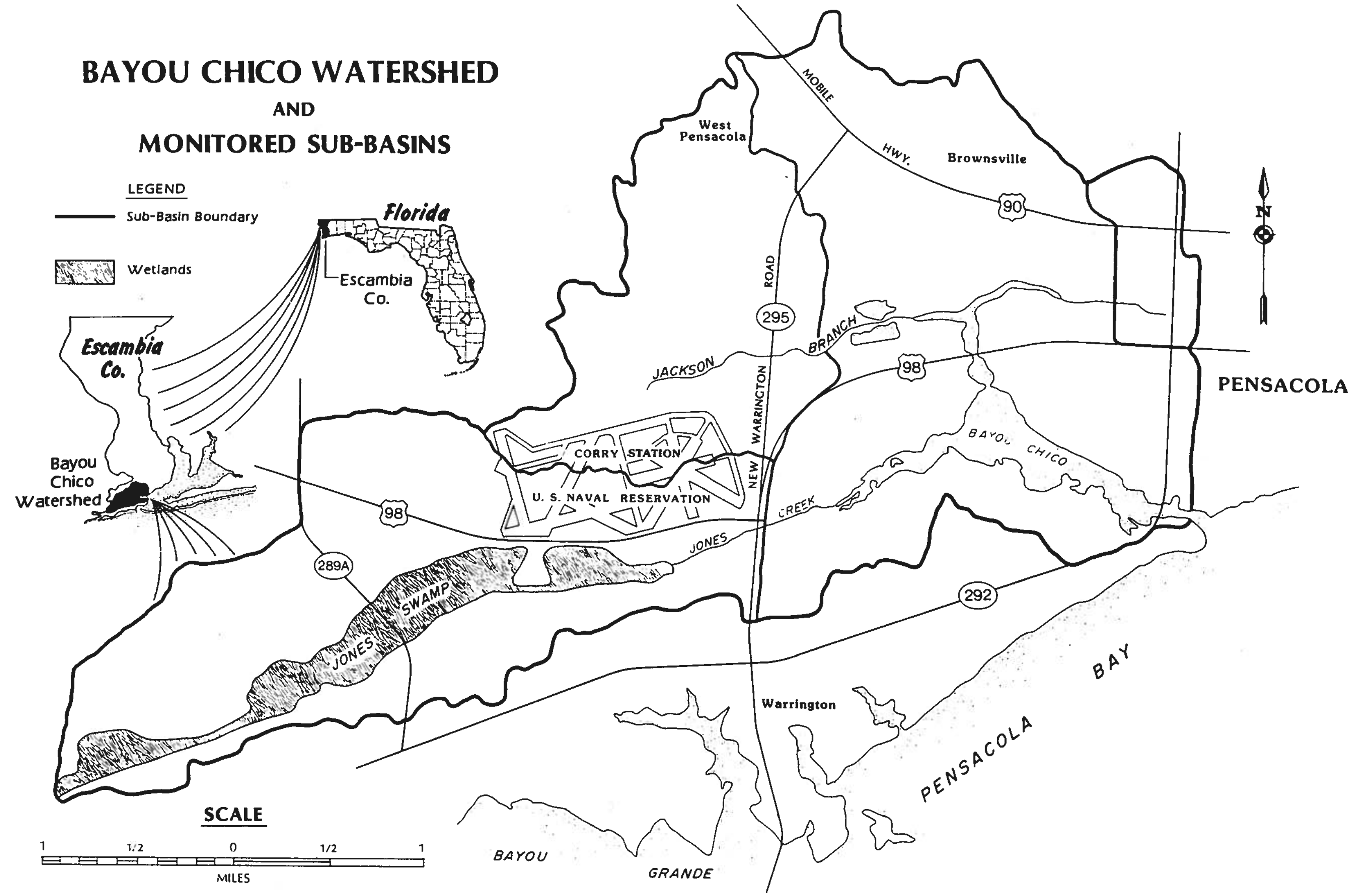


Figure 5-1. Bayou Chico Watershed in Southwestern Escambia County, Florida.

6.0 HYDROGEOLOGY

6.1 Regional Hydrogeology

Within the westernmost panhandle area of Florida, 4 hydrogeologic units define the regional ground water flow system. In descending order from land surface these units are the Sand-and-Gravel Aquifer, the Intermediate System, the Floridan Aquifer System and the Sub-Floridan Confining Unit. The Sand-and-Gravel Aquifer and the Floridan Aquifer System are primarily composed of moderate to highly permeable sediments capable of transmitting and storing large quantities of water. Both of these units form regionally significant aquifers in northwest Florida. The Intermediate System and the Sub-Floridan Confining Unit are primarily composed of low permeability sediments and form regionally extensive confining units which serve to restrict the vertical flow of ground water (FGS, 1991). The age of the sediments comprising the ground water flow system ranges from Middle Eocene to Recent. Sediments beneath the Sub-Floridan Confining Unit are generally not of interest to a potable ground water supply investigation since these deeper sediments contain very highly mineralized water throughout most of northwest Florida.

The hydrogeology of the western Florida panhandle is influenced by subsidence associated with the Gulf of Mexico Sedimentary Basin. A northeast to southwest hydrogeologic section which shows the major geologic structure is presented in Figure 6-1. The hydrogeologic units generally dip toward and thicken toward the southwest. Of particular significance is the thickening of the Sand-and-Gravel Aquifer and the thickening of the Intermediate System. As the Sand-and-Gravel Aquifer thickens to the southwest it becomes a very productive and major source of ground water supply. The significance of the thickening of the Intermediate System is the increasing degree of confinement provided by the Intermediate System. The Intermediate System hydraulically separates and restricts the exchange of water between the Sand-and-Gravel Aquifer and the underlying Floridan Aquifer. As the Intermediate System thickens to the west and south, the vertical exchange of water between the Sand-and-Gravel Aquifer and the Floridan Aquifer System is further restricted which results in lower recharge to the Floridan Aquifer and a more sluggish, less well-developed Floridan Aquifer flow system (Richards, 1993).

6.1.1 Sand-and-Gravel Aquifer

The Sand-and-Gravel Aquifer is the uppermost hydrogeologic unit and is composed of quartz sand, gravel, silt and clay. Sand, along with some gravel, is the dominant lithology of this hydrogeologic unit. Silt and clay generally form regionally minor, discontinuous layers within the Sand-and-Gravel Aquifer. Ground water exists under unconfined to semi-confined conditions. The water table marks the top of the

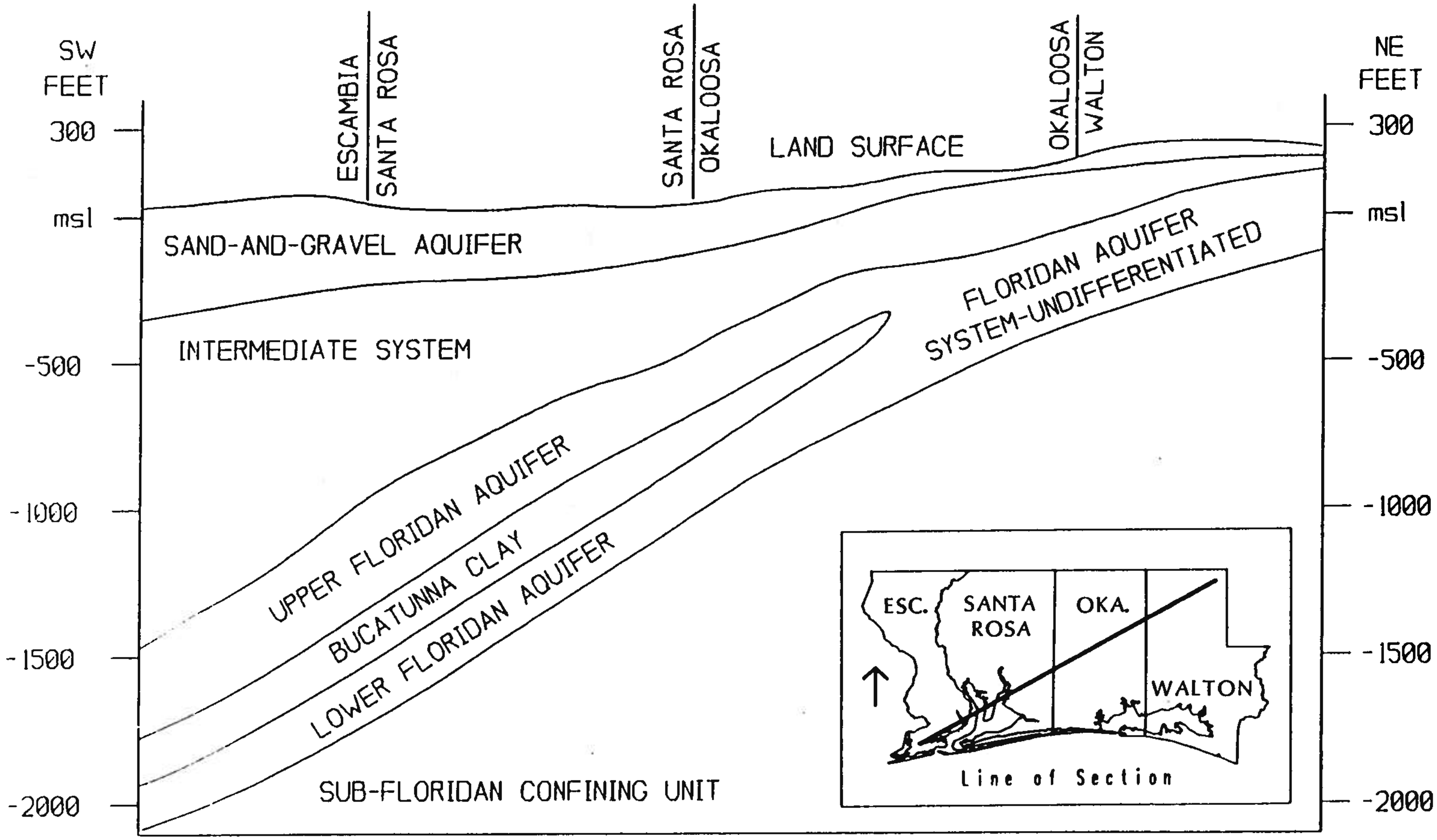


Figure 6-1. Hydrogeologic Section of the Western Florida Panhandle.

Sand-and-Gravel Aquifer. The discontinuous layers of silt and clay typically provide for semi-confined conditions in the lower portions of the aquifer.

Across the western Florida panhandle, the thickness of the Sand-and-Gravel Aquifer increases to the west. Thickness ranges from less than 50 ft. in Walton County to more than 400 ft. in Escambia County. Considerable local variation in the thickness of the Sand-and-Gravel Aquifer does occur due to local topography and the somewhat irregular surface of the Intermediate System. The Sand-and-Gravel Aquifer is upper Pliocene to Recent in age and primarily includes the Citronelle Formation and the Undifferentiated Alluvium and Terrace Deposits. In Santa Rosa and Escambia counties the Sand-and-Gravel Aquifer forms a significant aquifer which is the primary source of potable and industrial water supply for these counties.

In Escambia County including the Corry Station area, the Sand-and-Gravel Aquifer is generally subdivided into three zones. The designation of these zones is based on permeability contrasts and includes the Surficial Zone (SZ), the Low Permeability Zone (LPZ), and the Main Producing Zone (MPZ).

The uppermost layer, or Surficial Zone, is composed primarily of fine to medium sand. Locally, some gravel and layers of sandy clay are also present in the zone. Underlying the Surficial Zone is the Low Permeability Zone which is composed of various mixtures of clay, silt and sand. In the northern and central portions of Escambia County, clay and silt-sized sediment dominate the Low Permeability Zone, while to the south in the vicinity of Corry Station this unit becomes considerably more sandy. The hydraulic conductivity of the Low Permeability Zone is less than that of the overlying and underlying zones. Beneath the Low Permeability Zone lies the Main Producing Zone of the Sand-and-Gravel Aquifer, which consists of moderately to well sorted sand and gravel layers which are typically interbedded with fine sand and clayey sand beds. The majority of the ground water withdrawn from the Sand-and-Gravel Aquifer is derived from the Main Producing Zone.

6.1.2 Intermediate System

The Intermediate System occurs directly beneath the Sand-and-Gravel Aquifer. The Intermediate System is defined as all sediments which collectively retard the exchange of water between the overlying Sand-and-Gravel Aquifer and the underlying Floridan Aquifer. The Intermediate System serves as a confining unit and generally consists of fine-grained clastic deposits along with clayey limestone and shells. The top of the Intermediate System is marked by the uppermost, regionally persistent, areally continuous, low permeability sediments, and it ranges in elevation from approximately 150 ft above sea level in northern Walton County to more than 300 ft below sea level in Escambia County.

The Intermediate System is Middle Miocene to Upper Pliocene in age and includes several different stratigraphic formations. Throughout most of northern and central Walton and Okaloosa counties, the Intermediate System includes the Undifferentiated Alum Bluff Group which consists of clayey quartz sand with shells and shell beds. In the southern coastal portions of these counties, the Intermediate System includes the Intracoastal Formation which consists of clayey, sandy limestone. In Escambia and Santa Rosa counties and the western portion of Okaloosa County the Intermediate System includes the Miocene Coarse Clastics. In addition, in the southern half of Escambia and Santa Rosa counties, the Pensacola Clay is also part of the Intermediate System.

Across the western Florida panhandle, the permeability of the Intermediate System changes with the lithology. To the east in Walton County, the clayey sand and clayey limestone lithologies cause the permeability of the Intermediate System to be relatively high compared to further west, where the Miocene Coarse Clastics and Pensacola Clay make up the Intermediate System. Regionally, the sediments become finer grained and exhibit lower permeabilities in the western and southwestern portion of the Florida panhandle which includes the Corry Station area.

The Intermediate System dips and thickens toward the southwest (Figure 6-1). The thickness of the Intermediate System ranges from approximately 50 ft in northeast Walton County to over 1,400 ft in southwest Escambia County. The combination of the thickening of the Intermediate System to the southwest and the lithology of the Intermediate System becoming finer-grained to the west and southwest greatly restricts the exchange of water between the Sand-and-Gravel Aquifer and the Floridan Aquifer in the vicinity of Corry Station.

6.1.3 Floridan Aquifer System

The Floridan Aquifer System occurs beneath the Intermediate System and consists of a carbonate sequence of sediments of varying permeability, and a regionally extensive clay confining unit. Locally, minor amounts of clay and sand also occur within the carbonate portion of the Floridan Aquifer. The Floridan Aquifer underlies all of northwest Florida and ranges in age from Upper Eocene to Middle Miocene. The top of the Floridan Aquifer System dips from the northeast to the southwest with the elevation of the top of the Floridan Aquifer System ranging from approximately 100 ft above sea level to more than 1,400 ft below sea level in southwest Escambia County.

Within the area including Escambia, Santa Rosa and western and coastal portions of Okaloosa County, the Floridan Aquifer System is split into the Upper and Lower Floridan Aquifer by a regional confining unit (Figure 6-1). The confining unit separating the 2 portions of the aquifer is the Bucatunna Clay which is a highly effective clay confining unit. Beneath the Bucatunna Clay is the Lower Floridan Aquifer. The Upper Limestone of the Floridan Aquifer includes the Bruce Creek Limestone, the Undifferentiated Miocene Limestone, the Chickasawhay Formation and the Suwannee Limestone. The Lower Limestone of the Floridan Aquifer includes the Ocala Group. To the east, where the Bucatunna Clay pinches out, the Floridan Aquifer is 1 undifferentiated hydraulic unit.

The Floridan Aquifer (including the Upper Floridan Aquifer) is the prime source of potable ground water in all of Walton and Okaloosa counties. The Upper Floridan Aquifer is also utilized extensively in southeast Santa Rosa County, and to a limited degree in east-central Santa Rosa County. In Escambia and Santa Rosa counties, mineralization increases steadily in a southwestward direction in both the Upper and Lower Floridan Aquifer. Due to excessive mineralization and the presence of the productive Sand-and-Gravel Aquifer, the Upper Floridan Aquifer is not used in the southwestern quarter of Santa Rosa County or in southern half of Escambia County, including the Corry Field area. Likewise, the Lower Floridan Aquifer is not utilized for potable water supply due to the presence of highly mineralized water which is present in the Lower Floridan Aquifer throughout most of Santa Rosa and Escambia counties.

6.1.4 Sub-Floridan Confining Unit

The Sub-Floridan Confining Unit consists of low permeability sediments which form the base of the Floridan Aquifer System. The Sub-Floridan Confining Unit is Middle Eocene in age and includes the Lisbon and Tallahatta Formations. The elevation of the top of the Sub-Floridan Aquifer ranges from 200 ft below sea level in Walton County to over 2,000 ft below sea level in Escambia County.

6.2 Hydrogeologic Setting Of Corry Station

6.2.1 Hydrogeologic Framework

In the immediate vicinity of Corry Station, sand dominates the lithology of the entire thickness of the Sand-and-Gravel Aquifer. Very little clay occurs in the subsurface and no locally significant confining units appear to be present. The Surficial Zone and the Main Producing Zone are separated by an extremely leaky Low Permeability Zone which affords only a minimum degree of confinement to the Main Producing Zone. At Corry Station, the Sand-and-Gravel Aquifer may essentially be a water table aquifer with no confinement other than a horizontal to vertical hydraulic anisotropy of approximately 10:1 (Roaza et al., 1993). For this reason, the Main Producing Zone is particularly susceptible to contamination in and around Corry Station.

Due to the high percentage of sand in the Low Permeability Zone, only subtle changes in lithology occur between the various zones. These subtle lithology changes are often difficult to identify during typical well installation. Accurate delineation of the zones is best accomplished by analysis of geophysical logs in conjunction with a detailed lithologic log. Figure 6-2 shows the location of geophysical logs available in the Corry Station vicinity and the location of the hydrogeologic section. Geophysical log data for these wells are presented in **Appendix A-3 -- Geophysical Logs.**

The hydrogeologic cross-section in Figure 6-3 shows the zonation and general lithology of the Sand-and-Gravel Aquifer at Corry Station. Thickness of the Surficial Zone increases from 50 ft west of Corry Station to over 75 ft to the south and east of Corry Station. The Surficial Zone is a relatively homogeneous layer of fine to medium sand with some coarse sand and minor amounts of clay. No significant clay or sandy clay layers appear to be present within this zone.

The Low Permeability Zone consists of poorly sorted, predominantly fine to medium sand with silt and minor amounts of clay. Layers of moderately sorted medium to coarse sand also occur within this zone. The elevation of the top of the Low Permeability Zone decreases to the south and east as the overlying Surficial Zone thickens. Although the overall permeability of this zone is lower than that of the Surficial or the Main Producing Zone, the Low Permeability Zone is extremely leaky.

The Main Producing Zone is approximately 150 ft thick in the vicinity of Corry Station. It is composed of moderate to well sorted, medium to coarse sand along with thin layers of poorly sorted sand and silt containing minor amounts of clay. Individual clayey sand layers within the Main Producing Zone thicken to the south

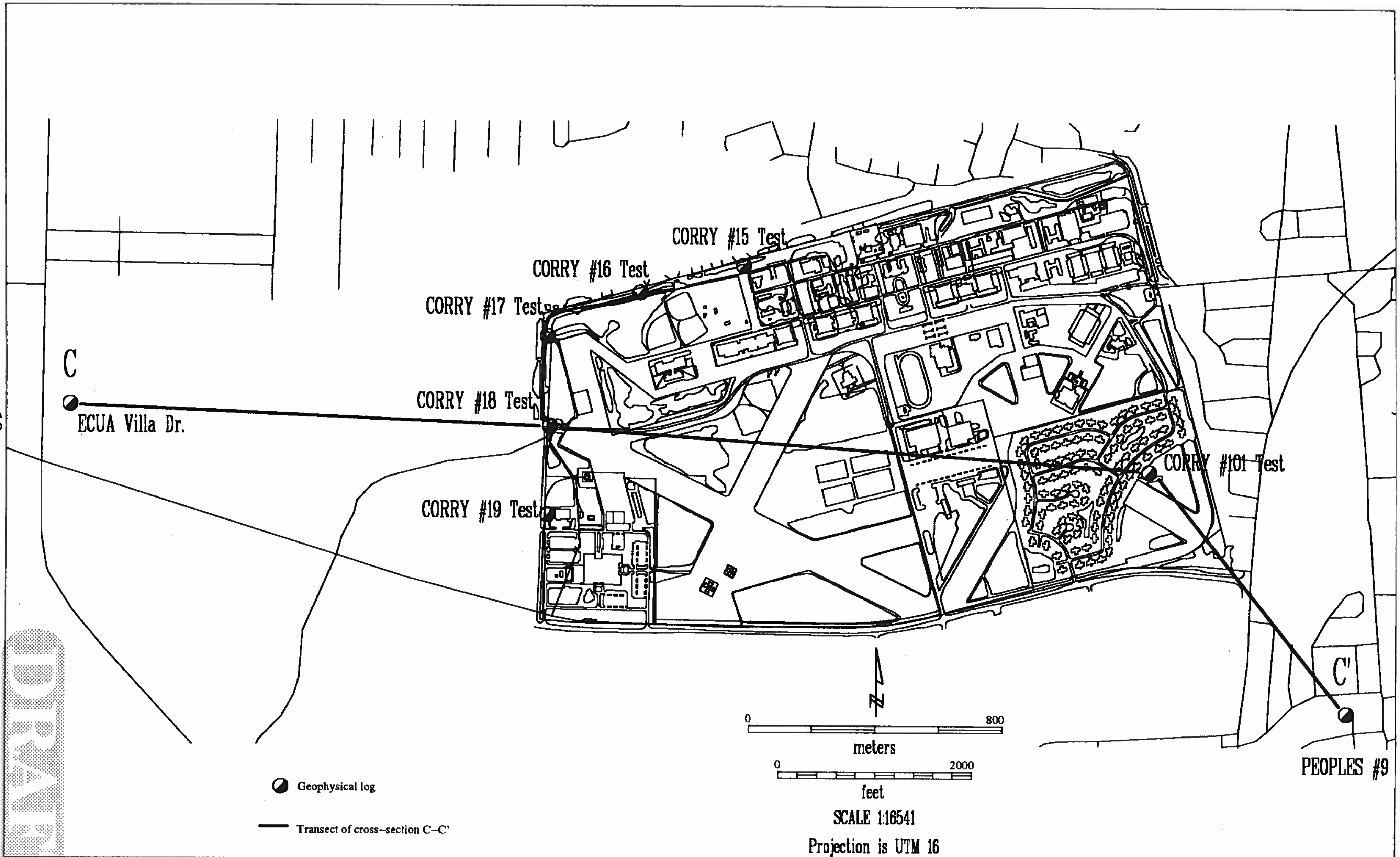
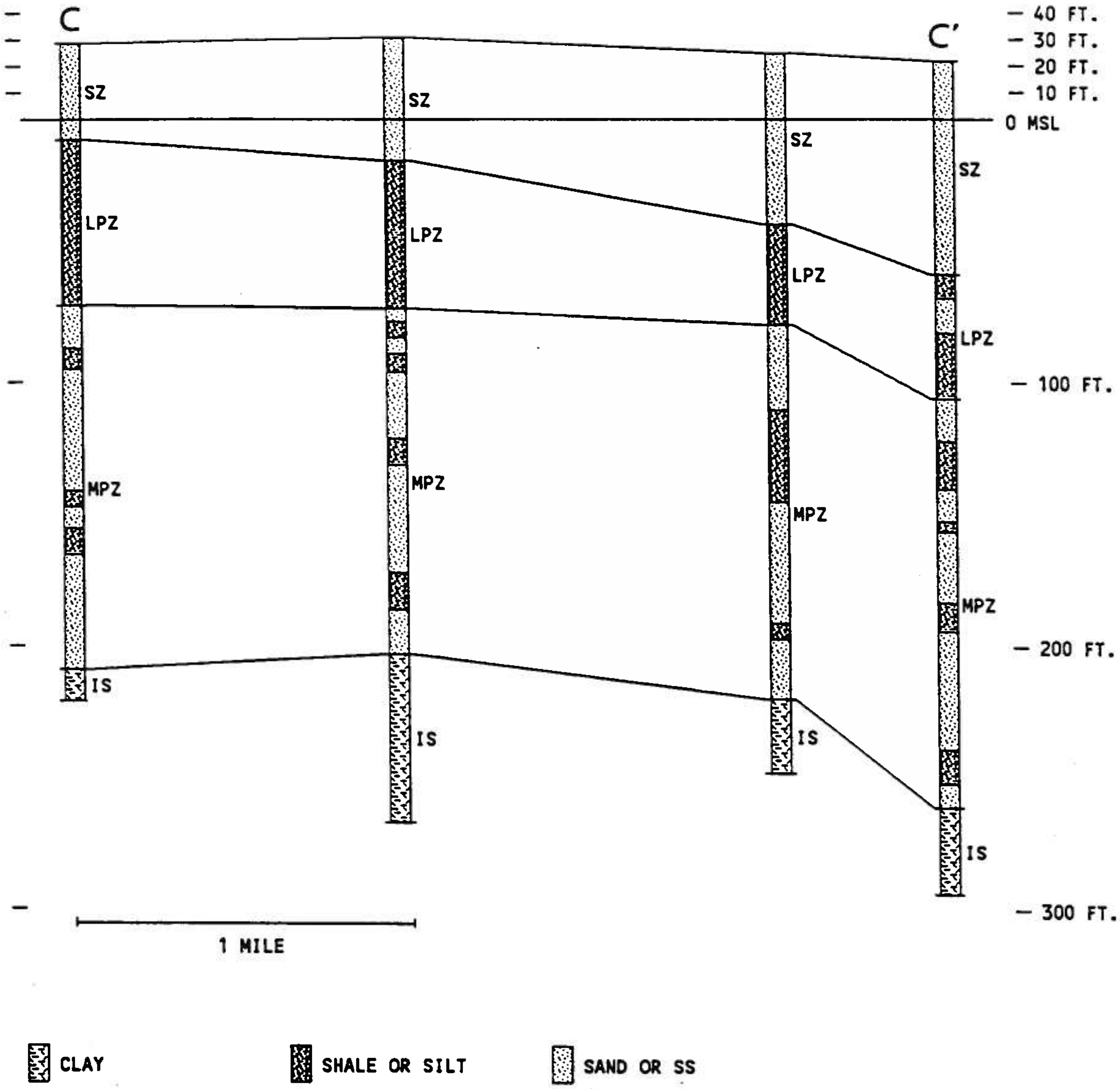


Figure 6–2. Location of Geophysical Logs and Hydrogeologic Section C–C' Through Corry Station.



SZ - SURFICIAL ZONE
LPZ - LOW PERMEABILITY ZONE
MPZ - MAIN PRODUCING ZONE
IS - INTERMEDIATE SYSTEM

Figure 6-3. Hydrogeologic Section C-C'.

and east across Corry Station. As these layers thicken towards the southeast, the effective (net productive sand), thickness of the Main Producing Zone is reduced. To the southeast of Corry Station much of the upper portion of the Main Producing Zone contains poorly sorted sand with minor amounts of clay.

Beneath the Main Producing Zone is the Intermediate System. The Intermediate System is a thick, effective confining unit which marks the base of the Sand-and-Gravel Aquifer. The Intermediate System provides a high degree of confinement which hydraulically separates the Sand-and-Gravel Aquifer from the underlying Floridan Aquifer. In this area, the Floridan Aquifer contains highly mineralized water and is not utilized as a source for water supply. Aside from forming the base of the Sand-and-Gravel Aquifer, the sediments below the Intermediate System are not a significant consideration in addressing ground water contamination at Corry Station.

6.2.2. Recharge, Discharge, and Movement of Ground Water

Virtually all fresh water in the Sand-and-Gravel Aquifer is derived from locally occurring rainfall. A portion of the rainfall infiltrates under the influence of gravity through the unsaturated soils to the water table. The Corry Station area averages nearly 60 in of rainfall annually; approximately 13 in of which recharges the Sand-and-Gravel Aquifer beneath the Corry Station area (Roaza et al., 1991).

The Surficial Zone of the Sand-and-Gravel Aquifer in the Corry Station area contains the water table, which is estimated to range from 10 to 25 ft above sea level. When the ground water flow is not affected by pumpage, a portion of the flow in this zone is laterally to points of natural discharge. Points of discharge include creeks, drainage ways, wetlands, bayous and bays. For the Corry Station area, the northeast portion of the area is assumed to drain north-northeast to Jackson Branch, a tributary to Bayou Chico. In the northwest part of the area, the flow is in a northerly direction toward a wetland area and sandpit area just north of the field. The surficial zone in the remaining portion of the area is expected to drain in a southerly direction toward Jones Creek, another tributary to Bayou Chico. That portion of the flow system that does not move laterally and discharge to the surface water bodies, flows vertically downward to recharge the underlying main producing zone. It is assumed that under the influence of pumping, a greater percentage of the lateral flow is captured and diverted to the main producing zone. In addition, pumping may also affect the lateral ground water flow direction within the Surficial Zone.

The predominantly downward vertical gradient is illustrated by the head differences among the three zones underlying the Corry Station area. Under static conditions, the hydraulic head in the Surficial Zone ranges from 3 to 11.5 ft higher than the Main Producing Zone in the Corry Station area (Wiegand et al., 1990;

Roaza et al., 1991). Testing to the south of Corry Station indicates that the difference in head between the Surficial Zone and the Low Permeability Zone ranges from about 1.5 to 11 ft, and the difference between the Low Permeability Zone and the Main Producing Zone is about 0.2 to 2 ft. The non-pumping head in the Main Producing Zone is estimated to range from 17 to 10 ft above sea level across Corry Station from a northwest to southeast direction (Figure 9-1).

Movement in both the Low Permeability Zone and the Main Producing Zone is in a southerly direction toward Bayou Grande/Pensacola Bay under static conditions. However, due to pumping at Corry Station and in the vicinity of Peoples Water Service and Pensacola Junior College - Warrington Campus, flow directions can be significantly altered in these zones. There are nearly a dozen major production wells in the immediate vicinity of Corry Station (Figure 6-4). These wells are capable of producing a cone of depression at the pumping wells that extends from 30 to 50 ft below sea level. These individual cones of depression can reverse the natural flow gradient in the vicinity of the pumping wells. Where the individual cones of depression overlap, a composite cone of depression is developed which will have a greater areal extent. Results of testing near Corry Station (Wiegand et al., 1990) indicate, however, that areally, the magnitude of the decline resulting from the composite cone of depression is relatively small. Whereas up to 50 ft of decline may occur in a pumping well, only about 2 ft of decline may be expected 0.5 mi from the well.

Wells pumping at Corry Station control the direction of ground water flow within the immediate vicinity of the station. Off-site to the east and south, wells owned by the Peoples Water Service also impact the ground water flow system at Corry Station. Other major pumping wells, 1.4 mi to the northeast (ECUA-West Pensacola), 1.5 mi to the northwest (ECUA-Lillian) and 1 mi to the west (ECUA-Villa Drive)are not expected to have a significant impact on the ground water flow at Corry Station. These wells will, however, be important for establishing boundary conditions for flow model analysis.

In summary, at Corry Station there is a natural downward hydraulic gradient interconnecting all the zones of the Sand-and-Gravel Aquifer. Pumping increases the downward head gradient and the flux of ground water from the SZ to the MPZ. Contaminants entering the water table are readily transported into the Main Producing Zone. The flow pattern within the main producing zone is such that a contaminant can be spread throughout the entire thickness of the Sand-and-Gravel Aquifer.

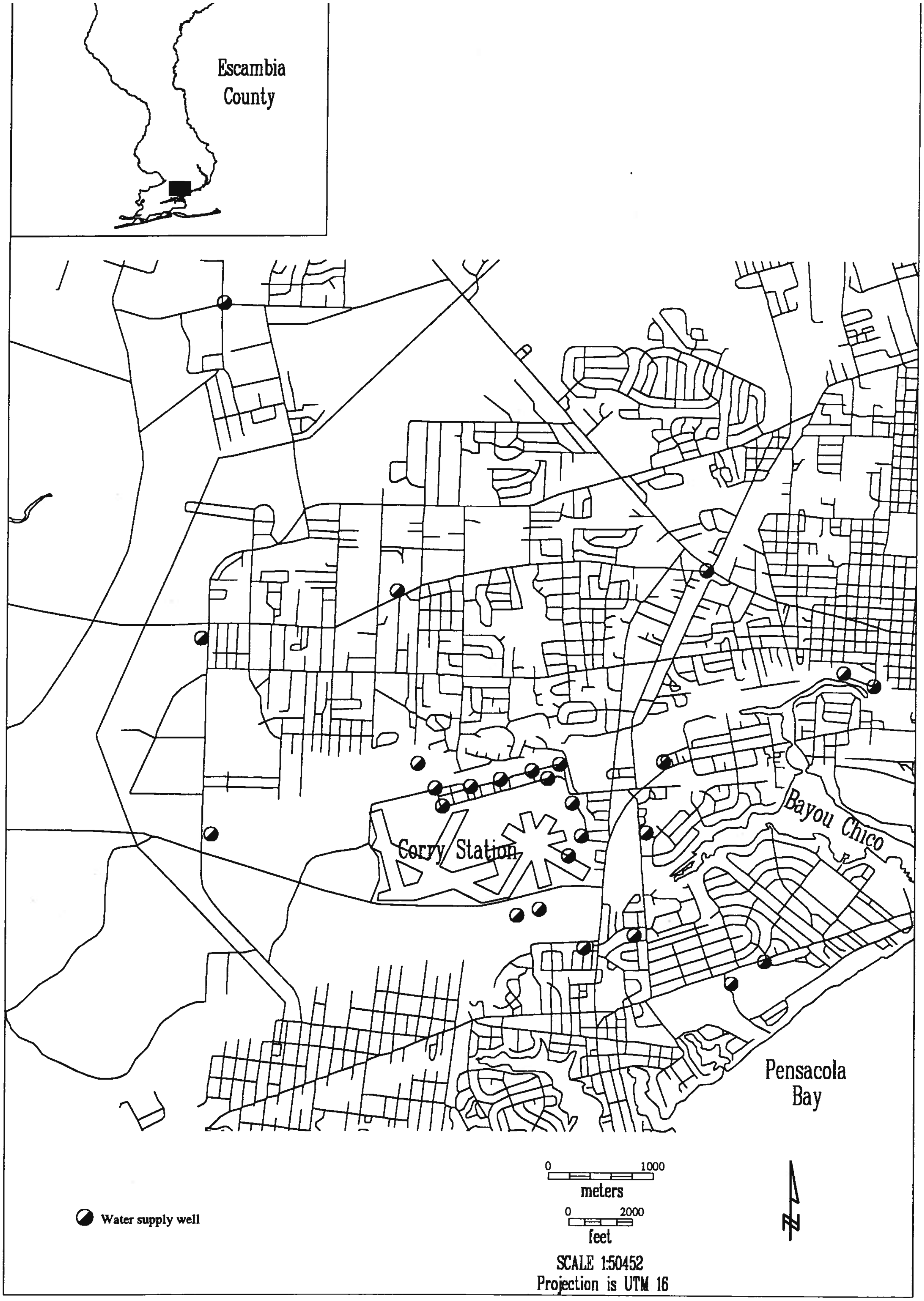


Figure 6-4. Location of 6-Inch Diameter and Greater Supply Wells On or Near Corry Station.

6.3 Current Contamination Status of the Sand-and-Gravel Aquifer

Existing ground water contamination of the Sand-and-Gravel Aquifer in Escambia County demonstrates the vulnerability of the aquifer to land surface activities. Much of the contamination is attributed to the type of hydrogeology which characterizes the aquifer. Some of the important features are high local recharge, high infiltration rates of the sandy soils, and poor confinement of the deeper portions of the aquifer which supply potable water.

In 1985, the NWFWMD established a water quality network in Escambia County in cooperation with the Florida Department of Environmental Protection. The VISA network (Very Intensive Study Area) is comprised of 41 wells which monitor the water quality in both the deeper Main Producing Zone and the Surficial Zone of the aquifer. The purpose of the network is to evaluate water quality impacts due to land use. Water quality analyses for these sites include major ions, nutrients, trace metals, base-neutral extractable organics, acid extractable organics, volatile organics, herbicides, pesticides, total dissolved solids and total and dissolved organic carbon.

In southern Escambia County, 9 out of the 41 VISA wells contained dieldrin and/or aldrin. The presence of aldrin holds special significance because dieldrin is a transformed product of aldrin. The distribution of the dieldrin/aldrin sites is aerially sporadic and includes sites located several miles from Corry Station. Dieldrin was observed in both the SZ and the MPZ. Preliminary retrievals of data from the U. S. Environmental Protection Agency (USEPA) STORET data base indicate that other ground water sites in Escambia County also have dieldrin concentrations. Therefore, the dieldrin problem at Corry Station is not unique in the region.

The NWFWMD also collects water quality information in conjunction with special projects as well as activities performed by other state agencies. Because land use in the southern portion of the county is a mosaic of industrial, military, commercial, residential and urban sectors, the water quality of the aquifer reflects the nature of the diverse land use. Documented contaminants include PCE, TCE, PCB, pentachlorophenols, petroleum products (i.e., benzene), inorganics (i.e., fluoride), nitrates, metals and radioactive substances. Most of the contaminated sites are concentrated in the vicinity of the Pensacola region. Some of the sites are classified by the USEPA as SUPERFUND sites, American Creosote Works and Escambia Treating.

7.0 DETAILED FACILITY DESCRIPTION

7.1 Previous Investigations at Corry Station

Previous investigations into the nature and extent of ground water contamination at Corry Station are few in number. The most significant investigation to date was a potable water investigation conducted by the Oak Ridge National Laboratory (ORNL, 1989). This effort had several objectives, including confirmation of the presence of dieldrin in raw water from potable wells on Corry Station. A risk assessment was performed, as were mixing simulations. The goal of the mixing simulations was to assess the feasibility of reducing dieldrin concentrations to acceptable levels by judicious use of the existing wells. The ORNL work effort confirmed the presence of dieldrin at Corry Station. Data developed by ORNL are included in **Section 7.4 -- Existing Data**.

E. C. Jordan Co. (1990) prepared a brief report on the status of the UST release detection program at Corry Station. The report cites regulated underground storage tanks (USTs) at 3 locations on Corry Station. These include: 3 tanks at the old base exchange service station; 1 tank at facility 1064; and 2 tanks at facility 3765 (Vehicle Fuel Dispensing Facility). The report documents construction details and boring logs for 4 compliance monitoring wells (CRY-1064-1 through CRY-1064-4) installed around Building 1064. Construction details are found in **Appendix A-1 -- Well Location and Construction Information.**

The Naval Energy and Environmental Support Activity (NEESA) prepared a Preliminary Assessment Report (NEESA, 1992) for Corry Station. This report documents a Potential Hazardous Waste Site Preliminary Assessment conducted for Corry Station. The report discusses: previous and current underground storage tanks; a suspected landfill; and the dieldrin contamination problem.

7.2 Previous Investigations in the Vicinity of Corry Station

The Florida Department of Environmental Protection (Wiegand et al., 1990) conducted an investigation into tetrachloroethylene (PCE) contamination in a nearby public supply well. Peoples Water Service #3 well was contaminated by PCE sometime before May 1988. The report describes an investigation into possible contaminant sources, focusing on nearby dry cleaning facilities. PCE concentrations in Peoples #3 ranged between 2.4 µg/L and 5.0 µg/L in the period from May to August 1988. Peoples #3 is located 3,500 feet south of Corry #12.

In 1993, the NWFWMD completed a detailed investigation of the hydrogeology and hydraulics of the Sand-and-Gravel Aquifer in Escambia County (Roaza et al., 1993). This report described a numerical ground water flow and transport model developed by the NWFWMD for the entire county. The report (and its companion report, Roaza et al., 1991) provide a refined conceptualization of the Sand-and-Gravel Aquifer flow system for the county, including the Corry Station area. This includes an analytical aquifer test analysis that supports the conceptualization of the Sand-and-Gravel as a leaky aquifer system. Included in Roaza et al. (1993) are results of numerical simulations of flow that cover the Corry Station area.

7.3 Records Search/Interviews

In an attempt to determine the nature and extent of past dieldrin use at Corry Station and to obtain other information pertinent to development of the work plan, records searches and personal interviews were conducted. The purpose of these activities was two-fold; to determine the extent of dieldrin use at Corry Station and to obtain all available information pertinent to a hydrogeologic investigation. Records of the following departments were examined: NAS Pensacola PWC Facilities Management Department; PWC Utilities Department; Resident Officer in Charge of Construction (ROICC); and PWC Engineering Department. Historical areal photographs of Corry Station were obtained from U.S. Navy personnel at Saufly Field and the Florida Department of Transportation, Tallahassee, Florida. Some of the information obtained through the records search is presented in **Section 7.4 -- Existing Data** and in **Appendix A -- Existing Site-specific Data**. The PWC Facilities Management Department, Environmental Section provided contaminant concentration data collected from the 10 public supply wells at Corry Station. The PWC Utilities Department provided pumpage and pump run time data for these wells as well as information on the standard operational procedures relevant to the Corry Station well field. ROICC provided information on some of the structures at Corry Station, including names of general contractors and contract numbers associated with particular buildings. A number of maps and engineering drawings for Corry Station were obtained from the PWC Engineering Department. The Engineering Department also provided copies of current and historical termiticide application specifications for new construction. The Engineering Department, Survey Section provided a digital base map of Corry Station.

7.3.1 Dieldrin Use at Corry Station

Interviews were conducted with various persons currently, or previously, associated with each of the above listed activities. These included Mr. Clarence Nelson, former PWC Pest Control Foreman. Mr. Nelson was employed with the PWC for a period of approximately 33 years, until his retirement in 1986. He reported that dieldrin was occasionally used on Corry Station, principally to control ants. Both granular and liquid dieldrin formulations were utilized. He recalled the use of 10 percent granular and 0.5 percent liquid formulations. According to Mr. Nelson, there was neither a mix-and-load nor a pesticide storage facility at Corry Station. When pesticides were needed at Corry, they were prepared at NAS Pensacola and transported to Corry. Further, pesticides were transported to Corry in small lots, sufficient for the requirements of a particular job. Outdoor work for ant control was done on a service call basis. Mr. Nelson recalled the use of dieldrin on the football field for the control of ants. Dieldrin was not routinely used for maintenance control of termites. The pesticide of choice for this application was chlordane. The use of dieldrin was generally limited, due to concerns regarding its toxicity (Mr. Clarence Nelson, personal communication, 1993).

An attempt was made to locate any remaining pesticide application records for the period ending 1987 (corresponding to the cessation of dieldrin registration as a termiticide). According to Mr. Bobby Roberts, current PWC Pest Control Foreman, historical monthly pesticide application reports for this period are unavailable at NAS Pensacola (Mr. Bobby Roberts, personal communication, 1993).

Using information obtained from the ROICC, an attempt was made to contact as many of the general contractors as could be located who constructed major buildings at Corry Station. Five firms were contacted, as were 2 pesticide application companies. Contractors were asked to provide any information still available on the types and amounts of termiticides applied to the grade upon original construction of buildings. The available information is summarized in Table 7-1. Information on other Corry Station buildings was not obtainable.

In the absence of complete information on termiticides used in conjunction with new building construction, PWC Engineering Department construction specifications were reviewed for insight into permissible toxicants used for subterranean termite control. Several sets of bid specifications were located, covering various time periods. For example, the specification for Bachelor Enlisted Quarters, NTTC Corry Station (Spec. No. 06-74-0540), dated April 25, 1975, contained the following toxicant provisions. Four chemicals were permissible for use: chlordane -- 1.0 percent (by weight); dieldrin -- 0.5 percent; aldrin -- 0.5 percent; or heptachlor -- 0.5 percent. Toxicants were applied as water-based emulsions. Slabs on grade were specified to receive no less that 1.5 gal of toxicant per 10 ft^2 Along the exterior perimeter of the slab and under expansion joints 2 gal of toxicant per 5 linear ft (in a strip one ft wide) were specified. Footings had a similar specification (2 gal of toxicant per 5 linear ft per ft of depth). Footings were specified to receive toxicant in the following manner: one-third of toxicant in bottom of trench; one-third in half full trench; and one-third in virtually full trench. The specifications also required that the subcontractor provide a written certification of the type and quantity of toxicant applied, as well as the rate of application. Efforts to locate written certifications for any buildings were unsuccessful. Specifications in effect at other times were less specific regarding allowable toxicants, accepting any material registered by the USEPA for use in controlling subterranean termites.

Based on the above termiticide application specifications and the dimensions of the Bachelor Enlisted Quarters (Buildings #3701 through #3710), an estimate of the quantity of termiticide applied at the time of construction (1975) can be made. Assuming a total square footage of 63,200 and approximately 4,150 perimeter feet with the foundation footer 2 ft below grade, the volume of 0.5 percent termiticide solution applied to the building complex is approximately 12,800 gal. If the dieldrin or aldrin formulation used contained 4 lb/gal of active ingredient, the amount of

TABLE 7-1

TERMITICIDE APPLICATION INFORMATION FOR SELECTED CORRY STATION BUILDINGS

Building Number	Date Constructed	Building Use	Area (ft^2)	Termiticide Used (percent)
3749	1984	PWC Shop	3,600	Termide, 0.5[1,5]
3738	1989	Bowling Center Complex	29,000	Pryfon, 0.75[2,6]
3781	1989	Crypto Training Building	14,000	Pryfon, 0.75[2,6]
3782	1989	Instrumentman Training Facility	50,000	Chlordane, 1.0[3]
3777	1987	Main Gate Security	132	none applied[2]
3757	1986	Chapel, with Wing	14,000	Chlordane, 1.0[4]

1 per Mr. Larry Hall, Larry Hall Construction, Inc., personal communication, 1993.

2 per Mr. Hank Barnard, Jack Moore, Inc., personal communication, 1993.

3 per Mr. Mike Weed, Terminex, Inc., personal communication, 1993.

4 per Mr. Reb Tatum, Whitesell-Greene, Inc., personal communication, 1993.

5 Termide is a trade name for a formulation containing chlordane and heptachlor

6 Pryfon is a trade name for a formulation containing isofenphos

concentrate applied to this building complex would be 134 gal. The actual amount of termiticide applied may be greater due to actual footer depth and the possiblepresence of expansion joints which would require application of additional termiticide.

To conclude, it was not possible to definitively identify any pesticide application sites at Corry Station, based on the records search/interview process. However, dieldrin was used at Corry. For example, the football field was identified as a point of application. The largest potential source on Corry Station, in the absence of mix-and-load and storage sites, are the buildings. Several large residential complexes were constructed at Corry, in the general vicinity of wells #7 and #8, during the 1970s and 1980s. It is reasonable to assume that dieldrin could have been used on these buildings, given the information revealed by the records search/interview process. However, it was not determined which buildings, if any, received dieldrin. Records pertaining to this issue could not be located.

7.3.2 Public Supply Well Operation Procedures

Mr. Tom Lee (foreman, PWC Utilities Department) provided information with regards to current operational procedures for the 10 existing public supply wells on Corry Station. Current supply well operation procedures require the purging of all supply wells each time a well is started. This is necessary due to the presence of sediment in the raw water. Immediately upon initiation of pumping, the supply wells produce cloudy, turbid water. This turbid water is pumped to waste and discharged onto the ground next to the well. The turbidity of the water decreases quickly as evidenced by the clearing of the raw water. Once cleared, the water is then redirected into the GAC unit with the GAC outlet directed to waste in order to purge the GAC unit. This GAC purge water is also discharged on the ground next to the well. After the GAC unit is purged, the well is then placed on line with the discharge directed into the water system. This process requires approximately 15 to 30 minutes, depending on the severity of the sediment problem for a specific well.

In addition, the GAC units are backwashed as necessary to remove sediment filtered out by the GAC media. When production rates decrease below a certain level for a given well, the GAC unit is backwashed to remove accumulated sediment from the GAC unit and to return the hydraulic efficiency of the GAC unit to normal. The turbid water and sediment backwashed from the GAC units are also discharged to the ground next to the well.

7.3.3 Areal Photography

Areal photographs of Corry Station are available from both the Navy and the Florida Department of Transportation. The Navy provided photographs taken in 1958 and in approximately 1972. The Florida Department of Transportation has areal photography on file for October 1961, April 1970, October 1973, April 1976, March 1981, September 1983, November 1986, October 1989 and March 1992. Review of the Navy photographs and many of the Florida Department of Transportation photographs (1961, 1970, 1976, 1983 and 1992) provided much information relative to land use changes both on and off of Corry Station, but did not result in the identification of specific source areas.

7.4 Existing Data

Several types of data pertinent to a hydrogeologic contamination assessment are available for Corry Station. The types of data available include well construction data, lithology logs, pumpage reports and water quality.

7.4.1 Well Construction Data

Potable supply wells, test wells and monitor wells have been constructed at Corry Station. The potable supply wells supply water to both Corry Station and the Pensacola NAS. The test wells were temporary wells installed as part of the process of developing the potable water supply. The monitor wells were designed and installed for monitoring underground storage tanks.

Sixteen potable supply wells have been constructed at Corry Station. These wells are designated Corry #1 through Corry #16. Of these 16 wells, Corry #1 through Corry #6 have been plugged. The remaining 10 wells, Corry #7 through Corry #16 are currently utilized.

A potable supply test well program was undertaken at Corry Station between 1986 and 1989. Initially, the program consisted of boring of 5 test holes, all of which fully penetrated the Sand-and-Gravel Aquifer. These 5 test holes are situated along the northwest perimeter of Corry Station, and included sample collection, lithology description, grain size analysis, geophysical logs (natural gamma and normal electric logs) and contractor recommendations regarding test well construction. Following construction of the 5 test holes, test wells were installed at four of these locations. Corry #15 Test, Corry #16 Test and Corry #17 Test were pumped for determination of aquifer yield, and analyzed for water quality. Due to water quality considerations (high iron concentrations in Corry #16 Test and Corry #17 Test), Corry #18 Test well, although constructed, was not pumped and was not analyzed for water quality. Corry #19 Test hole was never converted into a test well. Following evaluation of these 5 test holes/wells, a 6th test hole was drilled and converted into Corry #101 Test well. This test well was situated in the southeast quadrant of Corry Station. Based on the results of this test well program, 2 of the test wells were converted into potable supply wells. Corry #15 Test was converted into Corry #15 and Corry #101 Test was converted into Corry #16. All other test borings and test wells were plugged.

The test well construction program of the 1980's yielded information on the grain size distribution within the MPZ. Grain size data (in inches) were developed from core samples obtained from test wells Corry #15 Test, Corry #16 Test, Corry #17 Test, Corry #18 Test, and Corry #101 Test. Relevant results of this data collection effort are summarized in Table 7-2.

TABLE 7-2

GRAIN SIZE DATA FOR THE MAIN PRODUCING ZONE

Test Well Number	Core Depth (ft)	Diameter (inches) D10 (90% retained)	D30 (70% retained)	D60 (40% retained)	Uniformity Coefficient
15 Test	160	0.007	0.009	0.013	1.9
	190	0.008	0.011	0.014	1.8
	220	0.009	0.013	0.020	2.2
16 Test	160	0.009	0.016	nd	nd
	190	0.011	0.016	nd	nd
	220	0.010	0.014	0.022	2.2
17 Test	165	0.006	0.008	0.013	2.2
	190	0.007	0.010	0.016	2.3
	220	0.008	0.012	0.022	2.8
18 Test	155	0.007	0.011	0.017	2.4
	190	0.007	0.013	0.021	3.0
	225	0.013	0.020	nd	nd
101 Test	185	0.009	0.012	0.016	1.8
	200	0.010	0.014	0.018	1.8
	225	0.012	0.016	0.022	1.8

note: nd means not determined

Ten UST monitor wells have been constructed at 4 different locations; 4 wells near Building #1064, 4 wells near Building #3778, 1 well near Building #3719 and 1 well at Building #2230. The wells near Building #'s 3719 and 2230 have been plugged. The UST monitor wells are shallow wells, less than 20 ft deep and are completed with the screen interval straddling the water table.

Well location and available well construction information is provided in **Appendix A-1 -- Well Location and Construction Information**.

7.4.2 Lithology Logs

A number of boring logs, driller's logs and geophysical logs are available for Corry Station and the immediate surrounding area. These logs provide considerable information with regards to the hydrogeologic framework in the vicinity of Corry Station (**Section 6.2 -- Hydrogeologic Setting of Corry Station**).

Soil borings were performed as part of the engineering and design work associated with construction projects at Corry Station. Boring logs were located for Building No. 1099 and for the Unattached Enlisted Personnel Housing Complex (Building No. 3701 through Building No. 3710). The borings were performed in accordance with ASTM-D1586 and were described utilizing the Unified Soil Classification System. At Building 1099 the soil borings penetrate to approximately 15 ft below LSD and show the lithology to be predominantly sand with little or no fines (Meister & Associates, 1991 and NEESA, 1992). On May 2, 1991, the water table ranged from 6 to 9 ft below LSD at this site. Borings collected at the Unattached Enlisted Personnel Housing Complex penetrate to approximately 30 ft below LSD and also show the shallow subsurface lithology to consist of sand with little or no fines (NAVFAC Drawing No. 502870 and 502872). These borings were performed between April 19 and May 2, 1973 at which time the water table was encountered at approximately 12 ft below LSD. Boring locations and descriptions are presented in **Appendix A-2 -- Soil Boring Location and Descriptions**.

Driller's logs were located for most of the wells constructed at Corry Station. The deeper supply wells and test wells were constructed utilizing the hydraulic rotary drilling method. Deep wells, fully penetrating the Sand-and-Gravel Aquifer, have been constructed along the northwestern, northern and northeastern perimeter of Corry Station. Descriptions of samples from these wells show the predominantly sand lithology of the Sand-and-Gravel Aquifer and the lack of a significant confining unit. Only minor amounts of clay are noted on the driller's logs. Where noted in the logs, the clay or sandy clay intervals are very thin, generally less than 10 ft, and are not continuous throughout the northern portion of Corry Station. Descriptions of Corry #101 Test (Corry #16), located in the southeast quadrant of Corry Station, shows a higher percentage of clay to be present in that area. The locations and lithologic descriptions are included in **Appendix A-1 -- Well Location and Construction Information**.

Borehole geophysical logs are available for some of the more recently constructed wells. Natural gamma and electric logs were recorded on the 6 test wells installed at Corry Station between 1986 and 1989. In addition, geophysical logs are also available for several major supply wells in the vicinity of Corry Station. The geophysical logs verify the lack of significant clay layers in the vicinity of Corry Station. Slight increase in the natural gamma activity noted on most of these logs at a depth of approximately 50 ft to 100 ft indicates a slight increase in the amount of fine grained sediment (silt or clay) and the presence of less well sorted sediments. This characteristic is widespread throughout the area and used to delineate the LPZ. Minor clay intervals are noted on many of these logs, but are not continuous and do not provide effective confinement within the Sand-and-Gravel Aquifer. The geophysical logs for these wells are included in **Appendix A-3 -- Geophysical Logs**.

7.4.3 Well Pumpage and Water Quality

Pumpage from the Corry Station potable supply wells has been compiled for the period between November 1986 and July 1993. Individual well pumpage is not recorded directly at Corry Station. Operational procedures include volumetric metering of the total well field output (recorded daily) and recording the number of hours of operation per day for each well. Estimates of daily volumetric production of individual wells must be calculated utilizing an average pumping rate for that well and the hours of operation (run time). Average pumping rates for each well along with daily well run time was obtained from Tom Lee, PWC Utility Department, Foreman. A limited comparison of the total well field production (metered) to the sum of individual well production (calculated) for a few randomly selected days indicated discrepancies of 10 to 20 percent.

Plots of individual well pumpage and total system pumpage by month is presented in **Appendix A-4 -- Water Quality and Well Pumpage**. All 10 of the potable supply wells are utilized on a regular basis. Individual wells are occasionally taken off line for repairs or routine maintenance. Total system pumpage, by month, has decreased from approximately 185 million gallons per month in the late 1980's to 135 million gallons per month in the 1990's. Average pumping rates used in well pumpage calculations are presented in Table 7-3.

A thorough compilation of available water quality data concerning dieldrin, benzene and tetrachloroethene is also included in **Appendix A-4 -- Water Quality and Well Pumpage**. The presence of dieldrin was first detected in 1984. Further sampling in 1987 and 1988 confirmed the presence of dieldrin (ORNL, 1989). Since 1990, regular sampling for dieldrin has been performed on all Corry supply wells.

TABLE 7-3

AVERAGE PUMPING RATES USED IN WELL PUMPAGE CALCULATIONS

Well	Estimated Discharge (gal/min)
Corry #7	629
Corry #8	659
Corry #9	535
Corry #10	635
Corry #11	610
Corry #12	693
Corry #13	590
Corry #14	597
Corry #15	708
Corry #16	770

Corry #8 is located in the far northeast corner of Corry Station and exhibits the highest concentrations of dieldrin. Average concentration is approximately 0.5 μg/L. Dieldrin concentration values from Corry #10, #7 and #11 show decreasing concentrations to the west, southwest, and south. The only other Corry Station supply well which consistently shows dieldrin levels above the detection limit is Corry #14, which is located west of Corry #10 and exhibits concentrations similar to Corry #10. The remaining 5 Corry supply wells show minimum contamination by dieldrin. Dieldrin levels in these 5 remaining wells (Corry #9, #12, #13, #15 and #16) are generally at or below detection limits. Water samples from Corry #16 Test and Corry #17 Test were also analyzed for water quality in 1986. Dieldrin was not detected in either of these wells (dieldrin detection limit = 0.01 μg/L). Figure 7-1 shows the known distribution of dieldrin based on the average concentration values for each of the 10 supply wells and the 2 test wells.

Additional statistical tests were performed on the five most affected wells in order to gain insight in statistical correlations and time trends. Specifically, the purpose of the tests were to : (1). identify the relationship between dieldrin concentrations and well pumpage and (2). identify the trends of dieldrin concentration over time. The analysis targeted data of individual wells to establish the unique statistics of each well. All data were analyzed using SAS applications software (SAS Institute Inc. Cary NC 1991) and the Colorado State University's non-parametric applications software (WQSTAT).

The Shapiro-Wilk test statistic was initially used to determine the population distribution of the dieldrin concentration and the well pumpage data. Because the dieldrin concentrations and well pumpage were not from a normal distribution (including distributions from transformed data), non-parametric methods were subsequently used for testing bivariate variables (ie: concentration versus pumpage) and time trends (ie: concentration versus time). The BDLs were not included in these tests.

The Spearman correlation test was performed to establish possible correlation between well pumpage and dieldrin concentrations for Corry #7, #8, #10, #11 and #14. The correlations were not statistically significant for all wells except for Corry #7. The Spearman coefficent was -0.18 which suggests a relatively weak correlation of decreasing concentrations with increasing pumpage. It appears that within the range of pumpage and period of data collection, the dieldrin concentrations are not significantly affected by well pumpage.

The mean dieldrin concentrations by year for each of the above Corry Station wells are presented in Figure 7-2. As graphically shown, there are significant differences in the dieldrin populations between Corry #7 and #8 from the rest of the wells. In addition, this difference is also consistent for each year in the period of record.

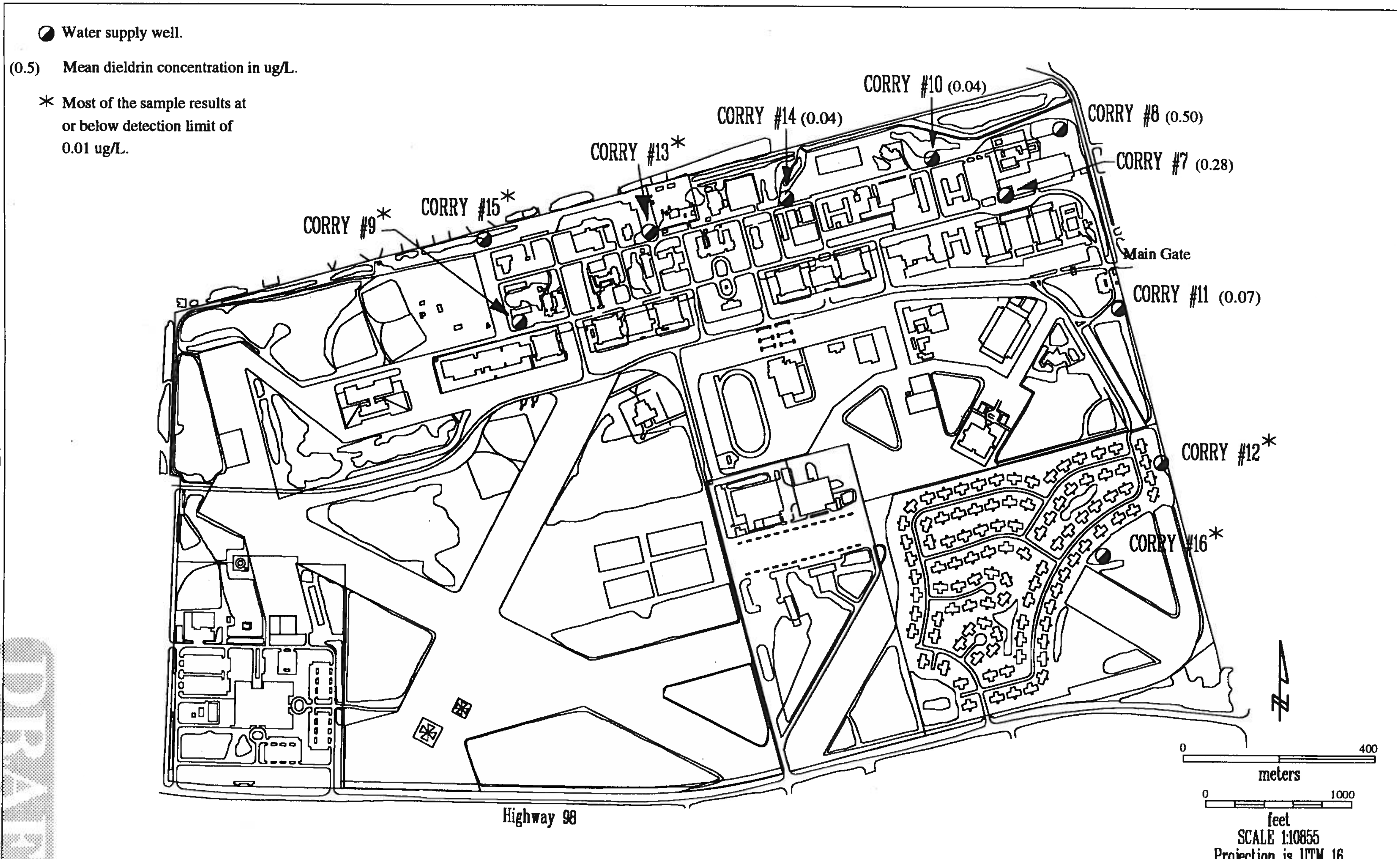
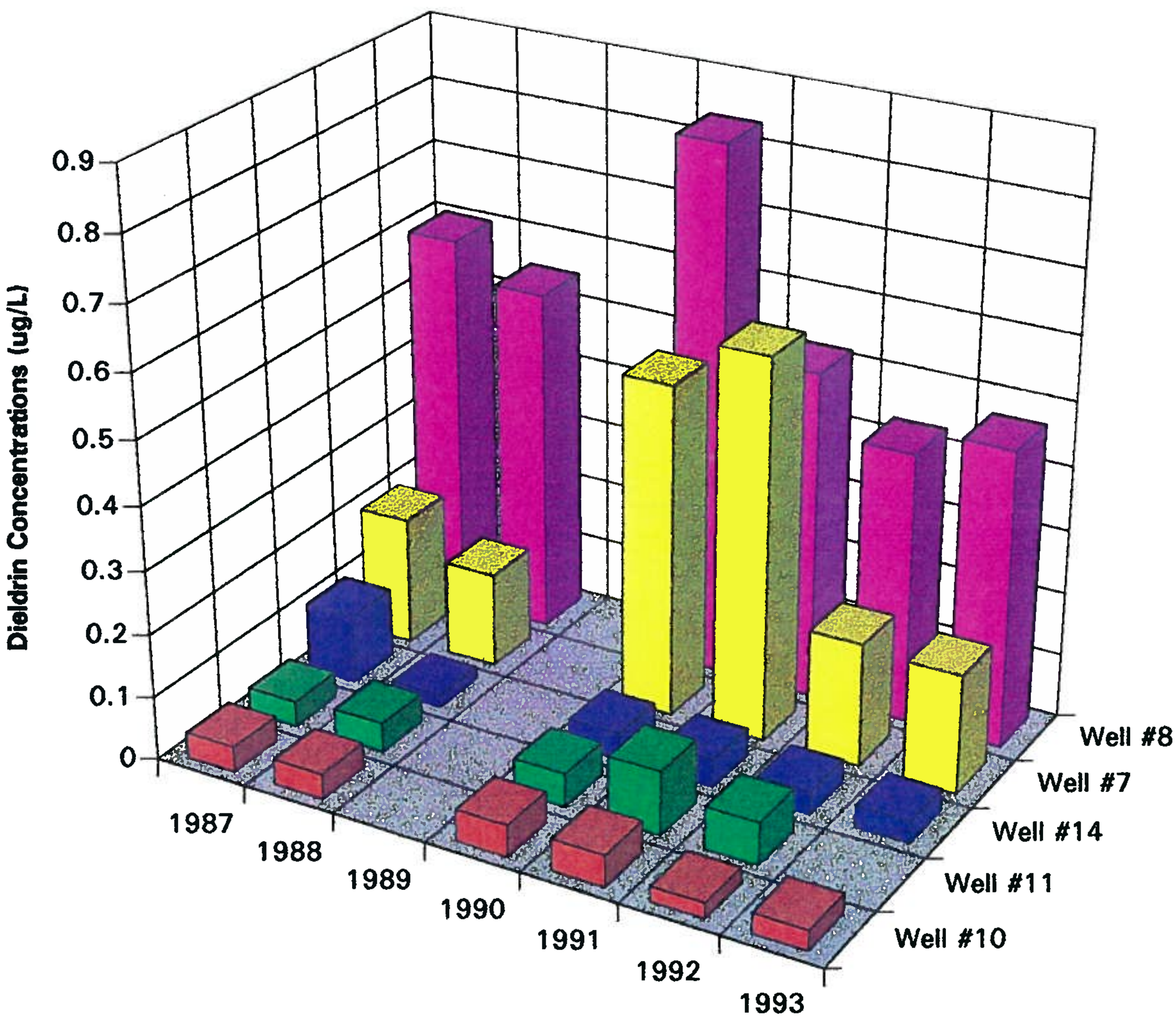


Figure 7-1. Average Dieldrin Concentrations in Corry Public Supply Wells.

Figure 7-2. Mean Dieldrin Concentrations by Year by Well



For the time trend analyses, the dieldrin data for each of the above wells were initially tested for serial correlation and seasonality. Accordingly, the Kendall Tau, the seasonal Kendall and/or Analysis of co-variance tests were used to establish time trends. The trend statistics were established at the 95 percentile confidence level. The results of the analyses indicate that a statistically significant dieldrin trend over the period of record (1987 to 1993) cannot be established for all of the above wells except for Corry #8. In Corry #8, a statistically significant decreasing trend was established in the dieldrin concentrations. The data used in both the correlation and trend statistics are given in **Appendix A-4. Water Quality and Well Pumpage**.

The actual amount of dieldrin produced from each of the 5 most affected wells (Corry #7, #8, #10, #11 and #14) was calculated for the period April 1991 through November 1992. Dieldrin mass calculations were performed for each month during this time period. The mass of dieldrin produced for a given well is the product of the monthly well pumpage (in liters) and the dieldrin concentration (g/L) for that month. The concentration value used for a specific month was an average value for that month if multiple samples were collected, or, an interpolated value for that month if no actual sample was collected for that month. Corry #8 showed the greatest mass of dieldrin produced per month. Average monthly production of dieldrin from Corry #8 was 27.6 grams of pure dieldrin product (active ingredient). Table 7-4 is a summary of the dieldrin mass calculations performed for the 5 most contaminated wells.

Existing dieldrin concentration data imply the presence of a source relatively close to Corry #8. It is assumed that most of the structures in the area (Corry Station and adjacent residential and commercial areas to the north and east) have been treated with an organochlorine termiticide (dieldrin, aldrin, heptachlor or chlordane). If contamination is due to the widespread, normal application of a termiticide, wells and test wells along the entire northern perimeter of Corry Station would be expected to show similar levels of contamination since all wells are within proximity of developed residential, commercial, or military areas. However, since contamination of Corry supply wells is irregular with some wells affected far more than others, a specific point source is suspected in the vicinity of Corry #8. It is likely that at least one source is located either in the immediate vicinity of Corry #8 or directly upgradient, to the northeast of Corry #8.

Although a specific point source is suspected as the primary cause of contamination, multiple sources may be responsible for some or all of the dieldrin contamination. Significant amounts of organochlorine termiticides have been applied to the larger buildings and building complexes on Corry Station implicating these structures as possible sources. Dieldrin is also known to have been applied on the football fields located in the northeast section of Corry Station **(Section 7.3 -- Records**

TABLE 7-4

CALCULATED DIELDRIN MASS

WELL	AVERAGE DAILY	AVERAGE MONTHLY	AVERAGE YEARLY
Corry #7	0.57 gm	17.0 gm	205 gm
Corry #8	0.92 gm	27.6 gm	332 gm
Corry #10	0.11 gm	3.4 gm	41 gm
Corry #11	0.20 gm	6.0 gm	72 gm
Corry #14	0.09 gm	2.7 gm	32 gm

Search/Interviews). If these potential sources were wholly responsible for the dieldrin contamination, Corry #8 would not be expected to show the highest level of contamination due to the greater distance of Corry #8 to these other potential sources and the relative proximity other supply wells to the football fields or Corry structures. However, multiple sources are a distinct possibility.

Benzene and tetrachloroethylene have affected Corry #11 and Corry #12. Neither of these contaminants has been detected in the other Corry wells. Between 1989 and 1991, benzene and tetrachloroethylene were both sporadically detected in Corry #11. Analytical results from Corry #11 show, on several occasions, detectable quantities of benzene and tetrachloroethylene while on other occasions these contaminants were not detected. Corry #12 exhibited widely fluctuating levels of benzene ranging from below detection limit to 24 μg/L between 1989 and 1991. Tetrachloroethylene analysis ranged from below detection limit to 0.60 μg/L. No recent benzene or tetrachloroethylene data is available for Corry #11 or Corry #12. Since 1991, no raw water samples have been analyzed for volatile organic compounds (personal communication, Gary Sweppenhiser, PWC Facility Management Department, Environmental Section, August 1993). Plots of concentration versus time for dieldrin, benzene and tetrachloroethylene are included in **Appendix A-4 -- Water Quality and Well Pumpage**.

Excessive iron concentrations locally affect the Sand-and-Gravel Aquifer in the vicinity of Corry Station. Corry #16 Test and Corry #17 Test both exhibited iron concentrations in excess of the established maximum contaminant level (MCL). The MCL for iron is 0.3 mg/L. Corry #16 Test showed 1.6 mg/L and Corry #17 Test showed 1.96 mg/L iron (as Fe). The other Corry Station supply wells exhibit iron concentrations well below the 0.3 mg/L threshold. **Appendix A-4 -- Water Quality and Well Pumpage** includes selected water quality information regarding the Corry supply and test wells.

Many of the major public supply wells in the vicinity of Corry Station are experiencing water quality problems. Both the Escambia County Utilities Authority and Peoples Water Service Company operate major supply wells in the immediate area. Peoples #3 well, located approximately 0.5 mile south of the southeast corner of Corry Station is affected by tetrachloroethylene. Concentrations range from 2 to 5 μg/L (MCL = 3 μg/L). The Florida Department of Environmental Protection determined the source of this contamination to be the Warrington Village Shopping Center which is located between Peoples #3 and Corry Station (Wiegand et al., 1990). Peoples #9, located approximately 0.5 mi. southeast of the southeast corner of Corry Station, and Peoples #5, located approximately 0.5 mi. east of Corry Station are both affected by tetrachloroethylene at levels below the MCL of 3 μg/L (personal communication, J. W. Hellums, Peoples Water Service Company, 1993).

ECUA operates three major supply wells in the vicinity of Corry Station. The ECUA West Pensacola well, located one mile northeast of Corry Station, is affected by low levels of tetrachloroethylene (2.0 to 2.3 μg/L). The ECUA Lillian well, located one mile northwest of Corry Station, is affected by excessive iron concentrations. Iron concentrations increase with increasing aquifer stress or well discharge. Consequently, the ECUA Lillian well discharge rate was reduced from 2,000 gpm to 1,000 gpm in order to maintain the iron concentrations at acceptable levels (.13 mg/L at 1,000 gpm). The ECUA Villa Drive well is located one mile west of Corry Station and currently experiences no water quality problems. Iron concentration averages .19 mg/L in the ECUA Villa Drive well. (personal communication, Danny Majors, ECUA, 1993). Figure 6-4 shows the location of the major supply wells in the immediate vicinity of Corry Station.

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7.5 Data Deficiencies

The records search and interviews **(Section 7.3 -- Records Search/Interviews)** indicated that no storage, mixing, loading or disposal of dieldrin took place on Corry Station. It is assumed that any application of dieldrin, used for fire ant control and possibly used as a termiticide, was performed according to label instructions. It was not possible to determine specific locations where dieldrin was applied, and no potential sources for the contamination could be specifically identified.

The available data **(Section 7.4 -- Existing Data)** provides insight into the general location of the dieldrin source(s). The existing data indicates the source(s) are likely located either in the immediate vicinity of Corry #7 or Corry #8, or immediately northeast of Corry #8. Insufficient data is available to further limit the geographic area most likely to contain the source(s). In order to reduce the suspect area additional data regarding the concentration and distribution of dieldrin in the Sand-and-Gravel Aquifer is required.

Existing dieldrin concentration data is limited to 12 supply and test well sites situated on Corry Station. All of these wells are completed in and are representative of the MPZ. Due to the distribution of these 12 wells and the dieldrin contamination, it is not possible to fully define the areal extent of the contamination or to positively identify the area where the MPZ is most affected by dieldrin. Additional MPZ wells are required to the northeast of Corry #8, and to the southwest of the most affected wells (Corry #7, Corry #11 and Corry #10). The additional water quality information obtained in these areas will allow for further delineation of the areal extent of contamination in the MPZ and further limit the possible location of the source(s).

Any water entering the MPZ of the Sand-and-Gravel Aquifer must pass through the SZ since the SZ serves as the source bed for the MPZ. Therefore, any contamination entering the MPZ and the Corry Station supply wells must also pass through the SZ. Location of areas of contamination within the SZ will aid considerably in locating and verifying the actual source of dieldrin.

No information is available with regards to the distribution of dieldrin in the SZ of the Sand-and-Gravel Aquifer. In addition, insufficient SZ data is available to determine the water table configuration, the ground water flow gradient and direction within the SZ, and the effect of the Corry Station supply wells on the SZ. Additional SZ monitor wells are required to provide this information.

Similar data deficiencies exist with regards to the benzene and tetrachloroethylene contamination found in Corry #11 and Corry #12. Due to the limited number of wells (2) affected by these contaminants very little is known about the distribution of these contaminants within the Sand-and-Gravel Aquifer. Additional monitor wells completed within the MPZ in the vicinity of these 2 wells would provide additional data required to identify the most likely source area.

The Site-Specific Assessments (**Section 9.1 through Section 9.7**) are specifically designed to provide data necessary to further delineate the distribution of dieldrin, benzene and tetrachloroethylene in the sub-surface environment. A compilation of data collected from these assessments will also help define the ground water flow directions and gradients required to verify the source of the contamination.

7.6 Geochemical Behavior of Dieldrin in the Environment

The purpose of the section is to discuss the interaction of aldrin/dieldrin and other related chlorinated hydrocarbons in the natural environment, specifically soils/sediments. The discussion is based primarily from published literature. The emphasis in the literature review was given towards ascertaining the modes of transport of the chlorinated hydrocarbons in the soil/sediment media.

7.6.1 Synopsis

Although recent studies of dieldrin are abundant in the literature, bioaccumulation rather than mobility through soil/sediment media is generally targeted. Many older studies (1960-1970) specifically address aldrin and dieldrin persistence in soils. These studies indicate, based on analysis at the parts per million range (ppm), there is no vertical movement of the insecticides in soils as a result of the insecticide/organic carbon interactions. More recently, the affinity of certain chlorinated hydrocarbons, e.g. DDT, to organic colloids and the subsequent transport of these substances through surface waters has been demonstrated. It is the movement of these organic colloid/chlorinated hydrocarbons through soils and the leaching of insecticides at the parts per billion (ppb) range that are of interest in this investigation.

Dieldrin has the longest half-life of the chlorinated hydrocarbons (USEPA, 1989) and is reportedly the most stable and hazardous insecticide in the environment (Matsumura and Boush, 1967). Before the partial ban on dieldrin in the U.S. in the 1970s, interest centered upon the persistence of the insecticide in agricultural soils. This interest was partly a result of the ability of liquid-gas chromatography to detect pesticides at the μg/L level (Lichtenstein et al., 1967). At this time, the study of mobility of the substances below the soil surface was largely neglected.

Later studies have focused on fate of organic pesticides in soils, specifically adsorption to other organic substances, and an abundance of literature on the bioaccumulation of dieldrin in the environment now exists. The solubilization of the pesticide DDT by humic substances (Wershaw et al., 1969) and the affinity of DDT for freshwater colloids (Poirrier, 1972) suggests similar interactions in other chlorinated hydrocarbons. In addition, recent studies focusing on movement of colloids in soils may be useful in explaining soil mobility of insecticides such as dieldrin.

7.6.2 Modes of Transport

While atmospheric transport of persistent pesticide residues is the primary means of long-range dispersion of pesticides via dust and rainfall (Matsumura, 1975), the presence of water appears to be the most important factor in determining the fate of pesticides in soils (Lichtenstein et al., 1967) and may ultimately influence the fate of pesticides in ground water. Other factors affecting the persistence of insecticides in soils include soil type, temperature, cultivation, air movement, and application and formulation of the substance (Matsumura, 1976). Although microbiological degradation of dieldrin has been identified in laboratory experiments, field experiments have not been successful (Anderson et al., 1970).

Introduction of insecticides into the hydrologic system may occur through volatilization and co-distillation of insecticides into the atmosphere and their return to the surface as dry fallout or in rainfall, as well as erosion of treated soils (Mattraw, 1975). Insecticides are less persistent in moist soils when compared with dry soils, although aldrin residues can be eluted more easily in quartz sands when compared with organic soils (Lichtenstein et al., 1967).

The absence of water results in reduced volatilization and commensurate increase in recovered aldrin and reduced conversion of aldrin to dieldrin in soils through epoxidation (Lichtenstein and Schulz, 1960). Results of studies to determine the effects of water on insecticides indicate insecticides can be displaced by water from the soil particles, in addition to the loss of pesticides due to volatilization (Lichtenstein et al., 1961, Lichtenstein and Schulz, 1961) and co-distillation (Weidhaas et al., 1961). Only insecticides with water solubility above 5 ppm were eluted during one experiment (Matsumura, 1975) and the bulk of organic pesticides were bound to mud particles and precipitated with the particles.

The persistence of dieldrin and other pesticides in agricultural soils is well documented. Several studies done in the 1960s and 1970s determined that 90 percent of recovered aldrin/dieldrin residues persisted in the upper 3 inches of soil after one year (Lichtenstein et al., 1962). Insecticides disappear from the soil surface much more quickly than from underlying layers (Lichtenstein and Schulz, 1961) and the loss of insecticidal residues from soils is attributable primarily to volatilization (Lichtenstein et al., 1962, Lichtenstein and Schulz, 1961).

In one study, minimal leaching, volatilization, photodecomposition, mechanical removal, and probably biological decomposition resulted in 31 percent of technical dieldrin and 28 percent of purified aldrin remaining on Congaree loamy sands after 15 years (Nash and Woolson, 1967). In another experiment, applications of 1 ppm resulted in concentration of aldrin in water extracts from quartz sands of 0.025 ppm, of dieldrin 0.09 ppm (Lichtenstein, 1967). The same application through loam soils resulted in water extracts of 0.0001 ppm aldrin and 0.011 ppm dieldrin and demonstrated the sorptive capacity of soil organic constituents. Importantly, small amounts of aldrin residues found in percolated water 17 days after application were attributed to the adherence of aldrin to tiny soil particles that passed with the water through the filter.

The fate of insecticides in soils is affected by adsorption to soil particles and organic matter in the soil, leaching and washing off by water, evaporation with water, microbial decomposition, photodecomposition, and biological translocation (Matsumura, 1975). While dieldrin is relatively insoluble in water (USEPA, 1989), like other organic pesticides it adsorbs strongly to organic particles (Miles, 1976, Lichtenstein et al., 1971, Wershaw et al., 1969, Weidhaas et al., 1961), and may be washed away from the soil surface.

Dieldrin has been identified in aquatic sediments (Miles, 1976, Mattraw, 1975) and appears to reflect local use as opposed to runoff from agricultural fields. For organic compounds, partitioning between water and the organic carbon content of soil is the most important sorption mechanism (Gschwend and Wu, 1985) and the addition of carbon to soil results in greater binding of insecticidal residues to the soil-carbon mixture (Lichtenstein et al., 1971).

Insecticides have also been found to adsorb more frequently to particulate matter in sediment samples when compared to water samples (Mattraw, 1975). In the same study, areas with little channelized runoff had lower concentrations of dieldrin and the author suggests that canal sediments in urban areas with high dieldrin residues may reflect local insecticide use rather than transport from adjacent agricultural areas. Additionally, concentrations of pesticides in bottom samples provide a good indication of long-term contamination, whereas levels in suspended matter indicate the amounts of pesticides being carried on a short-term basis.

Numerous studies have demonstrated the affinity of organic pesticides for soil and water particulate matter (Miles, 1976, Mattraw, 1975, Weidhaas et al., 1961, Lichtenstein et al., 1971, Wershaw et al., 1969, Weidhaas et al., 1961). In a study of insecticide residues in stream sediments in Canada (Miles, 1976), bed load samples (shifting detritus and sediments) contained 3 to 6 times greater concentrations of insecticides when compared with bottom material (more permanent bottom muds). Dieldrin residues ranged from less than 0.3 ppb in bottom materials at a stream source to 1.4 ppb at the stream mouth. Bed load samples ranged from 1.0 to 6.0 ppb, while residues on suspended sediments were limited to the ppm range. In another study, Mattraw (1975) found detectable levels of dieldrin in a number of surface waters (>0.005 ppb) and sediments (>0.05 ppb) in southern Florida.

Water solubility enhancement increased linearly with dissolved organic matter concentration and was greatest for the least soluble organic solutes in experiments performed by Chiou et al. (1986). Several studies have indicated that low concentrations of dissolved and/or suspended particulate-bound natural organic matter in water can significantly enhance the solubility of many organic compounds and sorption of hydrophobic organic compounds to natural sediments can be viewed as a phase partitioning process (Gschwend and Wu, 1985, Chiou et al., 1986).

Poirrier et al. (1972) observed that coloring colloids adsorbed DDT and resulted in an increase in concentration from 0.168 ppb by weight in water to 15,800 times that concentration in coloring colloids. The authors concluded that humic materials in colloidal suspension are capable of adsorbing and concentrating trace amounts of the pesticide DDT in water (Poirrier et al., 1972).

Importantly, colloid-facilitated transport of contaminants (Kaplan et al., 1993, McCarthy et al., 1989) may elucidate a mechanism by which characteristically insoluble pesticides may move through the soil subsurface in association with mobile colloids (Kaplan et al., 1993) and contaminate ground water. While previous authors describe conditions conducive to movement of chlorinated hydrocarbon - colloid aggregations in surface waters, Kaplan et al. (1993) investigated the generation of mobile colloids in the subsurface environment. In the Kaplan study, soils characteristic of the upper coastal plain of the southeast were used to investigate the generation of mobile colloids. Mobile colloid concentrations reported were in the rate of 0.3-1.7 g/L and were consistent with those observed in nature. The authors concluded that colloid generation occurred as a result of the porous profile, small mobile colloids relative to pore sizes, and highly charged colloids (due to organic coatings and pore chemistry). Other studies have demonstrated that increased well pumping rates may suspend otherwise stationary colloids in soils (Kaplan, 1993).

8.0 FIELDWORK METHODOLOGY

Several different reference sources pertaining to environmental field work methodology are available. These documents provide guidance and recommended procedures on a wide range of topics related to remedial investigations. Standard operating procedures are published by both the Florida Department of Environmental Protection (FDER, 1992) and the USEPA (USEPA, Feb. 1991). Guidance documents are also published by the USEPA (USEPA, May 1991) and the US Navy (**Appendix B -- Guidelines for Ground Water Monitoring Well Installation**). These documents are intended to insure proper methods, materials and techniques are utilized in environmental assessments in order to prevent environmental degradation of the site, safeguard the health and safety of field personnel and insure acquisition of reliable data.

Significant differences exist between certain portions of the FDEP and USEPA Standard Operating Procedures. In addition, guidelines are suggested procedures or materials intended to be used as a guide, and are subject to modifications based on site specific conditions. Therefore, decisions need to be made with regards to field work methodology in order to reconcile differences between the published standard operating procedures and to customize the guidelines to meet the conditions of the site and the project objectives.

Some of these decisions will impact the project budget. Examples of the more significant decisions to be made involve the casing/screen material to be used and the handling of the investigative derived waste. The USEPA Standard Operating Procedures and Quality Assurance Manual recommends stainless steel well casings and screens be used when installing wells for monitoring of organic compounds. However, in practice PVC materials are frequently used. The US Navy Guidelines for Monitor Well Construction recommends containment and analysis of all borehole cuttings and development water, while the USEPA (USEPA, May 1991) guidelines suggest using "best professional judgment" along with all information related to site history and contamination status in determining if containment and laboratory analysis of the investigation-derived waste is warranted.

The proposed field work methodology which follows is based on a review of the reference documents cited above and a review of all existing data regarding the nature of the contamination. Careful consideration should be given to the proposed fieldwork methodology.

8.1 Soil Sampling

Shallow soil samples and deep soil samples will be collected. Soil sampling will utilize different methodologies depending on the depth of sample being collected. All soil samples will be collected by the site geologist or qualified field technician. Soil lithologies will be characterized and recorded in the field notebook by the site geologist pursuant to **Section 8.8 -- Field Geologic Logging**. Organic vapor (headspace) analysis will be performed on each sample collected.

Soil sample locations (both horizontal and vertical), and physical/chemical analysis to be performed are specified in **Section 9.0 -- Site-Specific Assessments -- Phase II** and **Section 10.0 -- Ground Water Flow and Contaminant Transport Model -- Phase III**. Drilling and sampling equipment will be decontaminated in accordance with **Section 6.7 of the QAPP**. Implements utilized for collection of samples to be analyzed for chemical parameters will be decontaminated according to protocols for sampling equipment. If only physical parameters are to be analyzed, decontamination will be in accordance with downhole drilling equipment. The organic vapor headspace survey will be completed as described in **Section 8.4 -- Soil Headspace Survey**.

8.1.1 Shallow Soil Sampling

Shallow soil samples, to a depth of approximately 5 ft, will be collected utilizing trowels, soil sampling probes and hand augers. Stainless steel implements will be used. Composite samples will be collected as specified in **Section 9.0 -- Site-Specific Assessments -- Phase II**.

8.1.2 Deep Soil Sampling

Soil sampling at depths greater than 5 ft will be performed utilizing a 2 in by 24 inch split spoon sampler. Standard penetration rates shall be recorded in accordance with ASTM D-1586. When samples collected are to be analyzed only for physical parameters, carbon steel split spoons can be utilized. If chemical analysis is scheduled, stainless steel split spoons or carbon steel split spoons with a Teflon insert will be used.

8.2 Ground Water Sampling

Existing production wells and monitor wells will be sampled for water quality. Water quality sampling will be performed by qualified personnel. Detailed field notes of the sampling event shall be maintained.

Prior to sample collection, the static water level will be measured as outlined in **Section 8.6 -- Water Level Measurement**. If unable to measure static water level in an existing well, an estimate of the water level will be made. Based on the water level and the well construction information (T.D., and casing/screen diameter), the volume of water within the well will be calculated. The well will be purged until field parameters (temperature, conductivity and pH) have stabilized within 5 percent over 2 successive samples taken at least 5 minutes apart. The minimum purge volume will be 3 times the calculated volume of water contained within the well. Sample collection will commence immediately after field parameters have stabilized. Wells with existing pumps in place will be sampled from pre-tank spigots whenever possible.

Purge water shall not be moved off-site. Purge water will be allowed to infiltrate into the soil in the immediate vicinity of the well. The area of infiltration will be noted and recorded in the field notes. The senior field representative will determine if containment and analysis of the purge water is warranted based on the guidelines provided by the U.S. Environmental Protection Agency, (USEPA, May 1991). The purge water is not expected to pose an immediate threat to human health or the environment, and is not expected to degrade the condition of the site. If containment, chemical analysis and disposal of the purge water is deemed necessary, a modification to the work plan will be required.

Field notes will include well name, water level prior to well purging, calculated minimum purge volume, purge rate, start and stop time of purging, field parameters recorded with time during the purging of the well, pump used to purge well, sample identification number, date and time of sample collection, location of sample spigot if applicable, and name of sample team members. Well purging, sampling equipment, ground water sampling and decontamination of equipment is described in **Section 6.0 of the QAPP.**

Field parameters including specific conductance, temperature, pH, and dissolved oxygen shall be recorded each time a ground water sample is collected from a monitor well.

8.3 Well Installation

Construction of water quality monitor wells, potentiometric surface monitor wells and a production well will be required. Wells will be installed utilizing both hollow-stem auger and hydraulic rotary methods. A qualified geologist will supervise all drilling operations, collect split spoon samples and formation cuttings, and maintain a detailed lithology (**Section 8.8 -- Field Geologic Logging**) and drilling log. All wells constructed will be fully grouted utilizing a cement-bentonite grout consisting of 94 lbs of cement to 5 lbs to bentonite to 6.5 gal of potable water. The consistency will be approved by the on-site geologist prior to placement. All water utilized in the drilling process will be potable water obtained from the Corry Station public water supply system. A sample of the supply water will be collected during each mobilization involving well installation and analyzed for parameters of interest. In addition, a representative sample of the filter sand and the bentonite drilling mud will be collected during each mobilization and analyzed for parameters of interest. Actual well locations and construction specifications are specified in **Section 9.0 -- Site-Specific Assessments -- Phase II** and in **Section 10.0 -- Ground Water Flow and Contaminant Transport Model -- Phase III**.

Detailed notes regarding well installation will be recorded in the field. The placement of filter pack and bentonite materials will be verified by tagging their position in the borehole during well construction, and recorded in the field notebook. Drilling conditions, such as drilling rate, OVA readings, formation caving, fluid loss, quantity of mud mixed, core recovery, and other pertinent information regarding the drilling process, conditions and well installation shall be recorded in the field notebook as applicable.

Drill cuttings generated during well construction shall not be moved off-site. Drill cuttings will be spread over a small area in the immediate vicinity of the well, within the exclusion zone. The specific area where the cuttings are distributed will be noted and recorded in the field notes. The field geologist will determine if containment and analysis of the drill cuttings are warranted based on the guidelines provided by the U.S. Environmental Protection Agency. The drill cuttings are not expected to pose an immediate threat to human health or the environment, and are not expected to degrade the condition of the site (U.S.E.P.A., 1991). If containment, chemical analysis and disposal of the drill cuttings are deemed necessary, a modification to the work plan will be required.

Monitor wells shall be constructed in general accordance with **Appendix B -- Guidelines for Ground Water Monitoring Well Installation,** except for the deviations noted below and except as approved by the EIC. All monitor well construction will be performed by a qualified contractor. A qualified contractor must: 1) be licensed by the NWFWMD; 2) have experience working on similar projects (this will apply both to the individual drillers in the field and to the drilling company as a whole); 3) employ personnel who are OSHA-certified to work on hazardous waste sites; 4) have the necessary equipment capabilities; and 5) be approved by the Navy. All necessary well construction permits will be obtained by the contractor prior to well installation.

Subsequent to the completion of this project, all wells not needed for future monitoring shall be properly plugged in accordance with the requirements of Chapter 40-A3, Florida Administrative Code, Regulation of Wells. The actual wells selected for abandonment are dependent on the future monitoring needs of the Navy and can only be determined at the completion of this project. At that time provisions will be made to provide for plugging of all unneeded wells constructed as part of this investigation.

8.3.1 Ground Water Quality Monitor Wells

Ground water quality monitoring wells will be constructed by using hollow stem auger and hydraulic (mud) rotatory drilling methods. Monitoring wells will be completed in the shallow and deep zones of the Sand-and-Gravel Aquifer. All water quality monitoring wells will be completed with 4-in I.D., schedule 40 PVC casing and well screen. All well casings, screens, and end plugs will be flush-threaded. No solvent bonded joints will be allowed. Slotted pipe screen type will be used. Screen slot size is based on a multiplier of 3 times the 70 percent retained grain size (sieve analysis of core samples from Corry Station **Section 7.4 -- Existing Data**). This provides for a U.S. standard sieve 20/30 filter pack and a conservatively selected screen slot size of 0.015 in. All screens will have an end plug to seal the open end and to act as a trap for sediment entering the well.

Water quality monitoring wells constructed to a depth less than 65 ft will be installed utilizing the hollow stem auger method with an inside diameter of 6.25 in or greater. Cuttings will be collected and described on 5 ft intervals and the depth to water table will be noted and recorded. Once the desired depth has been reached, the well screen and casing will be inserted inside of the hollow stem auger into the borehole. The augers will provide for centralization of the well screen and casing. The filter pack (20/30 filter sand) will be installed around the well screen to approximately 2 ft or 10 percent of the screen length above the top of the screen while removing the hollow stem augers from the borehole. The formation will not be allowed to collapse around the well screen.

A 2-ft thick bentonite seal will be installed directly above the filter pack. If the bentonite seal is above the water table, potable water will be poured into the borehole to hydrate the bentonite. Time will be allowed, as per manufacturer recommendations, for hydration of the bentonite before grouting commences.

The remaining annular space will be filled, from bottom to top, with grout to a level of 3 ft below land surface. The grout will be pumped into the borehole with a tremie pipe. The remaining auger flights will be removed a section at a time during grouting. The grouting will be conducted continuously and in such a manner as to achieve filling the entire annular space. The formation will not be allowed to collapse around the well casing.

The 3 ft of annular space above the grout will be filled with 100 percent cement to land surface and a protective security cover will be set into the cement. Surface completion and well protection will be in general conformance with **Appendix B -- Guidelines for Ground Water Monitoring Well Installation**.

Water quality monitor wells greater than approximately 65 ft will be installed utilizing the hydraulic rotary method with an 8 in nominal diameter borehole. Only self-contained, non-excavated mud pits and bentonite drilling muds will be used for this drilling method. The borehole will be flushed free of cuttings, and cuttings will be sampled and described each 10 ft.

Once the desired depth of the borehole is reached and the borehole stabilized, the drilling mud will be thinned and the borehole flushed of all remaining cuttings. After removal of the drill string, the screen and casing will be installed into the borehole. The screen and casing will be centralized using stainless steel centralizers spaced 30 to 40 ft along the length of the screen and casing. The filter pack (20/30 filter sand) will be installed around the well screen, utilizing a tremie pipe and potable water, to approximately 2 ft or 10 percent of the screen length above the top of the screen. A 2-foot cap of fine sand (30/40 filter sand) will then be installed directly on top of the filter pack to insure grout does not infiltrate the screened interval.

The remaining annular space will be filled with grout, to a level of 3 ft below land surface. The grout will be pumped into the borehole with a tremie pipe. The grouting will be conducted continuously and in such a manner as to achieve filling the entire annular space from just above the 30/40 filter sand cap to 3 ft below land surface. The 3 ft of annular space above the grout will be filled with 100 percent cement to land surface and a protective security cover will be set into the cement. Surface completion and well protection will be in general conformance with **Appendix B -- Guidelines for Ground Water Monitoring Well Installation**.

8.3.2 Potentiometric Surface Monitor Wells

Potentiometric surface monitoring wells will be constructed using mud-rotary drilling methods. These wells will be used for determining water surface elevations and for sampling parameters appropriate to the construction methodology (turbidity and inorganic parameters, such as iron. Potentiometric surface monitoring wells will be completed in the shallow and deep zones of the Sand-and-Gravel Aquifer. All potentiometric surface monitoring wells will be completed with either 2-in or 4-in I.D., Schedule 40 PVC casing and well screen as specified in **Section 10.0 -- Ground Water Flow and Contaminant Transport Model -- Phase III**. Based on existing sieve analysis, both shallow and deep well casings will terminate in a manufactured, slotted pipe type, 0.015-in well screens. All screens will have an end plug to seal the open end and to act as a trap for sediment entering the well. Well casing and screen will be installed using centralizers. Wells will be filter-packed, grouted, and finished as per the hydraulic rotary method specifications contained in **Section 8.3.1 -- Ground Water Quality Monitor Wells.**

In order to allow for organic sampling efforts, some potentiometric surface monitor wells planned as part of the **Phase III** study (**Section 10.0 -- Ground Water Flow and Contaminant Transport Model -- Phase III**) will be constructed according to guidance found in **Appendix B -- Guidelines for Ground Water Monitoring Well Installation** and in **Section 8.3.1 -- Ground Water Quality Monitor Wells**. Those wells not constructed to the specifications of **Section 8.3.1** will be constructed with well casings, screens and end plugs having solvent-welded joints, precluding use of these wells for organic water quality sampling. The drilling equipment will be decontaminated prior to beginning installation of potentiometric surface monitoring wells and between all well sites.

8.3.3 Production Well

One 10 in PVC production well will be required for the Surficial Zone aquifer test. The production well will be used solely for the purpose of determining the hydraulic properties of the aquifer and not as a water quality sampling well. The production well will be constructed of solvent-bonded PVC materials installed in a 16-in borehole. Continuous slot 'wrapped type' screen will be used. Screen slot size will be based on split spoon samples and sieve analysis. Screen slot size will be designed to retain 90 percent of the filter pack material. Filter pack material size will be approximately 3 to 6 times the 70 percent retained size of the formation samples. Well casing and screen will be installed using centralizers. The well will be filter-packed and grouted as per the hydraulic rotary method specifications contained in **Section 8.3.1 -- Ground Water Quality Monitor Wells**. The well head will be finished in such a manner to facilitate the installation of a pump and pumping of the well. Location and additional construction information is provided in **Section 10.0 -- Ground Water Flow and Contaminant Transport Model -- Phase III**

8.3.4 Surface Casing

Surface casing will be utilized when drilling and installing monitoring wells through contaminated zones. Surface casing is intended to limit the spread of contaminants during well construction. When utilized, surface casing will be 8 in diameter, schedule 40 PVC, either threaded, flush joint or bell end secured with stainless steel screws. No solvent bonded connections will be allowed in wells utilized for water quality monitoring. The surface casing will be installed and fully grouted into a 12 in nominal diameter borehole and allowed to cure for a minimum of 12 hrs before proceeding with well installation.

For Surficial Zone water quality monitoring wells (depth less than approximately 65 feet) surface casing will be installed if soil headspace survey **(Section 8.4 -- Soil Headspace Survey)** taken between land surface and the water table shows organic vapor headspace concentrations greater than 10 ppm, or if significant contamination of the soils are known to exist. No clay layers or locally significant confining units appear to be present **(Section 7.4 -- Existing Data)**, therefore, surface casing will be installed to a depth of 10 ft below the observed water table. When surface casing is required, surface casing installation and subsequent Surficial Zone water quality monitoring well construction will be performed using the hydraulic rotary method.

For water quality monitoring wells completed in the Main Producing Zone (depths generally greater than 100 ft) the use of surface casing will be based on the results of water quality analysis of the Surficial Zone wells and the results of organic vapor headspace analysis performed during the construction of the Surficial Zone wells. Surficial Zone wells will be installed and sampled prior to installation of the Main Producing Zone wells **(Section 11.0 -- Field Mobilization Plan)**. If Surficial Zone analytical results show pesticides or volatile organic compounds to be present at levels greater than 10 times the detection limit, 8 in PVC surface casing will be installed approximately 20 ft into the Low Permeability Zone, or to a depth of approximately 80 ft below land surface.

8.3.5 Well Development

All newly constructed wells will be developed. Well development shall commence no sooner than 24 hrs after grouting of the well casing. Development of water quality monitoring wells will be accomplished by swabbing and pumping of the well, or, using compressed air with appropriate organic filter system to insure the compressed air is free of petroleum products. Development of potentiometric surface monitor wells and the production well will be accomplished using compressed air. Development will continue until clear, turbidity-free water is consistently produced and temperature, conductivity and pH fluctuations are less than 5 percent over a period of 10 minutes. Following development, the total depth below land surface of each well will be measured to within 0.1 ft using a weighted tape. The tape will be decontaminated as specified in **Section 6.3 of the QAPP.**

Development water shall not be moved off site. Development water will be allowed to infiltrate into the soil in the immediate vicinity of the well. The area of infiltration will be noted and recorded in the field notes. The senior field representative will determine if containment and analysis of the development water is warranted based on the guidelines provided by the U.S. Environmental Protection Agency, (USEPA, May 1991). The development water is not expected to pose an immediate threat to human health or the environment and is not expected to degrade the condition of the site. If containment, chemical analysis and disposal of the purge water is deemed necessary, a modification to the work plan will be required.

8.4 Soil Headspace Survey

Selected soil samples and drill cuttings will be screened in the field for volatile organics compounds using an organic vapor analyzer (OVA) in the survey mode. Organic vapor analysis will be performed for all unsaturated soil samples. In addition, hollow stem auger drill cuttings, collected on 5 ft intervals between land surface and the water table, will be analyzed for organic vapors.

Representative samples will be placed in 2 16-oz jars, filling each half full, and promptly capped. Following collection, the jars are allowed to equilibrate for approximately 5 minutes at a temperature of approximately 70° F. At the end of the equilibration period the container lid is carefully removed or pierced to allow the insertion of the OVA probe. One sample will be measured with a carbon-tip filter attached to the OVA probe, and the other sample will be measured with no carbon-tip filter. Both readings obtained on the OVA in ppm will be recorded in the field notebook. The carbon filter will allow naturally occurring methane to be distinguished from other volatile organics. The OVA screening will be conducted in a sheltered area, affording protection from the potentially adverse affects of wind, precipitation, direct sunlight, and in an area where exhaust fumes are less likely to be present. Pertinent information such as weather conditions, (e.g., temperature, wind and humidity/rain) will be recorded during the screening process.

All OVA(s) that will be used for this process shall be calibrated at least one time each day of use. All calibration of the OVA will be completed in accordance with **Section 13.0 of the QAPP**. The carbon in the carbon filter shall be replaced at a minimum of once per day or once every hour, depending upon the frequency of OVA readings of 20 ppm or greater to ensure that breakthrough of the carbon does not occur.

8.5 Well Survey, Elevation, and Location

Following the installation of the monitoring wells, all existing and newly installed wells will be surveyed for elevation and horizontal location. All elevation and location surveys will be completed by a registered Florida Land Surveyor or a Professional Land Surveyor. Horizontal and vertical control benchmarks referenced will be recorded for each well surveyed.

All wells will be surveyed to determine the elevation of the top of casing (TOC), and a representative elevation of land surface immediately adjacent to the well's protective concrete pad, or adjacent to the well itself if no concrete pad is present. For existing supply wells where top of casing is not accessible, other suitable water level measurement point will be determined and surveyed. All elevations will be reported in feet and will be based on the National Geodetic Vertical Datum (NGVD) of 1929. Elevations will be surveyed to an accuracy of 0.01 ft. Each well's TOC will be permanently marked or identified on the well casing in order to reference water level measurements.

All wells will be surveyed to determine their horizontal location to an accuracy of 0.1 ft. Horizontal locations will be provided in Latitude/Longitude, UTM Zone 16 and State Plane coordinate systems. If horizontal accuracy of 2 to 5 m is acceptable to the EIC, Differential Corrected Global Positioning System equipment and methods will be used.

8.6 Water Level Measurement

Routine water level measurements will be made to determine purge volumes, ground water gradients, flow directions, potentiometric surfaces, and to calibrate flow and transport models. All water level measurements shall be recorded to an accuracy of 0.01 ft and shall be measured from the designated, surveyed measure point (TOC for most wells, other surveyed measure point for selected supply wells). Date, time, held and wet measurements, measuring point utilized and the individual making the measurement will be recorded as applicable. A minimum of 2 consistent measurements will be made and recorded each time a water level measurement is required. All field data will be recorded in a hard-bound, water resistant field notebook.

Either electronic or steel measuring tape capable of 0.01 ft accuracy may be used. The tape will be decontaminated prior to use in any water quality monitoring well. Decontamination procedure of the water level measuring device will be completed in accordance with **Section 6.3 of the QAPP**.

Electronic data recorders will be installed on selected wells. Data recorders will utilize either float or pressure transducers and will provide water level accuracies within 0.01 ft and be referenced to the TOC measure point. Electronic recorders will generally be programmed to record water levels at intervals of 5 to 60 min, or as needed to meet project objectives.

8.7 Physical Soil Parameters

Selected deep soil samples, collected using split spoon methodology, will be analyzed for physical parameters. Physical parameters will include grain size analysis (sieve) and falling head permeability test. Grain size analysis will be in conformance with ASTM D-422. Falling head permeability test will be in general conformance with US Army Corps of Engineer (Engineering Manual 1110-2-1906, 5/1/80, Appendix VII) methodology. In addition, selected drill cuttings may be analyzed for grain size distribution only if an adequate volume of split spoon sample can not be recovered. Location and depth of split spoon samples to be analyzed for these parameters is provided in **Section 9.0 -- Site-Specific Assessments -- Phase II** and **Section 10.0 -- Ground Water Flow and Contaminant Transport Model -- Phase III**.

8.8 Field Geologic Logging

A site geologist will be present during all drilling and boring activities. A field lithology log will be prepared for each boring or well installation operation. Sample intervals will be 5 ft for augured borings and 10 ft for hydraulic rotary boreholes. Both washed and unwashed samples will be used for lithology descriptions. Samples will be submitted to the Florida Geologic Survey's core and well cuttings repository in Tallahassee for future reference.

Detailed descriptions will be provided for each sample. Descriptions shall include well name, date, depth interval, modal grain size, size range, roundness, sphericity, percent sand/clay content, Munsell color of sand grains and any clay present, and presence and percentage of accessory minerals. Descriptions shall be in accordance Florida Geological Survey standards. The standards pertaining to sand and clay lithologies are summarized below.

Modal grain size: the most common grain size as follows:
- very fine (1/16 - 1/8 mm)
- fine (1/8 - 1/4 mm)
- medium (1/4 - 1/2 mm)
- coarse (1/2 - 1 mm)
- very coarse (1 - 2 mm)
- granule (2 - 4 mm)
- gravel (greater than 4 mm)

Size range: the finer and coarser limits that the main part (about 70%) of the size population falls within; not the extremes.

Roundness: up to 2 terms describing roundness of the main part of the grain population (A - angular, S - subangular, R - rounded)

Sphericity: (H - high, M - medium, L - low)

Accessory minerals: examples include clay, feldspar, heavy minerals, mica, limonite, pyrite, peat, plant remains, etc.

Classification of soils samples, including split spoon samples, will include, at a minimum, a description according to the Unified Soil Classification System. Other pertinent information such as Munsell color, unusual odor, volume recovered and other significant characteristics will also be recorded as applicable.

8.9 Borehole Geophysics

Borehole geophysical logs will be run at many sites where wells are constructed. Where both shallow and deep wells are constructed, only the deep well will be geophysically logged. Logs will be recorded utilizing digital uphole equipment with a minimum sampling interval of 0.5 ft. Natural gamma ray logs will be recorded in units of counts per second, and if available, a conversion to API (American Petroleum Institute) units will be provided. Normal electric logs (16 in and 64 in) will be recorded in units of ohm-m. Spontaneous potential (SP) will be recorded in units of millivolts. Verification of logging instrument calibration will be required.

The basic logging program will consist of a natural gamma ray log recorded through the PVC casing. Where only natural gamma ray log is specified, logs will be run after well installation and water quality analysis is performed. Where natural gamma ray, normal electric and SP logs are specified, logs will be run in the open, hydraulic rotary drilled borehole prior to installation of casing and screen. All logs will be depth referenced to land surface.

Wells designated for geophysical logs are specified in **Section 9.0 -- Site-Specific Assessments -- Phase II** and **Section 10.0 -- Ground Water Flow and Contaminant Transport Model -- Phase III**. Open hole logs will be run at deep well sites where no surface casing is required, therefore, the deep wells selected for open hole logging are subject to change. If surface casing is required (based on chemical analysis of a Surficial Zone well), open hole logging will be performed on an alternate deep well.

Decontamination of all downhole logging equipment will be in accordance with decontamination of downhole drilling equipment. Downhole logging equipment will be decontaminated prior to and between logging of water quality monitor wells.

8.10 Decontamination Procedures

All drilling equipment will be decontaminated prior to entering Corry Station and prior to leaving Corry Station. All drilling equipment will also be decontaminated between installation of all wells used for ground water quality monitoring. The decontamination of drilling equipment will take place at the well site where the equipment was used, and within the contamination reduction zone. The drilling equipment will be decontaminated as specified in **Section 7.2 of the QAPP**. In addition, all downhole drilling equipment will be free of paint and rust, and will be sandblasted prior to each mobilization to Corry Station.

Decontamination of all drilling equipment used will consist of pressure steam cleaning and the use of laboratory grade, phosphate-free detergent. No solvents will be used in the decontamination of this equipment. Potable water will be used. The wash water is not expected to pose an immediate threat to human health or the environment, and is not expected to degrade the condition of the site, therefore, wash water will be allowed to infiltrate into the ground within contamination reduction zone surrounding the well or boring. This decontamination pertains only to well installation equipment (drill rig, drill pipe, tremie pipe, bits, etc.) not used to collect samples for chemical analysis. If containment, analysis and disposal of the wash water is deemed necessary by the senior field representative, based on guidelines provided by the USEPA, (USEPA, May 1991), a modification to the work plan will be required.

All PVC well casings and screens used in the construction of water quality monitoring wells will be factory decontaminated and sealed in plastic. The plastic wrappers will remain intact and be removed immediately prior to being installed into the borehole. Field decontamination of these materials will not be required.

All sampling equipment used for collection of soil and water for chemical analysis will be decontaminated in accordance with **Section 6.0 of the QAPP**. Field decontamination of this equipment will provide for containment and disposal of all wash water, rinse water and solvents used **(Section 6.3 of the QAPP)**.

8.11 Management of Investigation Derived Wastes

Management of investigation derived wastes will be in accordance with the guidelines established by the USEPA OERR Directive 9345.3-02 (Management of Investigation-Derived Waste During Site Inspections, May 1991).

A review of existing data, site history and field reconnaissance does not indicate the presence of highly contaminated soil or water within our current area of investigation. It is anticipated that this phase of the investigation will not involve soil, drill cuttings or ground water which pose an immediate threat to human health or the environment. In addition, spreading this type of waste on the well or boring site where the investigation derived waste was generated is not expected to leave the site in worse condition than existed prior to the investigation. Therefore, in accordance with USEPA guidelines (USEPA, May 1991), all soils, drill cuttings, purge water and wash water (generated during decontamination of drilling equipment) will be distributed on site in the immediate vicinity where it was generated. The actual location where the drill cuttings, purge water, development water, are spread or allowed to infiltrate will be documented in the field notebook.

Although not expected, it may be necessary to contain a portion of the waste (soil and water) generated. This decision will be made in the field by the senior field personnel. This field decision will be based on field observations in accordance with the guidelines established by USEPA OERR Directive referenced above. If deemed necessary by the senior field personnel, the waste (soil and water) generated by the investigation will be contained, analyzed and disposed of appropriately. Containment and disposal of soil, drill cuttings, development water and purge water will require a modification this work plan and associated contractual arrangements.

Disposable equipment and personal protective equipment is expected to be nonhazardous. These items will be double bagged and disposed of in an industrial dumpster or a municipal landfill (RCRA Subtitle D facility).

9.0 SITE-SPECIFIC ASSESSMENTS -- PHASE II

9.0.1 Introduction

The principal objectives of the Corry Station investigation are to perform a detailed water quality site assessment in an effort to characterize the extent of the dieldrin contamination and determine the potential source(s) (**Section 1.0 -- Introduction**). In order to adequately address the study objectives, some important elements must be considered. The elements, which in essence define the scope of the problem and hence, the methodology, include dieldrin source characterization, transport process, distribution in ground water and the hydrogeologic setting of the contamination problem. Each element has been discussed in previous sections (**Section 6.1 -- Regional Hydrogeology, Section 6.2 -- Hydrogeologic Setting of Corry Station** and **Section 7.0 -- Detailed Facility Description**). The purpose of this section is to integrate the available information and develop a conceptualization (conceptual model) to the dieldrin problem. The conceptual model, then, forms the technical premise in which to design the site-specific assessments.

9.0.2 Conceptual Model

9.0.2.1 Source Characterization

The presence of dieldrin in ground water underneath Corry Station is not unique relative to the regional area. Recent ground water quality results from the NWFWMD's sampling efforts in the City of Pensacola and vicinity have shown dieldrin and aldrin concentrations at a significant number of sites. In light of these results and the observations made at the Corry Station, a multiplicity of dieldrin sources in the region cannot be discounted.

The possibility of multiple dieldrin sources complicates assessment of the contamination problem. For instance, the assessment must attempt to characterize both recent and historical sources, whether ground water impact is caused by nonpoint (collective point sources) and/or specific point sources, which sources are likely to contaminate ground water and which sources are responsible for the current contamination at Corry Station.

The possible categories of dieldrin sources can be outlined as follows: (1) routine land surface application for insect eradication; (2) standard subsurface application as part of building construction specification; (3) accidental spills from categories 1 and/or 2; (4) spills from mix/load sites; (5) leakage from storage sites; and (6) dieldrin source outside Corry Station.

Based on the findings in **Section 7.3 -- Records Search/Interviews**, documented evidence regarding the quantity, spatial extent and type of dieldrin use/application at Corry Station is nonexistent. Undocumented information (i.e., personal communication, bid specification, etc.), dieldrin was applied within Corry Station in the past. The usage appears to be restricted to routine land surface application (Category 1) and possibly building construction application (Category 2) (**Section 7.3 -- Records Search/Interviews**). It also appears that dieldrin was never stored or mixed within Corry Station; therefore, leakage from storage facilities (Category 5) and spills from mix load sites appears (Category 4) are only a remote possibility. Given the general absence of evidence to specific dieldrin applications within Corry Station, the contamination was most likely been caused by any one or combination of the source categories outlined above, with the exception of Category 4 and Category 5.

9.0.2.2 Geochemical Behavior and Mode of Transport

From **Section 7.6 -- Geochemical Behavior of Dieldrin in the Environment,** several important characteristics of organochlorine pesticides shed light in conceptualizing ground water contamination by dieldrin. First, dieldrin is an extremely stable compound which allow it to persist in soils many years after its application. From one perspective, the current problem at Corry Station could have been caused by a source(s) whichwas generated many years ago.

Although the water solubility of dieldrin is low (190 µg/L), a large amount of ground water can be contaminated from a relatively small initial input. As an analogy, PCE (tetrachloroethylene), which has a higher solubility than dieldrin, may contaminate as much as 10,000 times its own volume due to its solubility limit (Mackay et. al., 1985). Therefore, a small mass of dieldrin in ground water may represent a significant source of contamination.

Finally, organochlorine insecticides such as dieldrin are characterized with a high affinity to adsorb onto naturally occurring organic substances in the subsurface environment; hence, the rationale for the use of granular activated carbon units (GAC) to remove dieldrin from dissolved phase. The conventional knowledge in ground water transport of organochlorine insecticides is generally based on the concepts of phase partitioning due to varying degrees of insecticide/organic carbon sorption characteristics and water solubility. The rationale is that mass-wise, the bulk of the contaminant is adsorbed or "held" up by soil organics such as fulvic acid, tannic acid, humic acid, etc. Therefore, ground water impacts of organochlorine insecticides represent the relatively small mass which is leached beyond the soil zones in dissolved form (solubility limit). Within this perspective, the contaminant source which resides in the soil/root zone is static and aqueous-phase solute transport is the primary mechanism for ground water contamination.

However, the mode of transport for dieldrin in ground water may not be restricted to aqueous-phase transport process. The concept of colloidal transport in sandy soils/sediments has been demonstrated from published literature (**Section 7.6 -- Geochemical Behavior of Dieldrin in the Environment**). Also, it has been shown in published literature, that hydrophobic compounds such as dieldrin has an affinity to adsorb onto colloidal fractions. The sorption of dieldrin to colloids and colloidal transport has important ramifications for the following reasons: (1) the generation of colloids in the near subsurface environment (soil/root/vadose zones) and subsequent removal by pore water into the aquifer implies a second transport process is active and contributing to the aquifer contamination in addition to the dissolved phase contribution; (2) there is a possibility of competition in the sorption of dieldrin between colloids and GAC during the filtration process. The implication is that the GAC may not be efficient in removing dieldrin/colloidal fractions; (3) although the GAC filters are designed specifically to remove hydrophobic contaminants such as dieldrin, they also filter sediments which restricts the flow of water. Therefore, the GAC filters are routinely purged and backwashed. The purged sediments and turbid water from the GAC filter are disposed at the well site. In this regard, there is a potential to perpetuate the contamination problem at the well site if the purged product contains dieldrin.

9.0.2.3 Ground Water Hydraulics and Dieldrin Distribution

The dieldrin problem at Corry Station is best understood when placed within the context of the ground water framework. Ground water flow in porous media is governed by the aquifer hydraulic pressure gradient which commonly is translated as the ground water head gradient, where ground water flows towards areas of lower hydraulic pressure or head. Given the hydraulic conductivity of the aquifer medium and the effective porosity, in addition to the head gradient, a linear average ground water velocity can be formulated. This is the basis of Darcian flow which is the fundamental concept in ground water hydraulics of porous media.

The phenomenon of contaminant migration in porous media is governed by 2 known processes of advection and dispersion. In advective transport, contaminants move with the average linear ground water velocity and in the direction of ground water flow. Because of the heterogeneity in geologic media, contaminants spread due to local velocities which deviate from the average linear ground water velocity. To a lesser extent, contaminant spread is also governed by molecular diffusion. This phenomenon of contaminant spreading, due to aquifer heterogeneity and diffusion, is known as dispersion. Because the precursor to transport processes is ground water flow, it is important to understand the local hydrogeologic framework in order to gain a maximum benefit from the contamination assessment.

The potentiometric surface for the deeper zone (MPZ) of the aquifer under non-pumping condition is shown in Figure 9-1. The surface is generated from a calibrated and verified three-dimensional ground water model which was recently completed as part of a county-wide ground water model development. As shown by the ground water head contours, the general head gradient and therefore, the direction of flow is generally north to south and towards natural discharge areas (Bayou Chico, Bayou Grande, Pensacola Bay, etc.). This scenario is a simulation with the discharge wells at Corry Station turned off.

In Figure 9-2, the potentiometric surface for the MPZ represents the aquifer under stressed or pumping conditions. Again, the scenario is a simulation from the three-dimensional ground water model. Under stressed conditions, the ground water flow at Corry Station changes significantly relative to the previous scenario. Ground water flow is radial to the pumping centers at Corry Station and the zones of influence extend outward and beyond Corry Station property boundary. Since ground water withdrawal at Corry Station is continuous on a daily basis, the ground water scenario as presented by this simulations representative of current conditions in the area.

The current interpretation of the extent of the dieldrin contamination is essentially limited to the dieldrin sampling data of the production wells at Corry Station (**Section 7.4 -- Existing Data**). Basically, the dieldrin monitoring effort was restricted to an area approximating an inverted "L" transect along the northern boundary and the eastern boundary of Corry Station. Within this area, the highest levels of dieldrin were observed in Corry #8 and Corry #7, the former being the highest. The dieldrin concentrations attenuated rapidly with distance. The concentrations in Corry # 11, etc. were in the order of magnitude less (Figure 7-1).

From the historical sampling evidence, a logical perspective is that the extent of the dieldrin is restricted to the northeast corner of the Corry Station; the "hotspot" being the immediate area of Corry #8. However, in applying the ground water framework as discussed above, the possibility of a dieldrin source northeast of Corry Station cannot be discounted. The concept is based on the historically high concentrations observed at Corry #8 and the simulated potetiometric surface under pumping conditions (Figure 9.2). In addition, the flow gradient, in the general area south of Corry #10 and southwest of Corry #7 where dieldrin concentration data is lacking, is towared Corry #7 and Corry #8. Therefore, there exists a possibility that this area southwest of Corry #7 is contributing to the dieldrin contamination and that the distribution of dieldrin in the aquifer may be larger than currently percieved.

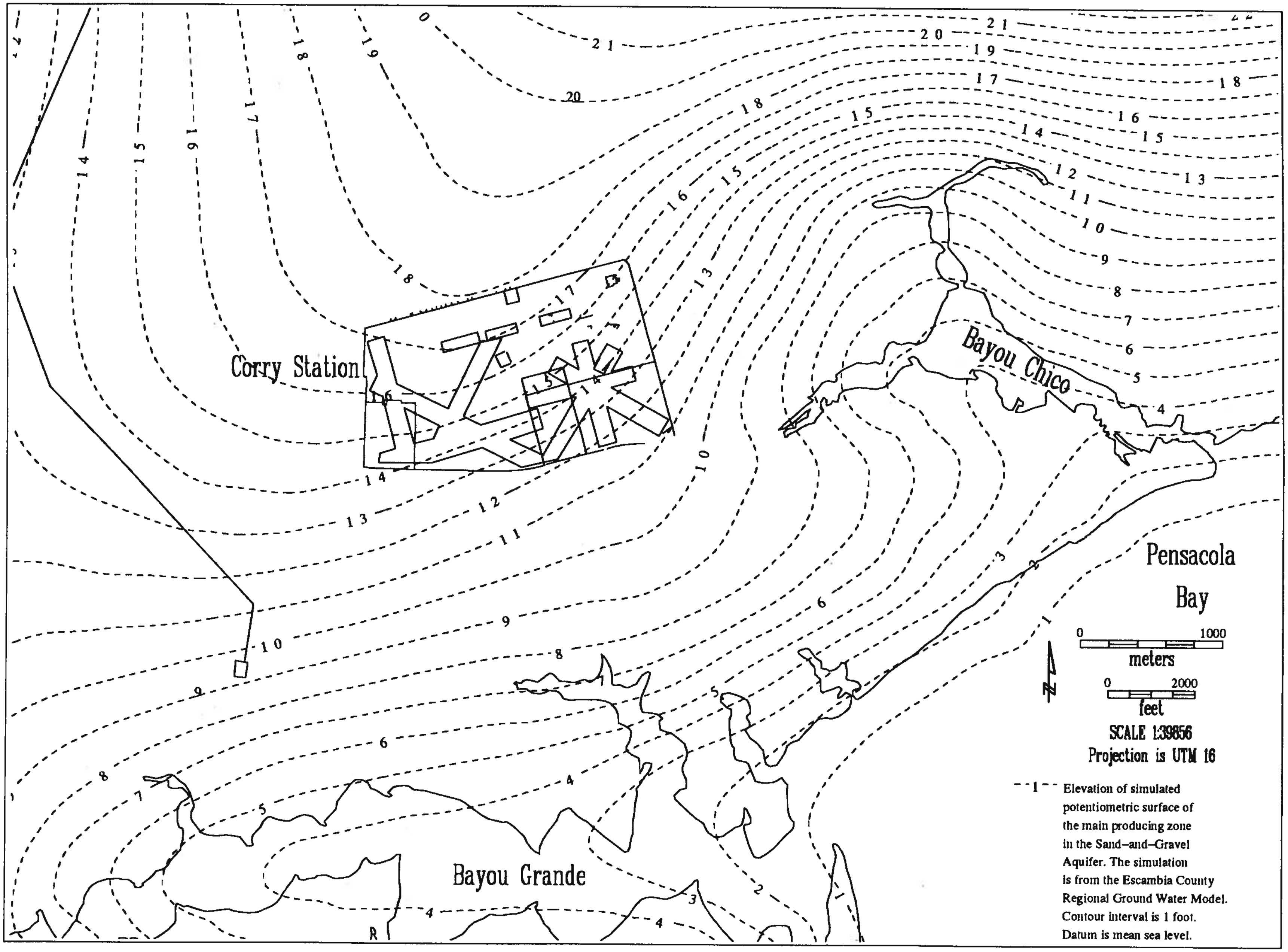

Figure 9–1. Simulated Potentiometric Surface of the MPZ Under Non–Pumping Conditions.

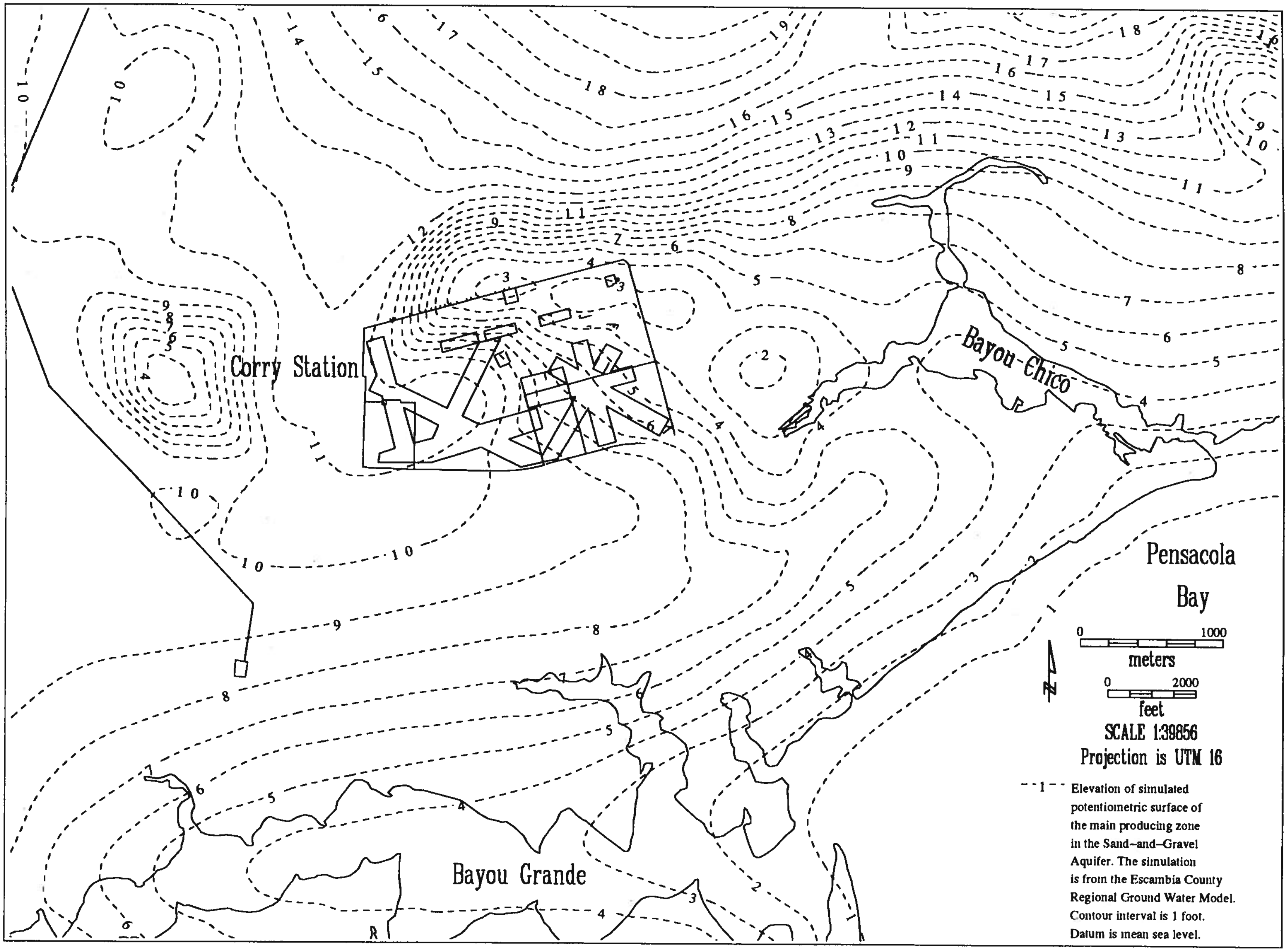

Figure 9-2. Simulated Potentiometric Surface of the MPZ Under Pumping Conditions.

9.0.3 Assessment Methodology

Based on the current perception of the dieldrin problem, the northeast area of Corry Station is the logical and rational area to initiate the field activities. The principal methodology for the investigation is in the form of field data collection activities. The data collection activities are organized within the context of site-specific assessments. The site-specific assessments are developed to address specific investigative issues identified in the conceptual model to the dieldrin problem. These issues are as follows:

(1) Source characterization based on land use activities.

(2) Source characterization based on accidental spills/leaks.

(3) Source characterization based on dieldrin contribution outside Corry Station.

(4) Source characterization based on current GAC filter maintenance operations.

(5) Refinement of the dieldrin distribution within Corry Station.

(6) Refinement of the site hydrogeology.

There are 7 site-specific assessments. Each assessment is designed to gain insight to a specific issue as listed above. The approach of the investigation is such that the site-specific assessments are independent from each other, therefore, each assessment is essentially an investigation in itself. Within each assessment, there is a serial order of work tasks. The primary work task within each site-specific assessment targets the best perceived means to answer the particular issue of the assessment. In the event there is a basis for additional activities within the site-specific assessment, those activities are identified and will require work plan modifications.

The format of each site-specific assessment is organized as listed below:

(1) A brief discussion of the investigative issue is presented. The discussion targets specific areas and the basis for the investigation.

(2) The objective of the assessment is determined.

(3) The technical approach of the assessment is discussed. The technical approach briefly presents the nature of the work tasks required to address the objective.

(4) Planned activities are specified. The planned activities are the primary work task(s) for the assessment. The section specifies the exact type of field and analytical work tasks planned for the assessment.

(5) Other activities are defined. In the event, there is a definitive basis to progress the investigation beyond the primary work level, additional work tasks are defined. These work tasks are contingent upon the results and interpretations made from the efforts of the primary activity. The additional work tasks will require a work plan modification.

In the absence of documented and definitive evidence of specific dieldrin source(s) (as discussed in the Conceptual Model), the site-specific assessments target areas which are perceived to be potential sources based on best available information and reasoning. Without having to perform a costly operation of "uprooting" Corry Station, it was determined that the site-specific assessment approach was reasonable. In this regard, the investigative approach of the assessments is to gather information and interpret the possibility of the targeted area as a contributing source to the dieldrin problem (source characterization). The function of the assessment, then, is fundamentally a screening tool. Hence, the primary planned activities developed for each assessment are based on a scientific premise of obtaining a maximum benefit from a cost-effective representation of work tasks. It is anticipated that through the efforts of the Phase II site-specific assessments, contributing areas to the dieldrin problem will be identified. For instance, is there dieldrin contribution from outside of Corry Station? Is there a contribution from the football field (Corry Station # 3739)? Is dieldrin migrating from the southwest area of Corry Station where monitoring efforts are currently absent?; and so on. It was deemed logical to approach the investigation in such means to answer these issues first. From this basis, the additional work activities which are defined in each assessment are, in essence, efforts to more accurately locate specific source areas.

The spatial area targeted by each assessment is given in Figure 9-3. The site-specific assessments are outlined in Table 9-1. The assessments are presented in **Section 9.1 -- Northeast Perimeter Assessment** through **Section 9.7 -- Potable Supply Assessment**.

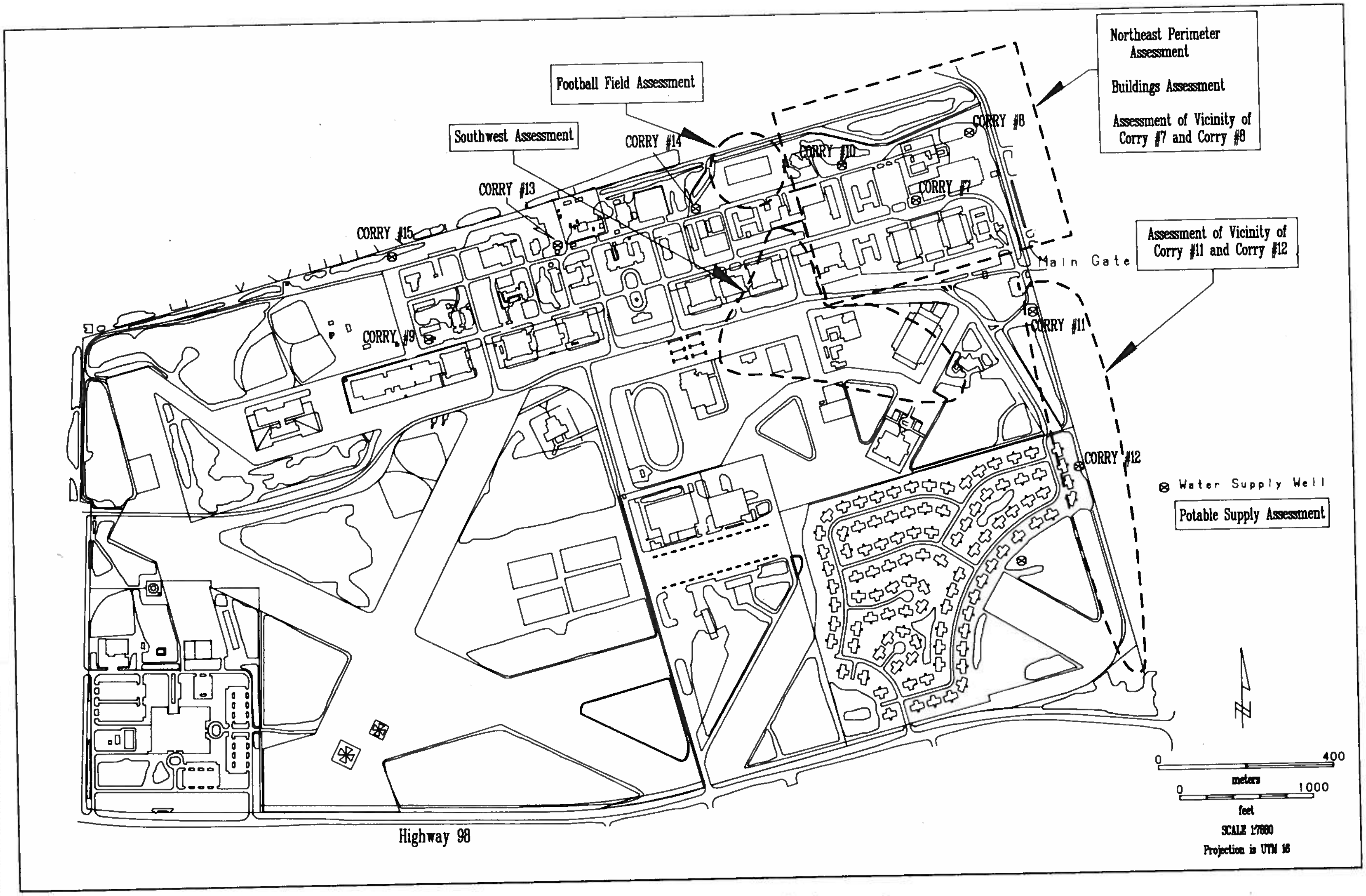

Figure 9-3. Targeted Areas for the Site-Specific Assessments.

TABLE 9-1

SITE-SPECIFIC ASSESSMENTS

Section	Assessment	Purpose	Site #
9.1	Northeast Perimeter Assessment	Dieldrin distribution, Source characterization	1
9.2	Buildings Assessment	Source characterization	2
9.3	Football Field Assessment	Dieldrin distribution, Source characterization	3
9.4	Assessment in the Vicinity of Corry Wells #7 and #8	Dieldrin distribution, Source characterization	4
9.5	Southwest Assessment	Dieldrin distribution, Source characterization	5
9.6	Assessment in the Vicinity of Corry Wells #11 and #12	Dieldrin, benzene, and tetrachloroethlyene distribution, Source characterization	6
9.7	Potable Supply Assessment	Dieldrin distribution, Source characterization, Mode of transport characterization	7

9.1 Northeast Perimeter Assessment

Corry #8, located in the far northeast corner of Corry Station, shows the highest concentrations of dieldrin. Dieldrin concentrations decrease significantly to the west and south (Figure 7-1) indicating the primary source(s) of the dieldrin contamination may be located to the northeast of Corry #8. The land area northeast of Corry #8 is privately owned and consists primarily of residential (single and multi-family) and commercial land use. Dieldrin has likely been applied in these areas to control termites and fire ants. Accordingly, these areas, which are located directly upgradient of Corry #8 (Figure 9-2) are potential source areas.

9.1.1 Objective

The primary objective of the northeast perimeter assessment is to determine if the area northeast of Corry Station is contributing to the relatively high levels of dieldrin contamination found in Corry #8. The northeast perimeter assessment will also aid in determining the distribution of the dieldrin in the ground water and aid in the establishment of contaminant concentration gradients.

9.1.2 Technical Approach

Corry #8 exhibits the highest concentrations of dieldrin. Since all wells are utilized on a regular basis, it is assumed Corry #8 is the production well closest to the primary source(s). In order to determine if contamination is migrating from off-base areas northeast of Corry Station, a series of monitor wells will be constructed and sampled.

Ground water gradients within the MPZ in the immediate area northeast of Corry Station is toward Corry #8 (Figure 9-2). Although not verified, ground water gradients within the SZ are also expected to be towards Corry #8. This is expected due to the extremely leaky nature of the LPZ and the expected influence of the MPZ withdrawal rates of the Corry Station wellfield on the SZ. In order to determine if contaminants are migrating laterally from areas northeast of Corry Station, both the SZ and the MPZ will need to be monitored.

Detection of dieldrin in these ground water samples will indicate the presence of a source to the northeast of the Corry Station wellfield. No attempt to specifically identify any potential source(s) northeast of Corry Station is included as part of this work plan. If the presence of a source is indicated northeast of Corry Station, a work plan modification will be recommended. Additional recommended work includes locating and sampling approximately 6 existing lawn irrigation wells and the installation of approximately 12 new monitor wells. A search of the NWFWMD records show the existence of numerous 2-inch and 4-inch, privately-owned irrigation wells located immediately to the north and east of the Corry Station. All of these irrigation wells are relatively shallow and completed in the SZ. Sample analysis from approximately 6 of these wells will assess the impact of this land use (single/multi-family residential and commercial land use) on the ground water resource and determine if the dieldrin contamination is due to widespread application in these areas. Installation and sampling of the 12 additional monitor wells to the northeast of Corry Station would be intended to determine the distribution of the dieldrin in the MPZ and possibly be sufficient to identify the type of source (point or multiple point/nonpoint) and specific source areas.

9.1.3 Planned Activities

Construction and sampling of monitor wells along the northeast perimeter of Corry Station, directly upgradient of Corry #8 is planned. Eight wells completed in the SZ and 8 wells completed in the MPZ are required. Wells will be installed in pairs: 1 SZ and 1 MPZ well constructed at each of 8 sites as shown in Figure 9-4. Spacing between sites is approximately 300 ft. Due to the extreme northeast location of Corry #8 and the presence of electric utility lines, some of these sites will be located beyond the property boundaries of Corry Station. Based on available well and lithology information obtained from Corry #8, #10(#3A), #3(B) and #4(C), the recommended screened interval for the MPZ wells is 140 to 210 ft below land surface (Navy Department Bureau of Yards and Docks drawing #659249, #659130 and NAS drawing #4997). The recommended screened interval for the SZ wells is 30 to 55 ft below land surface. Well construction specifications and geophysical logging/split spoon sampling requirements are provided in Table 9-2. Monitor well construction will follow technical guidance found in **Section 8.3 -- Well Installation** and in **Appendix B -- Guidelines for Ground Water Monitor Well Construction**. Subsequent to well completion and development, each well will be sampled and analyzed for parameters as specified in Table 9-3.

9.1.4 Other Activities

If dieldrin contamination is detected, sampling of existing irrigation wells and construction of additional wells as outlined above **(Section 9.1.2 -- Technical Approach)**, is recommended and should be incorporated in a work plan modification.

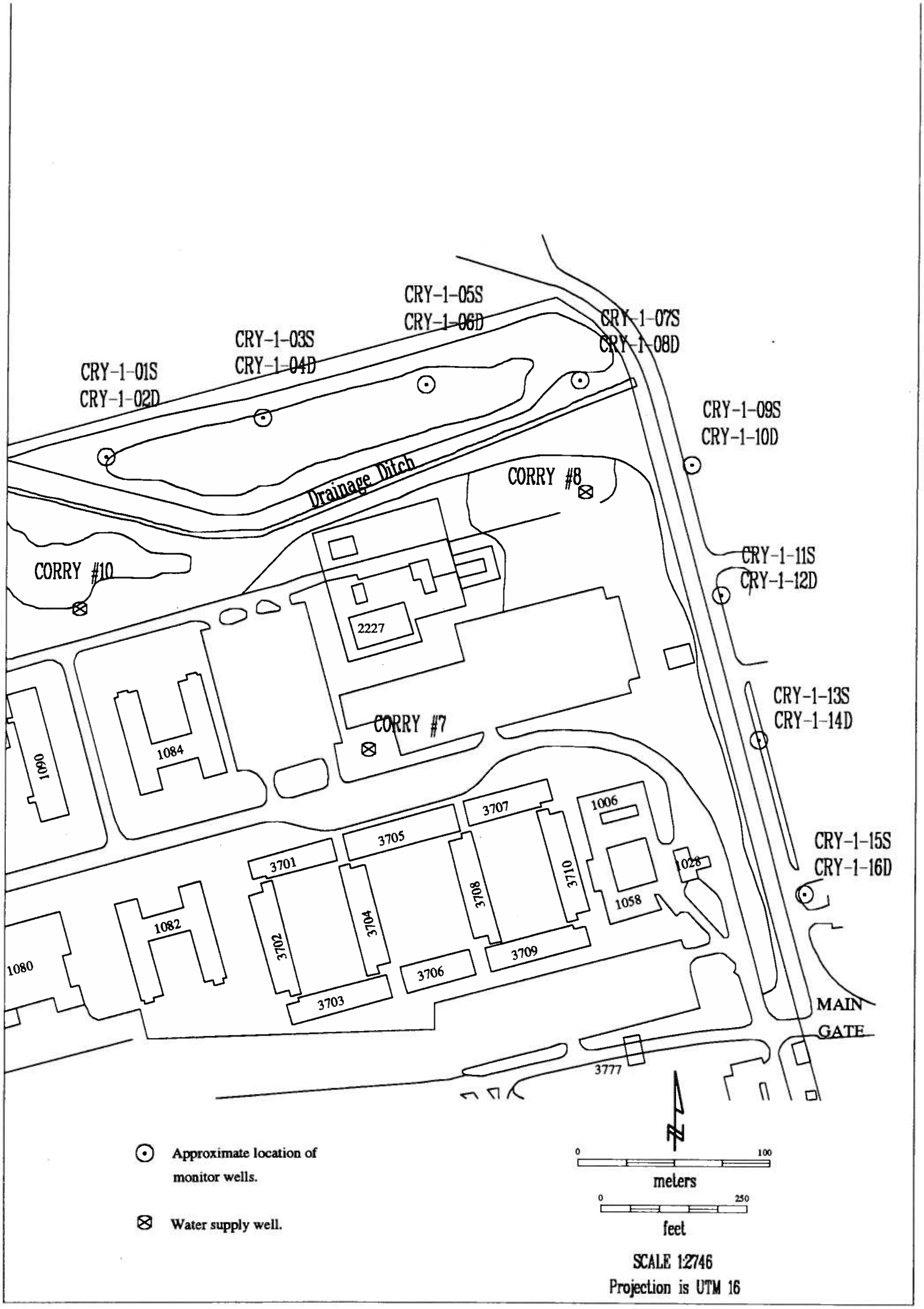

Figure 9-4. Northeast Perimeter Assessment.

TABLE 9-2

PHASE II WELL CONSTRUCTION SPECIFICATION -- NORTHEAST PERIMETER ASSESSMENT

Well Number	Estimated Depth (ft)	Well Diameter (in)	Screen Interval (ft)	Geophysical Log[2]	Deep Soil Sampling (Split spoon)
CRY-1-01S	55	4	30-55		No
CRY-1-02D	210	4	140-210	j,e,i,c	Yes[1]
CRY-1-03S	55	4	30-55		No
CRY-1-04D	210	4	140-210	j	No
CRY-1-05S	55	4	30-55		No
CRY-1-06D	210	4	140-210	j	No
CRY-1-07S	55	4	30-55		No
CRY-1-08D	210	4	140-210	j	No
CRY-1-09S	55	4	30-55		No
CRY-1-10D	210	4	140-210	j	No
CRY-1-11S	55	4	30-55		No
CRY-1-12D	210	4	140-210	j	No
CRY-1-13S	55	4	30-55		No
CRY-1-14D	210	4	140-210	j,e,i,c	Yes[1]
CRY-1-15S	55	4	30-55		No
CRY-1-16D	210	4	140-210	j	No

notes: Surface casing only utilized if conditions warrant (Section 8.3.4 Surface Casing).
1. Splitspoon sampling intervals: 25ft, 40ft, 65ft, 90ft, 150ft, 180ft.
2. j = natural gamma
e = 16, 64 normal electric
i = spontaneous potential
c = caliper

TABLE 9-3

PHASE II SAMPLING AND ANALYTICAL PLAN -- NORTHEAST PERIMETER ASSESSMENT

Well/Boring Number	Sample ID Number	Sample Type(1)	Parameter Group(2),(3)
CRY-1-01S	CRY-1-01S-1	w	A,B
CRY-1-02D	CRY-1-02D-1	w	A,B
CRY-1-03S	CRY-1-03S-1	w	A,B
CRY-1-04D	CRY-1-04D-1	w	A,B
CRY-1-05S	CRY-1-05S-1	w	A,B
CRY-1-06D	CRY-1-06D-1	w	A,B
CRY-1-07S	CRY-1-07S-1	w	A,B,C,D
CRY-1-08D	CRY-1-08D-1	w	A,B,C,D
CRY-1-09S	CRY-1-09S-1	w	A,B
CRY-1-10D	CRY-1-10D-1	w	A,B
CRY-1-11S	CRY-1-11S-1	w	A,B
CRY-1-12D	CRY-1-12D-1	w	A,B
CRY-1-13S	CRY-1-13S-1	w	A,B
CRY-1-14D	CRY-1-14D-1	w	A,B
CRY-1-15S	CRY-1-15S-1	w	A,B,C,D
CRY-1-16D	CRY-1-16D-1	w	A,B,C,D
CRY-1-02D	CRY-1-02D-B25	ds @ 25	G
CRY-1-02D	CRY-1-02D-B40	ds @ 40	G
CRY-1-02D	CRY-1-02D-B65	ds @ 65	G
CRY-1-02D	CRY-1-02D-B90	ds @ 90	G
CRY-1-02D	CRY-1-02D-B150	ds @ 150	G
CRY-1-02D	CRY-1-02D-B180	ds @ 180	G
CRY-1-14D	CRY-1-14D-B25	ds @ 25	G
CRY-1-14D	CRY-1-14D-B40	ds @ 40	G
CRY-1-14D	CRY-1-14D-B65	ds @ 65	G
CRY-1-14D	CRY-1-14D-B90	ds @ 90	G
CRY-1-14D	CRY-1-14D-B150	ds @ 150	G
CRY-1-14D	CRY-1-14D-B180	ds @ 180	G

note:

(1). w = water
ss = shallow soil
ds @ 25 ft = deep soil (split spoon) at designated depth.

(2). If OVA indicates VOC contamination of sediments monitored during well construction, VOC analysis (Method 624) will be included.

(3). Group parameters are listed in Appendix C.

9.2 Buildings Assessment

The Records Search/Interview process (**Section 7.3 -- Records Search/Interviews**) identified the major buildings at Corry Station as possible sources of dieldrin. For some of the buildings, dieldrin may have been used as a below-slab control for subterranean termites. Based on available records, it was not possible to determine which buildings, if any, actually received dieldrin at time of construction. However, specifications in place at the time of construction indicate it is possible dieldrin was used on some of the buildings. If it was used as a toxicant, the quantities involved would be rather large. Estimates indicate that toxicant quantities as great as 5 pounds of toxicant per 1,000 ft^2 of slab area were used for control of termites (**Section 7.4 -- Existing Data**).

Records indicate that a number of buildings (Buildings 3701-3710, 1080, 1084, 1082, and 1090) were constructed in the vicinity of Corry #7 and #8 during the period 1966 through 1975. These buildings are used primarily for housing and have an aggregate square footage of approximately 150,000 ft^2. As they are the largest buildings in the immediate vicinity of Corry #7 and #8 meeting the time criteria (constructed between 1948 and 1987), they were selected for investigation as a part of the Buildings Assessment.

9.2.1 Objective

It is the objective of the Phase II Buildings Assessment to determine whether or not leaching of dieldrin from the perimeter of buildings is affecting nearby potable supply wells.

9.2.2 Technical Approach

The technical approach for the Phase II Buildings Assessment will consist of soil borings and sampling. The objective is to determine if dieldrin was used on these structures as a termite control toxicant and if these structures are possibly contributing to the present ground water contamination. Of particular interest is whether or not dieldrin is leaching from points of application along the perimeter of these buildings. This will be determined by examining for the presence of dieldrin in the soils. If dieldrin is detected in the soils, SZ ground water wells and sampling in the immediate vicinity of these buildings will be recommended

9.2.3 Planned Activities

Field activities planned for this assessment is soils sampling along the perimeter of each of the 5 identified buildings or building complexes (Table 9-4 and Figure 9-5). In the case of a single building, a total of 4 soil borings will be performed. A boring will be performed on each side of the building. Borings will be conducted in each of 2 specific areas along the building perimeter; beneath downspouts (high infiltration areas) and away from downspouts (low infiltration areas). Two borings will be performed in the high infiltration area and 2 in the low infiltration area. In this manner the relative degree of leaching of any toxicants can be assessed. In all cases, the borings will be performed as close to the building as possible, in order to sample the trench in which the foundation footing was constructed (see **Section 7.3 -- Records Search/Interviews**).

In the case of the building complex 3701-3710, a total of 8 borings will be performed. They will be performed in this manner; 3 on the north side of the complex, 1 on either end, and 3 on the south side of the complex. The total of 8 borings will be divided equally among low and high infiltration sites.

Sampling of borings will be conducted as per **Section 8.1 -- Soil Sampling**. Each sample will be composited and analyzed as specified in Tables 9-4 and 9-5.

9.2.4 Other Activities

If the presence of dieldrin in soils is confirmed, contamination of the SZ will be investigated via monitoring wells. Preliminary plans for implementing this activity include installation and sampling of, in the case of a single building, a single SZ well on the down gradient side of the building. In the case of the building complex 3701-3710, 3 SZ monitoring wells are planned: 2 on the north, down gradient side of the building complex and 1 on the south, upgradient side of the complex. SZ monitoring is beyond the scope of Phase II, and planning and implementation of this activity will require a work plan modification.

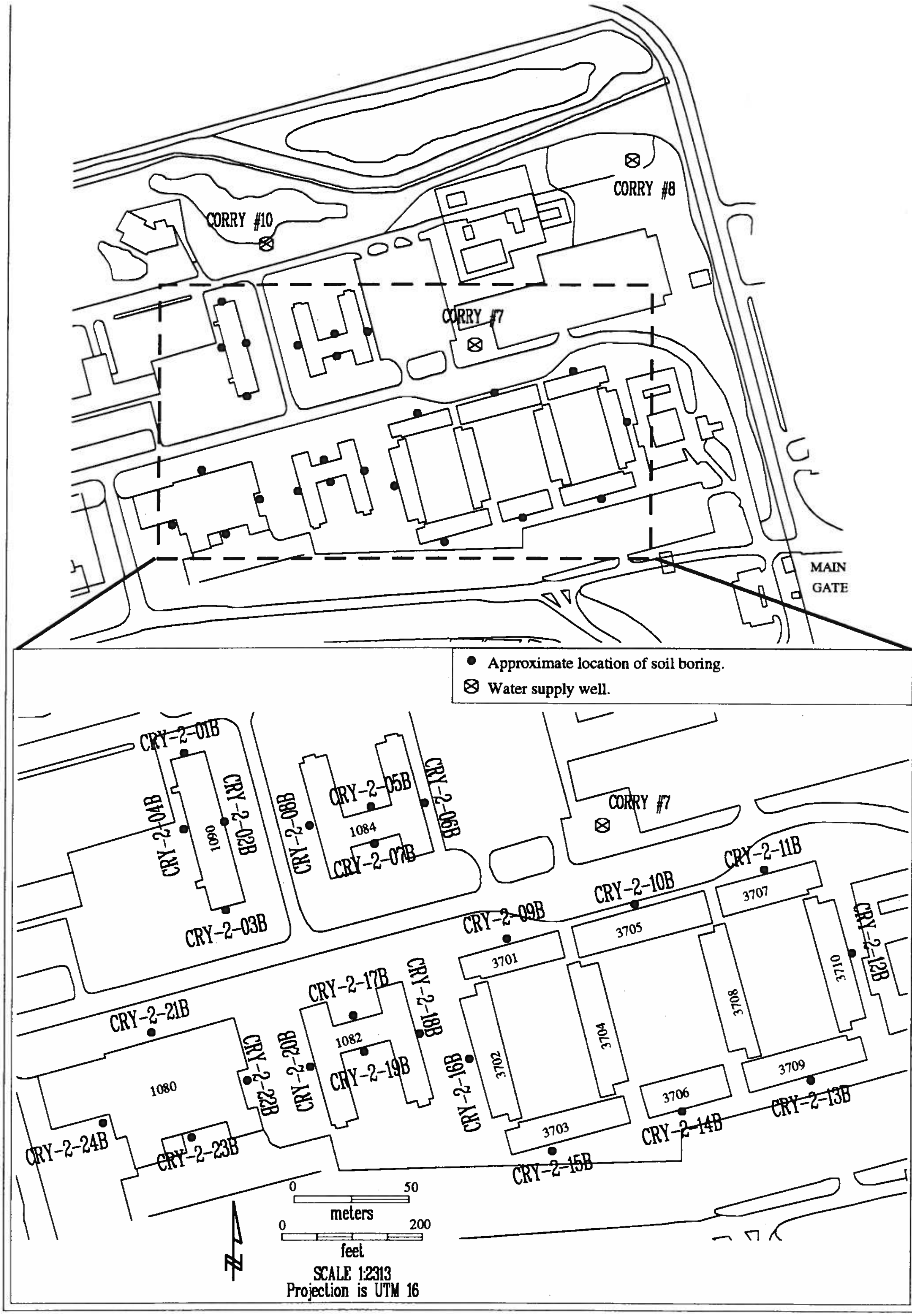

Figure 9-5. Buildings Assessment.

TABLE 9-4

PHASE II SHALLOW SOIL BORING SPECIFICATION -- BUILDINGS ASSESSMENT

BORING NUMBER	ESTIMATED DEPTH (FT)[1]
CRY-2-01B	3
CRY-2-02B	3
CRY-2-03B	3
CRY-2-04B	3
CRY-2-05B	3
CRY-2-06B	3
CRY-2-07B	3
CRY-2-08B	3
CRY-2-09B	3
CRY-2-10B	3
CRY-2-11B	3
CRY-2-12B	3
CRY-2-13B	3
CRY-2-14B	3
CRY-2-15B	3
CRY-2-16B	3
CRY-2-17B	3
CRY-2-18B	3
CRY-2-19B	3
CRY-2-20B	3
CRY-2-21B	3
CRY-2-22B	3
CRY-2-23B	3
CRY-2-24B	3

notes:

1. Composite shallow soil sample representative of 6, 12, 18, 24, 30, 36-inch depths.

TABLE 9-5

PHASE II SAMPLING AND ANALYTICAL PLAN -- BUILDINGS ASSESSMENT

Well/Boring Number	Sample ID Number	Sample Type(1)	Parameter Group(2)
CRY-2-01B	CRY-2-01B-1	ss	E
CRY-2-02B	CRY-2-02B-1	ss	E
CRY-2-03B	CRY-2-03B-1	ss	E
CRY-2-04B	CRY-2-04B-1	ss	E
CRY-2-05B	CRY-2-05B-1	ss	E
CRY-2-06B	CRY-2-06B-1	ss	E
CRY-2-07B	CRY-2-07B-1	ss	E
CRY-2-08B	CRY-2-08B-1	ss	E
CRY-2-09B	CRY-2-09B-1	ss	E
CRY-2-10B	CRY-2-10B-1	ss	E
CRY-2-11B	CRY-2-11B-1	ss	E
CRY-2-12B	CRY-2-12B-1	ss	E
CRY-2-13B	CRY-2-13B-1	ss	E
CRY-2-14B	CRY-2-14B-1	ss	E
CRY-2-15B	CRY-2-15B-1	ss	E
CRY-2-16B	CRY-2-16B-1	ss	E
CRY-2-17B	CRY-2-17B-1	ss	E
CRY-2-18B	CRY-2-18B-1	ss	E
CRY-2-19B	CRY-2-19B-1	ss	E
CRY-2-20B	CRY-2-20B-1	ss	E
CRY-2-21B	CRY-2-21B-1	ss	E
CRY-2-22B	CRY-2-22B-1	ss	E
CRY-2-23B	CRY-2-23B-1	ss	E
CRY-2-24B	CRY-2-24B-1	ss	E

note:

(1). w = water
ss = shallow soil
ds @ 25 ft = deep soil (split spoon) at designated depth.

(2). Group parameters are listed in Appendix C.

9.3 Football Field Assessment

The Records Search/Interview process (**Section 7.3 -- Records Search/Interviews**) identified the football field (structure 3739, Figure 9-6) as a place of dieldrin application. Given the nature of dieldrin application at this site (spot treatment to control ants), it is not possible to determine with certainty points of dieldrin application. It is possible, however, that dieldrin application is affecting ground water quality in the vicinity of the football field. Of particular interest are Corry #10 and #14, located approximately 600 ft southeast and 500 ft southwest, respectively, from the football field. These are the public supply wells nearest the football field and which have low levels of dieldrin (**Section 7.4 -- Existing Data**).

9.3.1 Objective

It is the objective of the football field assessment to determine whether or not nonpoint application of dieldrin on the football field is affecting nearby potable supply wells.

9.3.2 Technical Approach

The technical approach for the Phase II Football Field Assessment will involve construction and sampling of SZ wells. If dieldrin has moved from the point of application at land surface into the MPZ, it is reasonable to expect that the SZ has been affected. Accordingly, in an effort to eliminate the football field as a source of dieldrin contamination with the least possible effort, it is planned to sample the SZ in the vicinity of the football field, via monitoring wells.

Pending the outcome of SZ sampling, soil sampling on the football field may be required. This activity is not included in Phase II. If SZ sampling demonstrates the need for soil sampling, detailed planning for this activity will constitute a work plan modification.

9.3.3 Planned Activities

The first action at this site consists of construction of a SZ monitoring well on the southeast and southwest corners of the football field as shown in Figure 9-6. Each SZ well will be constructed to a total depth of approximately 55 ft; with 30 ft of casing and 25 ft of screen, placing the screen top approximately 20 ft below the water table. SZ monitoring well construction which results in the well screen straddling the water table will be avoided. Well construction specifications and geophysical logging/split spoon sampling requirements are provided in Table 9-6. SZ monitor well construction will follow technical guidance found in **Section 8.3 -- Well Installation** and in **Appendix B -- Guidelines for Ground Water Monitor**

Well Construction. Subsequent to well completion and development, each well will be sampled and analyzed for parameters as specified in Table 9-7.

9.3.4 Other Activities

If contamination of the SZ is verified by SZ monitoring wells, soil sampling on the football field will be implemented. Preliminary plans for implementing this activity include use of a regularly spaced, gridded sampling plan. Soil sampling is beyond the scope of Phase II, planning and implementation will require a work plan modification. Monitoring of the MPZ during Phase II at this site is not planned.

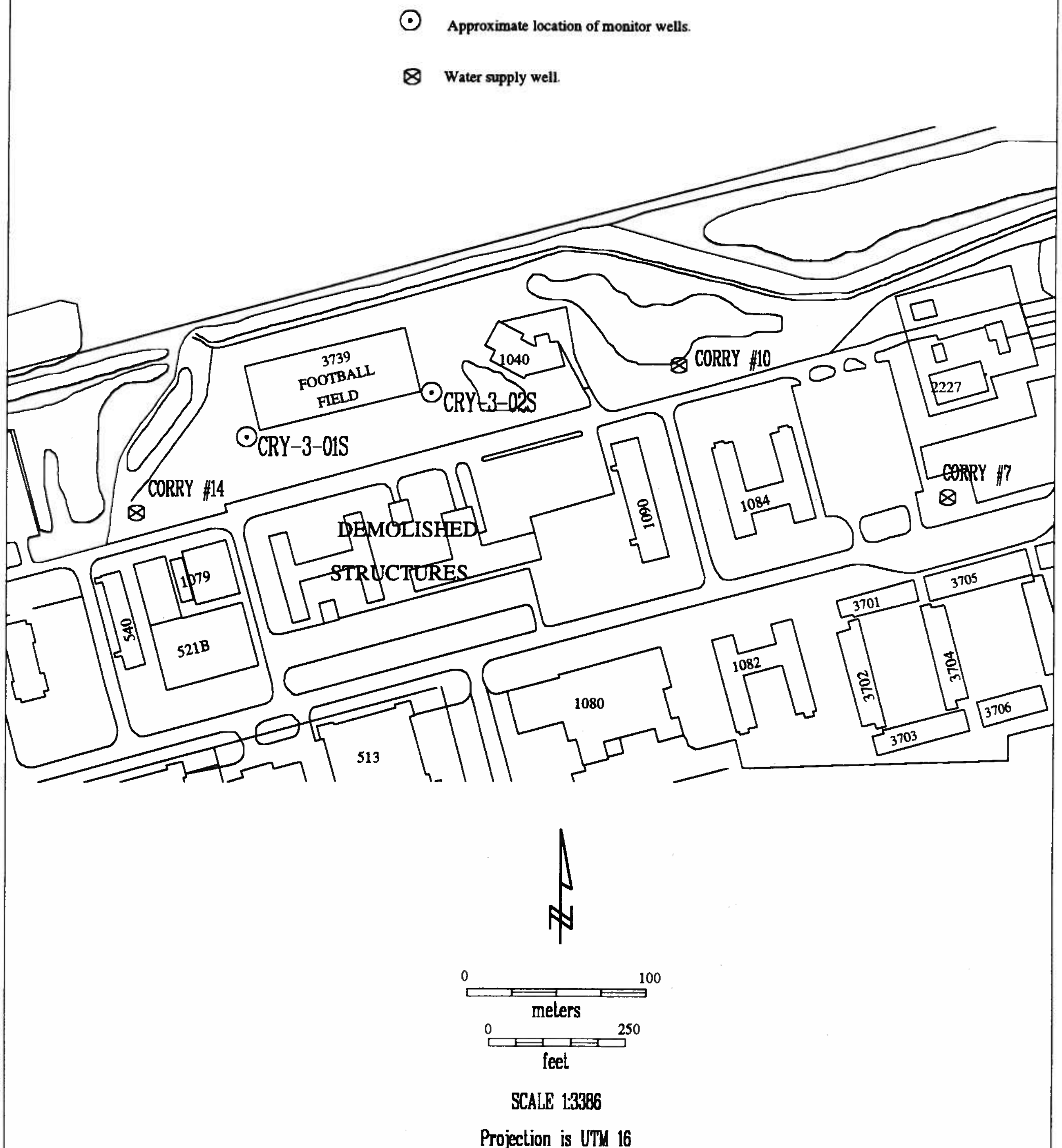

Figure 9-6. Football Field Assessment.

TABLE 9-6

PHASE II WELL CONSTRUCTION SPECIFICATION -- FOOTBALL FIELD ASSESSMENT

Well Number	Estimated Depth (ft)	Well Diameter (in)	Screen Interval (ft)	Geophysical Log[1]	Deep Soil Sampling (Splitspoon)
CRY-3-01S	55	4	30-55	j	No
CRY-3-02S	55	4	30-55	j	No

notes: Surface casing only utilized if conditions warrant (Section 8.3.4 Surface Casing).

1. j = Natural gamma
e = 16, 64 normal electric
i = spontaneous potential
c = caliper

TABLE 9-7

PHASE II SAMPLING AND ANALYTICAL PLAN -- FOOTBALL FIELD ASSESSMENT

Well/Boring Number	Sample I.D. Number	Sample Type(1)	Parameter Group(2),(3)
CRY-3-01S	CRY-3-01S-1	w	A,B,C,D
CRY-3-02S	CRY-3-02S-1	w	A,B

note:

(1). w = water
ss = shallow soil
ds @ 25 ft = deep soil (split spoon) at designated depth.

(2). If OVA indicates VOC contamination of sediments monitored during well construction, VOC analysis (Method 624) will be included.

(3). Group parameters are listed in Appendix C.

9.4 Assessment of the Vicinity of Corry Wells #7 and #8

According to existing water quality data (**Section 7.4 -- Existing Data**), historic dieldrin concentrations observed in Corry #7 and #8 were the highest relative to the concentrations observed in the other existing production wells at Corry Station (Figure 7-1). This assessment addresses the possible presence of the contamination source within the vicinity of Corry #7 and #8. It is anticipated that the assessment will resolve 2 questions: whether there is a dieldrin point source within the vicinity of those wells (i.e., unknown disposal sites, mix/load sites, accidental spills), and/or whether there is a dieldrin plume (originating from elsewhere) within the SZ, which acts as a diffuse source to the contamination observed in the deeper MPZ.

9.4.1 Objective

The objective of the assessment is to determine the presence of dieldrin point source and/or plume source within the vicinity of Corry #7 and #8.

9.4.2 Technical Approach

The technical approach for this Phase II assessment will involve the construction and sampling of SZ wells. If there is a subsurface point source in the vicinity of Corry #7 and #8, it is reasonable to anticipate dieldrin has impacted the Surficial Zone in this area. Likewise, in the event the high levels of dieldrin observed in Corry #7 and #8 are caused by a dieldrin plume within the SZ which acts as a diffuse source, the SZ is the appropriate hydrostratigraphic unit to be monitored. Accordingly, in an effort to eliminate the immediate vicinity of Corry #7 and #8 as a source of dieldrin contamination with the least possible effort, SZ ground water sampling is planned. The monitor well network is designed using a grid geometry to ensure a representative sampling coverage of the SZ ground water within the area.

Pending the outcome of SZ ground water sampling, soil and sediment sampling may be required. This activity is not included in Phase II. If the SZ ground water sampling demonstrates the need for soil/sediment sampling, detailed planning for this activity will constitute a work plan modification.

9.4.3 Planned Activities

The first activity in the assessment consists of construction of 9 SZ wells in the vicinity of Corry #7 and #8. The wells will be placed within 200 ft to 300 ft from each other and the network will be designed within an approximate gridded pattern distribution as shown in Figure 9-7. The network of the 9 SZ wells encompasses an area of approximately 240,000 ft^2. In addition, the sampling results of the 8 SZ wells in **Section 9.1 -- Northeast Perimeter Assessment** will be used to provide a larger sampling coverage for the SZ in the area (Figure 9-4). Therefore, the sampling activities from a total of 17 SZ wells, encompassing an area of approximately 520,000 ft^2, will constitute the analytical basis for investigating the possible presence of a dieldrin source in the vicinity of Corry #7 and Corry #8.

Each SZ well will be constructed to a total depth of approximately 55 ft, with 30 ft of casing and 25 ft of screen. The screen top will be approximately 20 ft below the water table. The bottom of the screen will coincide with the base of the SZ. SZ monitor well construction and geophysical logging/split spoon sampling specifications are presented in Table 9-8. Well construction will follow technical guidance found in **Section 8.3 -- Well Installation** and in **Appendix B -- Guidelines for Ground Water Monitor Well Construction**. Subsequent to well completion and development, each well will be sampled and analyzed for parameters as specified in Table 9-9.

9.4.4 Other Activities

If contamination of the SZ is verified by SZ monitoring wells, soil and sediment sampling activities will be implemented. The development of detailed plans for this activity will be contingent upon the contaminant distribution from the SZ ground water monitoring effort. The planning and implementation of the activity will require a work plan modification.

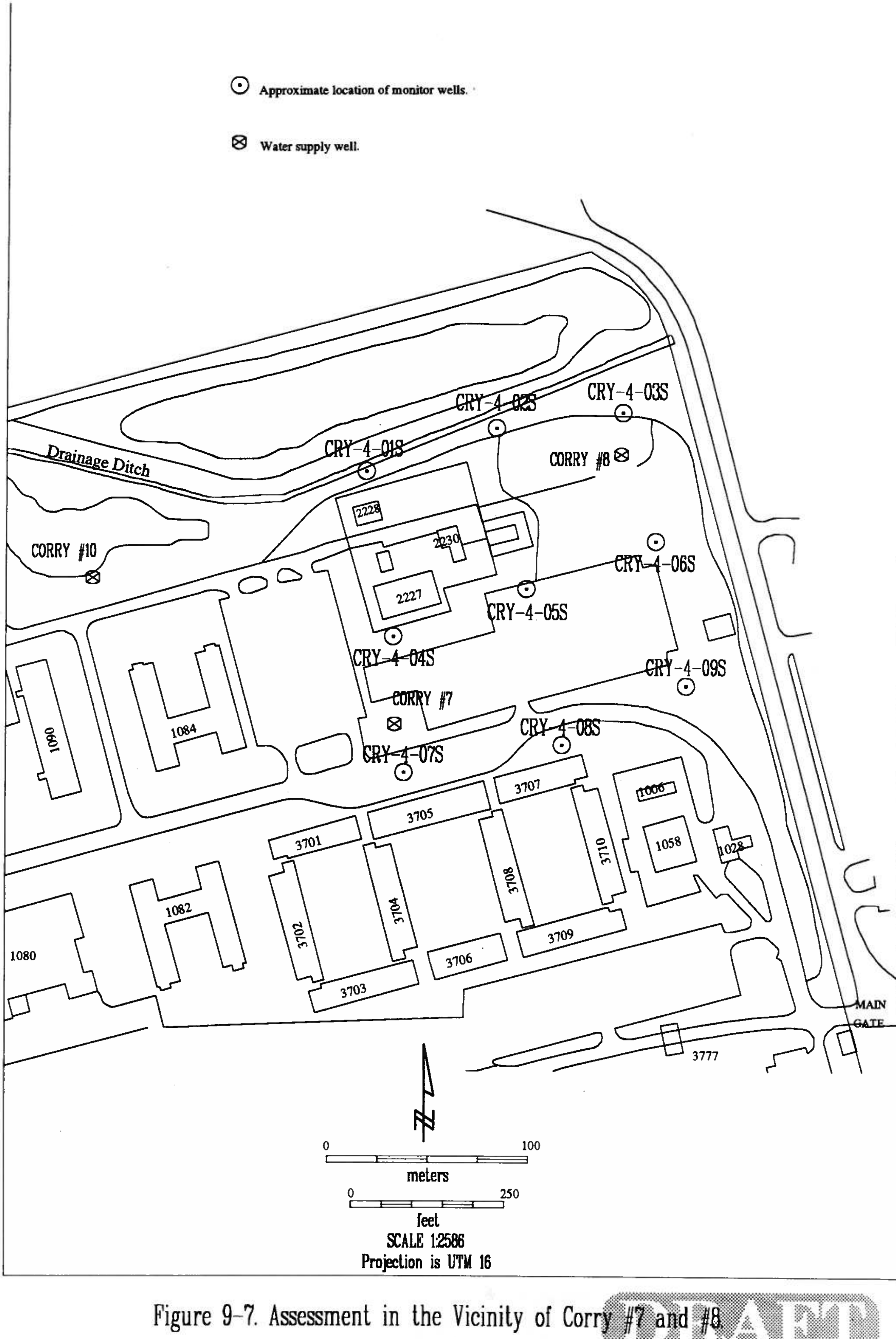

Figure 9-7. Assessment in the Vicinity of Corry #7 and #8

TABLE 9-8

PHASE II WELL CONSTRUCTION SPECIFICATION -- ASSESSMENT IN THE VICINITY OF CORRY #7 AND #8

Well Number	Estimated Depth (ft)	Well Diameter (in)	Screen Interval (ft)	Geophysical Log[1]	Deep Soil Sampling (split spoon)
CRY-4-01S	55	4	30-55	j	No
CRY-4-02S	55	4	30-55	j	No
CRY-4-03S	55	4	30-55	j	No
CRY-4-04S	55	4	30-55	j	No
CRY-4-05S	55	4	30-55	j	No
CRY-4-06S	55	4	30-55	j	No
CRY-4-07S	55	4	30-55	j	No
CRY-4-08S	55	4	30-55	j	No
CRY-4-09S	55	4	30-55	j	No

notes: Surface casing only utilized if conditions warrant (Section 8.3.4 Surface Casing).

1. j = natural gamma
e = 16, 64 normal electric
i = spontaneous potential
c = caliper

TABLE 9-9

PHASE II SAMPLING AND ANALYTICAL PLAN -- ASSESSMENT IN THE VICINITY OF CORRY #7 AND #8

Well/Boring Number	Sample I.D. Number	Sample Type(1)	Parameter Group(2), (3)
CRY-4-01S	CRY-4-01S-1	w	A,B
CRY-4-02S	CRY-4-02S-1	w	A,B
CRY-4-03S	CRY-4-03S-1	w	A,B
CRY-4-04S	CRY-4-04S-1	w	A,B
CRY-4-05S	CRY-4-05S-1	w	A,B
CRY-4-06S	CRY-4-06S-1	w	A,B
CRY-4-07S	CRY-4-07S-1	w	A,B,C
CRY-4-08S	CRY-4-08S-1	w	A,B,C
CRY-4-09S	CRY-4-09S-1	w	A,B,C

note:

(1). w = water
ss = shallow soil
ds @ 25 ft = deep soil (split spoon) at designated depth.

(2). If OVA indicates VOC contamination of sediments monitored during well construction, VOC analysis (Method 624) will be included.

(3). Group parameters are listed in Appendix C.

9.5 Southwest Assessment

As discussed in **Section 7.5 -- Data Deficiencies**, the current conceptualization of the dieldrin distribution in the MPZ is limited to the spatial network of the production wells where dieldrin has been detected. Basically, the dieldrin monitoring effort was restricted to an area approximating an inverted "L" transect along the northern boundary and the eastern boundary of Corry Station (Figure 7-1). In **Section 9.0 -- Site-Specific Assessment -- Phase II**, the modeled potentiometric surface of the MPZ within the sub-regional area of Corry Station is discussed. From the potentiometric surface, it is evident that under ambient non-pumping conditions the ground water flow in the MPZ is generally from north to south direction. However, when the aquifer is stressed with pumpage, the flow gradient changes significantly in the Corry Station area. Generally, the pumpage-induced flow gradient is radial to the pumping centers.

Currently, no data exists with regards to the dieldrin distribution in the MPZ in the general area southwest of Corry #7 and south of Corry #10 and #14. Because there is a flow gradient towards these pumping wells, this "southwest" area will be assessed for the presence of dieldrin in the MPZ. It is anticipated that this assessment will aid in rectifying 2 data deficiencies: defining the spatial extent of dieldrin contamination, and establishing the ground water flow gradients in this area. Currently there is no data available to indicate whether there is a contributing dieldrin source outside the current conceptualized bounds of the known dieldrin distribution.

9.5.1 Objective

The objective is to investigate the MPZ in the southwest area for dieldrin for the purposes of delineating the spatial extent of dieldrin contamination and expanding the multiple-source concept to this area where dieldrin monitoring effort is currently lacking.

9.5.2 Technical Approach

The technical approach for the Phase II Southwest Assessment will involve the construction and sampling of MPZ monitor wells. The MPZ well network is designed by applying a triangulation concept where synoptic sampling data of Corry #10, #14, #7, #11 and the MPZ wells will provide a basis for spatial analysis of dieldrin levels. Because of the pumpage-induced zone of influence from the Corry production wells and the characteristics of the MPZ in dispersing contaminants, it is reasonable to anticipate that the information gathered from existing wells and the MPZ monitor wells will be adequate in assessing the spatial extent of the contamination in this "southwest area".

The purpose of the assessment is to screen or to determine the presence or absence of the contaminant in the southwest area rather than to identify a particular source. Therefore, soil and sediment sampling within the assessment area is not planned.

9.5.3 Planned Activities

The primary activity in the assessment consists of 4 MPZ well construction in the southwest area as shown in Table 9-10. The wells will be placed approximately 800 to 1,000 ft from each other. The addition of sampling data from Corry #10, #14, #7, #11 and the 4 MPZ wells will complete the southwest monitoring network. Each MPZ well will be constructed to a depth of approximately 210 ft; with 140 ft of casing and 70 ft of screen. MPZ monitor well construction and geophysical logging/split spoon sampling specifications are presented in Table 9-10. Well construction will follow technical guidance found in **Section 8.3 -- Well Installation** and in **Appendix B -- Guidelines for Ground Water Monitor Well Construction**. Subsequent to well completion and development, each well will be sampled and analyzed for parameters as specified in Table 9-11.

9.5.4 Other Activities

Activities other than as described above are not planned for the Phase II Southwest Assessment. If the assessment results show a definitive basis for additional activities, the planning and implementation of such activities will require a work plan modification.

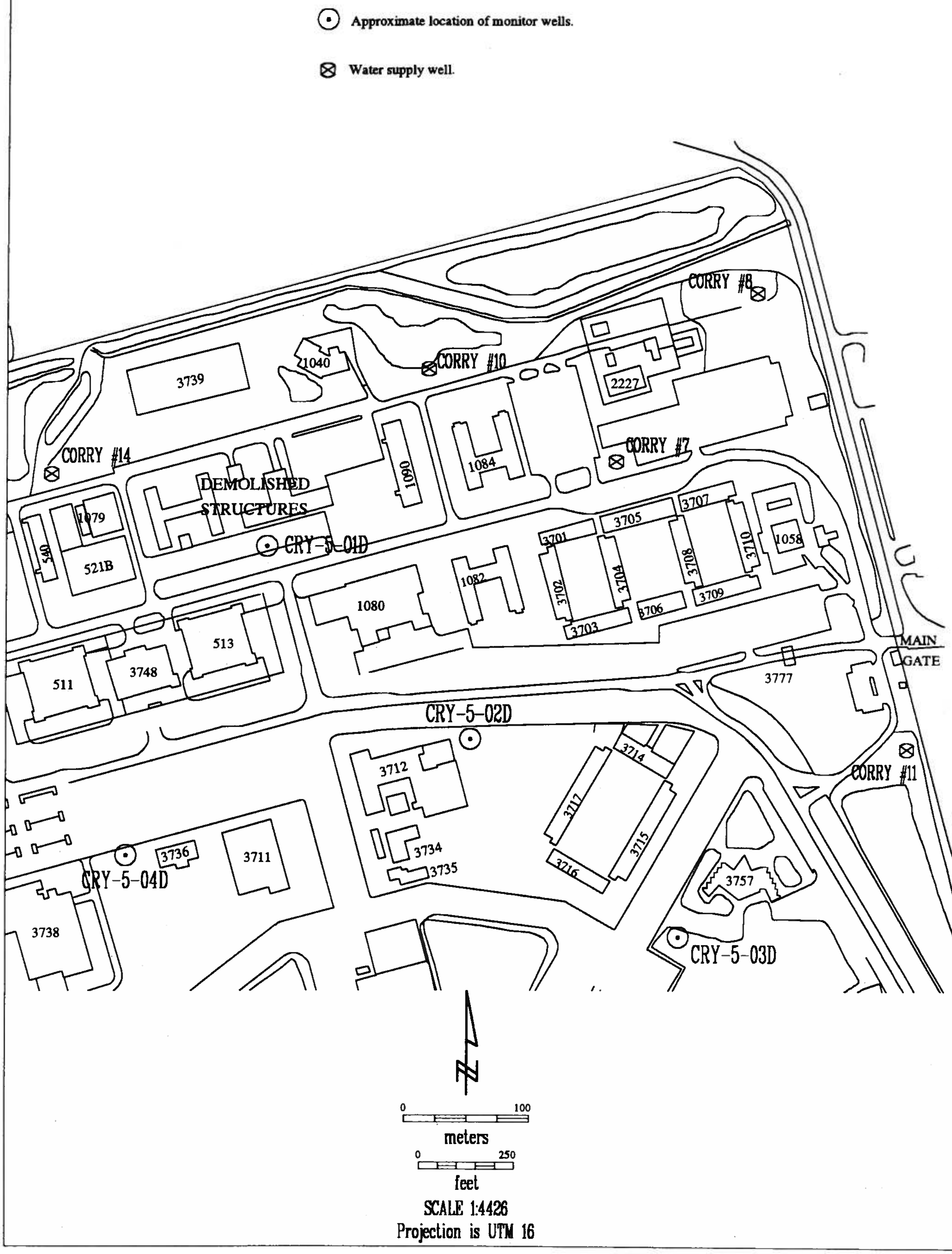

Figure 9-8. Southwest Assessment. DRAFT

TABLE 9-10

PHASE II WELL CONSTRUCTION SPECIFICATION -- SOUTHWEST ASSESSMENT

Well Number	Estimated Depth (ft)	Well Diameter (in)	Screen Interval (ft)	Geophysical Log[2]	Deep Soil Sampling (split spoon)
CRY-5-01D	210	4	140-210	j	No
CRY-5-02D	210	4	140-210	j	No
CRY-5-03D	210	4	140-210	j	No
CRY-5-04D	210	4	140-210	j,e,i,c	Yes[1]

notes: Surface casing only utilized if conditions warrant (Section 8.3.4 Surface Casing).

1. Split spoon sampling intervals: 25ft, 40ft, 65ft, 90ft, 150ft, 180ft

2. j = natural gamma
   e = 16, 64 normal electric
   i = spontaneous potential
   c = caliper

9.6 Assessment of the Vicinity of Corry Wells #11 and #12

Sampling of Corry Public Supply Wells #11 and #12 has determined that in addition to dieldrin these wells are impacted by benzene and tetrachloroethylene (PCE). The known concentration history for these contaminants is presented in **Section 7.4 -- Existing Data**. These are the only Corry Station public supply wells to have been effected by contaminants other than dieldrin. Contamination of the MPZ by PCE has been documented at a site 3,500 ft south of Corry #12. Also of relevance is the previous existence of a subsurface waste disposal system (septic tank and drain field) in the extreme southeast corner of Corry Station.

9.6.1 Objective

The purpose of this assessment is to further delineate the presence of ground water contaminants in the vicinity of Corry #11 and #12, rather than to identify a particular source. Therefore, soil and sediment sampling as a part of the assessment are not planned.

9.6.2 Technical Approach

This assessment will consist of the construction and monitoring of SZ and MPZ wells in the vicinity of Corry #11 and #12.

9.6.3 Planned Activities

Consistent with its limited scope, a modest sampling and analysis program is planned for this assessment. A total of 4 monitoring wells are planned, 3 in the MPZ and 1 in the SZ. Figure 9-9 shows the location of these wells. Two wells will be constructed in the extreme southeast corner of the station, a MPZ well and an SZ well. The purpose of these activities is twofold: to assess the possibility of SZ contamination (benzene and PCE) from previous waste disposal practices; and to assess the status of the MPZ with regard to PCE contamination originating off-base. Two MPZ wells are planned for the general vicinity of Corry #11 and #12. It is planned that these wells will be located off-base, approximately 600 ft northeast and southeast of Corry #12. These wells are to assess current conditions in the MPZ to the east of Corry Station. This monitoring will also complement the characterization of the MPZ with respect to dieldrin contamination provided by the other assessments.

The SZ well will be constructed to a total depth of approximately 55 ft, with 30 ft of casing and 25 ft of screen, placing the screen top approximately 20 ft below the water table. Each MPZ well will be constructed to a total depth of approximately 210 ft, with 140 ft of casing and 70 ft of screen. Monitor well construction and geophysical logging/split spoon sampling specifications are presented in Table 9-12. Well construction will follow technical guidance found in **Section 8.4 --Well Installation** and in **Appendix B -- Guidelines for Ground Water Monitor Well Construction**. Subsequent to well completion and development, each well will be sampled and analyzed for parameters as specified in Table 9-13.

9.6.4 Other Activities

Activities other than as described above are not planned for this assessment. If the assessment results show a definitive basis for additional activities, the planning and implementation of such activities will require a work plan modification.

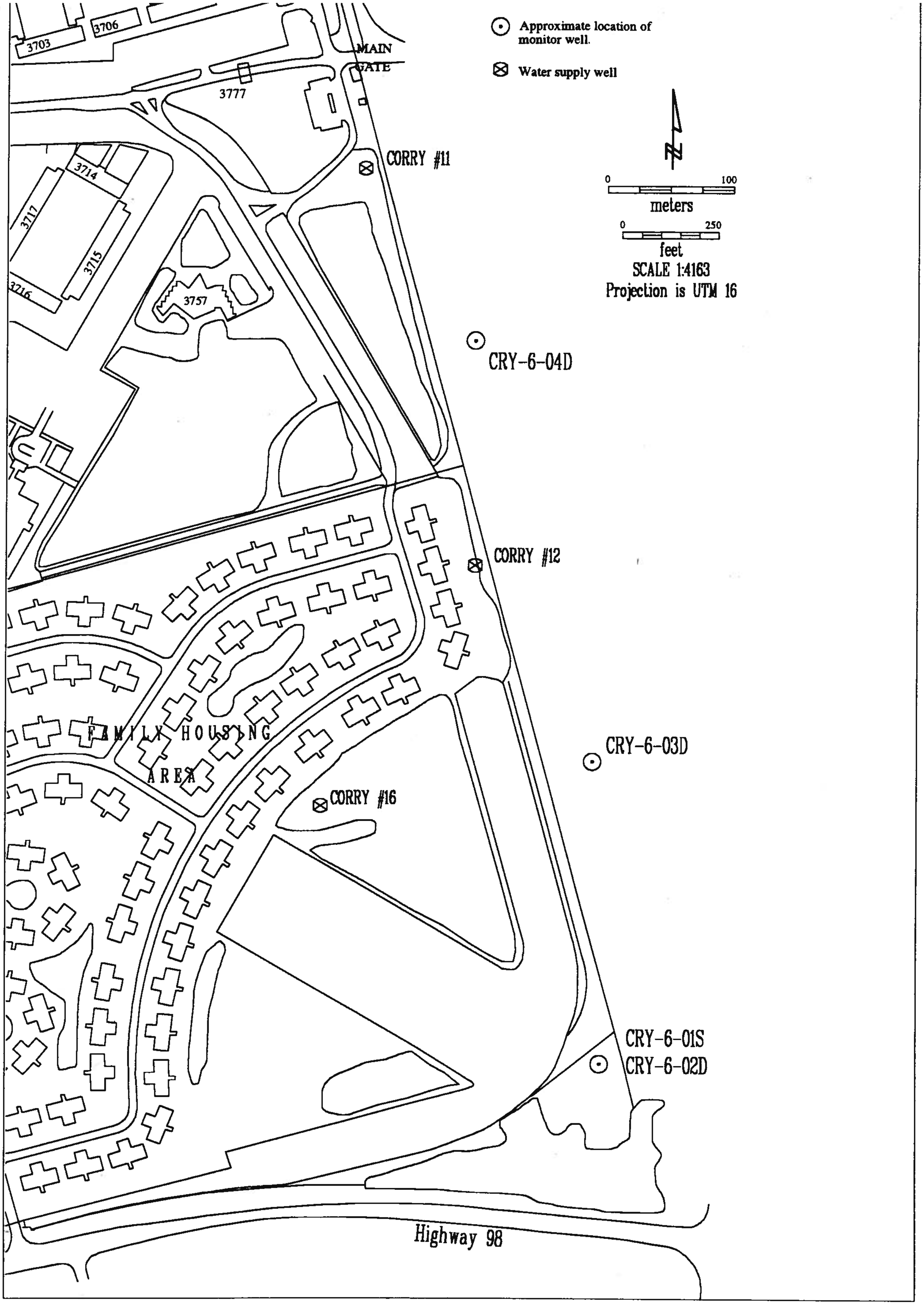

Figure 9-9. Assessment in the Vicinity of Corry #11 and #12.

TABLE 9-12

PHASE II WELL CONSTRUCTION SPECIFICATION -- ASSESSMENT IN THE VICINITY OF CORRY #11 AND #12

Well Number	Estimated Depth (ft)	Well Diameter (in)	Screen Interval (ft)	Geophysical Log[2]	Deep Soil Sampling (split spoon)
CRY-6-01S	55	4	30-55		No
CRY-6-02D	210	4	140-210	j,e,i,c	Yes[1]
CRY-6-03D	210	4	140-210	j	No
CRY-6-04D	210	4	140-210	j	No

notes: Surface casing only utilized if conditions warrant (Section 8.3.4 Surface Casing).

1. Split spoon sampling intervals: 25ft, 40ft, 65ft, 90ft, 150ft, 180ft

2. j = natural gamma
   e = 16, 64 normal electric
   i = spontaneous potential
   c = caliper

TABLE 9-13

PHASE II SAMPLING AND ANALYTICAL PLAN -- ASSESSMENT IN THE VICINITY OF CORRY #11 AND #12

Well/Boring Number	Sample I.D. Number	Sample Type(1)	Parameter Group(2), (3)
CRY-6-01S	CRY-6-01S-1	w	A,B,C,D
CRY-6-02D	CRY-6-02D-1	w	A,B,C,D
CRY-6-03D	CRY-6-03D-1	w	A,B,C
CRY-6-04D	CRY-6-04D-1	w	A,B,C
CRY-6-02D	CRY-6-02D-B25	ds @ 25	G
CRY-6-02D	CRY-6-02D-B40	ds @ 40	G
CRY-6-02D	CRY-6-02D-B65	ds @ 65	G
CRY-6-02D	CRY-6-02D-B90	ds @ 90	G
CRY-6-02D	CRY-6-02D-B150	ds @ 150	G
CRY-6-02D	CRY-6-02D-B180	ds @ 180	G

note:

1. w = water
ss = shallow soil
ds @ 25 ft = deep soil (split spoon) at designated depth.

2. If OVA indicates VOC contamination of sediemnts monitored during well construction, VOC analysis (Method 624) will be included.

3. Group parameters are listed in Appendix C.

9.7 Potable Supply Assessment

Sample analysis of ground water from the 10 existing supply wells will provide additional data useful for establishing the distribution of dieldrin in the MPZ. Due to the documented geochemical behavior of dieldrin in the subsurface environment (**Section 7.6 -- Geochemical Behavior of Dieldrin in the Environment**), selected supply wells will also be sampled utilizing custom sampling and processing procedures. Particular interest involves determination of the methods of transport of dieldrin in the subsurface at Corry Station. Understanding these transport processes is critical to management of the ground water resource and contaminant remediation. In addition, transport processes may have implications regarding the daily operation of the well field.

The transport of dieldrin in the subsurface is expected to involve both dissolved phase (aqueous) and colloidal transport. The potable supply well assessment is designed to determine the relative importance of these 2 processes and to determine if current management practices regarding the routine discharge of well purge waters (**Section 7.3 -- Records Search/Interviews**) are appropriate.

9.7.1 Objective

Objectives of the potable supply well assessment include: 1) obtain current dieldrin concentration levels for public supply wells, utilizing procedures and laboratory approved for this investigation; 2) gain insight into the subsurface transport mechanisms responsible for dieldrin contamination at Corry Station (colloidal/aqueous); 3) determine if current well field management practices (purging sediment laden well water to waste next to wells) are providing an additional pathway for the spread of dieldrin.

9.7.2 Technical Approach

This assessment has several objectives. For convenience, each of these will be presented below as a separate sub-assessment. A summary of sample collection and analytical plans for the potable supply assessment is provided in Table 9-14 and Table 9-15. Public supply well locations are provided in Figure 9-10.

Sub-assessment 1 -- Analysis of raw water samples collected from public supply wells will provide dieldrin concentration data comparable to ground water samples collected from the remainder of the monitoring network. It is important to process and analyze samples from all available wells utilizing a consistent methodology, to allow for delineation of concentration distributions and gradients. This sampling will be conducted concurrent with sampling of the MPZ monitoring well network.

Sub-assessment 2 -- Application of filtering procedures and analysis of both raw water and filtrate will provide insight into the relative importance of the various transport processes at work. The difference between dieldrin concentration of the raw water and the dieldrin concentration of the filtered water will indicate the portion of dieldrin transported by colloids. Additional analysis of turbid water samples produced during well and GAC unit purging operations (**Section 7.3.1 -- Public Supply Well Operations Procedures**) will further verify if dieldrin is being introduced back into the environment via public supply well management practices.

Sub-assessment 3 -- Soils samples collected within the discharge areas utilized for GAC purging procedures (around splash pads) will be corrected and analyzed. This will be undertaken to determine if current well management practices provide a pathway for the spread of dieldrin into the environment. For the same reason, GAC backwash and purge water will be analyzed for dieldrin. If soil contamination at the wellhead is detected, SZ ground water sampling would be required to further assess the impact of well management practices. A work plan modification would be required to provide for the installation and sampling of SZ monitor wells at selected Corry Station production wells.

9.7.3 Planned Activities

Sub-assessment 1 -- The potable supply wells assessment will include sampling and analysis of raw, ground water samples for each of the 10 supply wells. These samples will be collected after the wells have been purged in a normal manner and placed on line. Sample collection (preparation and location) and analytical specifications are presented in Table 9-15. Sampling will be conducted in accordance with **Section 8.2 -- Ground Water Sampling** and **Section 6.5 of the QAPP**.

Sub-assessment 2 -- Additional samples will be collected for three selected supply wells, Corry #7, #8, and #11. Corry #7, #8, and #11 are selected due to their relatively high dieldrin concentration. These three wells should provide information sufficient to clarify the mechanisms involved with dieldrin transport.

In addition to collecting raw water samples as outlined in **Sub-assessment 1**, samples from these selected wells will also be filtered. Both the filtrate and the filter cake (residue) will be analyzed. The samples to be filtered will be collected at the time of raw water sample collection (**Sub-assessment 1**). Filtration will be performed in the laboratory.

Also of interest is the quality of water discharged to the subsurface environment at the time the Corry wells are purged, prior to being placed on-line. To this end, the first-flush, turbid discharge water from Corry #7, #8 and #11 will be sampled.

Unfiltered and filtered water samples, as well as the filter cake (residue) from the first flush turbid water will be analyzed (Table 9-15). Filtration will be performed in the laboratory.

Sub-assessment 3 -- Unfiltered samples representing GAC purge water and GAC backwash water will be collected for Corry #7, #8 and #11 and analyzed. This will be undertaken to determine if disposal of GAC wastewater is introducing dieldrin into the subsurface environment. In addition, soil samples will be collected from areas where purge waters are discharged. Soil samples well be collected as specified in Table 9-14. Sample collection (preparation and location) and analytical specifications are presented in Table 9-15.

9.7.4 Other Activities

If soil contamination is verified, or if purge waters exhibit elevated dieldrin concentrations, SZ monitoring will be implemented in the immediate vicinity of the wellheads of Corry #7, #8 and/or #11. A modification to the work plan would be required to allow for the construction of SZ monitor well(s), and the associated sampling and analysis of ground water.

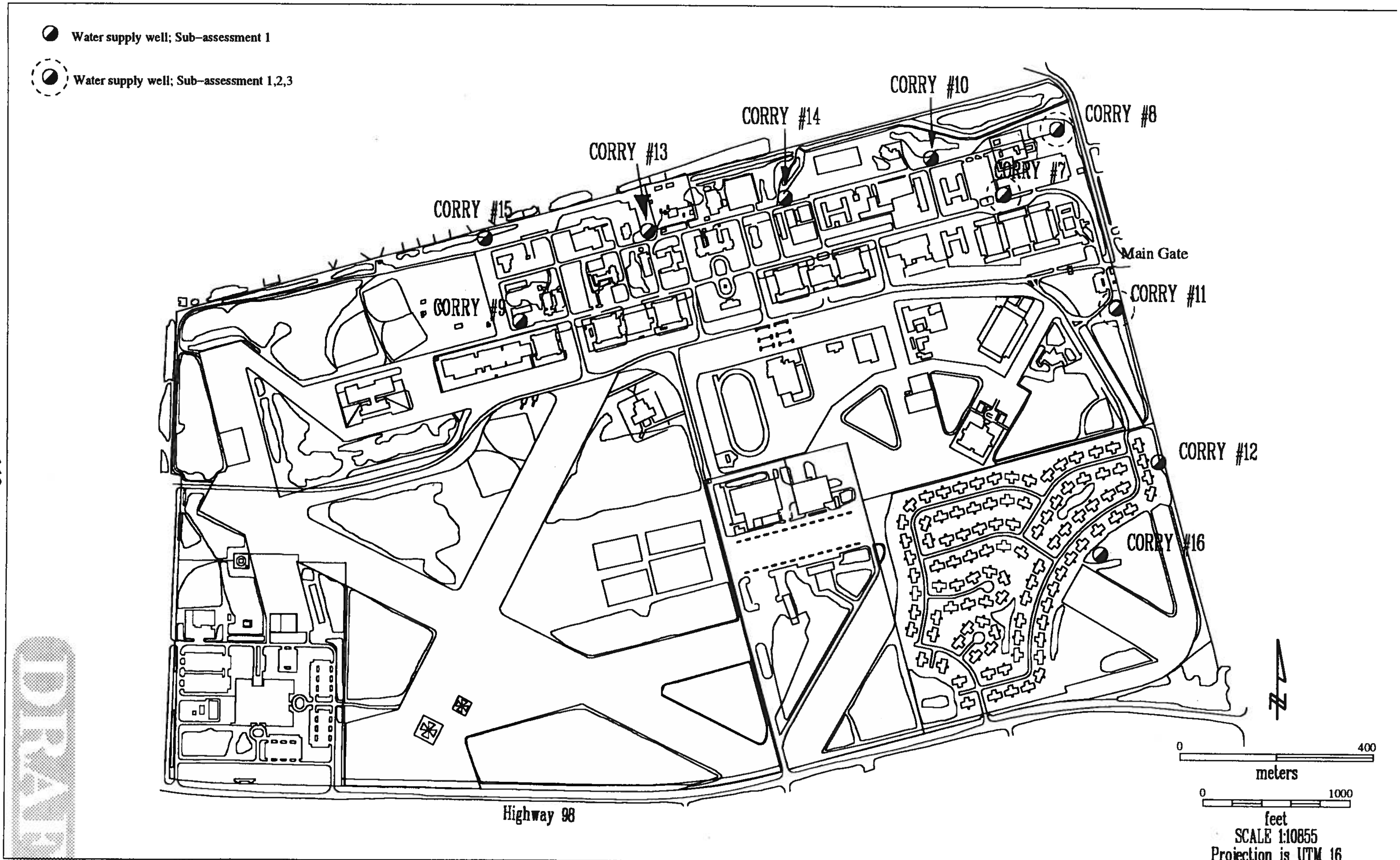

Figure 9-10. Potable Supply Assessment.

TABLE 9-14

PHASE II SHALLOW SOIL BORING SPECIFICATION -- POTABLE SUPPLY ASSESSMENT

BORING NUMBER	ESTIMATED DEPTH (FT)[1]
Sub-Assessment 3	
Corry # 7B	1.25
Corry # 8B	1.25
Corry # 11B	1.25

Notes:

1. Composite shallow soil sample representative of 3, 9, 15-inch depths.

TABLE 9-15

PHASE II SAMPLING AND ANALYTICAL PLAN -- POTABLE SUPPLY ASSESSMENT

Well/Boring Number	Sample I.D. Number	Sample Type(1)	Sample Preparation	Sample Location	System Purged(4)	Chemical Group(2),(3)
Sub-Assessment 1						
CORRY #7	CORRY #7-1	w	unfiltered	wellhead	yes	A,B,C
CORRY #8	CORRY #8-1	w	unfiltered	wellhead	yes	A,B,C
CORRY #9	CORRY #9-1	w	unfiltered	wellhead	yes	A,B,C
CORRY #10	CORRY #10-1	w	unfiltered	wellhead	yes	A,B,C
CORRY #11	CORRY #11-1	w	unfiltered	wellhead	yes	A,B,C
CORRY #12	CORRY #12-1	w	unfiltered	wellhead	yes	A,B,C
CORRY #13	CORRY #13-1	w	unfiltered	wellhead	yes	A,B,C
CORRY #14	CORRY #14-1	w	unfiltered	wellhead	yes	A,B,C
CORRY #15	CORRY #15-1	w	unfiltered	wellhead	yes	A,B,C
CORRY #16	CORRY #16-1	w	unfiltered	wellhead	yes	A,B,C
Sub-Assessment 2						
CORRY #7	CORRY #7-2	w	filtered	wellhead	yes	A,B
CORRY #8	CORRY #8-2	w	filtered	wellhead	yes	A,B
CORRY #11	CORRY #11-2	w	filtered	wellhead	yes	A,B
CORRY #7	CORRY #7-3	w	retained solids	wellhead	yes	E
CORRY #8	CORRY #8-3	w	retained solids	wellhead	yes	E
CORRY #11	CORRY #11-3	w	retained solids	wellhead	yes	E
CORRY #7	CORRY #7-4	tw	unfiltered	wellhead	no (first flush)	B,E
CORRY #8	CORRY #8-4	tw	unfiltered	wellhead	no (first flush)	B,E
CORRY #11	CORRY #11-4	tw	unfiltered	wellhead	no (first flush)	B,E
CORRY #7	CORRY #7-5	tw	filtered	wellhead	no (first flush)	A,B
CORRY #8	CORRY #8-5	tw	filtered	wellhead	no (first flush)	A,B
CORRY #11	CORRY #11-5	tw	filtered	wellhead	no (first flush)	A,B
CORRY #7	CORRY #7-6	tw	retained solids	wellhead	no (first flush)	E
CORRY #8	CORRY #8-6	tw	retained solids	wellhead	no (first flush)	E
CORRY #11	CORRY #11-6	tw	retained solids	wellhead	no (first flush)	E
Sub-Assessment 3						
CORRY #7	CORRY #7-7	tw	unfiltered	GAC outlet	no (first flush)	B,E
CORRY #8	CORRY #8-7	tw	unfiltered	GAC outlet	no (first flush)	B,E
CORRY #11	CORRY #11-7	tw	unfiltered	GAC outlet	no (first flush)	B,E
CORRY #7	CORRY #7-8	tw	unfiltered	GAC inlet	no (backwash)	B,E
CORRY #8	CORRY #8-8	tw	unfiltered	GAC inlet	no (backwash)	B,E
CORRY #11	CORRY #11-8	tw	unfiltered	GAC inlet	no (backwash)	B,E
CORRY #7	CORRY #7B-1	ss	composite	splash pad	n/a	E
CORRY #8	CORRY #8B-1	ss	composite	splash pad	n/a	E
CORRY #11	CORRY #11B-1	ss	composite	splash pad	n/a	E

Notes:

(1). w = water
ss = Shallow soil
tw = turbid water
ds @ 25 ft = deep soil (split spoon) @ designated depths.

(2). If OVA indicates VOC contamination of sediments monitored during well construction, VOC analysis (Method 624) will be included.

(3). Group parameters are listed in Appendix C.

(4). Yes response to system purged denotes well on-line and pumping into distribution system.
No (first flush) response to system purged denotes sampling of purge water from well or GAC vessel.
No (backwash) response to system purged denotes sampling of backwash water from GAC vessel.

9.8 Summary of Assessments

A summary of the field activities, as planned in the site-specific assessments of Phase II, is listed in Table 9-16. Approximate locations of the field activity details are presented in Figure 9-11.

At the conclusion of the Phase II, a Phase II report will be prepared. The report will describe the results of the specific field programs, including sample analytical data, methodologies, interpretations and recommendations (**Section 17.0 -- Reports**). As discussed in **Section 9.0 -- Site-Specific Assessments -- Phase II**, each assessment attempts to address a specific issue, i.e. source characterization, mode of transport, and/or dieldrin distribution. From the results of the individual assessments, a refined understanding of the dieldrin problem, including the current conceptual model and the site hydrogeology, will be developed.

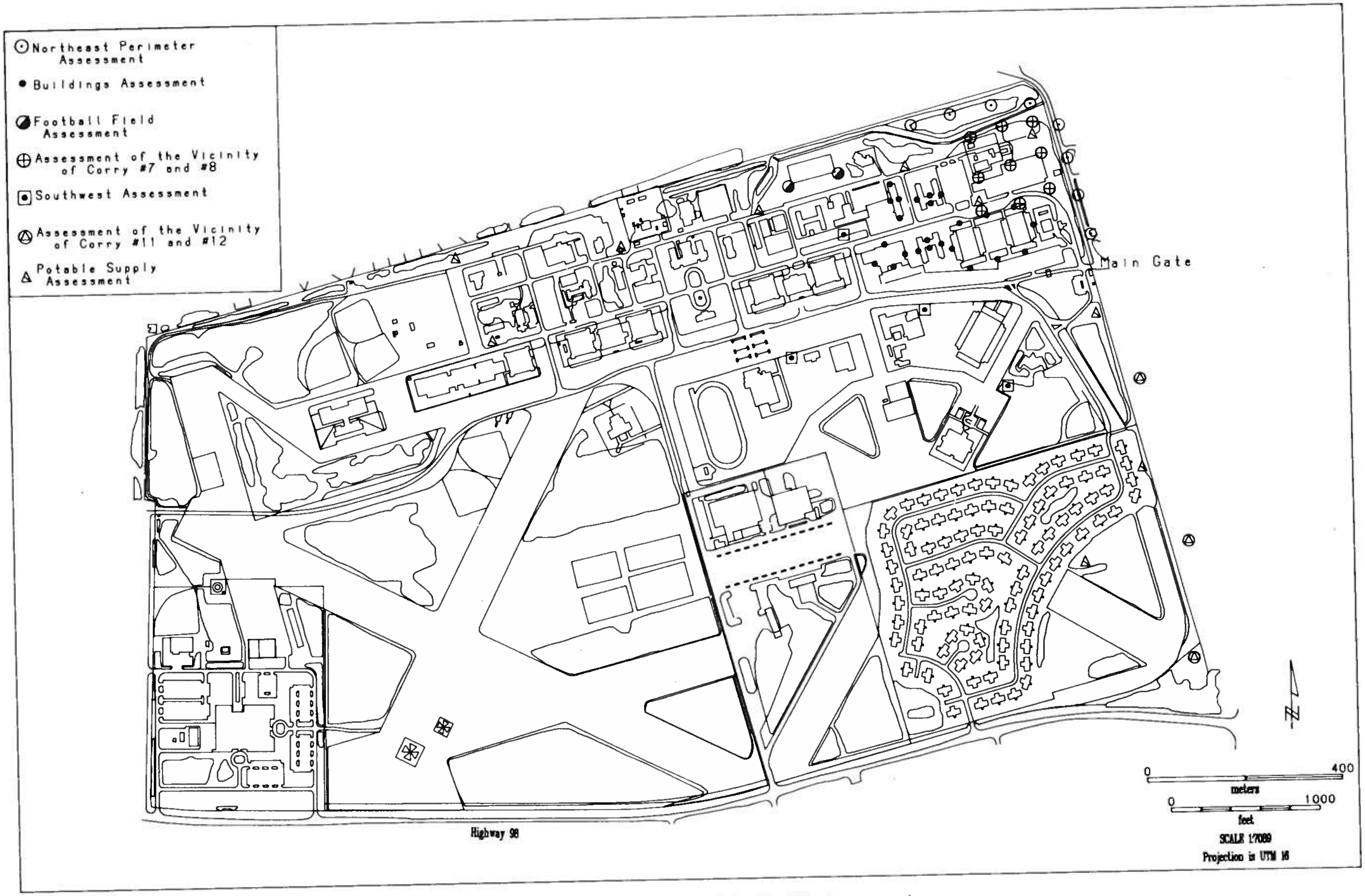

Figure 9-11. Summary of Site-Specific Assessments.

TABLE 9-16

PHASE II WELL CONSTRUCTION & SAMPLING PLAN - SUMMARY OF ASSESSMENTS

	Well Installation Activity (Number of Wells)		Sampling Activity (Number of Samples)*	
ASSESSMENT	**MPZ**	**SZ**	**SOIL**	**WATER**
Northeast Perimeter	8	8	--	16
Buildings	--	--	24	--
Football Field	--	2	--	2
Vicinity of Corry # 7 and # 8	--	9	--	9
Southwest	4	--	--	4
Vicinity of Corry # 11 and # 12	3	1	--	4
Potable Supply	--	--	3	31
TOTAL	15	20	27	66

* Estimated number for chemical analysis and does not include QA/QC duplicates, replicates, etc.

10.0 GROUND WATER FLOW AND CONTAMINANT TRANSPORT MODEL - -PHASE III

In Phase III, the principal objectives are to integrate the field-collected information from the efforts of Phase II, refine the dieldrin problem conceptualization, assess remediation alternatives, and apply ground water modeling techniques. Source characterization and soil remediation alternatives to be addressed as part of Phase III are subject to identifying the type and specific location of the source(s) responsible for dieldrin contamination. Specific recommendations with regard to analysis of a source remediation alternatives will be provided as part of the Phase II report. The development of the ground water model is to address the issues of risk potential and the remedial status of the site with regards to ground water.

A ground water flow and contaminant transport model is a numerical model which is run in a computer. The model incorporates numerical techniques to solve a set of equations that are known to govern the phenomena of Darcian flow and contaminant migration via advection and dispersion processes (**Section 9.0 -- Site-Specific Assessment -- Phase II**). A numerical model is most beneficial when applied within the context of gaining insight to the interaction of the hydrogeologic framework and ground water management options. The Corry Station model will be used to test remediation options via discharge wells, aid in locating future potable well sites, aid in determining the longevity of the dieldrin contamination problem, identify areas at risk, and assist in delineating wellhead or aquifer protection areas. The benefit of model use lies in the objective means in which to test management concepts and options in an economic and timely fashion, prior to implementation.

The development of an adequate three-dimensional model at Corry Station requires 2 basic tasks: conceptual model development and model calibration. The conceptual model forms the basis for the numerical model. It is essentially an interpretation of the hydrogeologic and contamination information in a quantitative form which is specific to the requirements of the numerical model. Therefore, the conceptual model for the numerical model, in purpose, is not unlike the conceptual model as discussed in **Section 9.0 -- Site-Specific Assessments -- Phase II** which formed the premise for the individual site-specific assessments.

Specifically, the conceptual model outlines the mathematical specifications of the area to be modeled. These specifications identify the geometry and the physical dimensions of the model domain (region to be modeled), the boundary and initial conditions of the model domain and the aquifer hydraulic properties within the domain.

The NWFWMD recently completed a three-dimensional model development for Escambia County as a cooperative effort with the Escambia County Utilities Authority. The calibrated model simulates ground water flow and contaminant transport as well as density-dependent transport such as saltwater in the Sand-and- Gravel Aquifer. It is the intent to develop the Corry Station model within the framework of the Escambia County model (regional model). In this manner, maximum use can be made of the data collected as part of the regional effort and impacts of withdrawals and initial aquifer parameters can be incorporated into the site assessment.

The accuracy of the numerical model is essentially governed by the level of detail and accuracy of the conceptual model. The regional model will provide the initial set of hydraulic parameters and boundary values for the Corry Station model. Because the modeling effort in the Corry Station area is far more detailed than the level of resolution of the regional model, additional and detailed data collection is planned.

Detailed information is necessary to calibrate the numerical model. Model calibration is the only means to verify that the model simulations approximate reality or field observed conditions. In this regard, the 2 major areas of data collection include a comprehensive potentiometric surface survey at Corry Station and its vicinity and characterization of the aquifer hydraulic properties in the area of concern.

Following calibration and verification of the model, specific model applications will be performed through scenario modeling. The principal emphasis will be in gaining insight into the dieldrin problem for risk assessments, to evaluate remediation techniques and identify alternate well sightings within Corry Station. However, the scope of the modeling effort is essentially restricted to and contingent upon the results of the Phase II data collection activities and data interpretation. Therefore, specific applications/scenarios of the model are not included in the work plan. Final recommendations and methodologies for the modeling effort which outline specific applications will be prepared as part of the Phase II Final Report (**17.0 -- Reports**).

10.1 Potentiometric Surface Survey

The potentiometric surface survey includes the mapping of the water table in the Surficial Zone and the semi-confined potentiometric surface of the deeper Main Producing Zone of the aquifer. As a part of this effort, potentiometric surface monitor wells will be constructed within and in the vicinity of Corry Station. The wells will serve as water level piezometers as well as limited water quality sampling points. Some of the potentiometric surface monitor wells will be constructed to allow for possible organic sampling efforts and according to guidance found in **Appendix B -- Guidelines for Ground Water Monitoring Well Installation** and in **Section 8.3.1 -- Ground Water Quality Monitor Wells**. The selection of these particular sites will be established following the data analysis, results and recommendations from the Phase II effort.

The ground water solution to the numerical model is given in the form of ground water heads. These simulated heads are then compared to the field observed water level data to determine the error (head residual). The model calibration procedure is basically an iterating process of making the necessary changes to the model such that the head residual is minimized to a satisfactory level. Therefore, an adequate potentiometric surface survey within the model domain is important in ensuring that the model is representative of the ground water framework; i.e., ground water flow. Because the precursor to contaminant transport is the ground water velocity distribution from the flow model, significant errors in the flow model can bias subsequent transport simulations; hence, the importance of model calibration.

The requirements to provide an adequate representation of the potentiometric surface survey include construction of SZ and MPZ water level wells (piezometers) and one or more synoptic water level surveys in the area. In addition, it is necessary to install continuous recorders at selected piezometers and water quality monitor wells to document the transient response of the SZ (water table) and the MPZ potentiometric surface to pumping conditions at Corry Station. Currently, detailed water levels are unavailable for much of the Corry Station area and the vicinity. Within Corry Station, there is a absence of water level information for the SZ and for the MPZ in the south and southwest area.

Approximately 5 nests of piezometers are required for potentiometric surface control within Corry Station. Each nest is comprised of a MPZ piezometer and a SZ piezometer (Table 10-1 and Figure 10-1). One additional SZ piezometer will be constructed along a north/south transect between Corry #11 and the southeast corner of the Corry Station property line. Outside of Corry Station, it is anticipated that construction of approximately 4 piezometer nests will be adequate to map the potentiometric surfaces. Each piezometer will be constructed according to guidance found in **Section 8.3.2 -- Potentiometric Surface Monitor Wells**. The water level survey network will include the piezometers, existing potable/irrigation wells within the area and the water quality wells proposed in **Section 9.0 -- Site-Specific Assessments -- Phase II**.

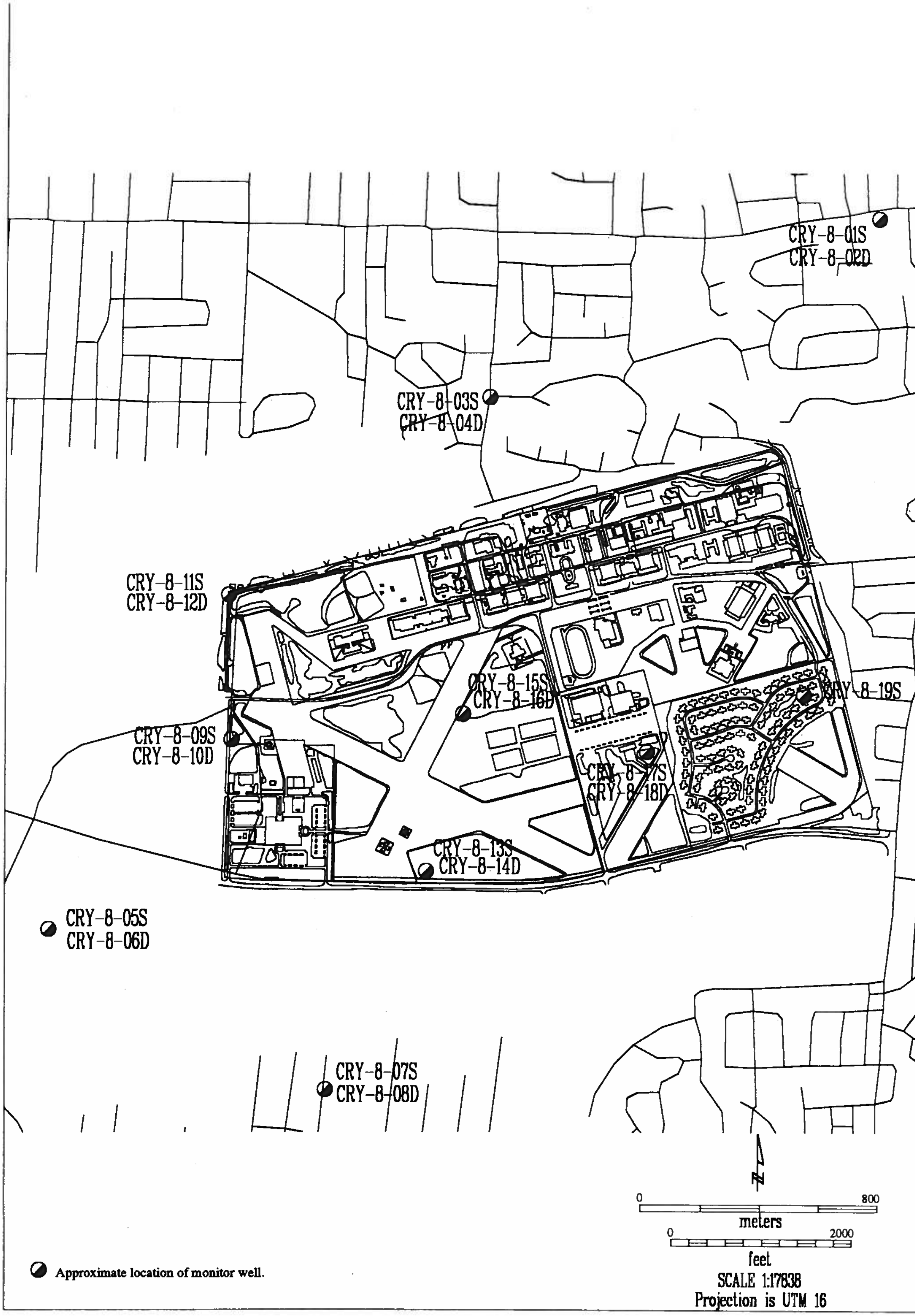

Figure 10-1. Potentiometric Surface Survey.

TABLE 10-1

PHASE III WELL CONSTRUCTION SPECIFICATION -- POTENTIOMETRIC SURFACE SURVEY

Well Number	Estimated Depth (ft)	Well Diameter (in)	Screen Interval (ft)	Geophysical Log[2]	Deep Soil Sampling (split spoon)
CRY-8-01S	80	4	30-80		No
CRY-8-02D	235	4	140-235	j	No
CRY-8-03S	65	4	30-65		No
CRY-8-04D	220	4	140-220	j	No
CRY-8-05S	55	2	30-55		No
CRY-8-06D	210	2	140-210	j	No
CRY-8-07S	50	2	30-55		No
CRY-8-08D	210	2	140-210	j	No
CRY-8-09S	55	2	30-55		No
CRY-8-10D	210	2	140-210		No
CRY-8-11S	55	4	30-55		No
CRY-8-12D	210	4	140-210		No
CRY-8-13S	55	2	30-55		No
CRY-8-14D	210	2	140-210	j,e,i,c	Yes[1]
CRY-8-15S	55	2	30-55		No
CRY-8-16D	210	2	140-210	j	No
CRY-8-17S	55	2	30-55		No
CRY-8-18D	210	2	30-55	j	No
CRY-8-19S	55	2	30-55	j	No

notes: Surface casing only utilized if conditions warrant (Section 8.3.4 Surface Casing).

1. Split spoon sampling intervals: 25ft, 40ft, 65ft, 90ft, 150ft, 180ft.
2. j = natural gamma
   e = 16, 64 normal electric
   i = spontaneous potential
   c = caliper

10.2 Hydraulic Property Determination

An understanding of the aquifer hydraulic properties is important for the development of an accurate numerical model. Specifically, the numerical model requires information on the permeability and storage characteristics of the SZ, the LPZ, and the MPZ. To a large degree, the aquifer flow regime and contaminant migration are a function of the aquifer hydraulic properties. Consequently, the accuracy of any model simulations will be largely controlled by the accuracy of the information available on the aquifer properties. The principal aquifer properties to be determined for the MPZ are transmissivity, hydraulic conductivity, hydraulic conductivity anisotropy ratio, specific storage; for the LPZ, vertical hydraulic conductivity; and for the SZ, transmissivity, hydraulic conductivity and specific yield.

The aquifer properties are determined by performing aquifer pump tests. Basically, a production well is pumped continuously at a given discharge rate. Water levels are recorded at selected piezometers to document the transient response of the water levels to the aquifer stress. From the time-drawdown information, analytical and/or numerical models are used to calculate the aquifer properties.

It is anticipated that 2 aquifer tests will be required to adequately characterize the hydraulic properties of the aquifer at Corry Station (Figure 10-2). One test will involve pumping the MPZ in order to determine the hydraulic characteristics of the MPZ and the overlying low permeability zone (LPZ). For this test, it is planned Corry #15 supply well will be utilized as a production well. The production well will be pumped continuously for at least 72 hrs while water levels are monitored at selected SZ and MPZ piezometers. During the test, water levels will be measured within an accuracy of 0.01 ft. Continuous water levels recorders will be utilized as necessary during the aquifer test program.

A total of 3 4-in diameter MPZ piezometers and 2, 4-in diameter LPZ piezometers will be installed in the vicinity of the production well (Figure 10-2). The MPZ piezometers will be installed to a similar depth as Corry #15 and construction will follow guidance found in **Section 8.3.2 -- Potentiometric Surface Monitor Wells**.

An aquifer test of the SZ will also be performed. One 10-in diameter production well will be constructed to a total depth of approximately 55 ft (corresponding to the base of the SZ). The SZ production well will be constructed in accordance with **Section 8.3.3 -- Production Wells**. A total of 3 4-in diameter SZ piezometers will be installed in the vicinity of the production well (Figure 10-2). The SZ piezometers will be installed to the same depth as the SZ production well and construction will follow guidance found in **Section 8.3.2 -- Potentiometric Surface Monitor Wells**.

Specifications for wells constructed for the aquifer tests are provided in Table 10-2 and Table 10-3.

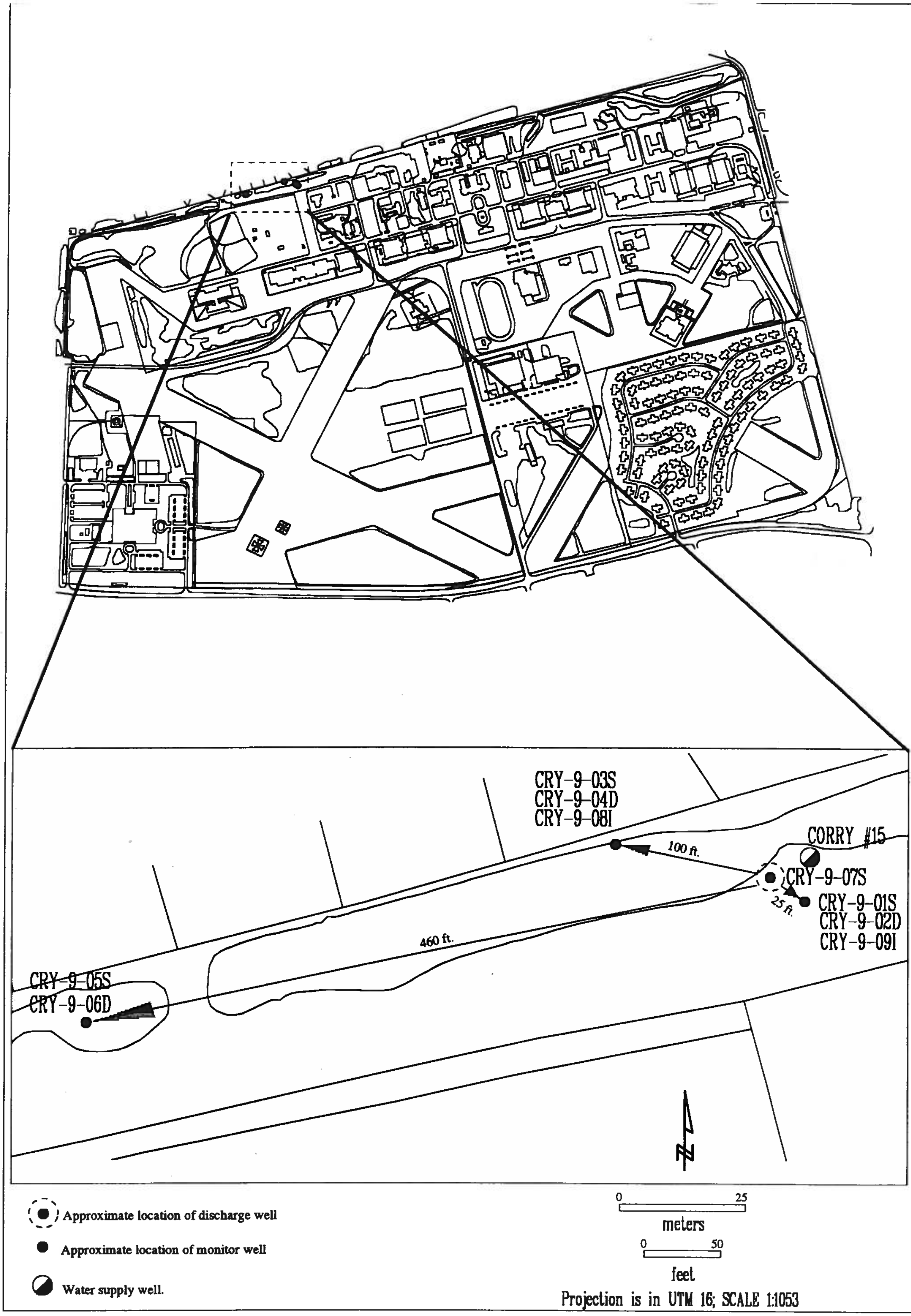

Figure 10-2. Aquifer Test Sites for Hydraulic Property Determination.

TABLE 10-2

PHASE III WELL CONSTRUCTION SPECIFICATION -- HYDRAULIC PROPERTY DETERMINATION

Well Number	Estimated Depth (ft)	Well Diameter (in)	Screen Interval (ft)	Geophysical Log[2]	Deep Soil Sampling (Split spoon)
CRY-9-01S	55	4	20-55		No
CRY-9-02D	210	4	150-230	j	No
CRY-9-03S	55	4	20-55		No
CRY-9-04D	210	4	150-230		No
CRY-9-05S	55	4	20-55		No
CRY-9-06D	210	4	150-230		No
CRY-9-07S	55	10	20-55		Yes[1]
CRY-9-08I	105	4	85-105		No
CRY-9-09I	105	4	85-105		No

notes: Surface casing only utilized if conditions warrant (Section 8.3.4 Surface Casing).

1. Split spoon sampling intervals: 27ft and 42ft.
2. j = natural gamma
   e = 16, 64 normal electric
   i = spontaneous potential
   c = caliper

TABLE 10-3

PHASE III SAMPLING AND ANALYTICAL PLAN -- HYDRAULIC PROPERTY DETERMINATION

Well/Boring Number	Sample I.D. Number	Sample Type(1)	Parameter Group(2)
CRY-9-07S	CRY-9-07S-B27	ds @ 27	G
CRY-9-07S	CRY-9-07S-B42	ds @ 42	G
CRY-8-14D	CRY-8-14D-B25	ds @ 25	G
CRY-8-14D	CRY-8-14D-B40	ds @ 40	G
CRY-8-14D	CRY-8-14D-B65	ds @ 65	G
CRY-8-14D	CRY-8-14D-B90	ds @ 90	G
CRY-8-14D	CRY-8-14D-B150	ds @ 150	G
CRY-8-14D	CRY-8-14D-B180	ds @ 180	G

note:

(1). w = water
ss = shallow soil
ds @ 25 ft = deep soil (split spoon) at designated depth.

(2). All group parameters are listed in Appendix C.

10.3 Water Quality Assessment

The addition of piezometers as part of **Section 10.1 -- Potentiometric Surface Survey** and **10.2 -- Hydraulic Property Determination** provides a monitoring network coverage which encompass Corry Station. Although the purpose of the piezometers is to assess ground water levels, they, nonetheless, are additionally useful as water quality wells. The importance of water quality assessment is evident when an area(s) is considered for future potable supply wells based on the results of the modeling effort. It is necessary to document the baseline water quality of these areas.

Southwest Escambia County is characterized by high levels of iron in ground water which occur naturally from iron-oxides in the aquifer sediments. Though the water yield may be adequate, high concentrations of iron can limit ground water development. This assessment provides for sampling ground water from selected piezometers for iron and turbidity. Table 10-4 includes the sampling and analytical plan for this assessment. Figure 10-1 designates the locations of the wells specified in Table 10-4.

10.4 Planned Field Activities

The field activities for the purposes of developing and calibrating the ground water flow and transport model include installation of piezometers in the SZ, LPZ, and the MPZ, performing one or more synoptic water level surveys, water quality sampling, installation of continuous water level recorders at selected wells, installation of a SZ production well and performing two aquifer pump tests.

TABLE 10-4

PHASE III SAMPLING AND ANALYTICAL PLAN -- POTENTIOMETRIC SURFACE SURVEY

Well/Boring Number	Sample I.D. Number	Sample Type[(1)]	Parameter List[(2)]
CRY-8-09S	CRY-8-09S-1	w	F
CRY-8-10D	CRY-8-10D-1	w	F
CRY-8-13S	CRY-8-13S-1	w	F
CRY-8-14D	CRY-8-14D-1	w	F
CRY-8-15S	CRY-8-15S-1	w	F
CRY-8-16D	CRY-8-16D-1	w	F
CRY-8-17S	CRY-8-17S-1	w	F
CRY-8-18D	CRY-8-18D-1	w	F

note:

(1). w = water
ss = shallow soil
ds @ 25 ft = deep soil (split spoon) at designated depth.

(2). All group parameters are listed in Appendix C.

11.0 FIELD MOBILIZATION PLAN

Field activities will be required to install monitor wells, collect samples and perform other miscellaneous data collection activities. Specific field activities are grouped together and will be performed during a single field mobilization. Each phase of this project will consist of a series of field mobilizations. As currently planned, Phase II will require 5 field mobilizations and Phase III will require 5 field mobilizations. Each field mobilization will be completed and a preliminary assessment of the mobilization performed before proceeding to the next mobilization.

11.1 Phase II Mobilizations

Phase II mobilizations include field activities primarily devoted to establishing the distribution of dieldrin in the subsurface, location of the source(s) of dieldrin, and gaining insight into the transport mechanisms and movement of dieldrin in the environment. Phase II mobilizations will accomplish all field and analytical work described in **Section 9.0 -- Site Specific Assessments -- Phase II**.

11.1.1 Mobilization II-1

The first field mobilization of Phase II will consist of a pre-construction meeting among the NWFWMD; appropriate subcontractors; and representatives of the Corry Station Base Civil Engineers Office, the PWC Utilities Department, the PWC Facilities Management Department and SOUTHDIV to discuss the operational aspects of implementing the investigation. Items to be discussed include logistics of site access, communications, field operations, utilities survey, availability of water for construction purposes, decontamination and waste management procedures. In addition, Mobilization II-1 will provide for the following.

1.) Select point of access to obtain Corry Station potable water to be used during field operations.
2.) With concurrence of Corry Station and U.S. Navy personnel, stake actual well locations proposed for Phase II.
3.) Obtain authorization from civilian authorities for installation of monitor wells located off Corry Station.
4.) Designate a staging area where drilling supplies and miscellaneous drilling equipment will be stored.
5.) Conduct utility surveys with U.S. Navy and civilian authorities to verify exact location of underground utilities in the vicinity of well sites.

6.) Identify nearest horizontal and vertical benchmarks suitable for use in determining location and elevation of all wells utilized in this investigation.
7.) Visit Corry Station supply wells with PWC Utilities Department personnel and identify sample spigot to be used when sampling these wells. Also identify reference point to be used for water level measurements, determine condition of air line and determine feasibility of measuring water level with a steel tape. Also identify, for Corry #7, #8 and #11, sample points for GAC unit purge and backwash water, and locate area where well and GAC unit purge water is discharged.

11.1.2 Mobilization II-2

The second mobilization of Phase II will consist of Surficial Zone well construction. All Surficial Zone wells specified in **Section 9.0 -- Site-Specific Assessments -- Phase II** will be constructed during this mobilization. Mobilization II-2 will provide for the following:

1.) Construction of Surficial Zone monitor wells including well surface completion and well development.
2.) Horizontal and vertical survey of all Surficial Zone wells constructed. The horizontal and vertical location of all Corry Station supply wells will also be surveyed at this time.
3.) Following construction and development of all Surficial Zone wells, perform a water level survey of these wells. Water level measurements will be taken over as short a time period as possible, and will be used to generate a map of the water table.

11.1.3 Mobilization II-3

The third mobilization of Phase II will consist of sample collection and analysis. Ground water samples from the Surficial Zone wells constructed during Mobilization II-2, and shallow soil samples specified in **Section 9.2 -- Buildings Assessment** will be collected and sent to the laboratory for analysis.

11.1.4 Mobilization II-4

The forth mobilization of Phase II will consist of Main Producing Zone well construction. All Main Producing Zone wells specified in **Section 9.0 -- Site Specific Assessments - Phase II** will be constructed during this mobilization. Data from construction and ground water analysis of the Surficial Zone wells will be used to determine if surface casing is required **(Section 8.3.4 -- Surface Casing)**. Open hole logging will not be performed on wells requiring surface casing. In addition, deep soil sampling (split spoon samples for physical analysis) will be collected from wells logged open hole. Therefore, final selection of MPZ wells scheduled for open hole logging (natural gamma, normal electric, SP and caliper) and deep soil sampling (split spoons) will be made after the previous mobilization. Mobilization II-4 will provide for the following:

1.) Construction of Main Producing Zone monitor wells including well surface completion and well development. Open hole well logging and deep soil sampling (split spoons) will be performed as specified during MPZ well construction.
2.) Perform cased hole logging (natural gamma) of Surficial Zone wells as specified.
3.) Horizontal and vertical survey of all Main Producing Zone monitor wells constructed.
4.) Following construction and development of all Main Producing Zone wells, perform a water level survey of these wells, all Corry Station supply wells and all Surficial Zone monitor wells. Water level measurements will be taken over as short a time period as possible, and will be used to generate potentiometric surface maps.

11.1.5 Mobilization II-5

The fifth mobilization of Phase II will consist of sample collection and analysis. Ground water samples from the Main Producing Zone wells constructed during Mobilization II-4 will be collected and sent to the laboratory for analysis. In addition, the assessment described in **Section 9.7 -- Potable Supply Assessment** will be performed. After all MPZ ground water samples have been collected, natural gamma ray logs will be recorded on MPZ monitor wells as specified in **Section 9.0 -- Site-specific Assessments -- Phase II.**

11.2 Phase III Mobilizations

Phase III mobilizations include field activities and data collection necessary for development of a numerical ground water flow and transport model. Phase III mobilizations will accomplish all field and analytical work described in **Section 10.0 -- Ground Water Flow and Contaminant Transport Model -- Phase III.** Additional characterization and delineation of the source(s) may also be required to fully assess remediation alternatives. A preliminary phase III mobilization plan is provided below.

11.2.1 Mobilization III-1

The first mobilization of Phase III will consist of a pre-construction meeting among the NWFWMD; appropriate subcontractors; and representatives of the Corry Station Base Civil Engineers Office, the PWC Utilities Department, the PWC Facilities Management Department and SOUTHDIV to discuss the operational aspects of implementing Phase III of the investigation. Items to be discussed include field operations, management of Corry Station well pumpage to facilitate aquifer testing, locate piezometer and SZ production well sites, and performance of utility surveys. Mobilization III-1 will specifically provide for the following.

1.) Select point of access to obtain Corry Station potable water to be used during Phase III field operations.
2.) With concurrence of Corry Station and U.S. Navy personnel, stake actual well locations proposed for Phase III.
3.) Obtain authorization from civilian authorities for installation of monitor wells located off Corry Station.
4.) Designate a staging area where drilling supplies and miscellaneous drilling equipment will be stored.
5.) Conduct utility surveys with U.S. Navy and civilian authorities to verify exact location of underground utilities in the vicinity of well sites.
6.) Determine disposal area/method for aquifer test discharge water.

11.2.2 Mobilization III-2

The second mobilization of Phase III will include construction of all potentiometric surface monitor wells and construction of the SZ production well. Associated geophysical logging and well survey are included in this mobilization. Following well installation and development, water level in all project wells will be measured. Mobilization III-2 will include the following.

1.) Construction of all potentiometric surface monitor wells and the SZ production well as specified in **Section 10.0 -- Ground Water Flow and Contaminant**

Transport Model -- Phase III. Geophysical logging and deep soil sampling (split spoon) will be performed as specified.

2.) Conduct horizontal and vertical survey of all potentiometric surface monitor wells and the SZ production well.
3.) Following construction and development of these wells, perform a water level survey of all project wells. Project wells include all water quality monitor wells constructed in Phase II, all Corry Station potable supply wells, all potentiometric surface monitor wells constructed in Phase III and other selected wells within the Corry Station ground water flow and contaminant transport model domain. Water levels will be taken in as short a time period as possible, and will be used to generate potentiometric surface maps used for model calibration.
4.) Finalize modified Corry Station well pumping schedule required for the duration of the aquifer testing period. Implement modified schedule approximately 1 week prior to test.

11.2.3 Mobilization III-3

The third mobilization of Phase III will consist of sampling and laboratory analysis of potentiometric surface monitor wells as specified in **Section 10.0 -- Ground Water Flow and Contaminant Transport Model -- Phase III**. Following sampling, automatic water level recorders will be installed as required for recording of background water level trends and aquifer test drawdown data.

11.2.4 Mobilization III-4

The fourth mobilization of Phase III will consist of the required aquifer testing. A high degree of coordination and cooperation will be required between the NWFWMD and Corry Station PWC Utilities Department in order to perform the aquifer test and obtain the necessary data. For the period of the aquifer testing (approximately 3 to 4 weeks), careful consideration will be needed with regards to which wells are used and the cycling of wells on and off. To facilitate obtaining the desired results, the aquifer testing will be conducted during a period of lower water demand which will allow greater flexibility in limiting the influence of existing Corry Station pumping on the aquifer tests. Mobilization III-4 will provide for the following.

1.) Install test pump in SZ production well.
2.) Install flow meter and provide for discharge of water from aquifer test.
3.) Conduct aquifer tests.

11.2.5 Mobilization III-5

The fifth mobilization of Phase III will consist of well plugging. Following completion of the project, all monitor wells installed as part of this investigation and not needed for future monitoring shall be plugged. Recommendations regarding long term monitoring will be included in the Phase III final report.

12.0 PROJECT MANAGEMENT PLAN

12.1 Technical Approach

The Project Management Plan is intended to outline the management approach and procedures to be utilized by the NWFWMD in conducting the field work, data collection and analysis of the Soil and/or Ground Water Contamination Investigation and Modeling for Corry Station. The investigation will be conducted utilizing a phased approach which includes a field data collection effort intended to characterize the presence, concentration levels and areal extent of contaminants in the soils and ground water underlying the site. Depending on the results of the Phase II investigation, a three-dimensional ground water flow and contaminant transport model may be applied in Phase III to provide a predictive tool for characterizing the continued subsurface transport of contaminants and to examine the technical and financial feasibility of alternative remedial action plans for removal or control of the soil and ground water contaminants.

The Project Management Plan outlined herein is for the field data collection and analysis to be performed as part of the Phase II characterization investigation. This includes a description of the management approach to be utilized by the NWFWMD in conducting the investigation, the roles and responsibilities of the key project personnel, and the procedures to be utilized for the selection of subcontractors. It is anticipated that conditions and personnel needs may change during the course of the investigation, depending upon the results of the field sampling program and data analysis. Therefore, periodic updates and amendments to the Project Management Plan may be required to ensure that the investigation is performed in the most efficient and cost-effective manner possible, and that the appropriate level of staffing and expertise is available to provide for timely completion of the investigation.

12.2 Management Approach

In performing the soil and ground water contamination investigation of the Corry Station, the NWFWMD will be responsible for the overall management and performance of the field data collection and analysis, and coordination, as needed, with other resource management and regulatory agencies. The following sections outline the NWFWMD's organizational structure and statutory relationship with the other regulatory agencies, and the planned organization structure for performance of the Corry Station investigation.

12.2.1 NWFWMD Organizational Structure

As an agency of the State of Florida, the NWFWMD operates under the authority of Chapter 373, Florida Statutes, entitled the Florida Water Resources Act of 1972. As 1 of 5 water management districts, the NWFWMD has the statutory authority and responsibility to provide for the conservation, protection, management and control of the waters of the state, which include all surface and ground water within the state and such estuarine and coastal waters that lie within jurisdiction of the State of Florida. The Florida Department of Environmental Protection (FDEP) provides for administration of Chapter 373, Florida Statutes, at the state level and exercises general supervisory authority regarding the establishment of state water policy, promulgation and adoption of water resources regulatory programs, and coordination of resource management and protection programs at the state level.

The NWFWMD is authorized to engage in such technical evaluations, special projects and programs, and to implement regulatory programs for consumptive uses of water, well construction and surface water management facilities as it deems necessary to conserve, protect and preserve the waters of the state. To accomplish this, the NWFWMD has adopted an organizational structure that encompasses four operational divisions, including Resource Management, Resource Regulation, Administration, and Land Management and Acquisition. The NWFWMD's organizational structure and lines of authority are illustrated in Figure 12-1. The NWFWMD's organizational structure is project and program oriented, and provides the flexibility necessary to form multi-disciplinary project teams that include the technical and regulatory staff appropriate for the project and full administrative support for all matters related to financial and contract management.

The Corry Station investigation will be conducted by the Division of Resource Management. This is the NWFWMD's principal technical division, and it has primary responsibility for all programs and projects related to ground water and surface water quality and quantity, engineering services, field services, and environmental and resource planning. Figure 12-2 illustrates the overall organizational structure of the Resource Management Division. Most technical

NORTHWEST FLORIDA WATER MANAGEMENT DISTRICT ORGANIZATIONAL CHART

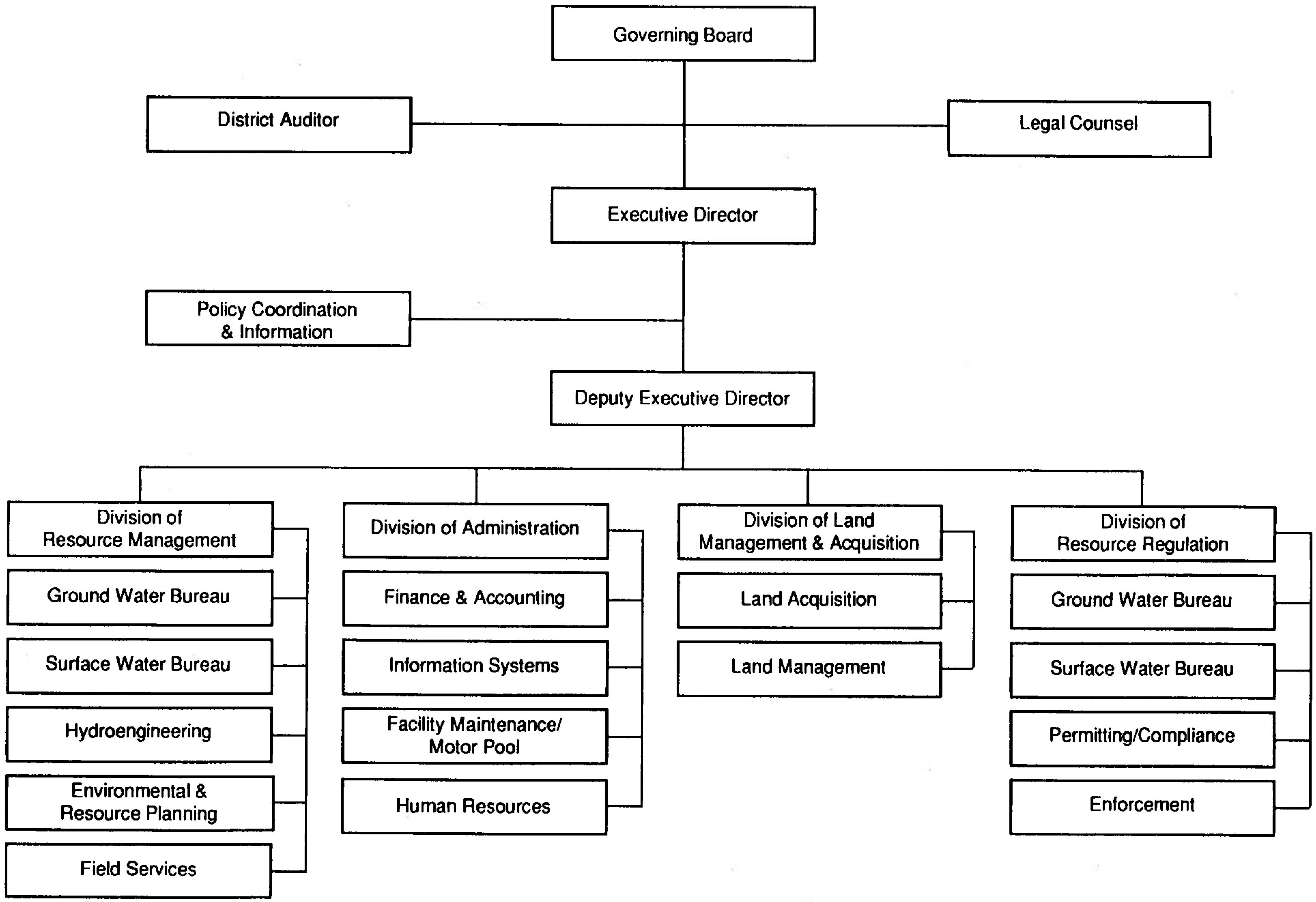

Figure 12-1. NWFWMD Organizational Structure.

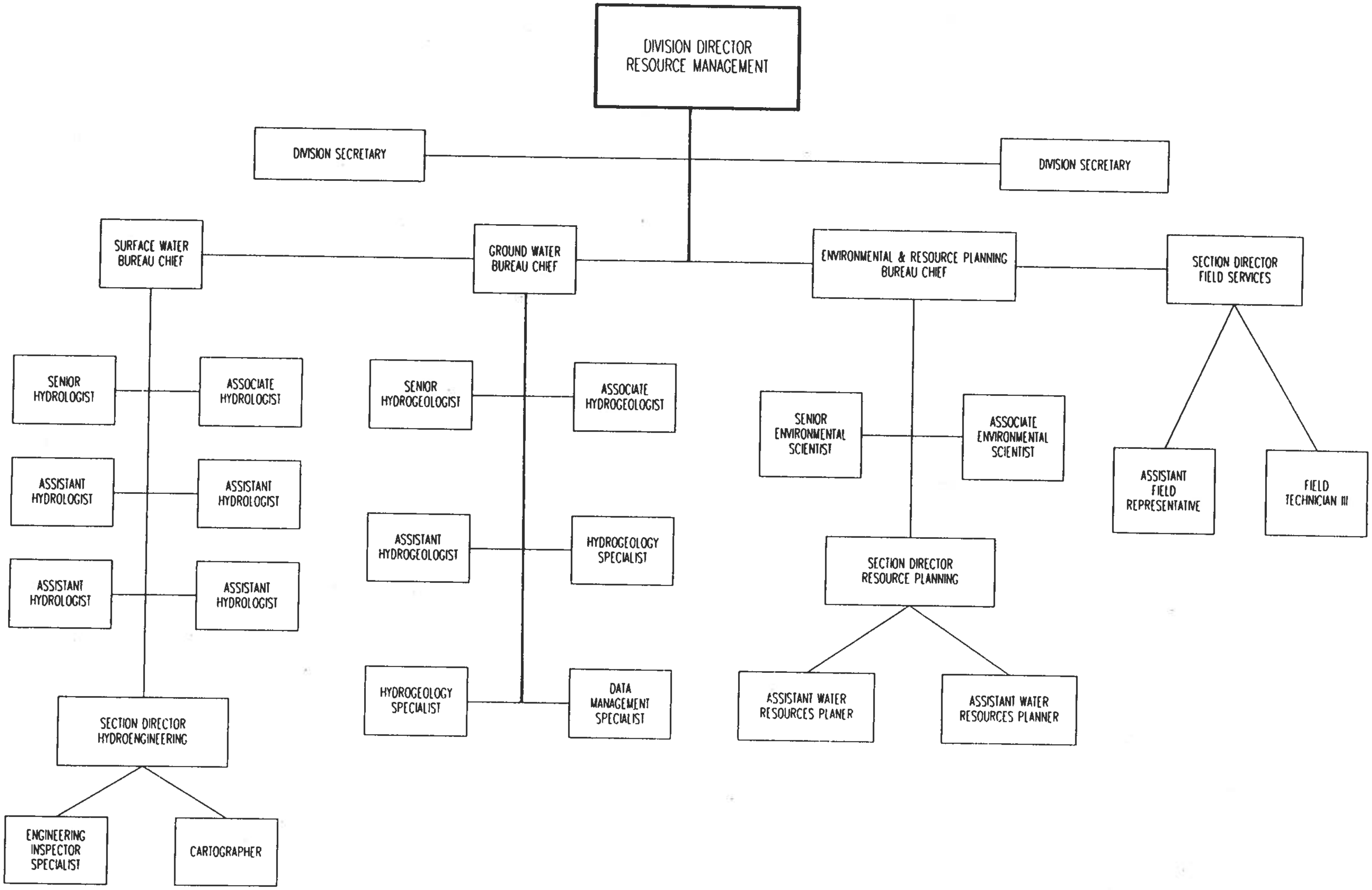

Figure 12-2. RMD Organizational Structure

work associated with the investigation will be performed by the division's Ground Water Bureau, with support from the Surface Water Management Bureau, the Environmental and Resource Planning Bureau, and the Field Services Section.

12.2.2 Project Organization

The Corry Station investigation will be completed using a combination of NWFWMD staff and subcontractors retained by the NWFWMD to provide specific services. These include: laboratory analysis, drilling services, selected field data collection and specialized consultant services. Procedures for selection of subcontractors are outlined in **Section 12.4 -- Subcontractor Selection Procedures**. Based on previous experience in completing projects performed under contract with state and federal agencies, the NWFWMD has developed a project management structure that includes the following: 1) a senior management or executive officer, 2) Project Director, 3) Project Manager, 4) task leaders responsible for performance of discrete project tasks or elements, 5) Program Administrative Officer, 6) Quality Assurance Officer and 7) technical staff and field personnel assigned to data collection, data management and analysis.

In performing the Corry Station investigation, senior NWFWMD staff will be assigned to the key roles of Project Director (Division Director level), and Project Manager (Bureau Chief level). Task leaders will be selected based upon experience and expertise for each principal element of the investigation. The NWFWMD's business manager and Director, Division of Administration, will serve as the Program Administrative Officer. For purposes of this investigation, the Project Director and Program Administrative Officer will report directly to the NWFWMD's Executive Director (Chief Executive Officer).

The proposed organizational structure of the investigation is illustrated in Figure 12-3. A major effort of the Phase II investigation is in field data collection and water quality/soils analyses. Therefore, emphasis is given towards a dedicated line of communication and quality assurance between the NWFWMD staff and the subcontractors who will perform specific services. There are two primary subcontractors: Drilling/Field Data Collection subcontractor and Laboratory Services subcontractor. The Task Leader for the field data collection activities will be in charge of the planning management, scheduling of all field work tasks and coordination of the two primary subcontractors. In order to adequately serve this function, a NWFWMD staff member will be assigned to the investigation as Field Supervisor. The Field Supervisor, who is directly charged by the Task Leader, will provide on-site field oversight during the critical periods of drilling, sampling and other field related activities. The primary contractor who will be responsible for performing the field activities will be in direct contact with the Field Supervisor. The Quality Assurance Officer will be responsible for ensuring that the primary subcontractor for field related services adheres to the Quality Assurance Project

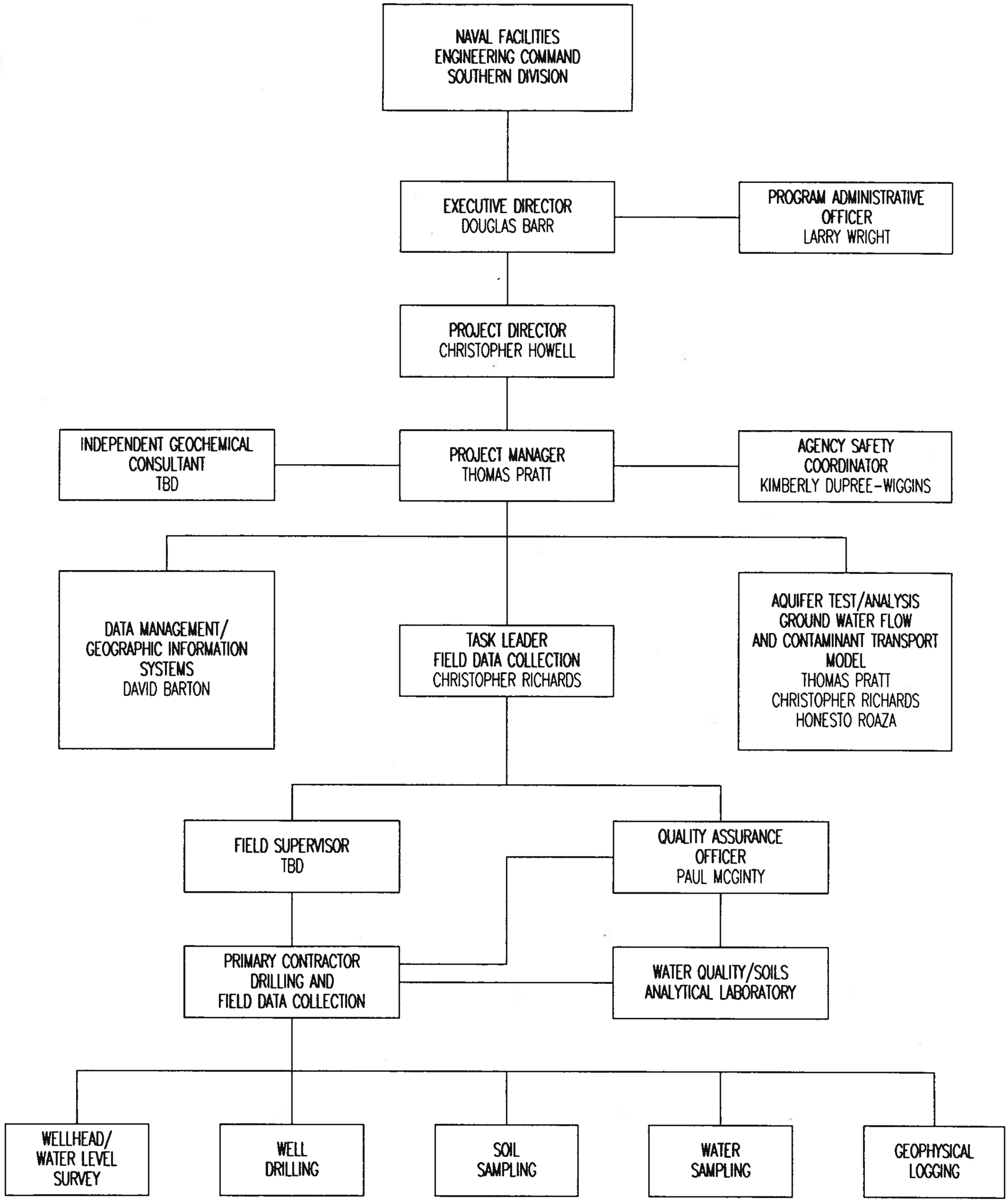

Figure 12-3. Project Organization

Plan. The Quality Assurance Officer will also review the quality control/assurance reports from the subcontractor who will perform the laboratory services. In addition to the primary contractors, a geochemical consultant will be retained to provide an independent quality assurance and guidance to NWFWMD on scientific issues related to colloidal geochemistry.

12.3 Key Project Personnel

The role and responsibility of the key project personnel for the Corry Station investigation are briefly summarized below. Resumes of the project staff are provided in **Appendix D -- Project Personnel Resumes**.

12.3.1 Executive Officer

Mr. Douglas Barr, P.G., NWFWMD Executive Director, will provide policy and executive level assistance to the Project Director and Project Manager in matters relating to approval of contracts and subcontracts, commitment of NWFWMD resources to the investigation, and the development of contracts, negotiated time and fee schedules, and contract amendments. As needed, he will also meet with SOUTHDIV and Corry Station staff to discuss the conduct and performance of the investigation and assist in the resolution of unforeseen problems and implementation of corrective actions.

12.3.2 Project Director

Christopher Howell, Ph.D., will serve as the Project Director and will assume overall responsibility for ensuring that the Corry Station investigation meets the objectives of SOUTHDIV and that the full resources of the NWFWMD are made available for performance of the investigation. He will also have primary responsibility for oversight of the project schedule, providing the necessary level of quality assurance, and serve as the principal point of control between the Project Manager, Program Administrative Officer and SOUTHDIV and Corry Station staff. As needed, the Project Director will also provide for coordination of the program activities with the appropriate state and federal agencies, including the Florida Department of Environmental Protection and the USEPA.

12.3.3 Project Manager

Mr. Thomas Pratt, P.G., will be assigned as Project Manager and will be responsible for overall management and timely completion of the project, including supervision of all technical work elements and tasks associated with completion of the investigation, scheduling of activities to be performed by project staff and/or subcontractors, monitoring and control of the project budget and scope of work, and preparing necessary project progress reports and final reports. Other duties will include:

- development of specific work plans for performance of all principal project tasks and assignment of task leaders and project staff;

- initiation and performance of all subcontracts for support services in compliance with Chapter 287, Florida Statutes, and monitoring of subcontractor performance and costs as stipulated in the terms of the subcontract;

- providing for regular meetings and contact with SOUTHDIV staff and appropriate staff from Corry Station regarding the progress and status of the program; and

- review and approval of all invoices submitted to the NWFWMD from subcontractors and vendors to ensure that all goods and services were received, and work was performed in accordance with the terms, conditions and specifications of the subcontract.

12.3.4 Task Leader--Field Data Collection

Mr. Christopher Richards, P.G., will serve as the Task Leader for performance of field work and data collection. In this capacity, he will coordinate and review the day-to-day activities of all field data collection staff and subcontractors, and have primary responsibility for the planning management and scheduling of all field investigations. These include surface and subsurface soil sampling, installation of soil borings and monitor wells, proper development of ground water monitor wells, ground water sampling and delivery of samples to the analytical laboratory, and performance of slug tests and single-well and multi-well aquifer tests. In addition, he will have direct responsibility for ensuring that all field data collection activities are performed in accordance with the Quality Assurance Project Plan and Site-Specific Quality Assurance Project Plan. Mr. Richards will be in charge of the on-site Field Supervisor and the Quality Assurance Officer whose roles are to assist Mr. Richards in adequately serving this primary function. Mr. Richards will also serve as the Site Safety Coordinator. The Task Leader will assist the Project Manager in the planning and development of work plans for performance of all field data collection activities, assuring adequate resources are available for the performance of the field activities, and provide direct support to the Project Manager in monitoring the schedule and budget for the field data collection programs. As needed, the Project Director and Project Manager may designate additional task leaders to coordinate and supervise the performance of other discrete project tasks.

12.3.5 Program Administrative Officer

Mr. Larry Wright will provide administrative services for the Corry Station investigation and will be responsible for all billing activities, final approval and payment of purchase orders and invoices received from subcontractors and vendors, and provision of program financial reports to the Project Director and Project

Manager for purposes of monitoring the program budget and expenditures. In addition, the Program Administrative Officer will be responsible for ensuring compliance with all applicable state and NWFWMD procurement procedures as provided for in Chapters 120, 287 and 373, Florida Statutes, Chapter 40A-1, Florida Administrative Code, and all federal acquisition regulations.

12.3.6 Quality Assurance Officer

The NWFWMD's Quality Assurance Officer is Mr. Paul McGinty. The Quality Assurance Officer will be responsible for ensuring that the Quality Assurance Project Plan for field data collection activities and laboratory analysis are strictly adhered to and enforced. The Quality Assurance Officer will also be responsible for implementation of quality control procedures and will conduct periodic audits of quality assurance procedures, and report the results to the Project Director and Project Manager. As needed, the Quality Assurance Officer will also update and amend QAPP.

12.3.7 Agency Safety Coordinator

The NWFWMD's Agency Safety Coordinator is Ms. Kim Dupree-Wiggins. The Agency Safety Coordinator will be responsible for the administrative issues of the Site Specific Health and Safety Plan. Ms. Dupree-Wiggins will work closely with the Project Manager and the Site Safety Officer during the course of the investigation.

12.3.8 Technical Staff and Field Personnel

Qualified technical and field personnel from the NWFWMD will accomplish specific work elements associated with field data collection, data analysis and report preparation. Technical activity leaders are designated by the Project Director and Project Manager to provide specific expertise for completion of selected project activities and elements. Generally, the technical activity leaders are the senior or most experienced members of the NWFWMD staff in any given technical area of the project. These staff are identified on the project organization chart (Figure 12-3), and their roles and anticipated responsibilities are summarized below.

- Mr. Honesto Roaza, P.G., Associate Hydrogeologist, will provide guidance and assistance in the development and performance of the field data collection program to ensure that all necessary information is obtained for the successful calibration, verification and application of the three-dimensional ground water flow and contaminant transport model to be developed in conjunction with Phase III of the investigation. Mr. Roaza will also assist in the interpretation of the Phase II field data and development of the conceptual model.

- Mr. David Barton, Director of Information Systems Section, will be responsible for computer services and ARC/INFO Geographic Information System support for the investigation. The computer services include computer resource availability, customized software support, software maintenance and coordination of the GIS staff to provide GIS related services.

As needed, other staff may be assigned to the project on a short-term basis to provide technical guidance or complete specific task elements. These include Dr. Graham Lewis (Project Biologist), Dr. Pam Latham (Statistical Analyst/Biologist) and Dr. Ruben Arteaga (Computational Hydrologist).

The following is a summary listing of the key project personnel that will be assigned to the Phase II investigation. Revisions and designation of additional personnel may be made prior to initiation of the Phase II investigation.

<u>Northwest Florida Water Management District</u>

Mr. Douglas Barr, Executive Officer
Dr. Christopher Howell, Project Director
Mr. Thomas Pratt, Project Manager
Mr. Christopher Richards, Task Leader--Field Data Collection
Mr. Larry Wright, Program Administrative Officer
Mr. Paul McGinty, Quality Assurance Officer

<u>SOUTHDIV</u>

Mr. David Driggers, Engineer-in-Charge

<u>Activity Environmental Coordinator</u>

Mr. Ron Joyner

12.4 Subcontractor Selection Procedures

Drilling services, laboratory services and selected field data collection activities will be provided by subcontractors retained by the NWFWMD. As an agency of the State of Florida, the NWFWMD will utilize statutory procedures for the certification and selection of the subcontractors as provided for in Chapters 287 and 120, Florida Statutes, and 404-1, Florida Administrative Code. These procedures are intended to provide for a competitive process in securing professional services and will provide assurances that competent contractors will be obtained in the most cost-effective manner possible. It is recognized, however, that cost is only one consideration in the selection of a contractor, and Florida statutes provide for the consideration of the professional expertise, experience and capabilities of a firm in the selection process.

12.4.1 Subcontractor Selection for Field Data Collection Activities

Selected field data collection activities will be performed by an engineering firm selected under the provisions of Chapter 287.055, Florida Statutes, entitled the "Consultants Competitive Negotiations Act." The selected contractor will be responsible for the collection of soil samples and subsurface cores obtained as part of the soil boring and monitor well drilling programs, performance of physical testing of the cores (grain-size distributions, permeability, Atterberg limits, etc.), performance of field permeability tests, and collection and preservation of water samples obtained from monitor wells. Outlined below is a brief description of the procedures the NWFWMD will utilize in selecting the subcontractor for this component of the investigation.

A. NWFWMD will prepare a Request for Proposal (RFP) that outlines the work to be accomplished, the schedule for completion of the project, the information to be provided in the proposal, certification criteria, and the procedures to be followed in the certification and selection of the consultant. Copies of the RFP will be provided to all firms on the NWFWMD's consultant mailing list, and notice will be published in the "Florida Administrative Weekly." Firms will be provided 30 days to submit their proposals.

B. Following receipt of the proposals, a certification and selection committee will be formed, comprised of the Project Director, Project Manager and one additional member of the NWFWMD's project management team. The committee will evaluate the proposals based on the pre-established certification criteria to ensure that all firms submitting proposals are qualified to perform the work.

C. Once the proposals have been certified, the committee will evaluate the statements of qualifications, performance data and other information submitted by interested firms, and shall conduct discussions with no less than 3 firms regarding their qualifications, approach to the project and ability to furnish the required services.

D. The selection committee will then rank no less than 3 firms in order of preference, deemed to be the most highly qualified to perform the required services. In ranking the firms, the following minimum criteria will be utilized:

1. Demonstrated specialized technical expertise of the firm in performing field data collection programs including soil borings, monitor well construction and field sampling procedures.

2. Size and professional qualifications of staff assigned to the project. Proposals will be accompanied by a resume for each of the personnel assigned to the project. The role of each individual in relation to the project shall also be outlined in the proposal.

3. The geographic location of the firm relative to the project area.

4. Past experience and record of the firm in field data collection programs associated with ground water contamination.

5. Present workload of the firm and capability of commencing work within 15 days of the date of contract award.

E. The Project Director and Project Manager will negotiate a contract and fee with the highest ranked firm at compensation determined to be fair, competitive and reasonable. Should the negotiations with the selected firm be unsuccessful, the NWFWMD will enter into negotiations with the 2nd highest ranked firm.

F. The final negotiated fee and contract will be subject to the approval of SOUTHDIV and the Governing Board of the NWFWMD.

12.4.2 Subcontractor Selection for Laboratory Analytical Services

As an agency of the State of Florida, the NWFWMD has several methods by which it may obtain laboratory analytical services. These include: 1) obtaining the services of a private laboratory through the competitive bid process; 2) obtaining the services of another governmental agency laboratory without a competitive bid process; and/or 3) obtaining the services of a laboratory under the provisions of

Chapter 287.055, Florida Statutes, entitled the "Consultants Competitive Negotiations Act" (**Section 12.4.1 -- Subcontractor Selection for Field Data Collection Activities**).

The NWFWMD anticipates obtaining laboratory services by either Method 1 or 2 above. Method 1 provides for the selection of contractors based on competitive sealed proposals which include a base bid for the services and a unit price bid for any additional services. In selecting the water quality and soil chemistry laboratory by the competitive bid process, NWFWMD staff will prepare an RFP which includes a statement of the services required, all applicable contractual terms and conditions, and bid schedule. The RFP will also outline criteria, including but not limited to price, to be used in selecting the contractor. The RFP will be provided to all contractors on the NWFWMD's Laboratory Services Mailing List and advertised in the "Florida Administrative Weekly."

Review of the proposals will be performed by a selection team composed of the Project Director, Project Manager and NWFWMD Quality Assurance Officer. The award will be made to the responsible offerer whose proposal is determined to be in the best interests of the NWFWMD and SOUTHDIV. The final contract will be subject to approval by the NWFWMD Governing Board.

Chapter 287.057, Florida Statutes, also provides that the NWFWMD may, as a governmental agency, obtain the services of another governmental agency without a competitive bid procedure (Method 2). The NWFWMD may elect to obtain laboratory services in this manner when it is determined to be in the best interests of the NWFWMD and SOUTHDIV to do so. At such time as the NWFWMD chooses to pursue this method of obtaining services, it will do so with the concurrence of the EIC and SOUTHDIV.

12.5 Project Schedule

The proposed schedule for completion of the Phase II field work, data collection and analysis is outlined in Figure 12-4, and is subject to review and approval by SOUTHDIV. The Phase II investigation will begin within 5 days of execution of the contract by the NWFWMD and SOUTHDIV. The schedule assumes that no State of Florida or federal permits will be required for any Phase II activities aside from issuance of well construction permits required under the provisions of Chapter 40A-3, Florida Administrative Code, for monitor wells. Modifications or addendums required to fully meet the objectives of Phase II may require modification to the Phase II schedule.

A preliminary schedule for Phase III is outlined in Figure 12-5. The Phase III schedule is subject to modification based on the results of Phase II and development of specific Phase III scope of work. A recommended scope of work for Phase III and a refined Phase III schedule will be provided in the Phase II report.

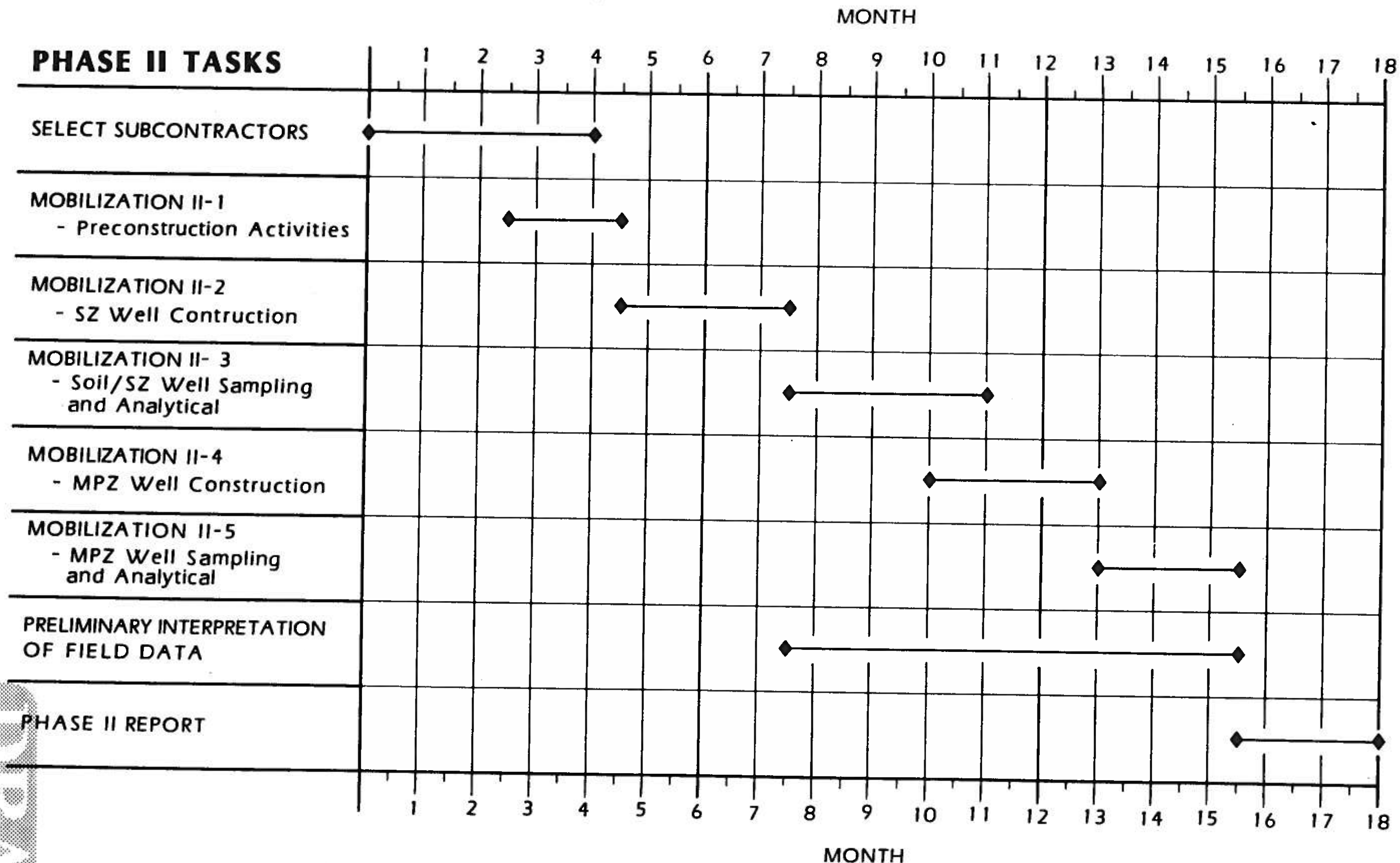

Figure 12.4 - Project Schedule, Phase II.

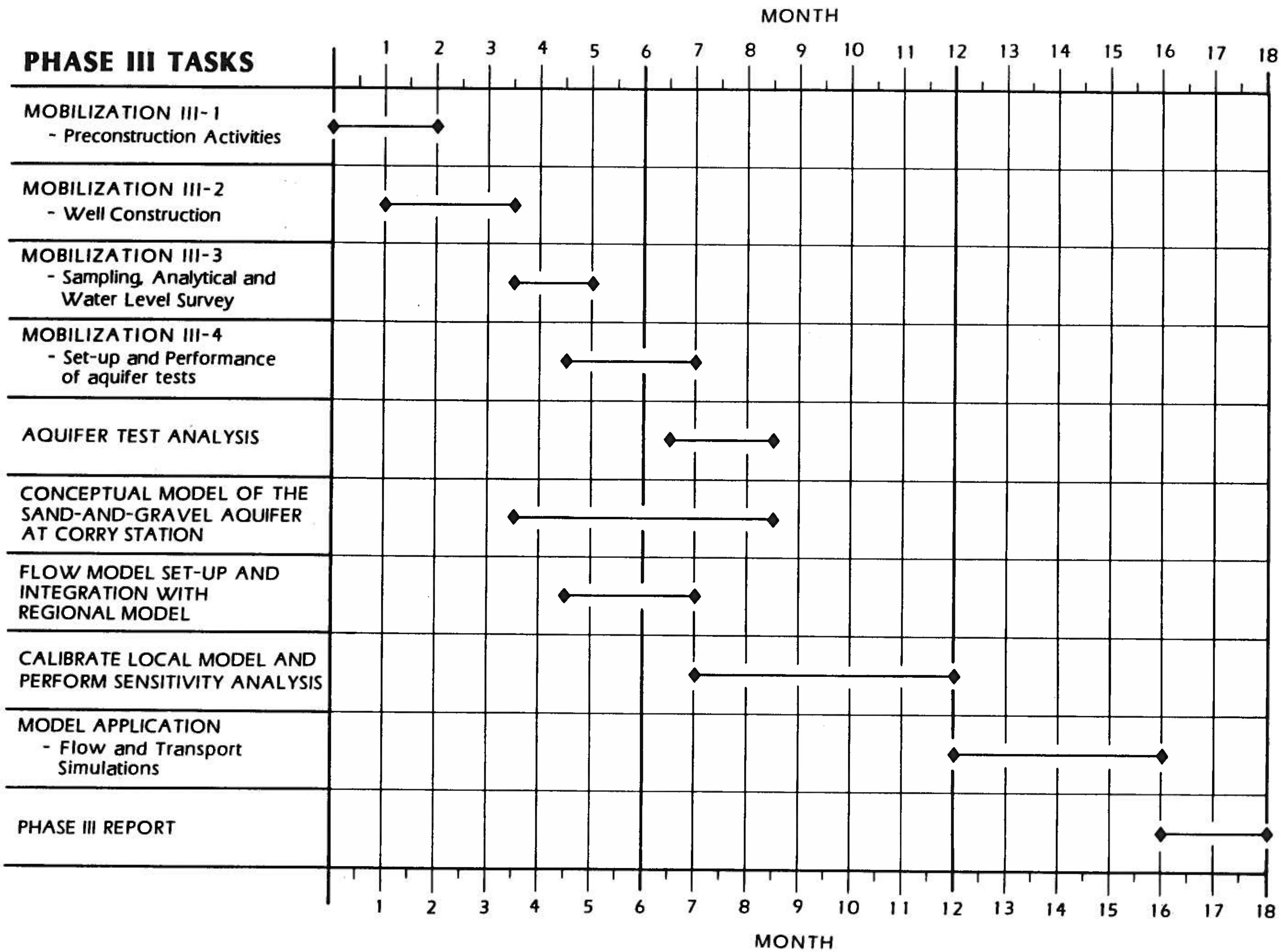

Figure 12.5 - Project Schedule, Phase III.

13.0 PROJECT LOGISTICAL PLAN

This section deals with the logistics of on-site field work. To ensure proper security arrangements for access and operations at Corry Station, a pre-mobilization meeting will be held among the NWFWMD, appropriate subcontractors, and representatives from the Corry Station Base Civil Engineers Office; the PWC Utilities Department; the PWC Facilities Management Department; and SOUTHDIV to discuss the operational aspects of implementing the investigation. The following sections address the logistics of site access, communications, field operations, and utilities survey.

13.1 Site Access

Access to Corry Station in general, and to any restricted areas, will be coordinated through the PWC Facilities Management Department and Corry Station base security. Information on subcontractor personnel involved in the project and a copy of the project contract will be provided to Corry Station base security at least 2 weeks before the beginning of field work.

Wellheads will be secured in general conformance with **Appendix B -- Guidelines for Ground Water Monitoring Well Installation.** Keys will be provided to the Activity Environmental Coordinator upon well completion and lock installation.

13.2 Communications

Subcontractor personnel will use cellular telephones while on Corry Station to maintain communication with off-base parties, and will have a list of emergency phone numbers available at all times. Personnel conducting on-site work will use either cellular telephones or two-way radios with frequencies approved by the Navy to maintain a communication link with personnel working in other areas of Corry Station. Daily communications for access needs and scheduling site operations will be coordinated with a representative of the PWC Facilities Management Department. As of this writing, the Activity Environmental Coordinator will be Mr. Ron Joyner (904-452-4515, ext. 318). Additional points of contact include the following:

Engineer-in-Charge, SOUTHDIV	Mr. David Driggers	803-743-0572
Corry Station Base Civil Engineer	Mr. Thomas Ramon	904-452-6469
Corry Station Utilities Foreman	Mr. Tom Lee	904-452-4280
PWC Facilities Management Dept. Environmental Section	Mr. Gary Sweppenhiser	904-452-2170

13.3 Field Operations

The field work at Corry Station will require mobilization and field activities to be performed by drilling crews, sampling crews and other personnel required to perform miscellaneous monitoring activities such as water level measurements. Staging of the field operations will be done from subcontractor vehicles located on Corry Station. Communication link with NWFWMD project personnel will be maintained at all times via cellular telephone. Vehicles utilized for general transportation and staging will not enter decontamination zones and will not require decontamination.

Drill rigs and backhoes left on Corry Station overnight will be disabled each night before on-site personnel leave the work area. Final approval for boring locations will be given by a representative of the Corry Station Base Civil Engineers' Office and the Activity Environmental Coordinator, during a site reconnaissance prior to the beginning of the field work. Potable water, which is necessary for drilling and decontamination procedures, will be obtained at fire hydrant locations specified by PWC Utilities Department personnel. Boreholes and wellheads will be covered and secured at the end of the work day to prevent unauthorized access.

13.4 Utility Survey

Prior to conducting any auguring, boring, drilling or other soil-disturbing activities, the contractor will locate all underground cables, pipes, utilities or other obstructions that might be damaged as a result of these activities. Appropriate authorities (Corry Station Base Civil Engineers' office; PWC Utilities Department; and appropriate private utility companies) will be contacted to identify all underground obstructions within the designated work area. All borings performed with mechanical drilling equipment will be advanced to a depth of approximately 5 feet by hand, to minimize the possibility of encountering underground obstructions with drilling equipment.

14.0 DATA MANAGEMENT PLAN

14.1 Data Documentation

Data for this project encompass both field and laboratory measurements as specified in **Section 8.0 -- Field Methodology** and in the **QAPP**. Field measurements and observations will be recorded in project-dedicated, hard bound field notebooks at the time of collection. Information to be recorded will include: sample location; sample site identification number; date and time; environmental setting; sampler identification; and any other pertinent information. At appropriate time intervals, appropriate data from the field notebooks will be transposed onto data summary sheets, soil boring logs, inspection reports, and/or computer data bases to facilitate data verification and interpretation.

Samples collected for laboratory analysis will be given a unique identification code. This code will appear on all sample containers, the chain-of-custody form, and in the field notebook. Details of this procedure are specified in the **QAPP**. Additional information will be recorded in the field notebook. Typical information to be recorded will include: sample location; data and time of sampling; sampling method; sampling equipment identification; sample medium; sampler; and sample site identification number.

Analytical results from samples submitted to the laboratory will be sent to NWFWMD along with copies of chain-of-custody forms. Summary sheets will be developed from the laboratory reports to aid in the interpretation of the data. In addition, large chemical databases will be stored on a local area network using commercially available software such as ORACLE™, to facilitate data handling and analysis. Backup copies of data files will be maintained by the NWFWMD Information Systems Section, per usual NWFWMD computer management practices.

A Geographic Information Systems (GIS; ESRI's Arc/Info GIS) will be used to keep track of and document all spatial data and data attributes. The GIS-based interpretive tasks will include refining the potentiometric surface (water level data), dieldrin contour gradients (sample analytical data) and the hydrostratigraphy of the vicinity (borehole geophysical logs).

14.2 Project File Requirements

Originals of all field notebooks, analytical laboratory reports, data summary sheets, logs, etc., will be stored in a dedicated project file. Access to this file will be controlled by the Project Manager. In addition, material removed from the file will be logged on a tracking sheet to maintain file integrity.

Data files will consist of 3 types: field data, laboratory data, and calculations and analysis. Field data will consist of field notebooks, boring logs, monitoring well installation reports, survey data, and field air monitoring summary sheets. The laboratory data file will consist of original laboratory reports and data files residing on the local area network. The calculation and analysis section of the file will contain results of all data manipulations and will include originals of all calculation forms and computer outputs.

14.3 Progress Reporting

Quarterly progress reports shall be sent to SOUTHDIV in Charleston, S.C., during the course of Phase II. Progress reports will contain a description of work completed; a summary of findings to date; summaries of any problems encountered; projected work for the next quarter; and copies of all inspection reports, laboratory and monitoring data, and other relevant information.

14.4 Data Presentation Format

The reduction of field and analytical data will consist of summarizing water level measurements, soil boring logs, well logs, field parameters, and analytical results. These summaries will be presented in the final report in the forms of tables, illustrations, and graphs. Original field data generated during soil borings and well installation will be stored in the project files as described previously. Original data collected by the field staff will be stored at the NWFWMD headquarters.

Chemical data and some physical data will be stored and managed using the NWFWMD's water quality data base system on the NWFWMD local area network. The system will be capable of various sorting routines so that data can be sorted by medium, location, parameter, etc., and presented in a tabular format.

Graphical presentation of the data and site conditions will also be included in the final report. Sampling locations, boundaries, plume definition, etc., will be illustrated on site maps based upon the data collected. Water level contours, geologic cross sections, and horizontal and vertical concentration profiles will be plotted.

Raw data will be included in the appendices. The contractor may add other information that will assist in review. Data on calibration, tuning, spikes, surrogates, and duplicates will also be presented.

15.0 HEALTH AND SAFETY PLAN

A Health and Safety Plan (**HSP**) has been prepared and is being submitted to SOUTHDIV as a separate volume of this Phase I work plan. This comprehensive volume will be referenced for all health and safety issues that arise during Phase II, and will be used to develop the Site-specific Health and Safety Plan (**SSHAP**).

16.0 QUALITY ASSURANCE PROJECT PLAN

A Quality Assurance Project Plan (**QAPP**) has been prepared and is being submitted to SOUTHDIV as a separate volume of this Phase I work plan. This comprehensive volume details all field procedures used in Phase II. A separate laboratory Quality Assurance Project Plan will be submitted to SOUTHDIV at such time as a laboratory is selected to perform the laboratory analytical work. The laboratory selected to perform the laboratory chemical analyses will be required to have an approved FDEP Comprehensive Quality Assurance Plan. Subcontractors will be required to abide by the provisions of the **QAPP**.

The quality assurance and quality control procedures detailed in the **QAPP** are in accordance with applicable professional technical standards, USEPA requirements, FDEP SOPs, and specific Navy goals and requirements identified for the project.

17.0 REPORTS

Following Phase II of this investigation, a report, which includes a compilation of data collected as specified in this work plan (Phase I), will be submitted to SOUTHDIV. This report will include all data collected during Phase II, interpretation of the data and specific recommendations regarding additional field activities, if any, required to further delineate the extent and identify the source(s) of dieldrin.

The Phase II report will also provide recommendations regarding analysis of remediation alternatives and application of ground water modeling techniques. Specific application of the ground water model is dependent on the results of Phase II data collection and interpretation. Analysis of remediation alternatives and determination of exposure pathways is subject to identification of the contaminant source(s).

Work plan modifications may be required to fully meet the project objectives (determine the extent and source of dieldrin contamination and to provide an evaluation of the risk potential and treatability of the site). Work plan modifications will be based on recommendations contained in the Phase II report. All future phases of this project will provide a report, which will include a compilation of data collected, interpretations/results, and recommendations.

For all reports, NWFWMD will submit a draft report to SOUTHDIV for review. The NWFWMD will revise the draft report based on comments received from SOUTHDIV and resubmit the report for final approval.

Quarterly progress reports shall be sent to SOUTHDIV in Charleston, S.C., during the course of Phase II. Progress reports will contain a description of work completed; a summary of findings to date; summaries of any problems encountered; projected work for the next quarter; and other relevant information.

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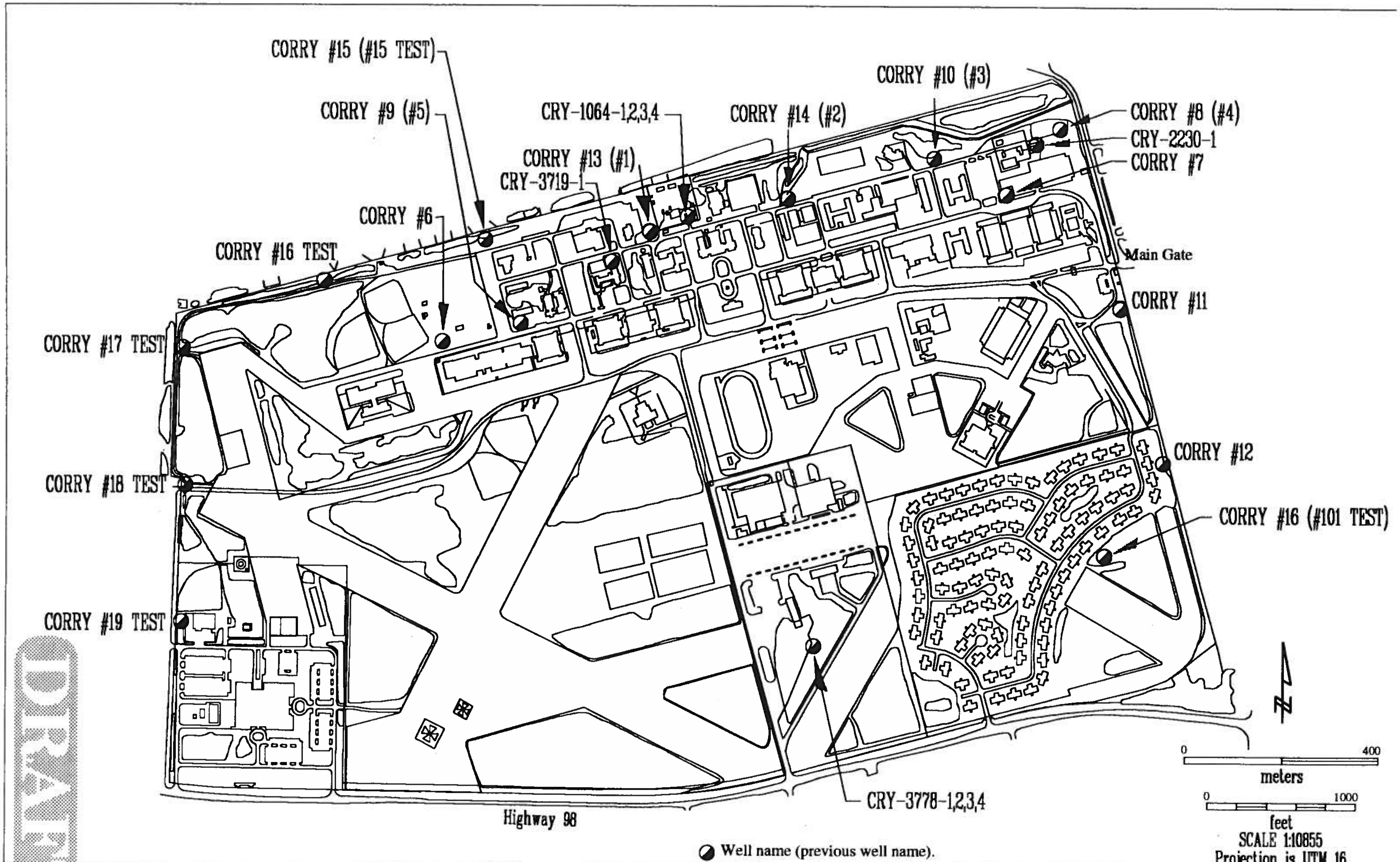
APPENDIX A-1

WELL LOCATION AND CONSTRUCTION INFORMATION



Location of Corry Station Wells.

APPENDIX A

WELL CONSTRUCTION DATA AND HYDRAULIC CHARACTERISTICS

Well Name	Use[1]	TD Ft.	CSG Ft.	Dia(In) Csg/Scrn	Screen Length	Screened Intervals (Ft)	Const. Date	Elev. ft. lsd	Specific Capacity
Corry #1	A	176	71	12	58	108/166	1/01/32	28.24	27.4
Corry #2	A	212	75	12	120	80/200	1/01/37	29.27	23.1
Corry #3	A	214	74	12	120	81/201	1/01/37	27.06	20.4
Corry #4	A	212	74	12	120	79/199	1/01/37	26.80	
Corry #5	A	212	140	24/12	60	140/200	5/20/42	29.37	21.5
Corry #6	A	228	104	24/12	70	144/214	6/11/43	31.50	12.3
Corry #7	W	226	140	24/12	70	147/217	8/23/50	31.00	25.0
Corry #8	W	238	143	26/16	75	148/223	5/25/55	33.68	34.9
Corry #9	W	251	157	26/16	75	160/235	4/25/55	31.50	39.5
Corry #10	W	209	109	26/16	80	114/194	12/01/54	25.50	26.8
Corry #11	W	251	157	26/16	75	161/236	1/01/55	31.50	39.7
Corry #12	W	238	143	26/16	75	143/218	3/01/55	33.68	37.5
Corry #13	W	232	132	26/16	80	137/217	10/24/55	28.40	32.0
Corry #14	W	230	130	26/16	80	135/215	11/11/55	27.65	23.5
Corry #15	W	230	144	26/16	80	150/230	9/26/89	31.00	32.3
Corry #16	W	242	174	26/16	65	177/242	9/26/89	29.00	15.5
Corry #15 Test	T	233	133	8/8	60	133/153 173/193 213/233	10/10/88	31.00	5.6
Corry #16 Test	T,A	233	133	8/8	60	133/153 173/193 213/233	5/12/88	31.00	7.3
Corry #17 Test	T,A	220	120	8/8	60	120/140 160/180 200/220	5/12/88	32.00	7.7
Corry #18 Test	T,A	235	135	8/8	60	135/155 175/195 215/235	5/12/88	31.00	
Corry #19 Test	T,A	237					6/01/86	33.00	
Corry #101 Test	T	246	172	8/8	74	172/246	2/12/87	29.00	6.2
CRY-1064-1	M	21	10	2/2	10	10/20	11/27/89	29.00	
CRY-1064-2	M	21	10	2/2	10	10/20	11/27/89	29.00	
CRY-1064-3	M	21	10	2/2	10	10/20	11/27/89	29.00	
CRY-1064-4	M	21	10	2/2	10	10/20	11/27/89	29.00	
CRY-3778-1	M	15	5	2/2	10	5/15	10/28/87	28.00	
CRY-3778-2	M	15	5	2/2	10	5/15	10/28/87	28.00	
CRY-3778-3	M	15	5	2/2	10	5/15	10/28/87	28.00	
CRY-3778-4	M	15	5	2/2	10	5/15	10/28/87	28.00	
CRY-2230-1	A	19	12	2/2	7	12/19	1/22/93	27.00	
CRY-3719-1	A	14	10	2/2	4	10/14	8/24/92	29.00	

[1]NOTE: A = Abandoned, W = Withdrawal, T = Test, M = Monitor

Driller's Logs For Corry Field Wells

CORRY #1 (Colocated with Corry # 13)

Depth (ft)	Description
0-10	Fine Black Sand
10-15	Coarse Cream Sand
15-20	Dark Brown Coarse Sand
20-25	Dark Gray Coarse Sand
25-30	Coarse Cream Sand
30-35	Fine Tan Sand
35-45	Fine Light Cream Sand
45-50	Coarse White Sand
50-60	Fine White Sand Containing Particles of Chalk
60-97	Sand
97-100	Chalk (dry)
100-117.5	Sand and Gravel
117.5-120	Chalk and Sand
120-122	Medium Tan Sand
122-130	Coarse Brownish Sand
130-143	Medium Tan Sand
143-153	Medium Light Tan Sand
153-163	Fine Light Tan Sand
163-175	Chalk and Clay

CORRY #2 (Colocated with Corry # 14)

Depth (ft)	Description
0-10	Surface White Sand
10-20	Fine White Sand, Streaks Blue Clay
20-60	Medium Coarse White Sand, Streaks White Clay
60-90	Fine White Sand, Streaks White Clay
90-100	Fine White Sand, Streaks Blue Clay
100-110	Medium Fine White Sand, Streaks Clay
110-120	Coarse Brown Sand, Streaks White Clay
120-130	Medium Coarse White Sand, Streaks Blue Clay
130-140	Coarse Gray Sand, Streaks White Clay
140-150	Coarse Gray Sand
150-170	Coarse Light Brown Sand
170-180	Coarse Gray Sand, Streaks White Chalk and Clay
180-200	Coarse Light Brown Sand, Streaks White Clay

CORRY #2 (Colocated with Corry # 14) -- continued

200-210	Coarse Light Brown Sand
210-220	Coarse Dark Brown Sand
220-230	Coarse Dark Brown Sand

CORRY #3 (Colocated with Corry # 10)

Depth (ft)	Description
0-40	Surface White Sand
40-70	Coarse White Sand (water bearing)
70-110	Coarse White Sand with White Clay Balls (water bearing)
110-150	Brown Sand with Streaks Very Fine Sand
150-160	Fine White Sand
160-180	Brown Sand (water bearing)
180-200	Yellow Sand (water bearing)
200-230	Coarse Brown Sand (water bearing)
230-250	Mucky Sand with Blue Mud

CORRY #4 (Colocated with Corry # 8)

Depth (ft)	Description
0-20	Surface Yellow Sand
20-50	Coarse White Sand (water bearing)
50-70	Fine White Sand (water bearing)
70-90	Coarse White Sand (water bearing)
90-100	Fine White Sand
100-110	Coarse White Sand
110-130	Fine White Sand
130-140	Fine Yellow Sand
140-170	Fine White Sand with White Clay Balls
170-180	Coarse White Sand with White Clay Balls
180-190	Fine White Sand with White Clay Balls
190-200	Coarse Yellow Sand
200-230	Coarse Brown Sand with Streaks of White Clay
230-274	Blue Sandy Clay (may begin at 225 ft.)

CORRY #5 (Colocated with Corry #9)

Depth (ft)	Description
0-10	Surface Sand
10-35	Sand with Brown Streaks
35-109	Coarse Sand with Chalky Clay
109-135	Fine Sand with Chalk
135-150	Pack Sand Streaked with Chalk
150-195	Pack Sand Coarser than Above
195-228	Brown Packed Sand
228-233	Clay
233-255	Sand, Clay and Gravel

CORRY #6 (Located west of Corry #9)

Depth (ft)	Description
0-30	Loose Coarse Sand and Muck
30-68	Soft Coarse Sand, few Hard Breaks
68-119	Pack Coarse Sand
119-120	Clay
120-140	Fine Pack Sand
140-142	Clay Streak
142-177	Pack Sand
177-218	White Sand Looser and Finer than Above

CORRY #8

Depth (ft)	Description
0-27	Red and White Sand
27-41	Black Muddy Sand
41-63	Coarse Black Muddy Sand
63-85	Coarse Muddy Sand
85-108	Coarse White Muddy Sand
108-126	Coarse White Muddy Sand
126-135	Muddy Sand and Clay
135-143	Soft Muddy Sand
143-154	Coarse Red Sand
154-224	Pack Sand
224-256	Coarse Soft Muddy Sand
256-330	Shale and Sand

CORRY #9

Depth (ft)	Description
0-8	Sand
8-35	Black Muddy Sand
35-115	Sand
115-135	Blue Sandy Shale
135-142	Blue Sandy Shale
142-158	Packed Sand
158-181	Grey Packed Sand
181-199	Packed Sand
199-203	Soft Sand
203-221	Packed Sand
221-229	Red Muddy Sand
229-238	Sandy Clay
238-323	Black Sandy Shale

CORRY #10

Depth (ft)	Description
0-40	Sand
40-60	Sand & Clay
60-65	Sand
65-80	Sandy Clay
80-116	Coarse Sand & Clay
116-139	Packed Sand
139-160	Packed Sand with Thin Clay Streaks
160-203	Coarse Sand Some Soft Streaks
203-207	Sand & Clay
207-209	Coarse Sand
209-213	Clay

CORRY #13

Depth (ft)	Description
0-2	Top Soil
2-8	Sand
8-138	White Sand and Clay
138-161	Packed Sand
161-184	Packed Sand

CORRY #13 -- continued

184-203	Packed Sand & Pink Clay
203-206	Red Clay
206-217	Packed Sand
217-219	Red Clay
219-229	Sand
229-242	Sand & Yellow Clay
242-258	Gray Sand & Clay
258-321	Sand & Clay

CORRY #14

Depth (ft)	Description
0-10	Top Sand
10-35	Coarse Sand and White Clay
35-103	Sand and White Clay
103-105	Red Sand
105-133	Sand and Clay
133-157	Sand
157-180	Packed Sand
180-202	Packed Sand
202-209	Packed Sand
209-219	Sandy Yellow Clay
219-224	Packed Sand
224-246	Sand and Yellow Clay
246-271	Gray Sandy Clay
271-316	Sand and Clay

CORRY # 15 TEST (Colocated with Corry # 15)

Depth (ft)	Description
0-2	Top Soil and Sand
2-235	Sand and Pea Gravel
235-260	Clay

CORRY# 16 TEST

Depth (ft)	Description
0-2	Top Soil and Sand
2-235	Sand and Pea Gravel
235-260	Clay

CORRY # 17 TEST

Depth (ft)	Description
0-3	Top Soil and Sand
3-240	Sand and Pea Gravel (235-240 Black Pea Gravel)
240-300	Clay

CORRY # 18 TEST

Depth (ft)	Description
0-3	Top Soil and Sand
3-235	Sand and Pea Gravel (230-235 Black Pea Gravel)
235-300	Clay

CORRY # 101 TEST (Colocated with Corry # 16)

Depth (ft)	Description
0-114	Sand
114-146	Clay and Sand Streaks (Rock @ 130)
146-172	Sand and Clay Streaks (Rock @ 150 - 152)
172-246	Sand
246-273	Clay with Sand Streaks

CRY - 1064-1

Depth (ft)	Description
0-2	Brown Fine Sand
2-9	Tan Fine Sand
9-14	Dark Brown Silty Fine Sand
14-20.5	Tan and Grey Fine Sand

CRY-1064-2

Depth (ft)	Description
0-2	Brown Fine Sand
2-6	Tan Fine Sand
6-10	Brown Fine Sand
10-12	Dark Brown Silty Fine Sand
12-20.5	Tan to Grey Fine Sand

CRY-1064-3

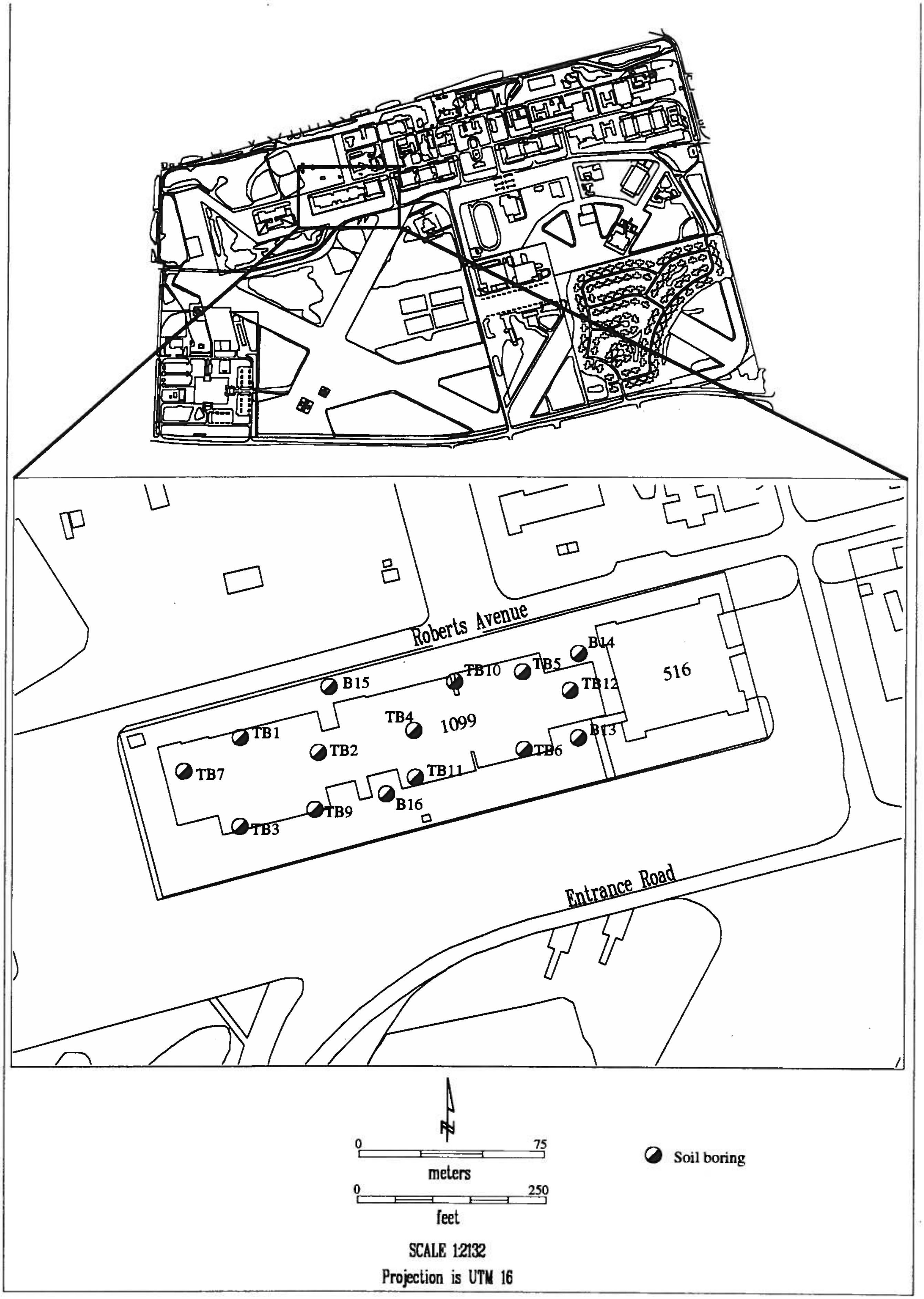
Depth (ft)	Description
0-3	Brown Fine Sand
3-5	Tan Fine Sand
5-7	Brown Fine Sand
7-12	Dark Brown Silty Fine Sand
12-20.5	Tand and Grey Fine Sand

CRY-1064-4

Depth (ft)	Description
0-3	Brown Fine Sand
3-8	Tan Fine Sand
8-13	Brown Fine Sand
13-20.5	Tan and Grey Fine Sand

APPENDIX A-2

SOIL BORING LOCATIONS AND DESCRIPTIONS



Soil Boring Locations in Vicinity of the Electronics Warfare Training Building 1099.

BORING LOGS -- BUILDING NO. 1099

Bore Hole Name	Brown Organic Stained Sand	Black Silty Organic Sand	Black Clayey Organic Silt
TB1	14-28 (FT)	None	29-44
TB2	14-23	5-8	31-44
TB3	6-29	34-38	None
TB4	12-24	6-12	29-39
TB5	None	4-10	None
TB6	7-32	4-7	32-38
TB7	3-4, 8-29	29-34	36-43
TB8	7-23	2-6	23-29
TB9	6-27	3-6, 27-38	None
TB10	16-27	3-8, 27-32	None
TB11	17-29	None	19-34
TB12	None	None	None

Source: Lopatka, McQuag, & Wall Corp (1974). All borings in the vicinity of Building 1099.

TEST BORING B-13

DEPTH	SOIL DESCRIPTION	WATER TABLE
0-4.5 ft.	Brown & Tan Slightly Silty Sand, Medium Dense	9 ft.
4.5-16.5 ft.	White Fine/Medium Sand, Medium Dense, Very Dense	

TEST BORING B-14

DEPTH	SOIL DESCRIPTION	WATER TABLE
0-4 ft.	Tan & Brown Silty Fine/Medium Sand Loose, Medium Dense	6 ft.
4-8 ft.	Black Slightly Silty Fine/Medium Sand w/Traces of Organics, Loose	
8-16.5 ft.	White Fine/Medium Sand, Loose Dense, Very Dense	

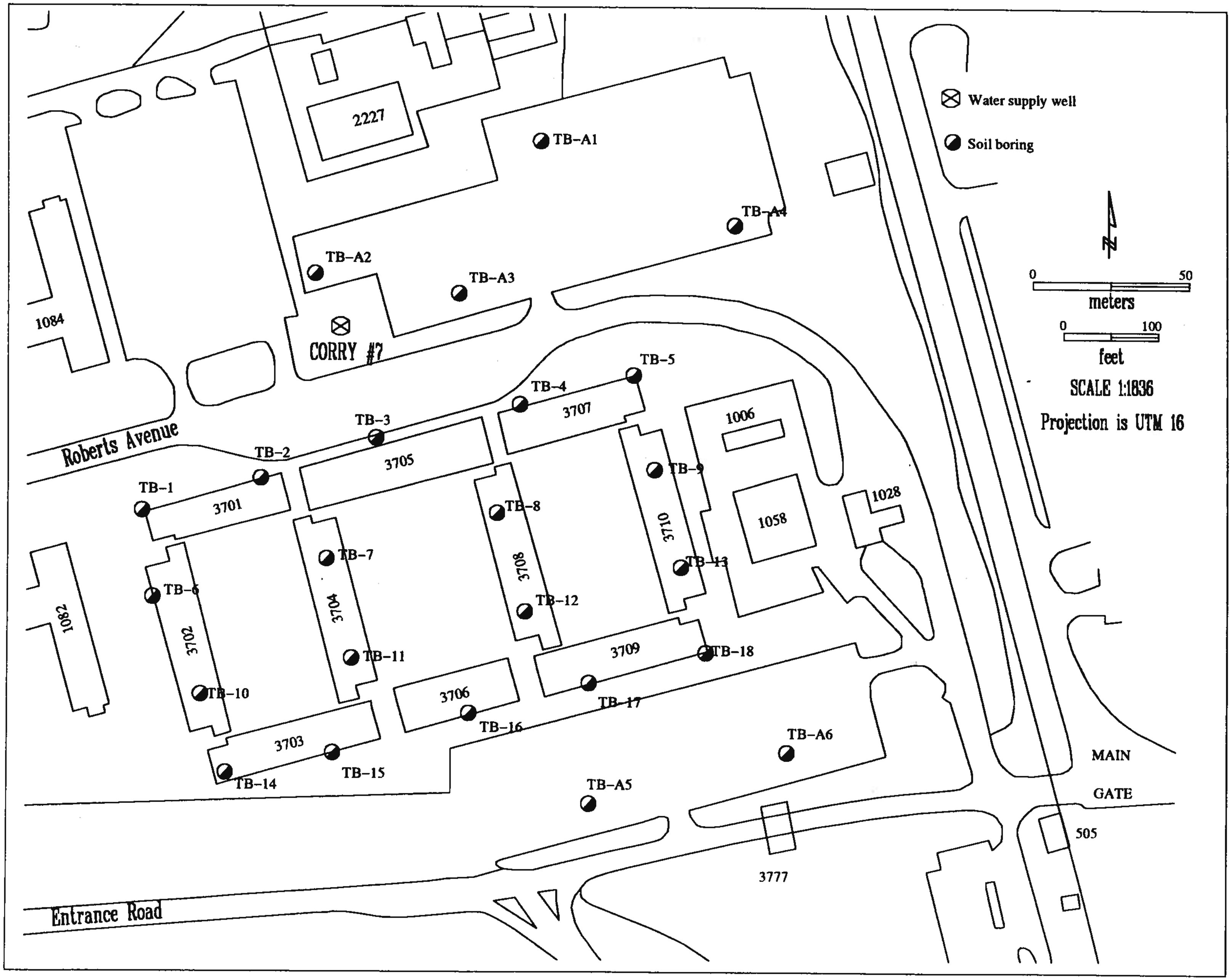
TEST BORING B-15

DEPTH	SOIL DESCRIPTION	WATER TABLE
0-1 ft.	Brown Fine/Medium Sand, Loose	7 ft.
1-8 ft.	Black Silty, Slightly Organic Clayey Sand, Loose Medium Dense	
8-16.5 ft.	Brown Organic Stained Fine/Medium Sand, Dense, Very Dense	

TEST BORING B-16

DEPTH	SOIL DESCRIPTION	WATER TABLE
0-1.5 ft.	Brown Slightly Silty Fine/Medium Sand w/Traces of Organics, Loose, Medium Dense	8.5 ft.
1.5-7.5 ft.	Brown & Black Slightly Organic Fine/Medium Sand w/Traces of Clay Loose	
7.5-12	Brown Organic Stained Fine/Medium Sand, Very Dense	
12-16.5	White Fine/Medium Sand, Very Dense	

Source: Meister and Associates, Inc., (1991)



Soil Boring Locations in the Vicinity of Unaccompanied Enlisted Personnel Housing (UEPH Bldg. 3701-3710).

BORING LOGS -- UEPH -- BUILDINGS NO. 3701 THROUGH 3710

BORING NO. 1

DEPTH	SOIL DESCRIPTION	WATER TABLE
0-7	SP[1]	13.5
7-14.5	SM[2]	
14.5-17.5	SP	
17.5-41	SM	

BORING NO. 2

DEPTH	SOIL DESCRIPTION	WATER TABLE
0-3	SP	
3-13	SP/SM	
13-36	SM	

BORING NO. 3

DEPTH	SOIL DESCRIPTION	WATER TABLE
0-5	SP	
5-31	SM	

BORING NO. 4

DEPTH	SOIL DESCRIPTION	WATER TABLE
0-5.5	SP	
5.5-31	SM	

BORING NO. 5

DEPTH	SOIL DESCRIPTION	WATER TABLE
0-6	SP	11.5
6-31	SM	

BORING NO. 6

DEPTH	SOIL DESCRIPTION	WATER TABLE
0-9.5	SP	
9.5-10	SM	

BORING NO. 7

DEPTH	SOIL DESCRIPTION	WATER TABLE
0-6	SP	12
6-31	SM	

BORING NO. 8

DEPTH	SOIL DESCRIPTION	WATER TABLE
0-6	SP	
6-31	SM	

BORING NO. 9

DEPTH	SOIL DESCRIPTION	WATER TABLE
0-10	SP	
11-31	SM	

BORING NO. 10

DEPTH	SOIL DESCRIPTION	WATER TABLE
0-6	SP	
6-31	SM	

BORING LOGS -- UEPH -- BUILDINGS NO. 3701 THROUGH 3710 (CONTINUED)

DEPTH	BORING NO. 11 SOIL DESCRIPTION	WATER TABLE
0-6	SP	
6-31	SM	

DEPTH	BORING NO. 12 SOIL DESCRIPTION	WATER TABLE
0-6	SP	
6-31	SM	

DEPTH	BORING NO. 13 SOIL DESCRIPTION	WATER TABLE
0-6	SP	
6-31	SM	

DEPTH	BORING NO. 14 SOIL DESCRIPTION	WATER TABLE
1-8	SP/SM	12.5
8-31	SM	

DEPTH	BORING NO. 15 SOIL DESCRIPTION	WATER TABLE
0-2	SW[3]	
2-6	SP	
6-31	SM	

DEPTH	BORING NO. 16 SOIL DESCRIPTION	WATER TABLE
0-6	SP	
6-31	SM	

DEPTH	BORING NO. 17 SOIL DESCRIPTION	WATER TABLE
0-6	SP	
6-31	SM	

DEPTH	BORING NO. 18 SOIL DESCRIPTION	WATER TABLE
0-6	SP	12.5
6-31	SM	

DEPTH	BORING NO. A1 SOIL DESCRIPTION	WATER TABLE
0-6	SP	

DEPTH	BORING NO. A2 SOIL DESCRIPTION	WATER TABLE
0-6	SP	

DEPTH	BORING NO. A3 SOIL DESCRPTION	WATER TABLE
	0-6	SP

DEPTH	BORING NO. A4 SOIL DESCRIPTION	WATER TABLE
0-6	SP	

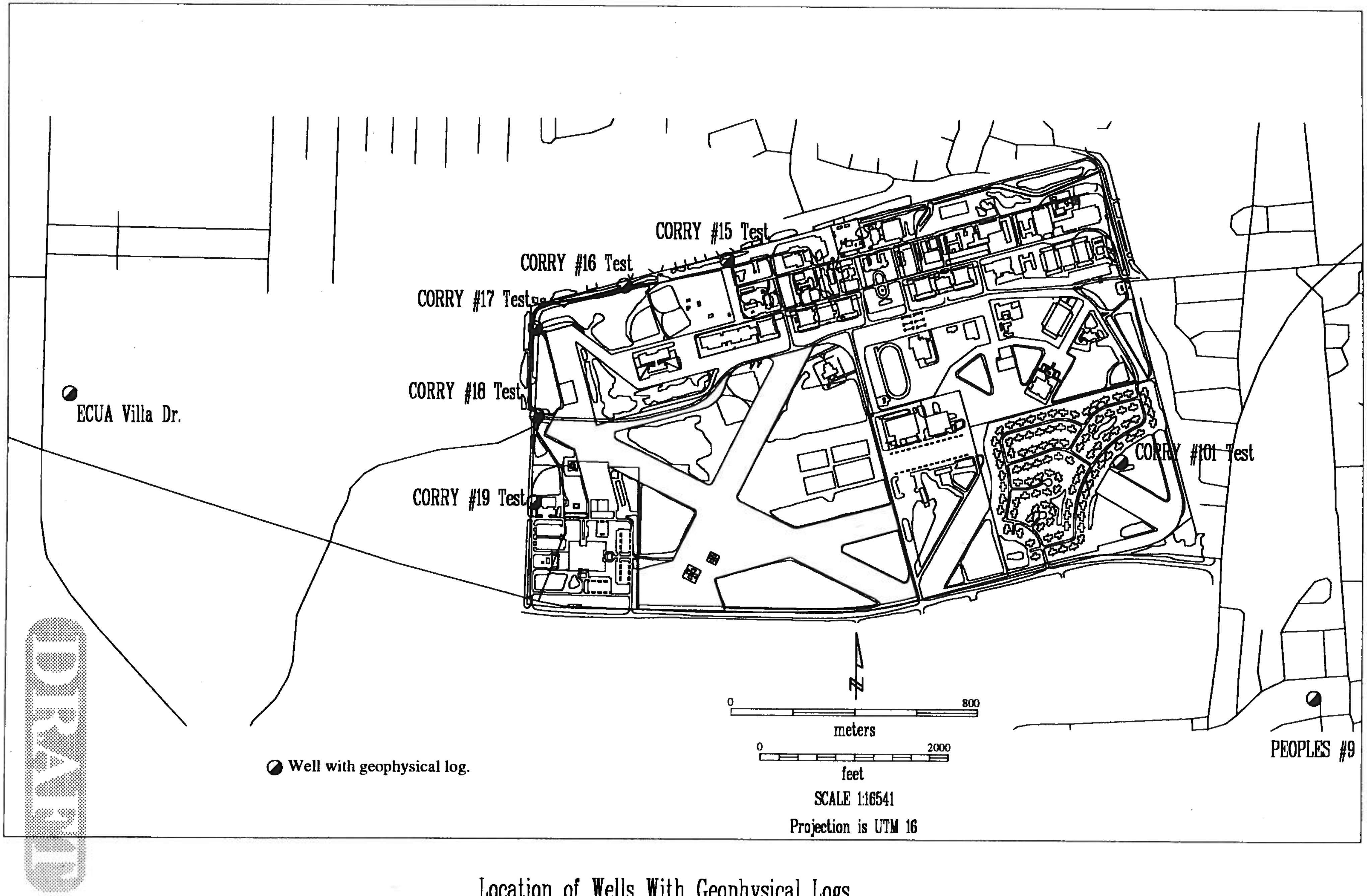
BORING LOGS -- UEPH -- BUILDINGS NO. 3701 THROUGH 3710 (CONTINUED)

DEPTH	BORING NO. A5 SOIL DESCRIPTION	WATER TABLE	DEPTH	BORING NO. A6 SOIL DESCRIPTION	WATER TABLE
0-6	SP		0-6	SP	

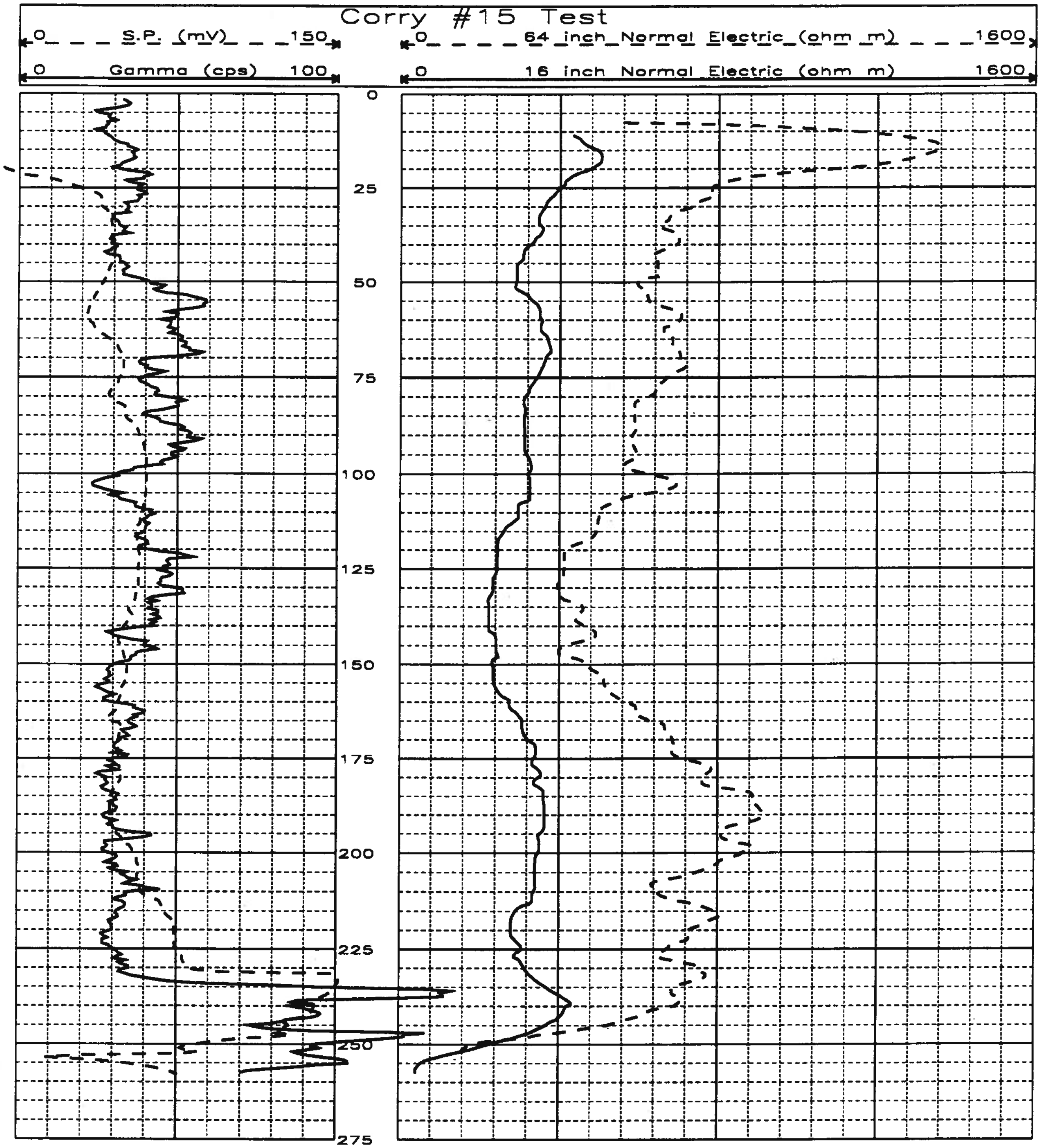
1. Poorly graded sands, gravellysands, little or no fines
2. Silty sands, sand-silt mixture
3. Well-graded sands, gravelly sands, little or no fines

APPENDIX A-3

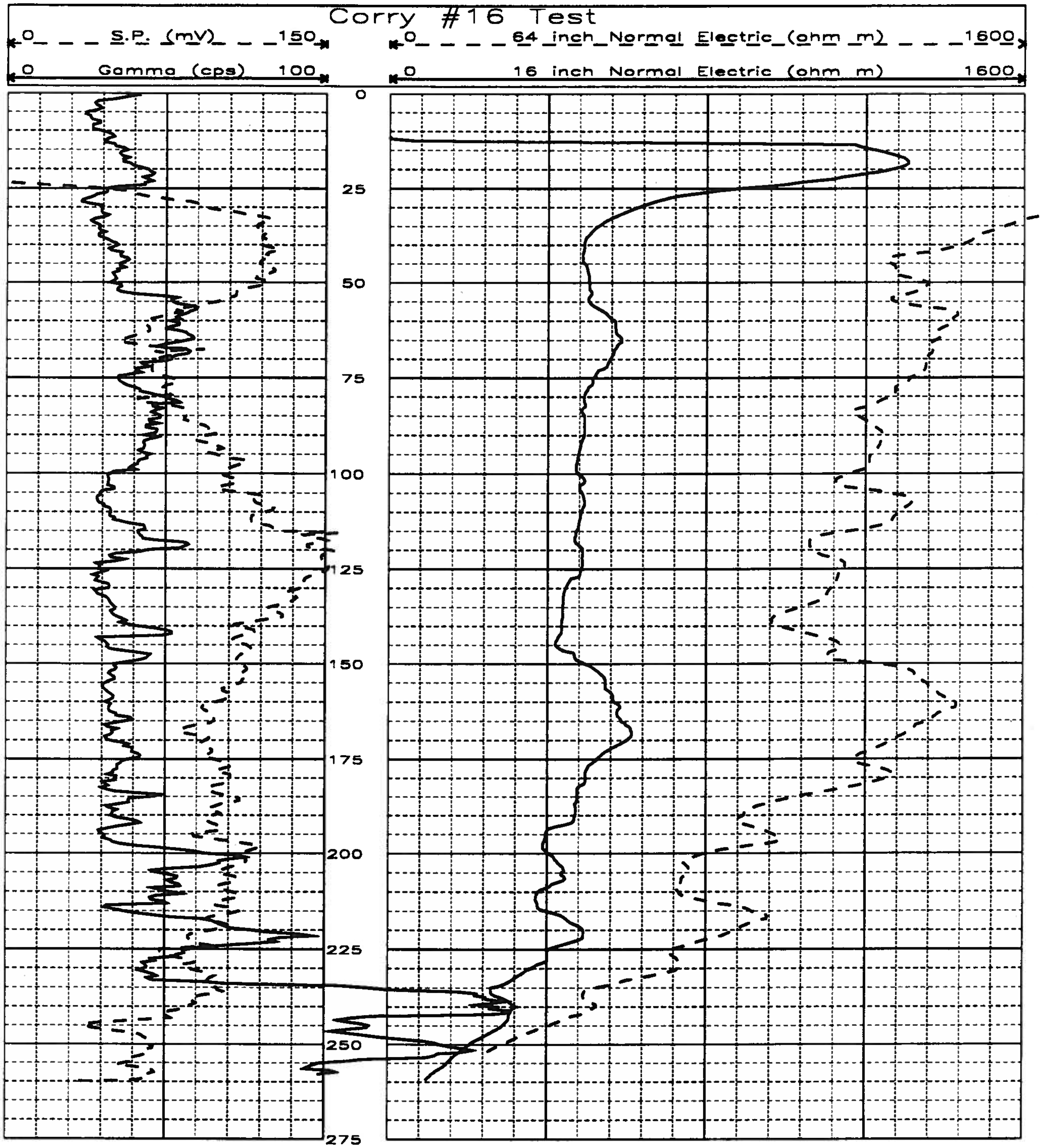
GEOPHYSICAL LOGS

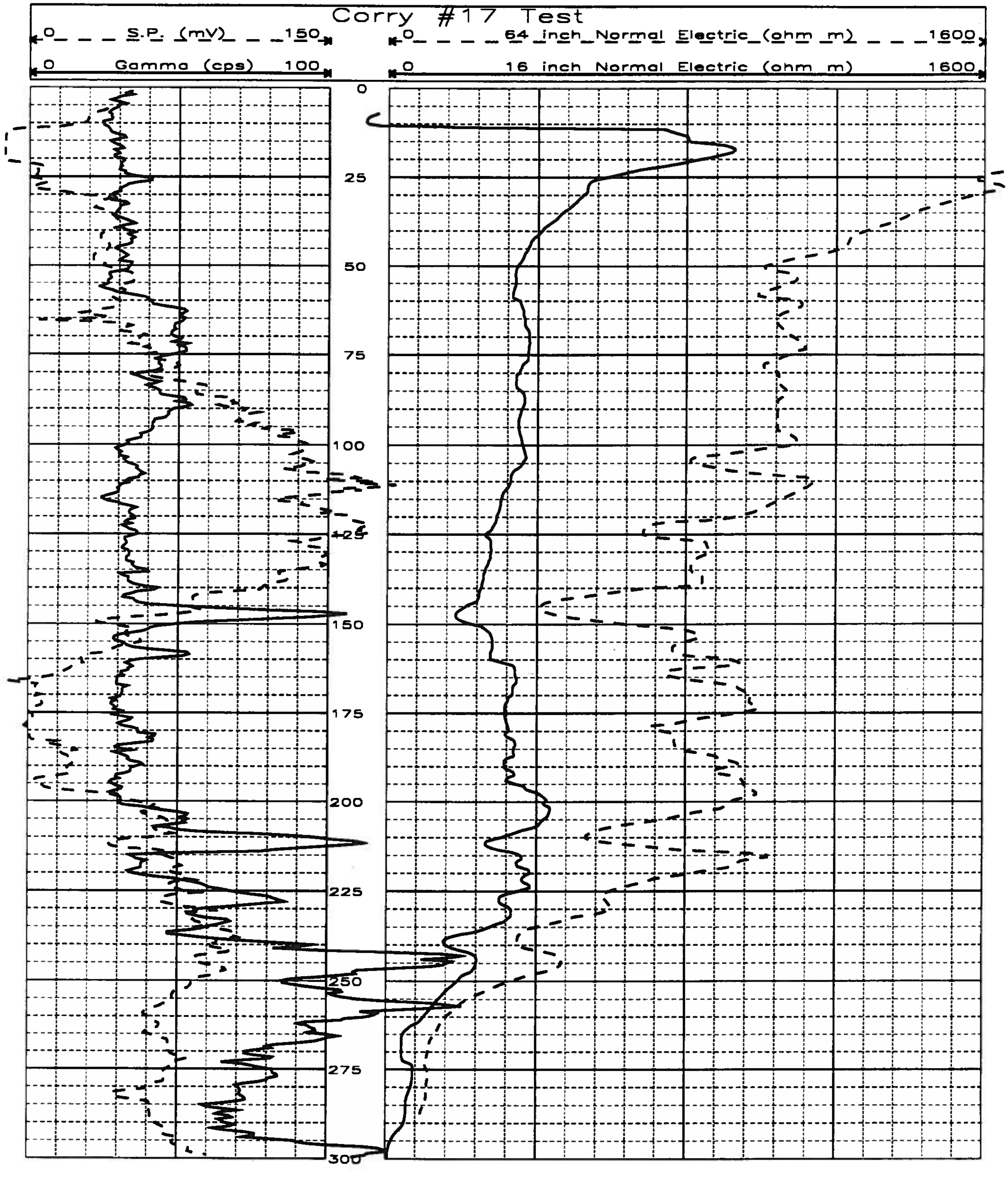


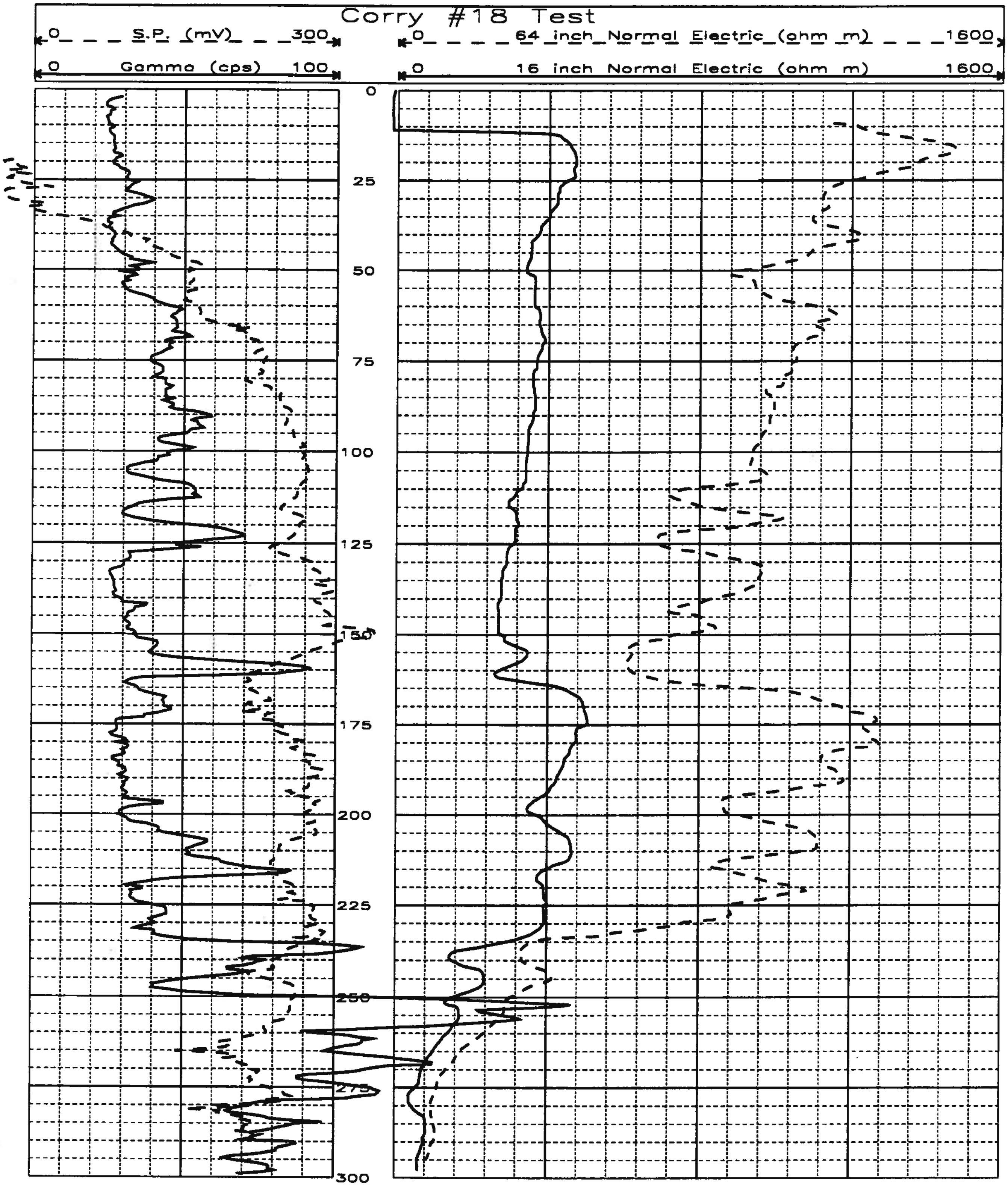
Location of Wells With Geophysical Logs.

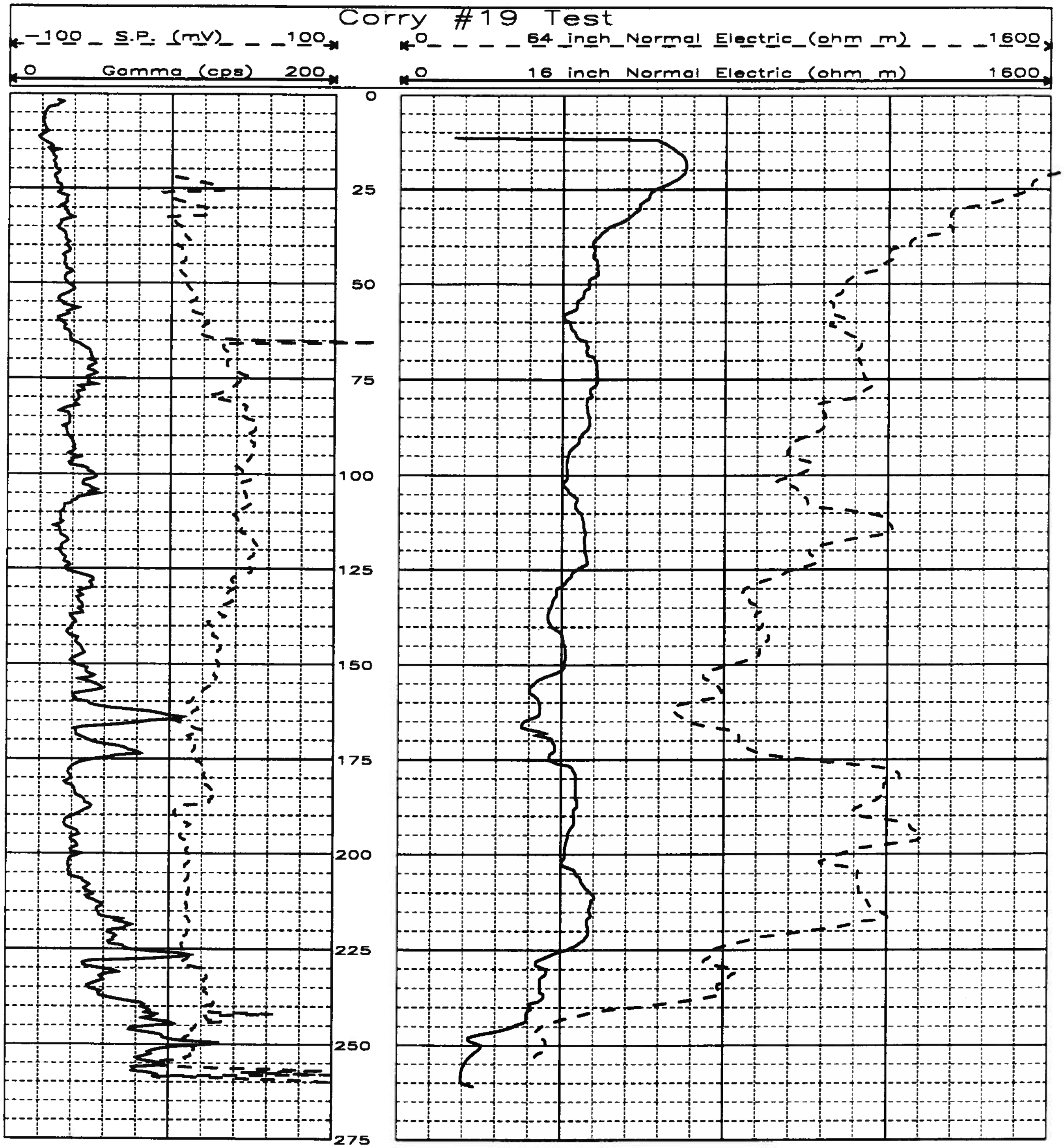


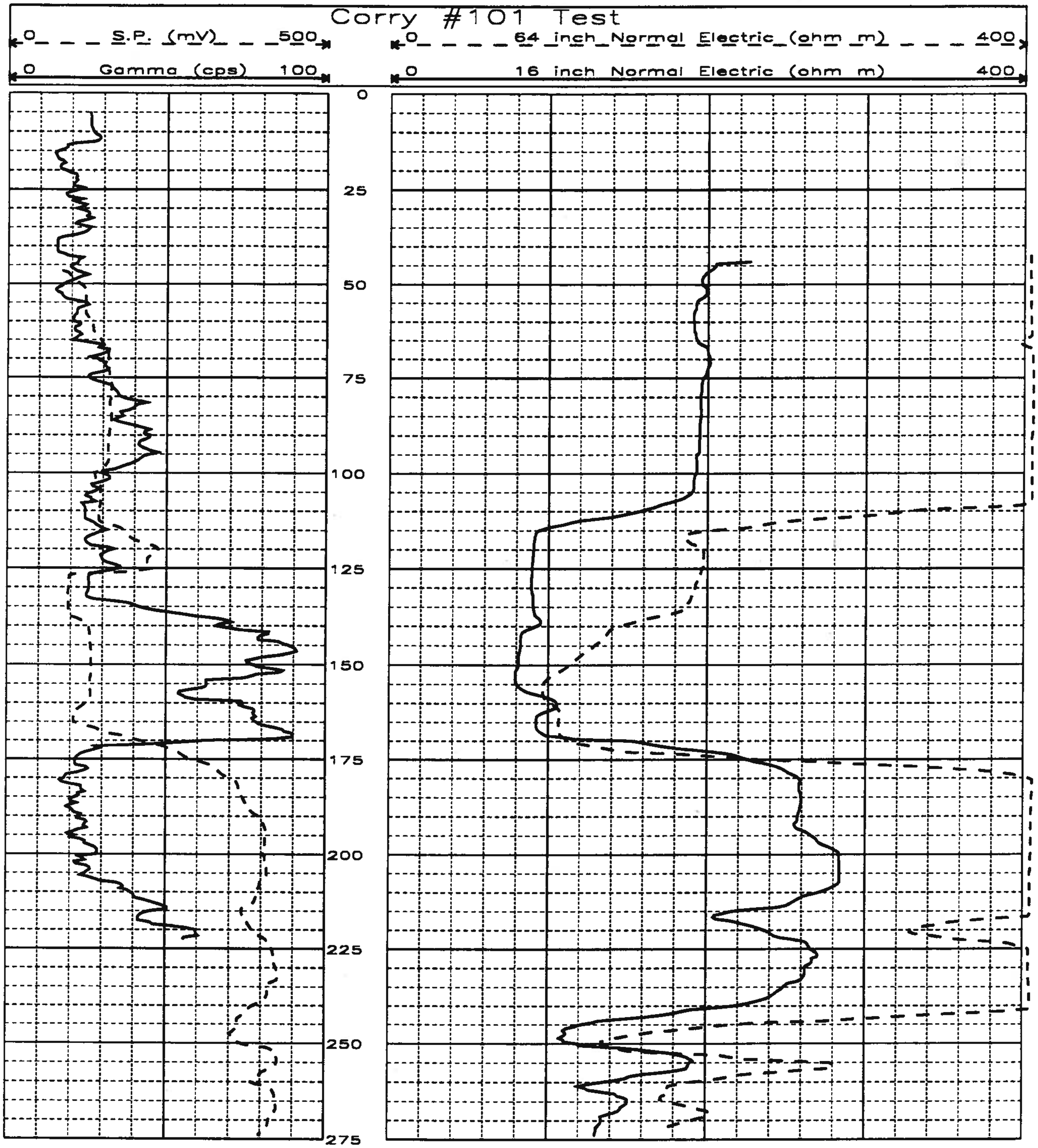
Corry #15 Test
0 S.P. (mV) 150
0 Gamma (cps) 100
0 64 inch Normal Electric (ohm m) 1600
0 16 inch Normal Electric (ohm m) 1600
0
25
50
75
100
125
150
175
200
225
250
275


Corry #16 Test
0 S.P. (mV) 150
0 64 inch Normal Electric (ohm m) 1600
0 Gamma (cps) 100
0 16 inch Normal Electric (ohm m) 1600
0
25
50
75
100
125
150
175
200
225
250
275

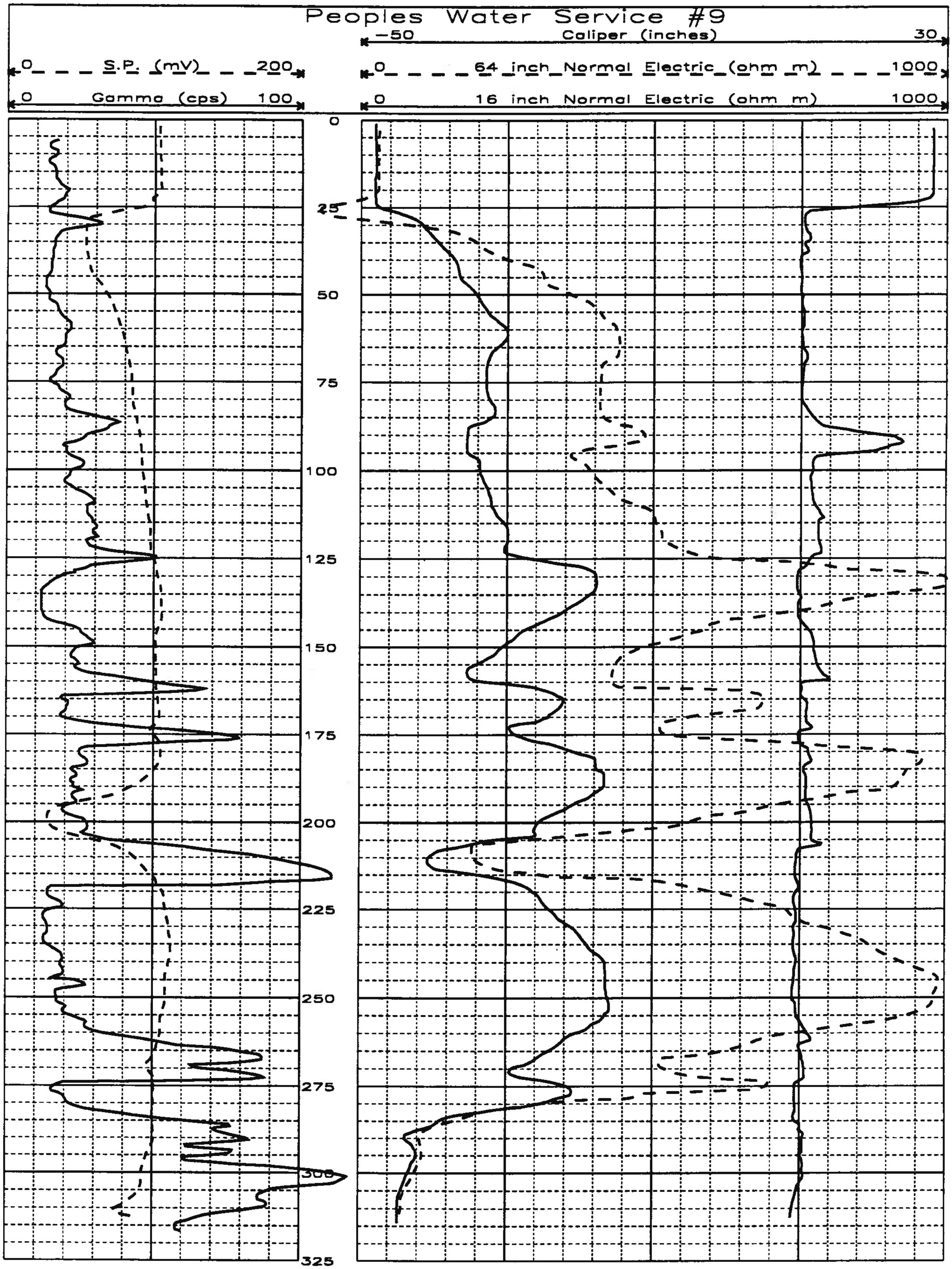

Corry #17 Test
0 S.P. (mV) 150
0 Gamma (cps) 100
0 64 inch Normal Electric (ohm m) 1600
0 16 inch Normal Electric (ohm m) 1600
0
25
50
75
100
125
150
175
200
225
250
275
300


Corry #18 Test
0 S.P. (mV) 300
0 64 inch Normal Electric (ohm m) 1600
0 Gamma (cps) 100
0 16 inch Normal Electric (ohm m) 1600
0
25
50
75
100
125
150
175
200
225
250
275
300

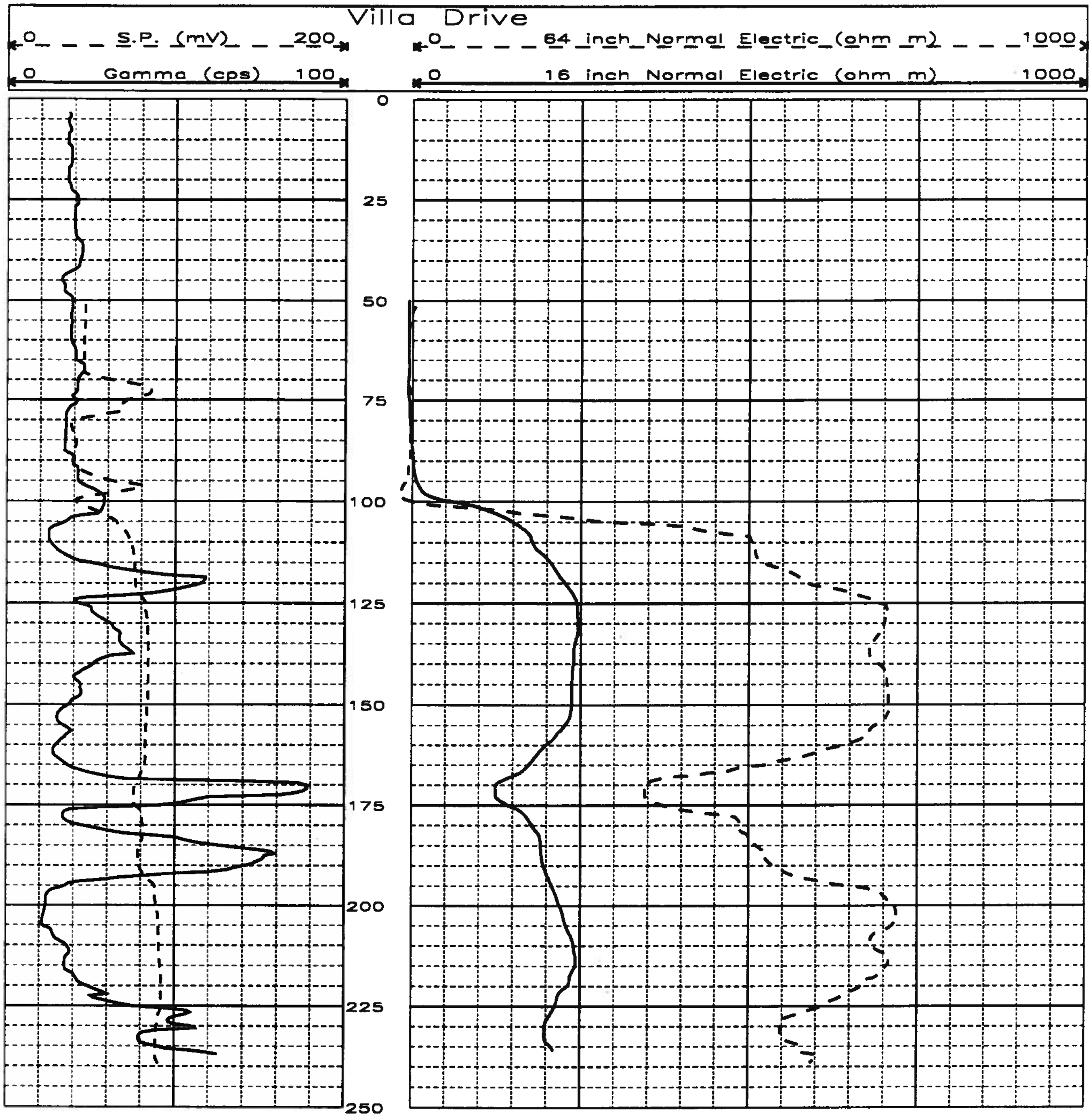

Corry #19 Test
-100 S.P. (mV) 100
0 Gamma (cps) 200
0 64 inch Normal Electric (ohm m) 1600
0 16 inch Normal Electric (ohm m) 1600
0
25
50
75
100
125
150
175
200
225
250
275



Corry #101 Test
0 S.P. (mV) 500
0 Gamma (cps) 100
0 64 inch Normal Electric (ohm m) 400
0 16 inch Normal Electric (ohm m) 400
0
25
50
75
100
125
150
175
200
225
250
275



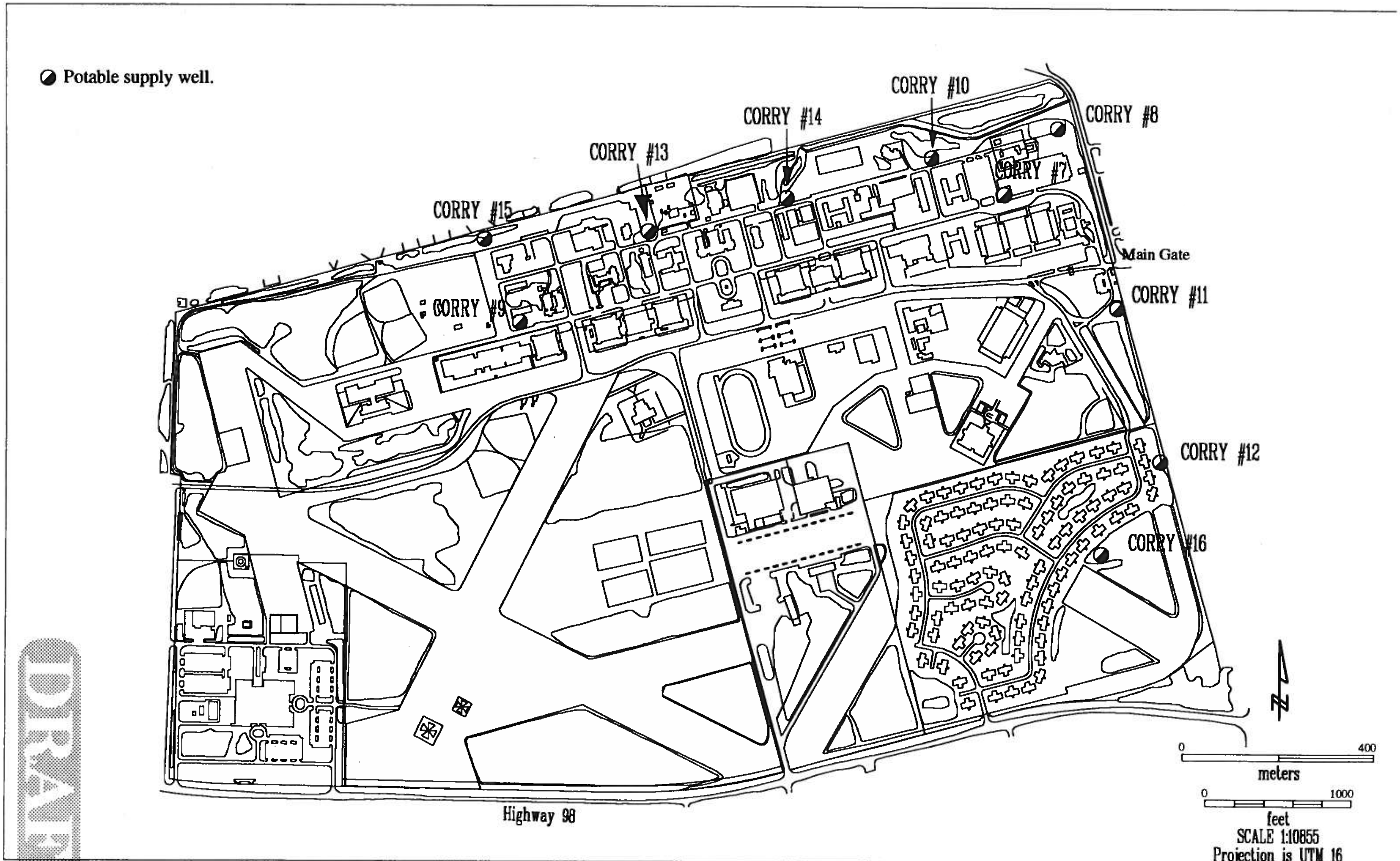
Peoples Water Service #9
-50 Caliper (inches) 30
0 S.P. (mV) 200
0 64 inch Normal Electric (ohm m) 1000
0 Gamma (cps) 100
0 16 inch Normal Electric (ohm m) 1000
0
25
50
75
100
125
150
175
200
225
250
275
300
325


Villa Drive
0 S.P. (mV) 200
0 Gamma (cps) 100
0 64 inch Normal Electric (ohm m) 1000
0 16 inch Normal Electric (ohm m) 1000
0
25
50
75
100
125
150
175
200
225
250

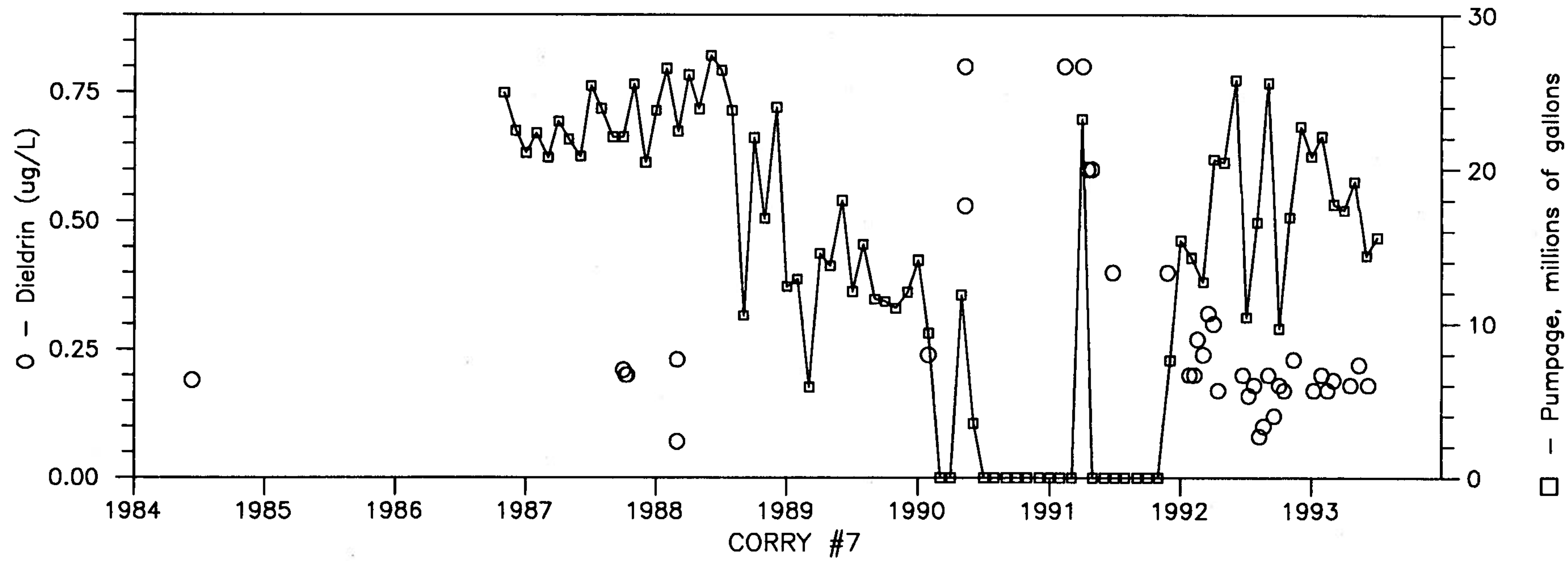
DRAFT

APPENDIX A-4

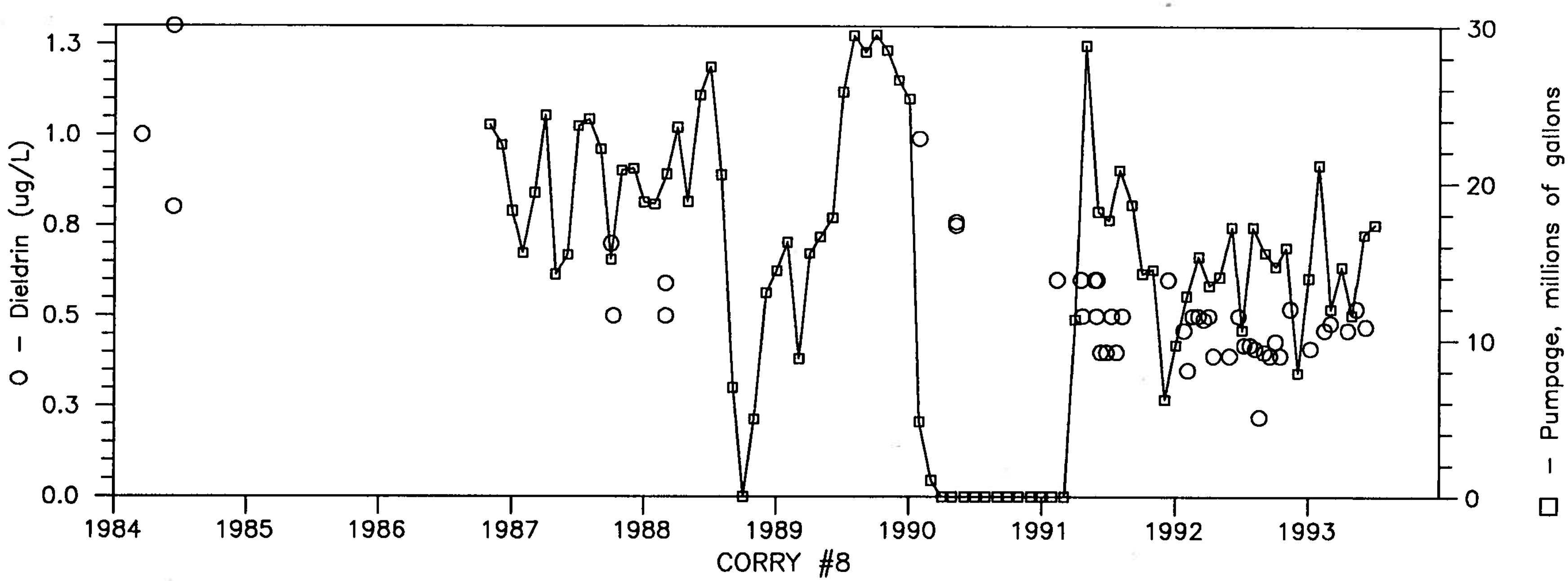
WATER QUALITY AND WELL PUMPAGE



Location of Potable Supply Wells.



TOTAL MONTHLY PUMPAGE AND DIELDRIN CONCENTRATIONS - CORRY # 7



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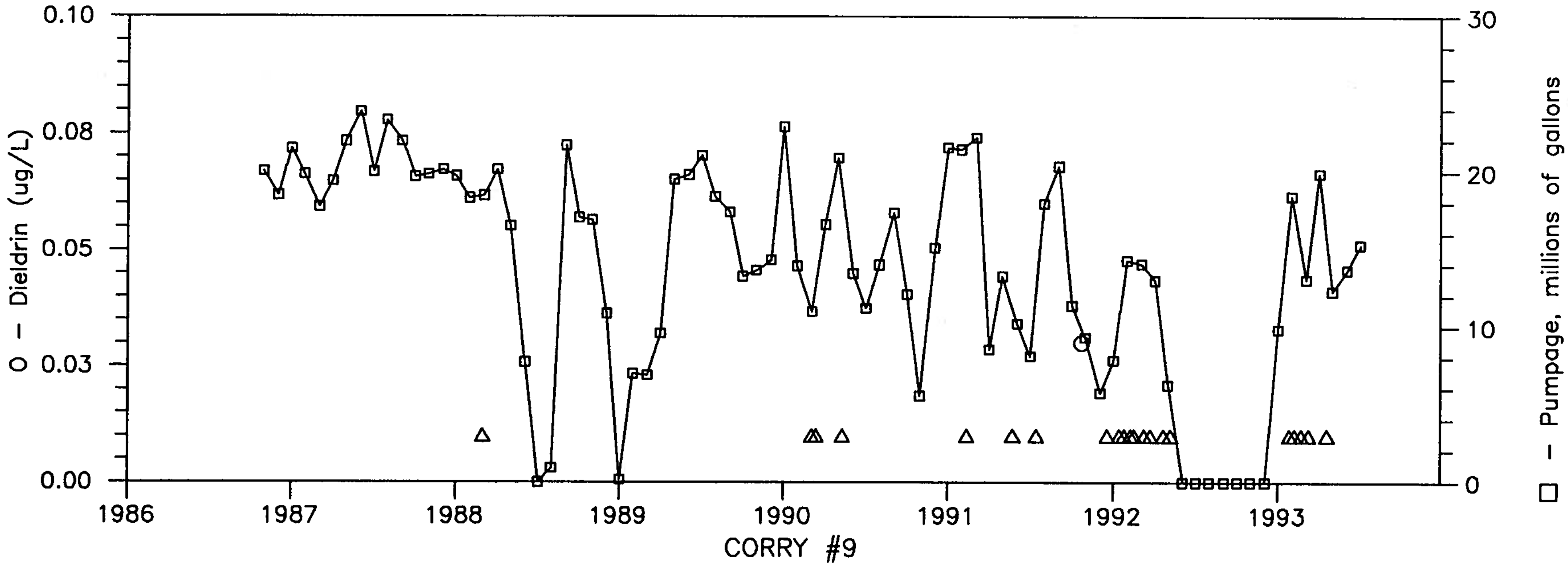
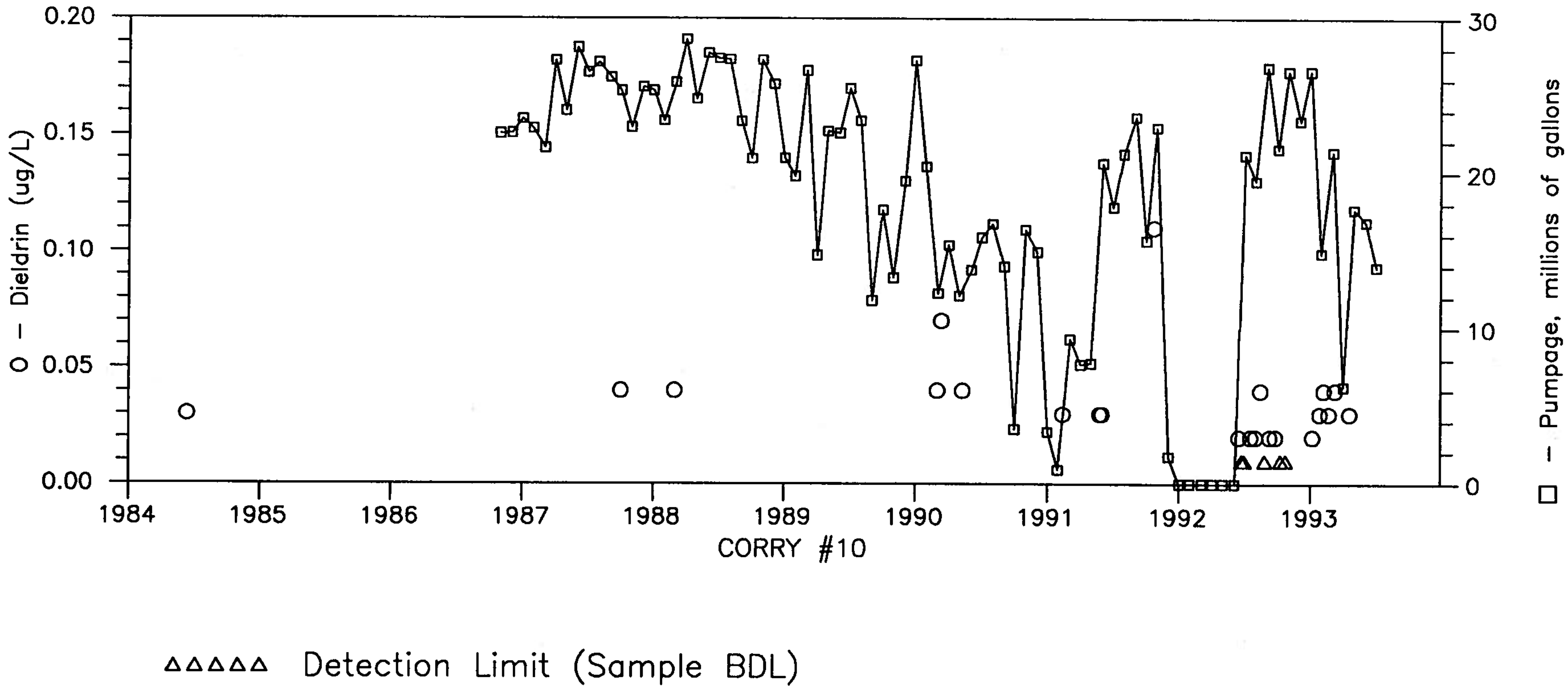


△△△△△ Detection Limit (Sample BDL)

TOTAL MONTHLY PUMPAGE AND DIELDRIN CONCENTRATIONS - CORRY # 9



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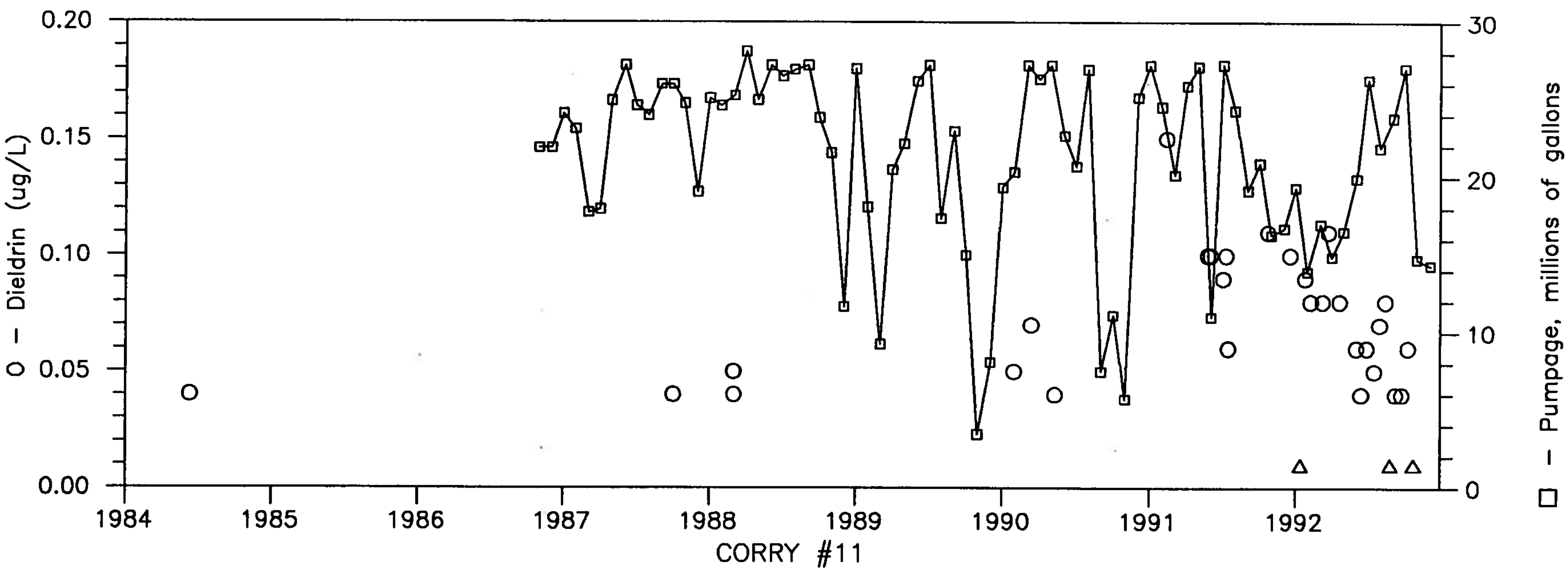

ΔΔΔΔΔ Detection Limit (Sample BDL)

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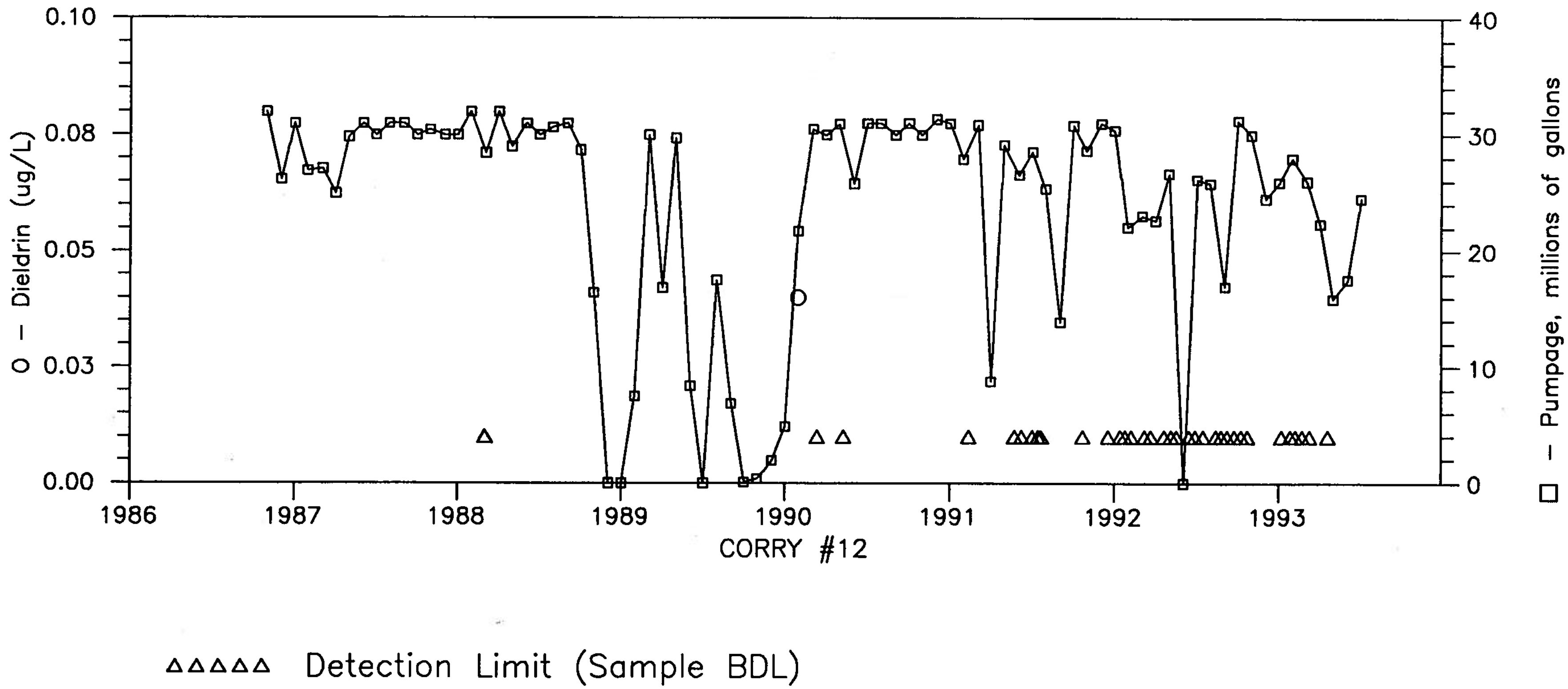

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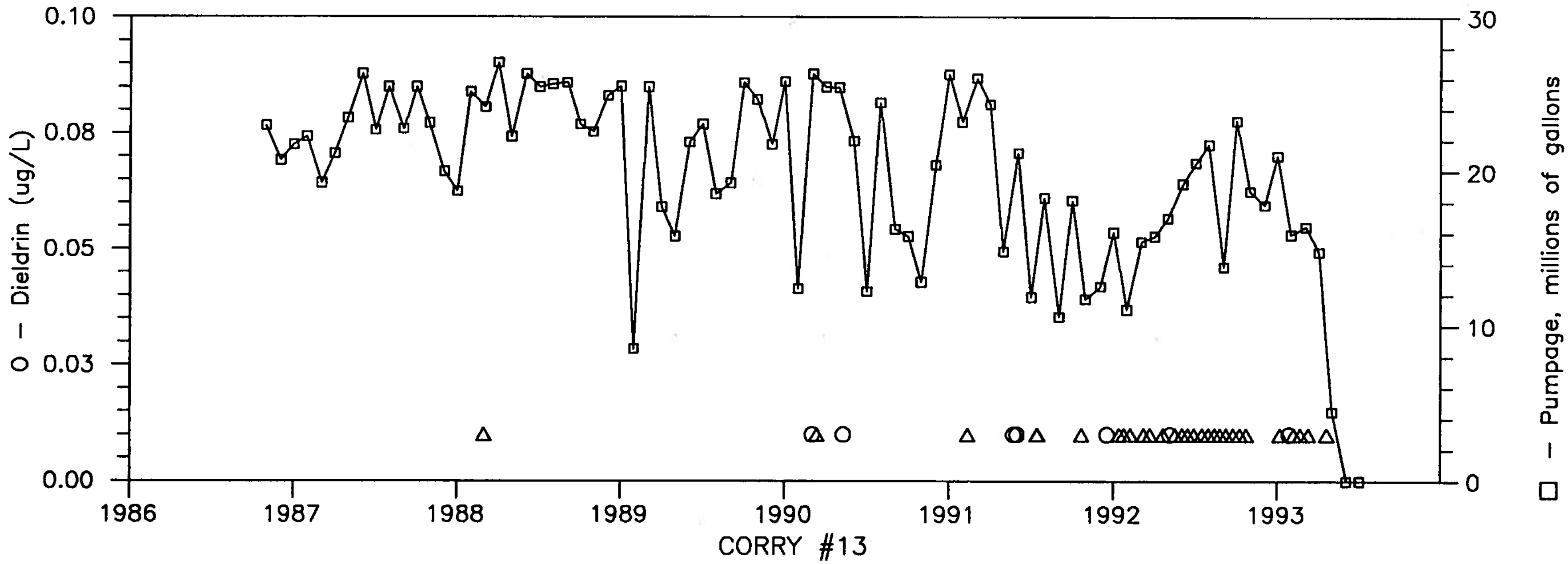

ΔΔΔΔΔ Detection Limit (Sample BDL)

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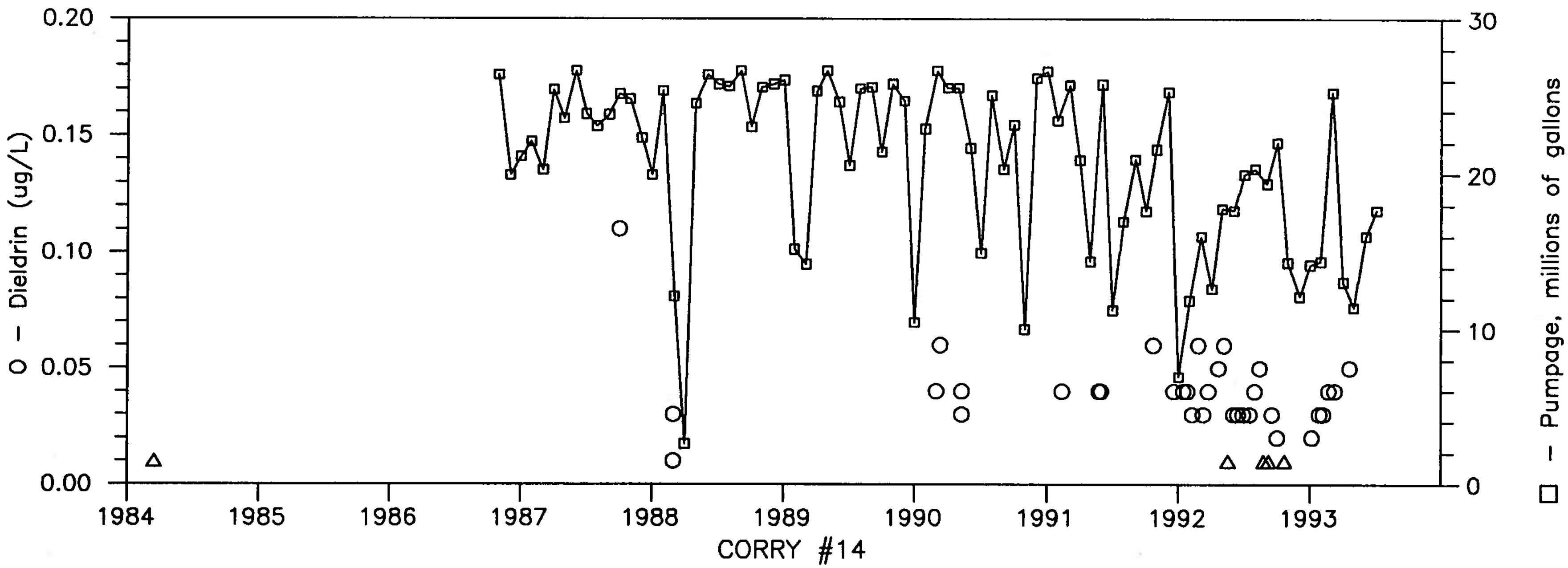

ΔΔΔΔΔ Detection Limit (Sample BDL)

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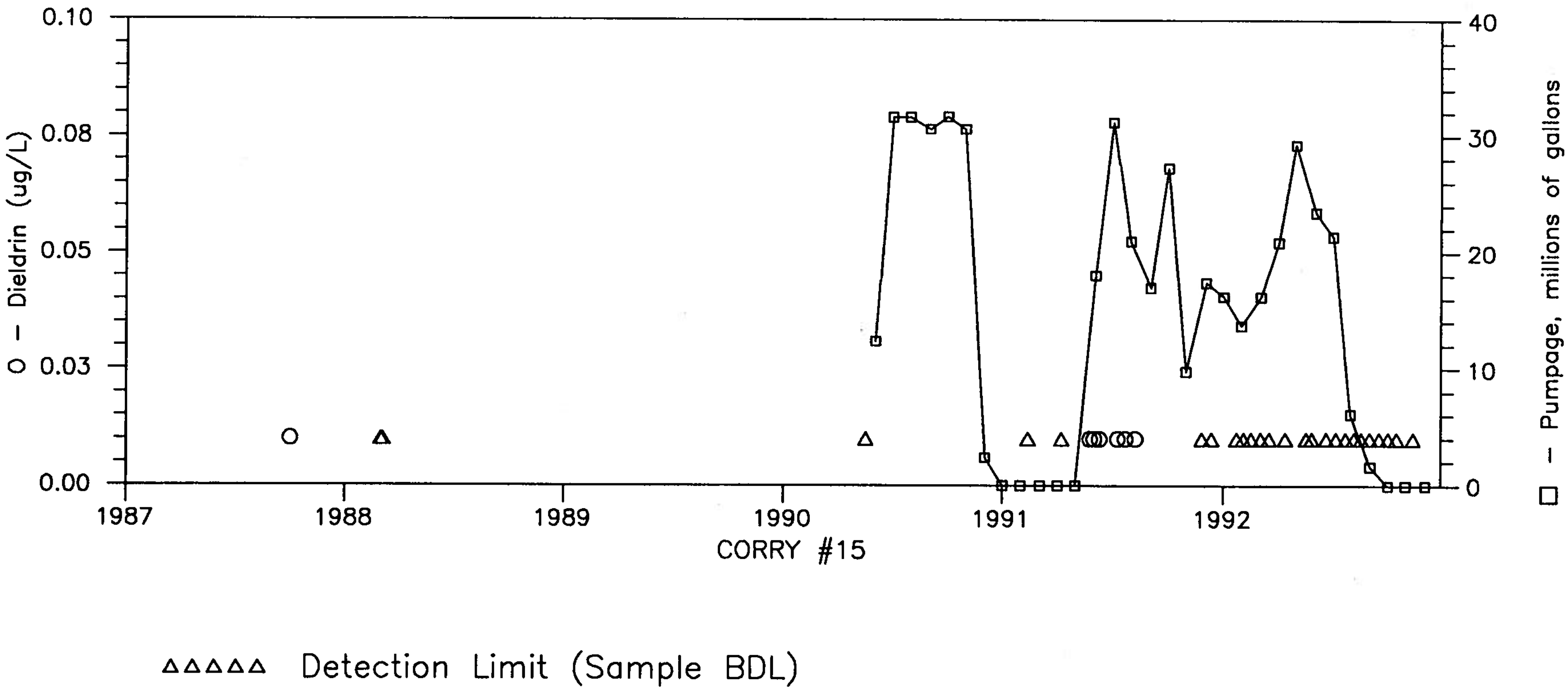

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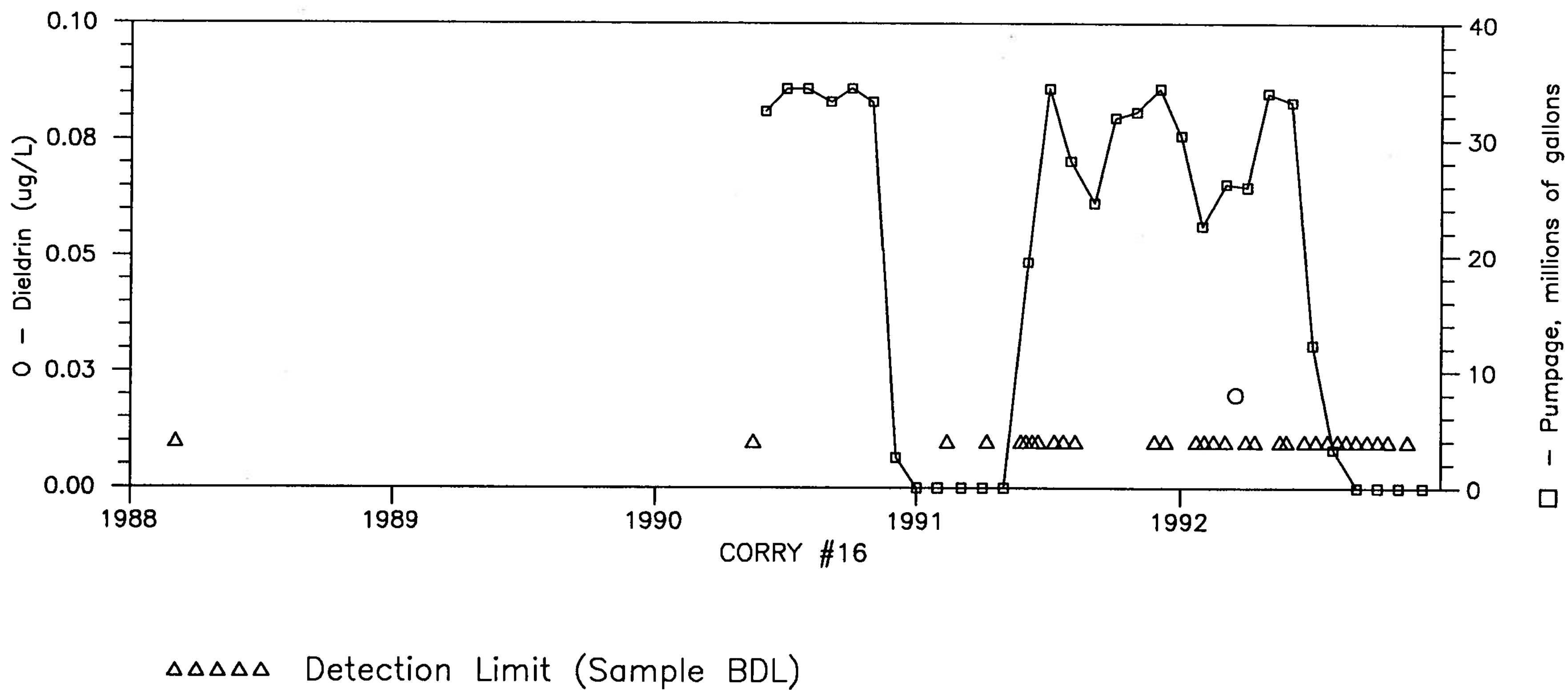
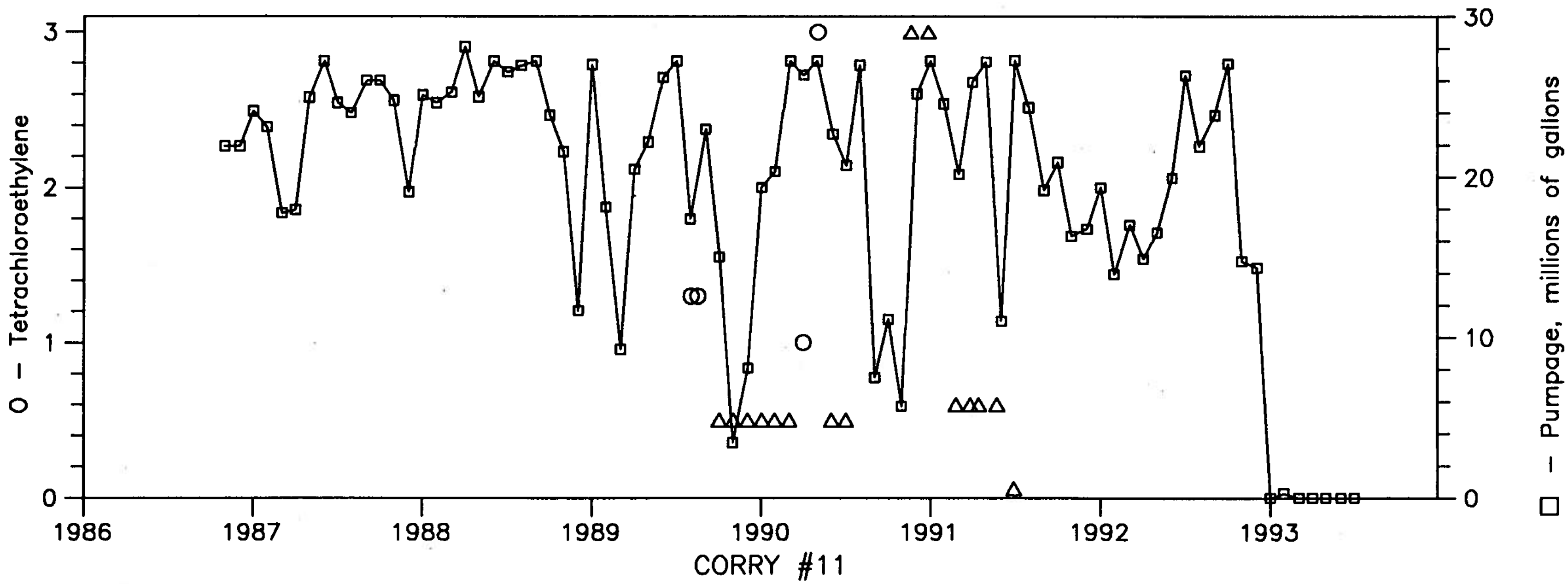
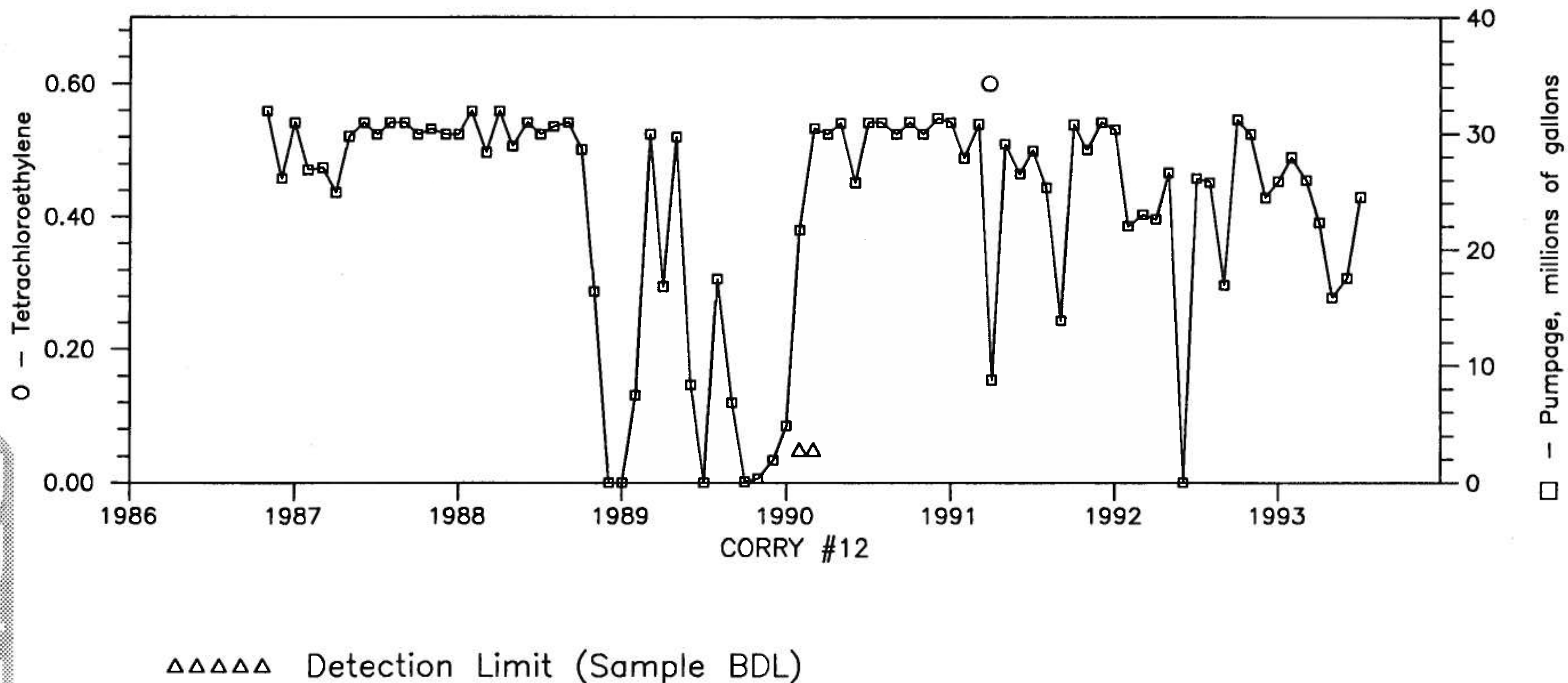


TOTAL MONTHLY PUMPAGE AND DIELDRIN CONCENTRATIONS - CORRY # 16

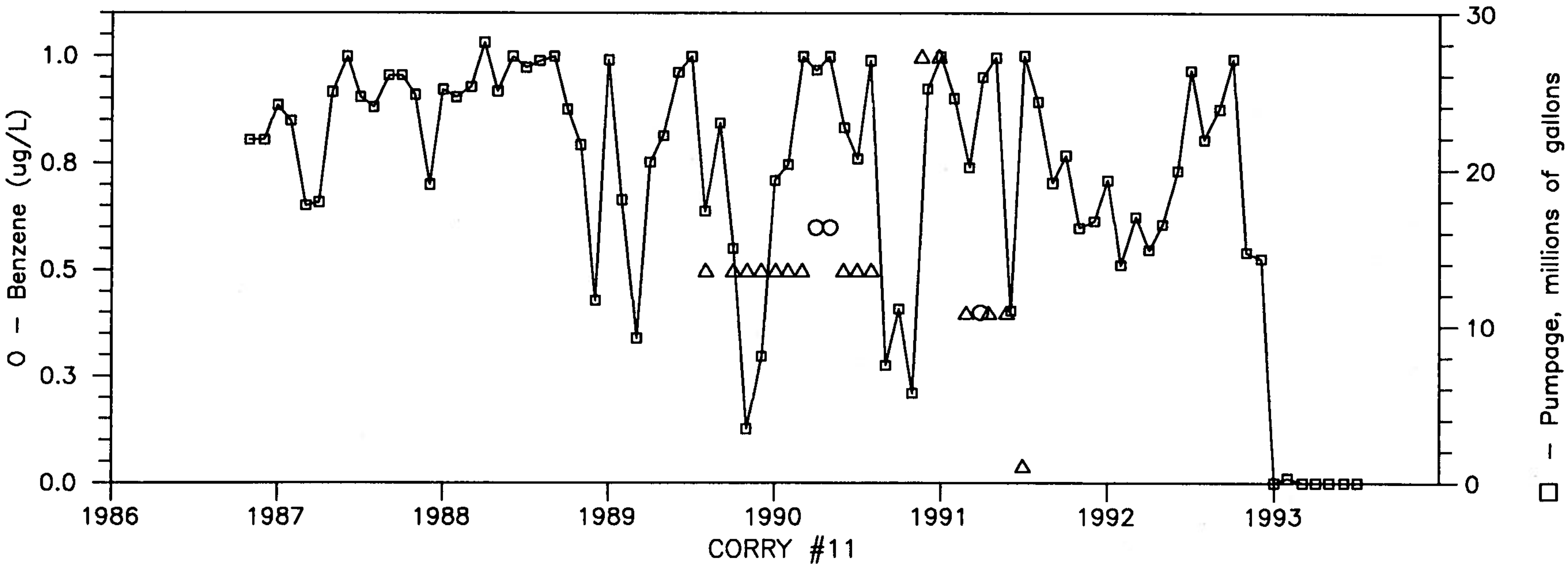


△△△△△ Detection Limit (Sample BDL)

TOTAL MONTHLY PUMPAGE AND TETRACHLOROETHYLENE CONCENTRATIONS - CORRY #11

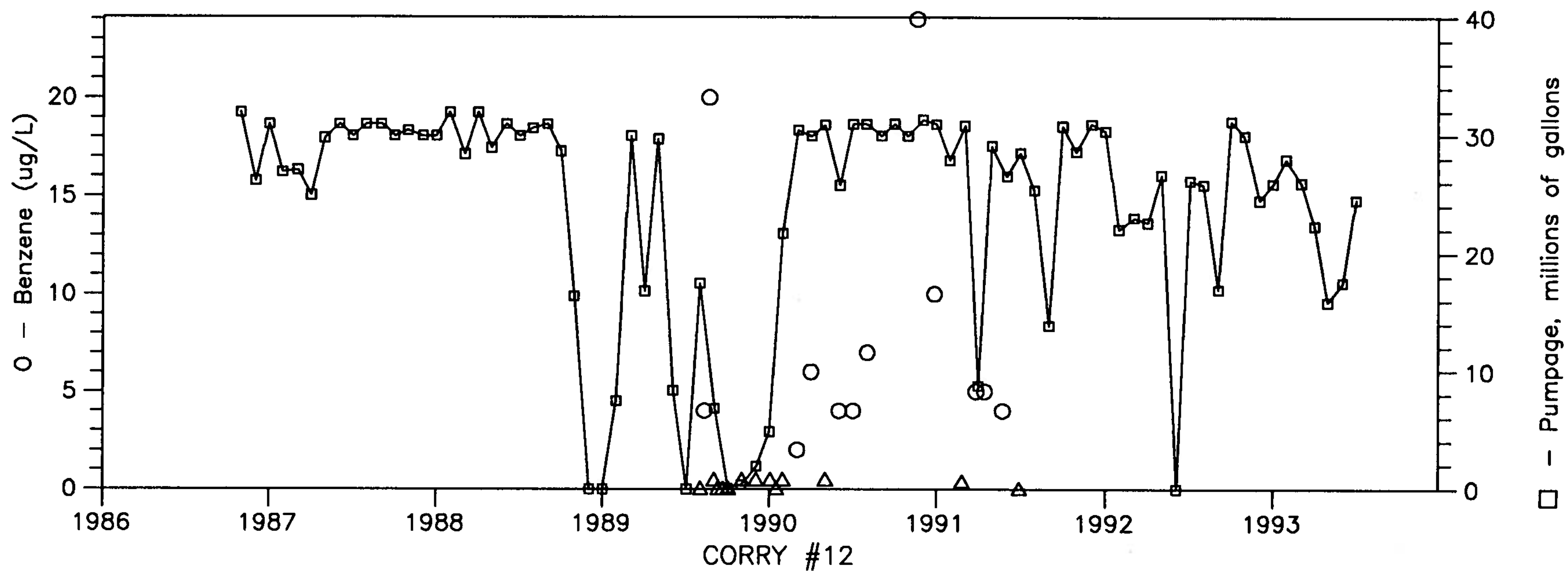


TOTAL MONTHLY PUMPAGE AND TETRACHLOROETHYLENE CONCENTRATIONS - CORRY #12



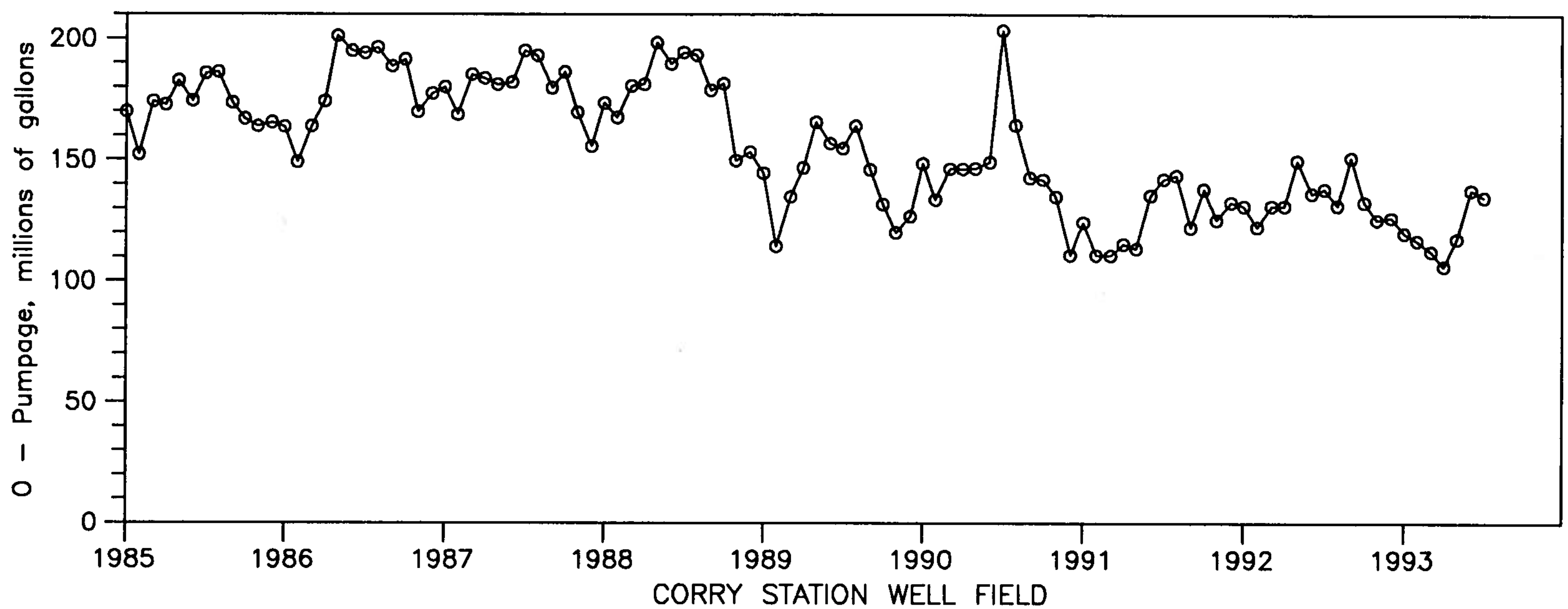
ΔΔΔΔΔ Detection Limit (Sample BDL)

TOTAL MONTHLY PUMPAGE AND BENZENE CONCENTRATIONS - CORRY # 11



ΔΔΔΔΔ Detection Limit (Sample BDL)

TOTAL MONTHLY PUMPAGE AND BENZENE CONCENTRATIONS - CORRY # 12



TOTAL MONTHLY PUMPAGE - CORRY STATION WELL FIELD

Miscellaneous Water Quality

Location	pH (su)	Spec Cond (μmhos/cm)	Chloride (mg/L)	Iron (mg/L)	Diss. Oxygen (mg/L)	Silica (mg/L)	Fluoride (mg/L)	CO_2 (mg/L)	Hardness as $CaCO_3$ (mg/L)	Date
Corry #2	--	35	4.6	0.30	--	8.7	0.1	--	3.9	2/16/40
Corry #7	5.4	20	11	0.04	6.0	8.0	0.2	16	6	9/28/71
Corry #8	5.7	50	14	0.02	5.6	8.5	0.2	28	8	9/28/71
Corry #9	4.5	20	7	0.05	5.4	5.2	0.2	18	6	9/29/71
Corry #10	5.5	--	5	--	--	--	--	--	4	5/15/69
	5.8	60	11	0.06	7.2	7	0.3	10	8	9/28/71
Corry #11	5.2	20	10	0.05	6.8	9	0.2	16	8	9/28/71
Corry #12	5.2	20	10	0.08	5.2	10	0.2	18	6	9/28/71
Corry #13	5.5	40	19	0.10	9.2	6.3	0.2	10	10	9/28/71
Corry #14	4.5	25	11	0.03	8.2	7.5	BDL	14	10	9/28/71
Corry #15	4.75	--	6	--	--	--	--	--	--	2/6/87
Corry #16	4.59	--	6.5	--	--	--	--	--	--	4/21/87
# 15 test	4.75	--	6	0.08	--	--	0.05	BDL	9	2/6/87
# 16 test	5.44	--	7	1.60	--	--	0.01	30	3.0	12/16/86
# 17 test	5.78	--	7	1.95	--	--	0.18	1.8	2.8	12/2/86
# 18 test	--	--	--	--	--	--	--	--	--	--
# 19 test	--	--	--	--	--	--	--	--	--	--
# 101 test	4.59	--	6.5	BDL	--	--	0.13	500	4	4/21/87

Location	Nitrate (mg/L)	Turbidity (NTU)	Manganese (mg/L)	TDS (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Total Coliform (__/100 ml)	Date
Corry #2	0.3	--	--	22	0.90	--	--	2/16/40
# 15 test	1.8	0.62	BDL	27	0.72	5.2	28	4/21/87
# 16 test	1.0	3.2	0.02	23	0.72	6.0	3	4/21/87
# 17 test	0.1	2.2	BDL	16	0.44	4.6	<1	4/21/87
# 101 test	0.2	0.96	BDL	14	0.57	3.0	<1	4/21/87

BDL = below detection limit

APPENDIX B

GUIDELINES FOR GROUNDWATER MONITORING WELL INSTALLATION

APPENDIX B

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND

GUIDELINES FOR GROUNDWATER MONITORING WELL INSTALLATION

PART 1: GENERAL

1.1 INTRODUCTION

Groundwater monitoring wells shall be located at sites approved by the Southern Division Engineer-In-Charge (EIC) and the Activity Environmental Coordinator (EC). All applicable local, state and federal regulations concerning well installations or soil borings shall be followed.

1.2 APPLICABLE PUBLICATIONS

The publications listed below form a part of this guideline to the extent referenced. The publications are referred to in this text by designation only. The latest revision of the specifications shall be followed.

1.2.1 American Association of State Highway and Transportation Officials (AASHTO)

M 220 Epoxy Coatings Specifications

1.2.2 American Society of Testing and Materials (ASTM)

A 120 Pipe, Steel, Black and Hot-dipped, Zinc coated, welded and seamless

A 312 Seamless and Welded Austenitic Stainless Steel Pipe

B 209 Aluminum and Aluminum-alloy Sheet and Plate

C 150 Portland Cement

C 778 Standard Sand

D 1457 Polytetrafluoroethylene (PTFE) Molding and Extrusion Materials

D 1785 Standard Specification of Polyvinyl Chloride Pipe (PVC Pipe, Schedules 40, 80, 120)

D 1586 Method for Penetration Test and Split Barrel Sampling of Soils

D 1587 Practice for Thin Wall Tube Sampling of Soils.

D 2113 Diamond Core Drilling for Site Investigation

F 480 Thermoplastic Water Well Casing, Pipe and Couplings Made in Standard Dimension Ratios (SDR)

F 883 Padlocks

1.2.3 American Petroleum Institute (API)

13-A Oil Well Drilling Fluid Specifications

1.3 SUBMITTALS

1.3.1 A completed "Southern Division Naval Facilities Engineering Command Groundwater Monitoring Well Installation Report" will be submitted for each well installation.

1.3.2 Certificates of Conformance: A certificate of conformance shall be provided to the EIC for any of the items below that are used in a well installation. The certificate shall describe in detail how the material meets or exceeds the required specifications for the following, as appropriate:

a) Casing
b) Screen
c) Grout
d) Drilling Mud
e) Gravel Pack
f) Caps and Plugs
g) Centralizers
h) Surface Casing
i) Well Protective Cover
j) Flush Mount Protective Cover
k) Padlock
l) Protective Post
m) Well Designation Sign
n) Epoxy Paint

1.4 DELIVERY AND STORAGE

All materials shall be delivered in undamaged condition, stored in accordance with manufacturer's recommendations (off the ground) and protected from the weather in an area designated by the EC. All defective or damaged material will be replaced with new material at no cost to the government.

PART 2: PRODUCTS

2.1 All materials shall conform to the respective specifications and other requirements as specified herein.

2.1.1 Well casing

Material type will be approved by the EIC. The material provided will have adequate strength to resist external forces both during and after installation. The casing threads shall be compatible with the screen listed in 2.2.2. Markings, writing or paint strips are not allowable on any of the materials. The casing shall conform to the specifications listed below.

a. PVC, flush threaded joints (schedule 40) ASTM F480 and ASTM D1785

All PVS flush threaded joints will meet or exceed the water pressure ratings (at 73 degrees Fahrenheit) for the size and schedule of PVC pipe used in the project, as listed in ASTM D1785: Table XI.2.

b. Polytetrafluoroethylene (PTFE), flush threaded joints, ASTM D1457

Virgin materials shall be used to meet the ASTM specification. Certification of compliance and joint evaluation are required. Shall be shipped in sealed containers that are capable of preventing contact with any foreign substances. PTEF "O" rings are required to seal all joints.

c. 316 stainless steel, flush threaded joints, ASTM A312
d. 304 stainless steel, flush threaded joints, ASTM A312

End fittings shall be double entry flush screw threads. The casing shall be leaned prior to delivery in the following manner: 5-minute immersion in static bath of dilute acid, pressure wash with detergent and cool water, rinse with warm water and allow to air dry.

2.1.2 Well screen

Material type will be approved by the EIC. The material provided will have adequate strength to resist external forces both during and after installation. Water velocity through the screen openings shall not exceed 0.1 feet/sec. The opening size will be determined from an analysis of the material in geologic formation to be screened and/or the size of the filter pack material. Markings, writing or paint strips are not allowable on any of the materials. The screens shall conform to the specifications listed below.

a. PVC, flush threaded joints (schedule 40), slotted, ASTM F480 and ASTM D1785

Two-inch I.D. screens will have 3 rows of slots with a spacing of 1/8-inch between slots. Four-inch I.D. screens will have six rows of slots with a spacing of 1/8-inch between slots. All PVC flush threaded joints will meet or exceed the water pressure ratings (at 73 degrees Fahrenheit) for the size and schedule of PVC pipe as listed in ASTM D1785, Table XI.2.

b. Polytetrafluoroethylene (PTFE), flush threaded joints, slotted, ASTM D1457

Virgin materials shall be used to meet the ASTM specification. Certification of compliance and joint evaluation are required. Shall be shipped in sealed containers. PTEF "O" rings will be used to seal all joints.

c. 316 stainless steel, wire wrapped, flush threaded joints, ASTM A312
d. 304 stainless steel, wire wrapped, flush threaded joints, ASTM A312

The well screen shall be of a continuous slot, wire wound design. It shall be fabricated by circumferentially wrapping a triangularly shaped wire around a circular array of internal rods. The configuration must produce sharp outer edges, widening inward. PTFE "O" rings will be used to seal all joints. End fittings will be welded to the screen body.

2.1.3 End Plugs

The end plug shall be flush threaded and shall be constructed of the same type of material selected for the screen or casing above. All ASTM specifications that apply to the screen and casing materials shall apply to the end plugs. Markings, writing or paint strips are not allowable on any of the above materials.

2.1.4 Well Caps

The well cap shall be flush threaded and be constructed of the same type of material selected for the casing above. All ASTM specifications that apply to the casing materials shall apply to the well caps. Markings, writing or paint strips are not allowable on any of the above materials.

2.1.5 Adjustable Centralizers

The centralizer shall be capable of maintaining the casing and screen straight and plumb in the borehole during well installation. The material type shall be the same type of material selected for the casing/screen above. No solvents or glues will be used.

2.1.6 Annular Space Fill Materials

a. Filter pack shall be 98 percent pure silicon, cleaned with potable water, have a uniformity coefficient of 1-3, and a specific gravity of 2.6 - 2.7. The filter pack shall meet ASTM C 775 standard sand specifications.

b. 1/4-inch bentonite pellets shall be 90 percent montmorillonite clay, with a bulk dry density 80 lbs/cu ft, a specific gravity 1.2, and a pH of 8.5-10.5.

c. Granular bentonite shall conform to API std 13-A for bentonite.

d. Portland Cement shall conform to ASTM C 150 Type I.

2.1.7 Surface Casing: shall be constructed of steel meeting ASTM A 120 and shall have a wall thickness as specified below.

a. 24 inch diameter 0.25 inch wall thickness
b. 20 inch diameter 0.25 inch wall thickness
c. 16 inch diameter 0.25 inch wall thickness
d. 10.75 inch diameter 0.25 inch wall thickness
e. 24 inch diameter 0.50 inch wall thickness
f. 20 inch diameter 0.50 inch wall thickness
g. 16 inch diameter 0.50 inch wall thickness
h. 10.75 inch diameter 0.365 inch wall thickness

2.1.8 Surface Completion: all materials provided for a well surface completion shall conform to the specifications listed below:

a. Locking 16-gauge steel protective well cover, round or square and 5-ft in length.

b. Flush mount 22-gauge steel, water resistant welded box with 3/8-inch steel lid, locking device and padlock guard.

c. Concrete pad at ground surface (3' X 4' X 6") ASTM C 150.

d. Padlock (brass, corrosion resistant, keyed alike) ASTM F 883.

e. Steel protective post (4-inch diameter, 6-feet length, 1/4-inch thickness, concrete filled) ASTM A 120.

f. Well designation sign, sheet aluminum, ASTM B 209, 1/8-inch by 18-inch by 6-inch, anchors and fasteners compatible with sign, designation to be provided by EIC, the designation shall be stamped into the plate with 4-inch letters and numbers.

g. High visibility yellow epoxy paint AASHTO M220.

PART 3: EXECUTION

3.1 DRILLING METHOD

The proposed drilling method must be approved by the EIC. Hollow-stem auger methods will be given first preference, rotary methods second and any other methods will require detailed evaluation by the EIC and written approval.

3.2 WELL INSTALLATION

Well depths, length of screen and sump will be determined on a site-specific basis with approval of the EIC. Screen lengths will be limited to 10-feet unless longer lengths are specifically approved in writing by the EIC. Two-inch well diameters will be specified for shallow well installations. Deeper well installations or wells that will be converted to recovery wells may require four-inch wells. Recovery well specifications will be approved by the EIC.

Well installation shall follow commonly accepted professional drilling procedures. The borehole will be logged by a qualified geologist/hydrogeologist as drilling proceeds. The minimum qualifications are those describing a "Geologist-in-Training", as described in Article 1, Chapter 23, Title 1, Code of Laws of South Carolina: Rules of the South Carolina State Board of Registration for Geologists. Soil samples shall be collected according to one of the following methods: ASTM D 1586-Method of Penetration Test and Split Barrel Sampling of Soils or ASTM D 1587-Practice for Thin Wall Tube Sampling of Soils. Consolidated Rock will be sampled according to ASTM D2113 Diamond Core Drilling for Site Investigation.

Gravel pack, seals, and grout will be installed using tremie methods. Bentonite seals shall be allowed to hydrate the time period specified by the manufacturer. Accurate measurements shall be made to the top of the gravel pack and sealed with a weighted steel tape and adjusted to reflect the top of casing.

If water is used in the drilling process, a sample shall be collected form the source and analyzed for the parameters specified in the investigation. Results will be included in the investigation report.

3.3 WELL DEVELOPMENT

Well development shall commence no sooner than 24 hours after placement of the grout. The development method shall be approved by the EIC. The selected method shall be capable of removing all drilling fluids and cuttings from inside the well, within the gravel pack and from within the formation. The development method shall not introduce any type of contamination into the aquifer. Introduction of outside water to the well shall be minimized. Any water introduced into the well shall be recovered to the maximum extent possible. A written report will be required describing the reasons why any introduced water could not be recovered.

The development process should result in wells that are sediment free. A well that produces turbid water (as defined by the Safe Drinking Water Act PL 93-523) may be rejected by the EIC.

3.4 MATERIAL DISPOSAL

All borehole cuttings and development water will be contained in DOT 17-C Open-top 55-gallon drums, permanently labeled by well number and stored in a location designated by the EC. The material will be handled as hazardous waste until laboratory results are reviewed and certification of the waste is submitted to the Navy. This requirement may be waived if approval is given in writing by the EIC. The material may then be disposed of as normal solid waste if it does not exceed any state or federal regulatory limits for the type of waste in question. The Navy will be responsible for disposal of all waste unless other direction is given by the EIC.

3.5 DECONTAMINATION

All down-hole drilling equipment (the drill rig, tools, etc.) will be decontaminated according to the approved Quality Control Plan prior to beginning work, between each well location and after the last well is completed. The drill rig will be placed on 10-mil polyethylene sheeting at each drilling site to contain any spillage or leaking of hydraulic fluid or fuel. All of the decontamination waste will be handled according to section 3.4 above.

3.6 WELL PROTECTION

A steel, hinged, locking protective casing will be installed within a 3-feet by 4-feet by 6-inch thick concrete pad. The pad will be set level and 4-inches below grade. The pad shall be installed so that surface runoff does not pond around the well casing and protective cover. The concrete mix shall obtain a minimum 28-day compressive strength of 3,000 pounds per square inch.

If designated by the EIC, four steel protective posts will be installed 0.5 feet from the corners of the pad but not set within the pad. The post will be 6-feet in length, 4-inches in diameter and have a wall thickness of 0.25-inch. The post will be filled with concrete and set three feet below grade in a 10-inch diameter hole with concrete backfill (as above).

The protective casing and any protective post installed shall be cleaned, primed and then painted with two coats of high visibility yellow epoxy paint that meets the specifications of AASHTO M 200. The protective casing will be locked with a Type P01 (Key Operated), Option E (Corrosion Resistant) padlock that conforms to ASTM F 883. When multiple wells are installed, padlocks for each well at an activity shall be keyed alike. The original and two copies of all keys shall be delivered to the EIC and two copies shall be delivered to the EC. All keys shall be tested to ensure performance prior to delivery.

3.7 WELL DESIGNATION

A permanent well designation sign will be attached to the protective casing. The sign shall be an 18-inch by 6-inch by 1/8-inch thick sheet aluminum plate, bolted to 1/4-inch studs welded to the casing. The sign shall be stamped with 4-inch letters and numbers in accordance with the numbering system in section 4.0 of this specification.

4.0 INSTALLATION RESTORATION PROGRAM WELL NUMBERING SYSTEM

The purpose of this well numbering system is to locate a particular well by activity, key it to the Initial Assessment Study (IAS) and sequentially number each well at each site. The EIC will provide designations for sites not included in the IAS.

Example:	CEF-1-1	Cecil Field, Site 1, Well Number 1
	KYW-5-8	Key West, Site 5, Well Number 8

FLORIDA

Cecil Field	CEF
Ft. Lauderdale	FLD
Key West	KYW
NavHosp Key West	KWH
Homestead	HST
Jacksonville	JAX
Mayport	MPT
Panama City	PCY
Whiting Field	WHF
Andros Island	AIS
Pensacola	PEN
Saufley	SFY
Corry Station	CRY
Orlando	OLD

GEORGIA

Albany	ALB
Atlanta	ATL
Kings Bay	KBA
Athens	ATH

SOUTH CAROLINA

Parris Island	PAI
Beaufort	BFT
NavHosp Beaufort	BFH
NWS Charleston	NWS
NS Charleston	CSY

LOUISIANA

NAS New Orleans	NOA
NSA New Orleans	NOS

MISSISSIPPI

Gulfport	GPT
NavHome Gulfport	GPH
Meridian	MRD

TENNESSEE

Memphis	MPH
Bristol	BRT

TEXAS

Corpus Christi	CCT
Chase Field	CAF
Kingsville	KVE
NAS Dallas	DNA
NWIRP Dallas	DWP
McGregor	MGR

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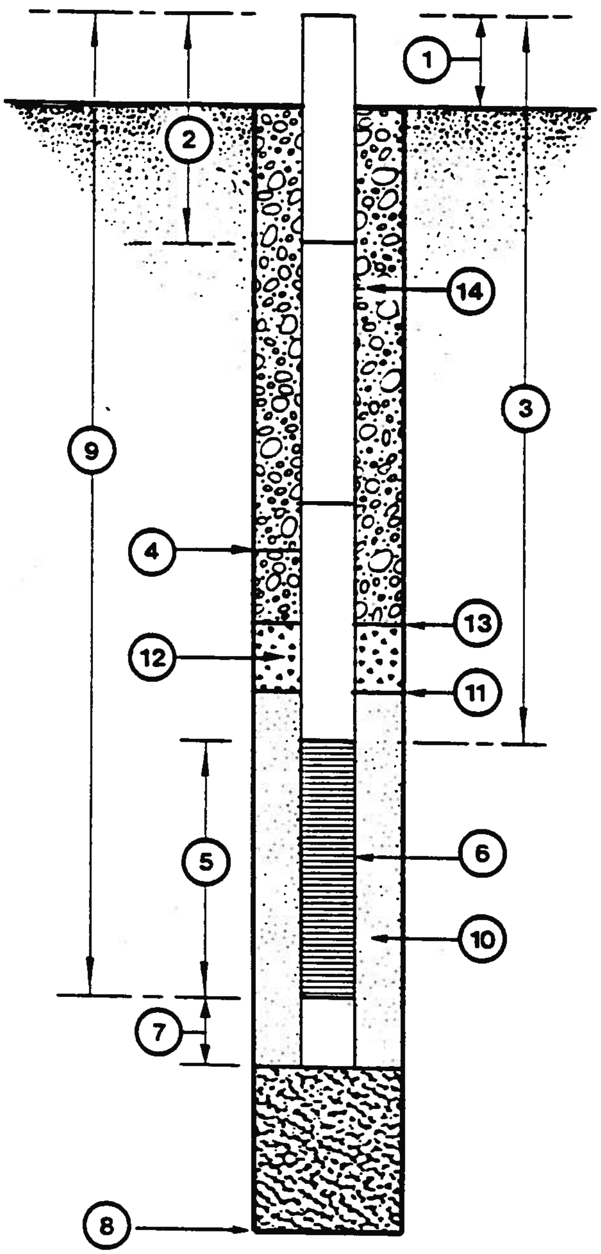

WELL CONSTRUCTION DETAILS

WELL NUMBER ______________________

DATE OF INSTALLATION ______________________

1. Height of Casing above ground ______________________
2. Depth to first Coupling ______________________
   Coupling Interval Depths ______________________
   ____
3. Total Length of Blank Pipe ______________________
4. Type of Blank Pipe ______________________
5. Length of Screen ______________________
6. Type of Screen ______________________
7. Length of Sump ______________________
8. Total Depth of Boring __________ Hole Diameter __________
9. Depth to Bottom of Screen ______________________
10. Type of Screen Filter ______________________
    Quantity Used __________ Size __________ U/C __________
11. Depth to Top of Filter ______________________
12. Type of Seal ______________________
    Quantity Used ______________________
13. Depth to Top of Seal ______________________
14. Type of Grout ______________________
    Grout Mixture ______________________
    Method of Placement ______________________

COMMENTS ON INSTALLATION:

APPENDIX C

PHYSICAL AND CHEMICAL SAMPLING PARAMETER LIST

Parameter Group*	Analysis Method	Analyte
Group A:	415.1	Total Organic Carbon, Dissolved Organic Carbon, Particulate Organic Carbon (TOC, DOC POC)
	160.1	Filtered, Residue
	160.2	Non-filtered, Residue
	160.3	Total Residue
	180.1	Turbidity
Group B:	608	Pesticides - Cl
Group C:	624	Volatile Organic Compounds (VOC)
Group D:	625	Base Neutral/Acid Extractables (BNA)
Group E:	8080	Pesticides - Cl
Group F:	200.7	Iron (Fe)
	180.1	Turbidity
Group G:	Grain size analysis, ASTM D-422 Falling head permeability	

* Specific analytes to Groups A - F are shown in following tables.

GROUP A SAMPLING PARAMETER LIST

Analyte	Prep Method	Analysis Method	Matrix	Accuracy Range %	Prcsn % RPD	MDL	PQL
Total Organic Carbon	415.1	415.1	w	80 - 120	<20	1 mg/L	2 mg/L
Residue, Filtrable	160.1	160.1	w	80 - 120	<20	2 mg/L	2 mg/L
Residue Non-Filtrable	160.2	160.2	w	80 - 120	<20	10 mg/L	10 mg/L
Residue, Total	160.3	160.3	w	80 - 120	<20	10 mg/L	10 mg/L
Turbidity	n/a	180.1	w	80 - 120	<20	0.5NTU	0.5NTU

Matrices are denoted as follows:

- w: ground water
- s: soil and sediment

RPD is the relative percent difference.

MDL is the Method Detection Limit, which is defined as the minimum concentration of an analyte that can be measured by the method with 99% confidence of its presence in the sample matrix.

PQL is the Practical Quantitation Limit, which is the lowest level of concentration that can be reliably achieved within specified limit of precision and accuracy during routine laboratory operating conditions.

GROUP B SAMPLING PARAMETER LIST

Analyte	Prep Method	Analysis Method	Matrix	Accuracy Range %	Prcsn % RPD	MDL µg/L	PQL µg/L
Aldrin	3510	608	w	14 - 90	<44	0.01	0.05
Alpha-BHC	3510	608	w	59 - 103	<25	0.01	0.05
Beta-BHC	3510	608	w	84 - 112	<11	0.02	0.10
Delta-BHC	3510	608	w	34 - 122	<20	0.01	0.05
Gamma-BHC	3510	608	w	72 - 108	<17	0.01	0.05
Chlordane Technical	3510	608	w	45 - 119	<50	0.10	1.0
p,p'-DDD	3510	608	w	80 - 116	<10	0.02	0.05
p,p'-DDE	3510	608	w	61 - 117	<15	0.02	0.1
p,p'-DDT	3510	608	w	80 - 138	<17	0.02	0.1
Dieldrin	3510	608	w	89 - 113	<11	0.02	0.1
Endosulfan I	3510	608	w	73 - 136	<30	0.01	0.05
Endosulfan II	3510	608	w	95 - 125	<10	0.01	0.10
Endosulfan Sulfate	3510	608	w	85 - 117	<10	0.02	0.1
Endrin	3510	608	w	30 - 147	<50	0.02	0.1
Endrin Aldehyde	3510	608	w	88 - 128	<23	0.02	0.14
Heptachlor Epoxide	3510	608	w	78 - 124	<20	0.01	0.10
Methoxychlor	3510	608	w	77 - 149	<18	0.05	0.4
Toxaphene	3510	608	w	41 - 126	<50	0.5	1
PCB 1016	3510	608	w	49 - 137	<15	0.2	1
PCB 1232	3510	608	w	60 - 110	<50	0.2	1
PCB 1248	3510	608	w	60 - 110	<50	0.2	1
PCB 1254	3510	608	w	60 - 110	<50	0.2	1
PCB 1260	3510	608	w	61 - 125	<10	0.2	1
Chlorothalonil	3510	608	w	36 - 128	<30	0.02	0.20
Permethrin	3510	608	w	70 -125	<50	0.20	0.50

Matrices are denoted as follows:
- w: ground water
- s: soil and sediment

RPD is the relative percent difference.

MDL is the Method Detection Limit, which is defined as the minimum concentration of an analyte that can be measured by the method with 99% confidence of its presence in the sample matrix.

PQL is the Practical Quantitation Limit, which is the lowest level of concentration that can be reliably achieved within specified limit of precision and accuracy during routine laboratory operating conditions.

GROUP C SAMPLING PARAMETER LIST

Analyte	Prep Method	Analysis Method	Matrix	Accuracy Range %	Prcsn % RPD	MDL µg/L	PQL µg/L
Benzene	5030	624	w	86 - 114	<20	0.5	1.0
Bromodichloromethane	5030	624	w	81 - 110	<15	0.5	1.0
Bromoform	5030	624	w	71 - 120	<15	0.5	1.0
Bromomethane	5030	624	w	0 - 242	<40	0.5	4.0
Carbontetrochloride	5030	624	w	76 - 107	<30	0.5	1.0
Chlorobenzene	5030	624	w	82 - 124	<20	0.5	1.0
Chloroethane	5030	624	w	37 - 243	<55	0.5	1.0
2-Chloroethylvinyl ether	5030	624	w	60 - 130	<30	0.5	1.0
Chloroform	5030	624	w	79 - 106	<30	0.5	1.0
Chloromethane	5030	624	w	0 - 110	<30	0.5	1.0
1,2-Dichlorobenzene	5030	624	w	79 - 116	<15	0.5	1.0
1,3-Dichlorobenzene	5030	624	w	86 - 112	<15	0.5	1.0
1,4-Dichlorobenzene	5030	624	w	80 - 109	<15	0.5	1.0
Dibromochlormethane	5030	624	w	84 - 117	<15	0.5	1.0
1,1-Dichloroethane	5030	624	w	81 - 117	<15	0.5	1.0
1,2-Dichloroethane	5030	624	w	82 - 116	<20	0.5	1.0
1,1-Dichloroethene	5030	624	w	67 - 130	<20	0.5	1.0
Cis-1,2-Dichloroethene	5030	624	w	65 - 129	<30	0.5	1.0
Trans-1,2-Dichloroethene	5030	624	w	85 - 115	<20	0.5	1.0
1,2-Dichloropropane	5030	624	w	83 - 116	<20	0.5	1.0
Cis-1,3-Dichloropropene	5030	624	w	81 - 107	<20	0.5	1.0
Trans-1,3-Dichloropropene	5030	624	w	73 - 108	<15	0.5	1.0
Ethylbenzene	5030	624	w	89 - 118	<15	0.5	1.0
Methylene Chloride	5030	624	w	78 - 120	<15	0.5	1.0
1,1,2,2-Tetrachloroethane	5030	624	w	70 - 136	<20	0.5	1.0
Tetrachloroethene	5030	624	w	79 - 117	<30	0.5	1.0
1,1,1-Trichloroethane	5030	624	w	81 - 116	<30	0.5	1.0
1,1,2-Trichloroethane	5030	624	w	76 - 118	<7.0	0.5	1.0
Trichloroethene	5030	624	w	77 - 111	<20	0.5	1.0
Trichlorogluro-methane	5030	624	w	31 - 190	<40	0.5	1.0
Toluene	5030	624	w	80 - 116	<10	0.5	1.0
o-Chloro-Toluene	5030	624	w	93 - 109	<15	0.5	1.0
Vinyl Chloride	5030	624	w	28 - 130	<17	0.5	1.0
Xylenes	5030	624	w	85 - 120	<10	0.5	1.0
2-Butanone (MEK)	5030	624	w	80 - 120	<40	10	100
Acetone	5030	624	w	80 - 120	<40	10	100
Carbon Disulfide	5030	624	w	80 - 120	<40	1.0	5
4-Me-2-Pentanone	5030	624	w	80 - 120	<40	10	50
2-Hexanone	5030	624	w	80 - 120	<40	10	50
Styrene	5030	624	w	80 - 120	<40	10	50

Matrices are denoted as follows:

w: ground water
s: soil and sediment

RPD is the relative percent difference.

MDL is the Method Detection Limit, which is defined as the minimum concentration of an analyte that can be measured by the method with 99% confidence of its presence in the sample matrix.

PQL is the Practical Quantitation Limit, which is the lowest level of concentration that can be reliably achieved within specified limit of precision and accuracy during routine laboratory operating conditions.

GROUP D SAMPLING PARAMETER LIST

Analyte	Analysis Method	Matrix	Accuracy Range %	Prcsn % RPD	MDL µg/L	PQL µg/L
4-Chloro-3-Methylphenol	625	w	49 - 115	<42	0.8	4.0
2-Chlorophenol	625	w	40 - 112	<42	0.8	4.0
2,4-Dichlorophenol	625	w	67 - 131	<42	0.8	4.0
2,6-Dichlorophenol	625	w	48 - 139	<42	0.8	4.0
2,4-Dimethylphenol	625	w	21 - 63	<42	3.0	15
2,4-Dinitrophenol	625	w	68 - 141	<42	6.0	30
2-Methyl-4,6-Dinitrophenol	625	w	62 - 142	<42	3.0	15
2-Nitrophenol	625	w	78 - 140	<42	1.5	7.5
4-Nitrophenol	625	w	25 - 47	<42	3.0	15
Pentachlorophenol	625	w	1 - 157	<42	3.0	15
Phenol	625	w	32 - 112	<42	0.8	4.0
2,4,6-Trichlorophenol	625	w	59 - 123	<42	0.8	4.0
Acenaphthene	625	w	58 - 118	<42	0.8	4.0
Acenaphthylene	625	w	56 - 116	<42	0.8	4.0
Anthracene	625	w	77 - 113	<42	0.8	4.0
Azobenzene	625	w	66 - 110	<42	0.8	4.0
Benzo[a]anthracene	625	w	81 - 97	<42	0.8	4.0
Benzo[b]fluoranthene	625	w	62 - 98	<42	0.8	4.0
Benzo[k]fluoranthene	625	w	76 - 86	<42	0.8	4.0
Benzo[a]pyrene	625	w	72 - 92	<42	0.8	4.0
Benzo[g,h,i]perylene	625	w	70 - 102	<42	1.5	7.5
Benzl butyl phthalate	625	w	68 - 106	<42	0.8	4.0
Benzidine	625	w	34 - 120	<42	50	250
Bis(2-Chloroethyl)-Ether	625	w	43 - 63	<42	0.8	4.0
Bis(2-Chloroethoxy)-Methane	625	w	43 - 153	<42	0.8	4.0
Bis(2-Chloroispropyl)-Ether	625	w	57 - 89	<42	1.5	7.5
Bis(2-Ethylhexyl)-Phthalate	625	w	54 - 180	<42	2.5	13
4-Bromophenylphenyl	625	w	87 - 133	<42	0.8	4.0
Chrysene	625	w	79 - 95	<42	0.8	4.0
2-Chloronaphthalene	625	w	28 - 100	<42	0.8	4.0
4-Chlorophenylphenyl Ether	625	w	71 - 143	<42	0.8	4.0
Dibenza[a,h]anthracene	625	w	69 - 99	<42	1.5	7.5
1,2-Dichlorobenzene	625	w	55 - 127	<42	1.5	7.5
1,3-Dichlorobenzene	625	w	52 - 118	<42	1.5	7.5
1,4-Dichlorobenzene	625	w	12 - 108	<42	1.5	7.5
3,3'-Dichlorobenzidine	625	w	52 - 130	<42	1.5	7.5
Diethylphthalate	625	w	65 - 135	<42	2.5	13
Dimethylphthalate	625	w	10 - 130	<42	0.8	4.0
Di-n-butyl phthlate	625	w	72 - 141	<42	0.8	4.0
2,4-Dinitrotoluene	625	w	40 - 121	<42	1.5	7.5
2,6-Dinitrotoluene	625	w	55 - 141	<42	1.5	7.5
Fluoranthene	625	w	79 - 121	<42	0.8	4.0
Fluorene	625	w	68 - 126	<42	0.8	4.0
Hexachlorobenzene	625	w	92 - 132	<42	0.8	4.0
Hexachlorobutadiene	625	w	39 - 105	<42	3.0	15
Hexachloro-Cyclopentadiene	625	w	25 - 111	<42	12	60
Hexachloroethane	625	w	54 - 126	<42	3.0	15
Indeno[1,2,3-c,d]pyrene	625	w	56 - 102	<42	1.5	7.5

Isophorone	625	w	56 - 120	<42	0.8	4.0
Naphthalene	625	w	42 - 133	<42	0.8	4.0
Nitrobenzene	625	w	52 - 196	<42	0.8	4.0
N-nitrosodimethylamine	625	w	45 - 126	<42	1.5	7.5
N-nitrosodi-n-Propylamine	625	w	41 - 131	<42	0.8	4.0
N-nitrosodiphenylamine	625	w	31 - 120	<42	0.8	4.0
Phenanthrene	625	w	65 - 128	<42	0.8	4.0
Pyrene	625	w	66 - 124	<42	0.8	4.0
1,2,4-Trichlorobenzene	625	w	12 - 132	<42	0.8	4.0
Acetophenone	625	w	35 - 131	<42	0.8	4.0
2-Acetylamino-Fluorene	625	w	58 - 128	<42	1.5	7.5
Aldrin	625	w	15 - 120	<42	0.8	4.0
4-Aminobiphenyl	625	w	31 - 146	<42	0.8	4.0
Aniline	625	w	25 - 120	<42	0.8	4.0
Alpha-BHC	625	w	33 - 119	<42	1.5	7.5
Beta-BHC	625	w	36 - 131	<42	1.5	7.5
Ganna-BHC	625	w	41 - 131	<42	1.5	7.5
Delta-BHC	625	w	23 - 141	<42	3.0	15
Benzylalcohol	625	w	20 - 140	<42	1.5	7.5
4-Chloroaniline	625	w	31 - 142	<42	0.8	4.0
4,4'-DDD	625	w	D - 130	<42	0.8	4.0
4,4'-DDE	625	w	23 - 133	<42	0.8	4.0
4,4'-DDT	625	w	D - 125	<42	1.5	7.5
Dibenzofuran	625	w	19 - 108	<42	0.8	4.0
Dieldrin	625	w	38 - 127	<42	1.5	7.5
Dimethylaminoazobenzene	625	w	18 - 109	<42	0.8	4.0
7,12-Dimethylbenz(A)anthracene	625	w	42 - 120	<42	0.8	4.0
1,3-Dinitrobenzene	625	w	35 - 116	<42	1.5	7.5
Dinoseb	625	w	28 - 138	<42	12	60
Diphenylamine	625	w	15 - 135	<42	0.8	4.0
Endosulfan I	625	w	D - 118	<42	12	60
Endosulfan II	625	w	D - 118	<42	12	60
Endosulfan Sulfate	625	w	D - 103	<42	3.0	15
Endrin	625	w	D - 133	<42	6.0	30
Endrin Aldehyde	625	w	D - 141	<42	6.0	30
Ethyl Methanesulfonate	625	w	36 - 141	<42	0.8	4.0
Hexachloropropene	625	w	15 - 120	<42	6.0	30
Isosafrole	625	w	40 - 132	<42	0.8	4.0
Methapryilene	625	w	D - 140	<42	3.0	15
3-Methylcholanthrene	625	w	40 - 120	<42	1.5	7.5
Methyl Methanesulfonate	625	w	40 - 120	<42	0.8	4.0
2-Methylnaphthalene	625	w	22 - 160	<42	0.8	4.0
1,4-Napthaquinone	625	w	21 - 136	<42	100	500
1-Naphthylamine	625	w	32 - 120	<42	0.8	4.0
2-Nitroaniline	625	w	D - 138	<42	1.5	7.5
3-Nitroaniline	625	w	D - 138	<42	1.5	7.5
4-Nitroaniline	625	w	D - 138	<42	1.5	7.5
5-Nitro-o-toluidine	625	w	10 - 114	<42	1.5	7.5
4-Nitroquinoline-1-oxide	625	w	D - 127	<42	12	60
N-Nitrosodiethylamine	625	w	16 - 149	<42	0.8	4.0
N-Nitrosomethylethylamine	625	w	10 - 146	<42	1.5	7.5
N-Nitrosopiperidine	625	w	28 - 116	<42	0.8	4.0
N-Nitrosopyrrolidine	625	w	26 - 132	<42	0.8	4.0
PCB-1016	625	w	19 - 121	<42	300	1500

PCB-1221	625	w	19 - 121	<42	300	1500
PCB-1232	625	w	19 - 121	<42	300	1500
PCB-1242	625	w	19 - 121	<42	300	1500
PCB-1254	625	w	19 - 121	<42	300	1500
PCB-1260	625	w	19 - 121	<42	300	1500
PCB-1262	625	w	19 - 121	<42	300	1500
Pentachlorobenzene	625	w	42 - 119	<42	0.8	4.0
Pentachloroethane	625	w	29 - 112	<42	100	500
Pentachloronitrobenzene	625	w	15 - 136	<42	3.0	15
Phenacetin	625	w	29 - 121	<42	0.8	4.0
2-Picoline	625	w	32 - 128	<42	0.8	4.0
Pyridine	625	w	44 - 130	<42	0.8	4.0
Safrole	625	w	D - 116	<42	3.0	15
1,2,4,5-Tetrachlorobenzene	625	w	42 - 132	<42	0.8	4.0
o-Toluidine	625	w	32 - 146	<42	0.8	4.0
2,4,5-Trichlorophenol	625	w	41 - 128	<42	0.8	4.0
1,3,5-Trinitrobenzene	625	w	28 - 136	<42	12	60
Toxaphene	625	w	14 - 142	<42	500	2500
m,p-Cresol	625	w	25 - 132	<42	0.8	4.0
o-Cresol	625	w	21 - 127	<42	0.8	4.0
Carbazole	625	w	35 - 140	<42	1.5	7.5
3,3'Dimethyl Benzidine	625	w	34 - 120	<42	50	250
Heptachlor	625	w	D - 172	<42	1.5	7.5
Heptachlor Epoxide	625	w	71 - 110	<42	1.5	7.5
2-Naphthylamine	625	w	32 - 120	<42	0.8	4.0
N-Nitrosodi-n-butylamine	625	w	13 - 198	<42	0.8	4.0
2,3,4,6-Tetrachlorophenol	625	w	48 - 128	<42	1.5	7.5

Matrices are denoted as follows:
- w: ground water
- s: soil and sediment

RPD is the relative percent difference.

MDL is the Method Detection Limit, which is defined as the minimum concentration of an analyte that can be measured by the method with 99% confidence of its presence in the sample matrix.

PQL is the Practical Quantitation Limit, which is the lowest level of concentration that can be reliably achieved within specified limit of precision and accuracy during routine laboratory operating conditions.

D in the Accuracy Range denotes use of a "detection" as the lower limit on accuracy.

GROUP E SAMPLING PARAMETER LIST

Analyte	Prep Method	Analysis Method	Matrix	Accuracy Range %	Prcsn % RPD	MDL µg/L	PQL µg/L
Aldrin	3550	8080	s	55 - 111	<35	0.47	1.7
Benfluralin	3550	8080	s	45 - 120	<50	0.70	3.3
Alpha-BHC	3550	8080	s	50 - 94	<60	0.4	1.7
Beta-BHC	3550	8080	s	61 - 125	<30	0.7	3.3
Delta-BHC	3550	8080	s	42 - 114	<47	0.4	1.7
Gamma-BHC	3550	8080	s	54 - 106	<50	0.4	1.7
Chlordane Technical	3550	8080	s	45 - 119	<50	5	33
Gamma Chlordane	3550	8080	s	45 - 120	<50	0.40	1.7
Alpha Chlordane	3550	8080	s	45 - 120	<50	0.40	1.7
p,p'-DDD	3550	8080	s	58 - 130	<30	0.7	3.3
p,p'-DDE	3550	8080	s	58 - 130	<50	0.7	3.3
p,p'-DDT	3550	8080	s	74 - 134	<30	0.7	3.3
Dieldrin	3550	8080	s	65 - 125	<30	0.7	1.7
Endosulfan I	3550	8080	s	65 - 121	<30	0.4	3.3
Endosulfan II	3550	8080	s	68 - 132	<30	0.4	3.3
Endosulfan Sulfate	3550	8080	s	60 - 124	<30	0.7	3.3
Endrin	3550	8080	s	30 - 147	<50	0.7	3.3
Endrin Ketone	3550	8080	s	45 - 120	<50	0.70	3.3
Endrin Aldehyde	3550	8080	s	16 -144	<50	0.7	3.3
Heptaclor	3550	8080	s	51 - 127	<40	0.4	1.7
Heptachlor Epoxide	3550	8080	s	78 - 112	<40	0.4	3.3
Methoxychlor	3550	8080	s	82 - 122	<30	1.7	13.3
Mirex	3550	8080	s	45 - 120	<50	0.70	3.3
Oxadiazon	3550	8080	s	45 - 120	<50	0.70	3.3
PCNB	3550	8080	s	50 - 100	<50	1.7	3.3
Toxaphene	3550	8080	s	41 - 126	<50	17	33
PCB 1016	3550	8080	s	50 - 120	<50	7	33
PCB 1221	3550	8080	s	15 - 178	<50	7	33
PCB 1232	3550	8080	s	60 - 110	<50	7	33
PCB 1242	550	8080	s	60 - 120	<50	7	33
PCB 1248	3550	8080	s	60 - 110	<50	7	33
PCB 1254	3550	8080	s	60 - 110	<50	7	33
PCB 1260	3550	8080	s	50 - 110	<50	7	33
Carbophenothion	3550	8080	s	50 - 130	<50	1.0	6.6
Chlorothalonil	3550	8080	s	50 - 110	<50	0.7	6.6
Dicofol	3550	8080	s	50 - 120	<50	0.7	13
Pendimetalin	3550	8080	s	50 - 120	<50	1.7	6.6
Trifluralin	3550	8080	s	40 - 120	<50	0.7	3.34
Cypermethrin	3550	8080	s	50 - 125	<50	1.7	7
Permethrin	3550	8080	s	50 - 125	<50	1.7	7

Matrices are denoted as follows:
- w: ground water
- s: soil and sediment

RPD is the relative percent difference.

MDL is the Method Detection Limit, which is defined as the minimum concentration of an analyte that can be measured by the method with 99% confidence of its presence in the sample matrix.

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GROUP F SAMPLING PARAMETER LIST

Analyte	Prep Method	Analysis Method	Matrix	Accuracy Range %	Prcsn % RPD	MDL µg/L	PQL µg/L
Iron	3005, 3015	200.7	w	80 - 120	<20	3	10
Turbidity	n/a	180.1	w	80 - 120	<20	0.5NTU	0.5NTU

Matrices are denoted as follows:

- w: ground water
- s: soil and sediment

RPD is the relative percent difference.

MDL is the Method Detection Limit, which is defined as the minimum concentration of an analyte that can be measured by the method with 99% confidence of its presence in the sample matrix.

PQL is the Practical Quantitation Limit, which is the lowest level of concentration that can be reliably achieved within specified limit of precision and accuracy during routine laboratory operating conditions.

APPENDIX D

PROJECT PERSONNEL RESUMES

DRAFT

RESUME

DOUGLAS E. BARR

AREAS OF INTEREST

Water Resources Management and Protection
Administrative and Fiscal Management
Project Development and Management
Ground Water Hydrology
Well Hydraulics

POSITIONS HELD

02/92 - Present	--	Executive Director, Northwest Florida Water Management District.
07/89 - 02/92	--	Deputy Executive Director and Director - Resource Management Division, Northwest Florida Water Management District.
03/89 - 09/89	--	Acting Executive Director, Northwest Florida Water Management District.
05/83 - 07/89	--	Director, Water Resources Division, Northwest Florida Water Management District.
11/80 - 05/83	--	Senior Hydrogeologist, Northwest Florida Water Management District.
03/80 - 10/80	--	Ground Water Hydrologist, Dames and Moore, Inc.- Chicago, Illinois.
10/78 - 12/80	--	Associate Hydrogeologist, Northwest Florida Water Management District.
05/77 - 10/78	--	Assistant Hydrogeologist, Northwest Florida Water Management District.

STATEMENT OF QUALIFICATIONS

The past ten years have been spent in senior supervisory positions at the Northwest Florida Water Management District including Executive Director, Deputy Executive Director, Acting Executive Director, Director of the Resource Management Division, and Director of the Water Resources Division. Duties as Executive Director include oversight of all District operations and supervision of a staff of over 100 professional, technical and support staff.

The District's responsibilities include statutory authority for the management and protection of the water resources of the 16-county area comprising the Florida panhandle, and covers such diverse areas as performance of technical programs and projects related to the water resources of northwest Florida, regulatory programs for the protection of the District's ground water and surface water resources, and acquisition of environmentally sensitive lands and riverine floodplain areas.

Duties as the Deputy Executive Director entailed primary responsibility for oversight of District operations and direct supervision of District technical programs and projects. These included over 40 water resources projects covering such diverse areas as ground water contamination and supply, surface water restoration projects and development of stormwater master plans, among others. Additional duties included activities as legislative liaison, including tracking of legislative bills, fiscal and programmatic analysis of bills, presentations to legislative committees on District programs, and preparation of legislative funding requests.

Duties as Director of the Resource Management Division included supervision of a highly technical, multidisciplinary staff of 38 hydrologists, hydrogeologists, engineers, water resources planners, field data collection staff and support staff, and management of all special projects and contracts. Other duties included development, planning and administration of water resources projects and technical programs, and preparation of project proposals and budgets.

Prior to assuming a supervisory position, the previous six years were spent primarily on various technical projects for the Northwest Florida Water Management District. Most projects entailed the application of two- and three-dimensional finite-difference computer models to problems in ground water flow and contaminant transport. These included model analysis of various ground water development schemes for meeting present and future water demands of the Fort Walton Beach metropolitan area, areal and profile modeling of projected ground water flow patterns following installation of environmental security measures at sites contaminated with polybrominated biphenyl and other contaminants, simulations of nutrient migration from wastewater percolation ponds, and prediction of water-level declines and saltwater intrusion resulting from development of the Sand-and-Gravel Aquifer in Santa Rosa County, northwest

Florida. Completion of these and other projects required extensive field data collection programs including test well drilling, aquifer tests, water-level mapping, and mapping of hydrogeologic units.

EXPERIENCE - Project Director (A complete listing is available upon request.)

Development of a Comprehensive Stormwater Management Plan for Leon County and the City of Tallahassee -- Analyzed and recommended cost-effective solutions to current and anticipated problems related to stormwater flooding and pollutant loading of area lakes. The completed master plan provides stormwater management strategies and projects (structural and nonstructural) including priorities, cost estimates and implementation schedules.

Surface Water Improvement and Management (SWIM) Program -- This program is specifically intended to preserve and restore the surface water bodies of state or regional significance in northwest Florida. The current program emphasis is the Pensacola Bay System and associated bayous, Deer Point Lake, Apalachicola Bay and River, and the Lake Jackson watershed in Leon County. At present, over 30 discrete projects are being conducted under this program.

Management and Treatment of Stormwater for the Restoration of Bayou Texar, Escambia County -- Bayou Texar in Escambia County has a history of persistent water quality problems, depressed productivity and periodic fish kills. Recognizing that the primary problem is discharge of large volumes of untreated stormwater, this project is intended to provide specific structural and nonstructural stormwater treatment projects that will lead to restoration of the bayou, including the location, sizing and design criteria for the treatment facilities.

Ethylene Dibromide Contamination Study of Jackson County -- Project entails describing the occurrence and movement of Ethylene Dibromide (EDB) within the Floridan Aquifer of Jackson County, correlating the EDB levels with well depths to map the vertical distribution of the contaminant, and to undertake computer modeling of the aquifer to determine how long the contamination may persist in the area.

Ambient Ground Water Monitoring Network -- For the past six years work has been conducted on the installation of a regional ground water monitoring network for purposes of establishing the background quality of ground water in northwest Florida, detecting any changes in quality. This project has also provided an extensive data base on the ground water conditions in northwest Florida, including basic hydrogeology, water quality, aquifer characteristics and ground water flow. Special emphasis has been placed on the Sand-and-Gravel Aquifer in southern

Escambia County because of the sensitivity of this aquifer to surface sources of contamination.

Preliminary Evaluation of Circulation and Flushing Characteristics of St. Andrews Bay -- Application of a three-dimensional estuarine model to examine the overall circulation and tidal flushing of a large bay system in the Panama City area of northwest Florida. The model is also designed to simulate the transport of contaminants discharged from a large wastewater treatment plant.

Water Quality Evaluation of Lake Munson, Leon County -- Identify major sources of pollution impacting the lake and develop restoration alternatives based on detailed evaluations of the hydrology, hydraulics and water quality characteristics of the lake and drainage basin.

Regional Solid Waste and Wastewater Disposal Plan -- Technical project director to the Walton/Okaloosa/Santa Rosa Regional Utility Authority for purposes of preparing a comprehensive plan for meeting the present and future waste disposal needs in a rapidly growing coastal area of northwest Florida.

Water Resources Restoration of Old Pass Lagoon, Destin, Florida -- Evaluation of engineering alternatives for restoring water quality in Old Pass Lagoon. Two and three-dimensional hydrodynamic models were applied to evaluate alternatives and to serve as management tools. Subsequently, a 50,000-gal/min circulation facility was selected as the preferred alternative and the engineering design and construction specifications were completed.

Nutrient Loading Assessment of Wastewater Percolation Ponds -- Design and installation of a ground water monitoring network to determine the distribution and concentration of nutrients in ground water adjacent to a large wastewater disposal facility.

Regional Water Supply Plan for the Coastal Areas of Santa Rosa, Okaloosa and Walton Counties, Northwest Florida -- Preparation of a detailed water supply plan for select coastal areas of northwest Florida, including assessment of future needs and evaluation of alternative sources of supply. The plan also included information on when additional supplies will be required and preliminary design of sub-regional water supply systems.

Construction of Old Pass Lagoon Circulation Facility, Phase I -- Project entailed the construction of a 50,000-gal/min pump station, associated discharge canal and seven foot diameter intake line for restoring the water quality of Old Pass Lagoon. The second phase of construction will include installation of approximately 1,000 feet of intake pipe into the Gulf of Mexico and construction of an intake structure.

Ground Water Monitoring Needs in the Coastal Areas of Northwest Florida -- Project included an assessment of the ground water conditions, adequacy of monitoring in the coastal areas of northwest Florida, and design of a coastal ground water monitoring network. To accomplish this goal, the project included mapping the lateral and vertical position of the freshwater/saltwater interface and delineation of major permeability zones in the Floridan Aquifer.

Hydrostratigraphic Investigation of Southern Escambia County -- Detailed hydrostratigraphic evaluation of southern Escambia County to provide basic data needed to assess the potential for contamination of major water-bearing zones utilized for public supply, and to establish a network of background monitor wells.

Resource Assessment of an Inland Well Field to Provide Public Water Supply for the Coastal Areas of Santa Rosa And Okaloosa Counties -- This project, scheduled to begin in June 1991, will provide a resource assessment of an inland well field proposed for southern Santa Rosa County. The well field is intended to provide public water supply for the coastal areas of southern Santa Rosa County and Okaloosa County. The project will include preparing plans for the number, location and distribution of wells that will comprise the well field and the resource impacts that can be expected. The project is being performed in conjunction with the Walton/Okaloosa/Santa Rosa Regional Utility Authority.

Northwest Florida Abandoned Well Plugging Program -- Abandoned wells represent a serious threat to the ground water resources in many areas of northwest Florida. As a result, a plan was prepared for proper disposal of abandoned wells throughout the District. Subsequently, funds were obtained from both state and local sources to initiate the program and begin to effectively deal with abandoned wells in northwest Florida.

Regional Water Supply Facility Master Plan for Walton, Okaloosa and Santa Rosa Counties -- Served as Project Director and principal technical advisor to the Walton/Okaloosa/Santa Rosa Regional Utility Authority in the preparation of the facility master plan for water supply, sludge disposal and wastewater disposal in the area. This included preparation of the Request for Proposals, consultant selection and technical oversight of the project. Was also retained by the Authority to develop all information needed to initiate negotiations with Eglin Air Force Base for installation of needed water supply facilities. This will include information on availability of water, demand projections, existing regulatory framework, requirements of state water policy, and development of tasks required to assess the impacts of the proposed ground water withdrawals.

Hydrogeologic Assessment of Solid Waste Landfills in Northwest Florida -- Assessment of ground water conditions, adequacy of monitoring and leachate generation rate for 36 solid waste landfills in northwest Florida. Later phases of the project included computer model simulations of contaminant migration and an assessment of environmental security measures for closure of selected landfills.

Environmental Security Measures for Containment of Contaminated Ground Water -- Computer model analysis of environmental security measures, including slurry cut-off walls, interceptor drains, and impervious cover for containing ground water at an industrial site contaminated with polybrominated biphenyl and other industrial pollutants.

Subsurface Migration of Wastewater Nutrients to Coastal Surface Water Bodies -- Application of ground water solute transport model to simulate the subsurface migration of wastewater nutrients through high permeability coastal beach and dune sands and discharge to saline surface waters. The results were used to establish appropriate setback lines for package sewage treatment plants in coastal areas of west Florida.

Chemical Characterization of Bottom Sediments in Choctawhatchee Bay -- A program of sampling and analysis of the bottom sediments of Choctawhatchee Bay to determine the levels of contaminants present in the sediments and the potential impacts of the contaminants on the productivity and biological diversity of the bay system.

Research Program to Enhance the Productivity of Choctawhatchee Bay -- Detailed evaluation of available information on the productivity and biological diversity of Choctawhatchee Bay, coupled with a series of experimental seagrass transplanting experiments to test the feasibility of re-establishing lost grass beds.

Choctawhatchee River Basin Surface Water Resources Assessment, Phases I and II -- A comprehensive multidisciplinary assessment of the biology, hydrology and hydraulics of the Choctawhatchee River basin including extensive biological and water quality analyses. The purpose of this project was to integrate available information on the bay with the hydrology and water quality characteristics of the upstream areas of the basin.

Stormwater Monitoring Program for the Lake Jackson, Lake Munson and Lake Lafayette Drainage Basins -- Establishment and operation of a long-term network of rainfall and stormwater flow monitoring stations to provide the information required by local governments to manage stormwater and provide a data base of hydrologic information for future stormwater planning activities.

Ambient Surface Water Monitoring Program -- Funded by the U.S. Environmental Protection Agency and the Florida Department of Environmental Regulation, the project entailed the sampling of streams throughout northwest Florida for use in establishing the ambient surface water quality of the streams.

EXPERIENCE - Project Manager (A complete listing is available upon request.)

Water Resources of Southern Okaloosa and Walton Counties, Northwest Florida -- Hydrogeologic and computer model evaluation of alternatives for developing ground water supplies from the Floridan and Sand-and-Gravel aquifers to meet present and projected water supply needs. Project included complete descriptions of the water quality and hydraulic characteristics of the aquifers and identification of areas for future ground water development.

Site Investigation of an Abandoned Industrial Disposal Area Containing Polybrominated Biphenyl -- Designed and implemented a program to determine the nature and extent of ground water contamination at a hazardous waste burial site and the potential for contaminant migration to a nearby river.

Hydrogeologic Evaluations of Hazardous Waste Disposal Sites -- Prepared descriptions of the hydrogeologic framework and ground water flow conditions at seven hazardous waste disposal sites and spill areas at various industrial sites covering a wide range of hydrogeologic conditions.

Availability of Ground Water from the Sand-and-Gravel Aquifer in Southern Santa Rosa County -- Computer model analysis of water-level declines and inland migration of saltwater resulting from development of a shallow ground water supply on a coastal peninsula. Model analysis included simulations of numerous pumping and development schemes under both normal and drought conditions.

EDUCATION

Bradley University, B.S., Geology
Texas Christian University, M.S., Specialty in Ground Water Hydrology
Thesis Topic: Hydrogeology of the Lower Rio Grande Valley Alluvial Aquifer

PUBLICATIONS (A complete listing is available upon request.)

Barr, D.E., 1990. Western Sub-Regional Water Supply System for the Walton/Okaloosa/Santa Rosa Regional Utility Authority. Summary Report to the Regional Utility Authority.

Maristany, A.E., Esry, D.H., and Barr, D.E., 1988. Harbor Restoration Through Improved Circulation. Proceedings, National Conference of the Hydraulic Division of American Society of Civil Engineers.

Barr, D.E., 1988. Regional Water Supply Plan for the Coastal Areas of Walton, Okaloosa, and Santa Rosa Counties - Addendum. Northwest Florida Water Management District Technical File Report 88-1.

Maristany, A.E., Esry, D.E., and Barr, D.E., 1987. Water Resources Restoration of Old Pass Lagoon, Destin, Florida. Northwest Florida Water Management District Water Resources Assessment 87-1.

Barr, D.E., and Bowman, E., 1985. Results of Ground Water Nutrient Monitoring at Wastewater Percolation Ponds in Destin, Florida. Northwest Florida Water Management District Technical File Report 85-1.

Barr, D.E., Hayes, L.R., and Kwader, T., 1984. Hydrology of the Southern Parts of Okaloosa and Walton Counties, Northwest Florida with Special Emphasis on the Upper Limestone of the Floridan Aquifer. U.S. Geological Survey Water Resources Investigation Report 84-4305.

Barr, D.E., Wilkins, K.T., and Barton, D.L., 1983. Evaluation of Minimum Package Sewage Treatment Plant Set-Back Lines on Selected Coastal Soils in West Florida. Northwest Florida Water Management District Special Report 83-9.

Barr, D.E., 1983. Ground Water Conditions in the Vicinity of Choctawhatchee Bay, Northwest Florida. Northwest Florida Water Management District Special Report 83-10.

Pratt, T.R., and Barr, D.E., 1982. Availability and Quality of Water from the Sand-And-Gravel Aquifer in Southern Santa Rosa County, Florida. Northwest Florida Water Management District Water Resources Special Report 82-1.

Hayes, L.R., and Barr, D.E., 1982. Hydrology of the Sand-And-Gravel Aquifer, Southern Okaloosa and Walton Counties, Northwest Florida. U.S. Geological Survey Water Resources Investigation Report 82-4110.

Barr, D.E., and Pratt, T.R., 1981. Aquifer Characteristics and Water Supply Potential of the Sand-And-Gravel Aquifer, Gulf Breeze, Santa Rosa County. Northwest Florida Water Management District Technical File Report 81-5.

Barr, D.E., and Wagner, J.R., 1981. Reconnaissance of the Ground Water Resources of Southwestern Bay County. Northwest Florida Water Management District Technical File Report 81-1.

Stidham, J.A., and Barr, D.E., 1981. Florida's Ground Water: An Endangered Resource Worth Saving! The Situation in Northwest Florida. Journal, Florida Engineering Society, pp. 15-16 and 25.

Barr, D.E., and Pratt, T.R., 1981. Results of Aquifer Test and Estimated Drawdowns in the Floridan Aquifer, Northern Gulf County, Northwest Florida. Northwest Florida Water Management District Water Resources Special Report 85-1.

Barr, D.E., Maristany, A., and Kwader, T., 1981. Water Resources of Southern Okaloosa and Walton Counties, Northwest Florida. Northwest Florida Water Management District Water Resources Assessment 81-1.

Wagner, J.R., Lewis, C., Hayes, L.R., and Barr, D.E., 1980. Hydrologic Data for Okaloosa, Walton and Southeastern Santa Rosa Counties, Florida. U.S. Geological Survey Open-File Report 80-741.

Barr, D.E. and Hayes, L.R., 1979. Hydraulic Characteristics and Digital Numerical Model of the Floridan Aquifer in Southern Okaloosa County, Northwest Florida. Fourteenth American Water Resources Conference, Lake Buena Vista, Florida.

PROFESSIONAL AFFILIATIONS AND ACTIVITIES

Registered Professional Geologist, State of Florida Registration No. 171

American Water Resources Association, Florida Section

Sigma Xi National Honorary Research Society

Florida Water Well Association

Member, Governor's Water Resources Coordination Commission

Technical Advisor and Coordinator, Walton/Okaloosa/Santa Rosa Regional Utility Authority

Member, Lake Jackson Action Team appointed By Leon County Commission to develop a management plan for restoring and preserving Lake Jackson

Member, St. Andrews Bay Resource Protection Committee

Former Board Member, Florida Section, American Water Resources Association

Member, Technical Coordination Committee, Florida Section, American Water Works Association

Member, Technical Review Committee, Naval Air Station, Pensacola, Florida

Member, Technical Liaison Committee, Georgia-Florida Coastal Plain National Water Quality Assessment

State of Florida Representative, Technical Coordinating Group, Apalachicola-Chattahoochee-Flint River System Interstate Water Resources Comprehensive Study

State of Florida Alternate, Executive Coordination Committee, Apalachicola-Chattahoochee-Flint River System Interstate Water Resources Comprehensive Study

Member, Florida-Alabama Water Resources Coordinating Council

Member, 1000 Friends of Florida

Member, Florida Defenders of the Environment

Chairman, Phipps Park Advisory Committee, Leon County

RESUME

CHRISTOPHER D. HOWELL, Ph.D.

AREAS OF EXPERIENCE

Environmental Resource Management
Project Management/Administration
Strategic Planning
Legislative Liaison

EDUCATION

B.Sc., Hons., Economics, University of London, 1969
M.Sc., Geography, University of London, 1970
Ph.D., Geography, University of Florida, 1978

PROFESSIONAL EXPERIENCE

1992 - Present: Director, Division of Resource Management, Northwest Florida Water Management District. Responsible for supervision of water resources projects, programs and studies, and administration of the Division.

1991 - 1992: Manager, Applied Population Research Unit, The University of Queensland, Australia. Responsible for financial and administrative management, marketing, operations assessment and strategic planning. (On leave of absence from NWFWMD).

1987 - 1991: Senior Policy Analyst, Office of Executive Director, Northwest Florida Water Management District. Served as legislative liaison, conduct fiscal and economic analysis, and research major policy decisions. Served as consultant on District special projects. Coordinated strategies and programs with the state university system, other water management districts and state advisory committees.

1985 - 1987: Senior Water Resource Planner, Northwest Florida Water Management District. Responsible for basin assessment program and water resources planning. Coordinated State comprehensive planning process with regional planning councils and local governments.

1979 - 1985: Associate Vice President -- Project Development, RSH International, Florida. Responsible for project management, analysis and coordination of overseas projects.

1976 - 1979: Senior Socioeconomist, PLANTEC Corporation (Subsidiary of RSH). Responsible for economic and social analysis, including environmental and economic impact statements, commercial/industrial feasibility studies, and project management.

1974 - 1976: Resource Geographer, Island Resources Foundation, Inc., U.S. Virgin Islands. Senior research analyst for various studies relating to environmental protection and alternative modes of economic development in the Caribbean.

1974: (Spring Semester) Adjunct Assistant Professor, Florida Atlantic University. Responsible for two advanced courses relating to resource development in the Caribbean and conservation of resources.

1971 - 1974: Graduate Research Fellow, University of Florida. Doctoral research into environmental resource management and planning.

1970 -1971: Resident Research Fellow, American Institute for Economic Research, Mass. Responsible for the formulation of welfare economic indices and research articles in monthly technical publication.

SELECTED PUBLICATIONS

Howell, C. Island Environment and Development: A Case Study of the British Virgin Islands. World Wildlife Fund/IUCN, 1976. Identification of development problems and remedial recommendations. The latter were accepted by the BVI Government for legislative implementation.

Towle, E.C., C. Howell and W. Rainey. Virgin Gorda: Natural Resources Survey. Rockefeller Brothers Foundation, 1977. Analysis of development alternatives within a fragile environmental system.

Howell, C. Tourism in the British Virgin Islands: Perceptions Toward Land Carrying Capacity. Ph.D. dissertation, University of Florida, 1978. Development of a computer model incorporating economic, physical and perceptual parameters to identify specific development areas within an overall strategy for economic growth.

Howell, C. A Guide to the Water Resources of Northwest Florida. Northwest Florida Water Management District, 1983. A layman's guide to water resources, problems and management.

Howell, C. and A. Maristany. Public Perceptions Toward Stormwater Problems, Management Alternatives and Funding: A Case Study of the City of Tallahassee and Environs. American Water Resources Association, Twenty-Fifth Annual Conference, 1989.

Howell, C. and J.W. McCartney. Water User Fees: A Supplemental Funding Mechanism for Water Resources Management. American Water Resources Association, Twenty-Fifth Annual Conference, 1989.

Leitman, S. and C. Howell. Does Water Flow Downhill? The Apalachicola-Chattahoochee-Flint River System: A View From the Bottom. Georgia Water Resources Conference, 1991.

Skinner, J. and C. Howell. Australian Business Demographics and Small Enterprise Planning. National Small Enterprise Conference, 1992.

SELECTED DOCUMENTS

Candidate, Draft and Final Environmental Impact Statements, FBM Submarine Support Base, Kings Bay, Georgia. Department of the Navy, 1976-1978. One of the most comprehensive EISs submitted the U.S. Council on Environmental Quality, and the first to address multiple site selection analysis. Responsible for economic and social methodology and production.

Environmental Impact Assessment Review, Fort Lauderdale International Airport. Broward County Commission/Federal Aviation Authority, 1978. Responsible for assessing economic and social impacts arising from the major expansion of a regional airport to handle 15 million persons annually.

Orlando Central Park Market Analysis. Martin Marietta Corporation, 1978. Phasing and alternative development scenarios for a major convention/multi-hotel/attraction center. Responsible for economic base analysis and market demand projections.

Key Biscayne Economic Impact Statement. Florida Department of Natural Resources, 1978. Analysis of economic impacts resulting from declaring Miami's Key Biscayne Bay a State Preservation Area. Responsible for analysis, project management and expert testimony.

Economic Impact Study of Jacksonville Seaport and Airport. Jacksonville Port Authority, Florida, 1979. Responsible for project management, methodology and analysis, and public presentation.

Feasibility Analysis and General Review for Egypt's Free Zones. General Authority for Investment and Free Zones, Ministry of Economy and Economic Cooperation, Government of Egypt, 1980. Culmination of a twelve-month study involving three major separate reports, covering all aspects of free zone operations and feasibility analyses for potential additional sites. Responsible for project management, economic, environmental and resource base analysis.

Industrial Estate Reconnaissance Survey. Ministry of Economy and Economic Cooperation, Government of Egypt, 1980. Investigation into a potential nationwide industrial estate program. Included investor and legal surveys and resource, market and site selection analyses. Responsible for project management, industry targeting and surveys.

Scoped Environmental Assessment: Egypt's Free Zones. U.S. Agency for International Development (USAID), 1980. The first Scoped EA to be undertaken for the Agency and accepted by USAID Washington as a model for future such studies. Responsible for project management and for social, economic and transportation analyses.

Economic Impact Statement, Regulation of Consumptive Use of Water. (Chapter 40A-2, F.A.C.). St. Johns River Water Management District, 1982. Responsible for production and expert testimony.

Comprehensive Regional Development Plan: Tabuk Region. Ministry of Regional and Rural Affairs, Kingdom of Saudi Arabia, 1985. The project involved a regional development strategy and detailed master plans for selected sites. Responsible for technical coordination; environmental resource assessments; demographic and economic surveys, analysis and projections; and formulation of alternative development strategies.

Stormwater Drainage Evaluation of the Lake Lafayette, Lake Munson, Lake Jackson and Fred George Basins. Northwest Florida Water Management District, 1986. Development of a comprehensive stormwater management strategy for the City of Tallahassee and neighboring urban areas in Leon County, Florida. As Project Planner, responsible for public survey design and implementation, and socioeconomic impact analysis for alternative management strategies.

Comprehensive Review of Water Resources Policies, Planning and Programs in Florida. Northwest Florida Water Management District, 1986. A joint water management districts/state university system study to explore options available for future planning and implementation of water resource programs. Responsible for District input and analysis.

PROFESSIONAL ASSOCIATIONS AND HONORARY POSITIONS

American Water Resources Association -- Florida Section
Research Affiliate, Caribbean Research Institute, U.S. Virgin Islands, 1974-1976
Editorial Reader, Rural Development, 1975-1976
Editorial Reader, University of Florida Press, 1976-1978
Steering Committee and Research Associate, Island Resources Foundation, U.S. Virgin Islands, 1976 to date
United Nations Expert -- Regional Planning, 1984 to date
Resource Person, Florida Speaker's Advisory Committee for the Future, 1986-1987
Resource Person, Florida Governor's Water Resource Commission, 1989
Member, Technical Advisory Committee for the Florida Aquatic Resources Education Program, 1993-1994

SCHOLARSHIPS AND GRANTS

American Institute for Economic Research Fellowship, 1970-1971
American Universities' Graduate Council Fellowship, 1971-1974
Barclays Bank International Development Fund Grant, 1974-1975

RESUME

LARRY R. WRIGHT

AREAS OF INTEREST

Administration, accounting, budgeting and finance

Administration and preparation of agency budgets, fiscal reporting and internal controls. Supervisory and hands-on applications pertinent to agency payroll, fixed assets, federal grants management, revenues and expenditures activity, fixed capital outlay, agency bonding issues and other areas associated with the Administrative, finance and accounting functions of a government agency.

Oversight of administrative functions pertinent to the day-to-day operations of a government agency to include agency computer and GIS operations, facilities maintenance and management (buildings, grounds, motor pool, etc.), contracts administration, procurement, property management.

POSITIONS HELD

4/92 - present -- Director, Division of Administration. Northwest Florida Water Management District

9/87 - 3/92 -- Chief, Bureau of Finance and Accounting. Florida Department of Environmental Regulation

2/84 - 9/87 -- Assistant Finance and Accounting Director. Florida Department of Environmental Regulation

8/80 - 2/84 -- Accounting Services Supervisor. Florida Department of General Services

3/78 - 8/80 -- Accountant IV. Florida Department of General Services

1/73 - 2/78 -- Accountant/Financial Consultant. Sole proprietor/owner Central Florida Accounting firm

STATEMENT OF QUALIFICATIONS

Accounting, budgeting, and administration experience with the Northwest Florida Water Management District, two major government agencies in the state of Florida and, corporate and private sector entities. Governmental accounting experience includes fifteen years of supervisory and hands-on experience as accountant and as chief financial officer for two agencies of the State of Florida. Non-governmental accounting experience includes five years of public accounting for corporate and non-corporate business entities.

EXPERIENCE

FLORIDA DEPARTMENT OF GENERAL SERVICES Responsibilities included but were not limited to the maintenance, accuracy and completeness of the agency's automated management accounting system. Preparation of agency interim and annual financial reports, financial analysis, forecasting, budget and cash flow monitoring.

FLORIDA DEPARTMENT OF ENVIRONMENTAL REGULATION Duties included supervision and control of the accountants and support personnel in the various fiscal sections in the Bureau of Finance and Accounting. Coordinated fiscal activities with the budgeting; purchasing; data management; personnel and administrative offices within the department. Worked directly with agency, State, and Federal auditors and agency management concerning fiscal related matters for the purpose of solving problems, ensuring compliance with applicable laws, rules and regulations and maintaining an open line of communication with all affected levels of management. The various sections under which I had supervision and control included Budgeting, Payroll, Fixed assets, Federal grants management, Account reconciliation, Contract disbursements, revenue/accounts receivable, Disbursements./accounts payable, Bond loan program, State revolving loan program and Fixed capital outlay.

EDUCATION

Bachelor's degree in Business Administration, major in Accounting, Tampa College, 1977

MEMBERSHIP

American Water Resources Association, Florida Section
Florida Institute of Certified Public Accountants
American Institute of Certified Public Accountants

PROFESSIONAL REGISTRATION

Certified Public Accountant, State of Florida

THOMAS R. PRATT

AREAS OF INTEREST

Ground Water Hydrology
Numerical Modeling of Ground Water Flow
and Solute Transport
Solute Transport in Heterogeneous Media

POSITIONS HELD

10/91 - Present -- Chief, Bureau of Ground Water. Northwest Florida Water Management District, Tallahassee, Florida

10/89 - 10/91 -- Senior Hydrologist. Northwest Florida Water Management District

08/86 - 10/89 -- Associate Hydrologist. Northwest Florida Water Management District

06/84 - 08/86 -- Graduate Research Assistant. Department of Civil Engineering, Auburn University, Alabama

07/79 - 05/84 -- Assistant Hydrogeologist. Northwest Florida Water Management District

05/78 - 02/79 -- Rig Hand. Layne-Central Company, Pensacola, Florida

STATEMENT OF QUALIFICATIONS

The past thirteen years have been spent developing professional skills in the area of ground and surface water resource management. This experience has included planning and implementation of field data collection programs, as well as synthesizing the results of data collection into resource assessments. Data collection programs have included installation of test wells, aquifer testing, water level mapping, operation of automated data collection systems, and water quality sampling. Associated supervisory responsibilities have involved oversight of drilling contractors, analytical laboratories, and field technical staff. More recent experience has included serving as principal investigator and/or project manager on a variety of resource assessments. Several of these projects involved use of numerical models to investigate ground water resource-related issues.

Recent project management experience includes implementation of a three-dimensional model of the principal fresh water aquifer in Escambia County, northwest Florida. Project objectives include preparation of an appropriate conceptual model of the aquifer, model implementation, and use of model results to identify aquifer best management practices. Numerical code utilized for this project is a three-dimensional, density-dependent, finite-element flow and transport code. A key component of the numerical model implementation has been integration of the code with a geographic information system. Conceptual model development required analysis of leaky aquifer test results.

Duties as Bureau Chief include the supervision of a staff of five professionals, who are currently involved in a variety of ground water-related technical projects. Bureau Chief has primarily managerial responsibilities and is responsible for project scheduling and cost-tracking, proposal preparation, invoice and budget preparation, and timely completion of deliverables. The position also requires interaction with the District Governing Board.

EXPERIENCE - Project Manager

Escambia County Ground Water Modeling -- Currently directing the application of a three-dimensional, finite-element, density-dependent flow and transport code to a coastal aquifer in northwest Florida. Study objectives include conceptualization of the aquifer flow system, assessment of ground water availability, and development of aquifer best management practices to address existing contamination. Modeling activities have included examination of aquifer salt water intrusion potential.

Ground Water Quality Monitoring Program -- Supervising the sampling and maintenance of a regional ground water monitoring network. Monitoring program is part of a state-wide, long-term assessment of ground water quality.

Regional Utility Authority Resource Assessment Project -- Overseeing the implementation of a two-dimensional, finite-difference model of the Floridan Aquifer. Project is designed to facilitate development of a regional well field and to assess impacts of aquifer development on adjacent users. Project approach entails integration of MODFLOW with a geographic information system.

Bayou Chico Restoration Project -- Supervised an assessment of the hydraulics, hydrology and water quality of a small, highly-degraded urban estuary. Assessment activities included application of the USEPA Stormwater Management Model to the estuarine watershed, characterization of existing stormwater quality and application of a hydrodynamic model to the estuary. Program goals included identification of preferred stormwater restoration alternatives.

Palafox and Coyle Watershed Project -- Prepared a stormwater assessment of two urban watersheds in northwest Florida. Utilizing the Stormwater Management Model, impacts of stormwater discharge and restoration alternatives were evaluated.

Ethylene Dibromide Contamination Study of Jackson County, Florida -- Conducted a study of the spatial distribution and movement of agriculture-related, nonpoint contamination in a hydrogeologically vulnerable portion of a northwest Florida county. Study objectives included a description of the hydrogeology of a karst recharge area and calibration of a two-dimensional flow model of the study area.

EXPERIENCE - Principal Investigator

Availability of Ground Water from the Sand-and-Gravel Aquifer in Southern Santa Rosa County -- Prepared a detailed assessment of the availability and quality of water in the Sand-and-Gravel Aquifer in the coastal portion of a northwest Florida county. Assessment included a description of aquifer hydrogeology, hydraulic properties, and water quality, and was designed to facilitate resource utilization.

Choctawhatchee River Basin Surface Water Resource Assessment, Phase II -- Directed an investigation of the hydraulics, hydrology and biology of a large northwest Florida river basin. Project objectives included a backwater model analysis of the river flood plain and application of a hydrologic watershed model to the basin.

Choctawhatchee River Basin Surface Water Resource Assessment, Phase I -- Implemented a surface water data collection program to quantify basin flows and water quality, with emphasis on nutrients, metals, sediments and agricultural chemicals. Information generated by project was used to prepare a basin water budget and annual load estimates for selected constituents.

EXPERIENCE

Quality Assurance Officer -- Prepared comprehensive and project-specific quality assurance plans for approval by the Florida Department of Environmental Regulation. Responsible for District-wide quality assurance of ground and surface water sampling programs.

Design of Dewatering System -- Utilizing a three-dimensional flow code, designed a deep well dewatering system for a barrier inland construction site. System was installed at a cost of approximately $100,000 and successfully dewatered a $1.3 million construction site for nine months. Evaluation included the performance of a water table aquifer test.

Solute Transport Modeling in Heterogeneous Porous Media -- Authored a three-dimensional solute transport code as a graduate research assistant at Auburn University. Applied this code to hypothetical hydraulic conductivity distributions to evaluate the effects of heterogeneous, isotropic hydraulic conductivity fields on advective transport of contaminants. Numerical experiments entailed utilization of MODFLOW.

Water Resources Assessment of Southern Okaloosa and Walton Counties -- Supervised an intensive ground water data collection program. Prepared a detailed description of the hydrogeologic framework for the study area with the data collected. Supervised well construction, performance of aquifer tests and field data collection.

Technical Review of Consumptive Use Permit Applications -- Participated in the development of a review procedure for pending consumptive use permit applications. Technically reviewed ground water use permit applications. Currently providing technical assistance to the Resource Regulation Division on an as requested basis.

Garcon Point Acquisition -- Prepared resource evaluation in support of acquisition of an 1,864-acre wetland parcel in northwest Florida.

Operation of Geophysical Logging Unit -- Maintained and operated a truck-mounted geophysical logging unit. Logged over 300 water wells during tenure as operator. Logger had natural gamma, caliper, electric, neutron and density capabilities.

EDUCATION

Master of Science in Civil Engineering, Auburn University. Specialty in Hydraulics and Hydrology.

Bachelor of Science in Geology, University of Alabama.

PUBLICATIONS

Pratt, T.R., P.F. McGinty, G.Z. Guo, W.C. Hunner. and E.F. Songer. 1991. Stormwater Assessment of the Bayou Chico Watershed. Escambia County, Florida (Preliminary Draft). Northwest Florida Water Management District. Water Resources Special Report 91-8, 199 p.

Roaza, H.P., T.R. Pratt, C.J. Richards, J.L. Johnson, and J.R. Wagner, 1991. Conceptual Model of the Sand-and-Gravel Aquifer, Escambia County, Florida. Northwest Florida Water Management District, Water Resources Special Report 91-6, 125 p.

Clewell, A.F., R.S. Beaman, W.O. Cleckley, and T.R. Pratt, 1991. Managing for Complexity in River Corridors. Proceedings of an International Symposium, Wetlands and River Corridor Management, Association of Wetland Managers, pp. 331-333.

Roaza, H.P., T.R. Pratt, and W.B. Moore, 1989. Hydrogeology and Nonpoint Source Contamination of Ground Water by Ethylene Dibromide in Northeast Jackson County, Florida. Northwest Florida Water Management District, Water Resources Special Report 89-5, 96 p.

Pratt, T.R., A.F. Clewell, and W.O. Cleckley, 1989. Principal Vegetation Communities of the Choctawhatchee River Flood Plain, Northwest Florida. Proceedings of the Symposium on Wetlands: Concerns and Successes. AWRA Technical Publication Series TPS-89-3, pp. 91-99.

Pratt, T.R., 1986. Numerical Experiments Involving Solute Transport in Heterogeneous Media. Masters Thesis, Auburn University, 191 p.

Pratt, T.R. and D.E. Barr, 1982. Availability and Quality of Water from the Sand-and-Gravel Aquifer in southern Santa Rosa County, Florida. Northwest Florida Water Management District, Water Resources Special Report 82-1, 99 p.

Barr, D.E. and T.R. Pratt, 1981. Results of Aquifer Test and Estimated Drawdowns in the Floridan Aquifer, Northern Gulf County, Northwest Florida. Northwest Florida Water Management District, Water Resources Special Report 81-1, 38 p.

PRESENTATIONS

Pratt, T.R. and H. P. Roaza, 1992. Ground Water Modeling of the Sand-and-Gravel Aquifer, Escambia County. Florida Water Management Research Conference. Orlando, Florida, March 16-17, 1992.

Roaza, H.P., T. R. Pratt, and W. B. Moore, 1991. Ground Water Contamination of the Floridan Aquifer by Ethylene Dibromide. American Institute of Hydrology International Conference of Hydrology and Hydrogeology in the 90s. Orlando, Florida, November 3-7, 1991.

MEMBERSHIP

American Geophysical Union

PROFESSIONAL REGISTRATION

Professional Geologist, State of Florida, No. 159

RESUME

KIMBERLY DUPREE-WIGGINS

AREAS OF INTEREST

Wage and Hour Laws
Family Medical Leave Act
OSHA Compliance
How to Reduce Unemployment Compensation Claims

POSITIONS HELD

6/93 - present -- Human Resources Specialist. Northwest Florida Water Management District

4/92 - 5/93 -- Human Resources Manager. National Linen Service

3/89 - 4/92 -- Personnel Coordinator. Medical Center Home Health Care Services, Inc.

STATEMENT OF QUALIFICATIONS

Safety compliance experience includes one year of hands-on experience as Safety Officer at National Linen Service. Responsibilities also included assuring that the medical staff at Medical Center Home Health Care were following proper universal precautions as well as other general safety procedures.

EXPERIENCE

NATIONAL LINEN SERVICE -- Responsibilities included but were not limited to orientating all new employees on safety rules and procedures. Teaching them proper techniques, such as how to lift properly, how to operate a forklift, use of ladder safety, how to avoid heat stress. I was also the instructor for Universal Precaution classes, as well as the Right to Know program, and served as the Hazard Communication Officer. I was also head of the safety investigation team, and the accident investigation team.

MEDICAL CENTER HOME HEALTH CARE SERVICES, INC. -- Responsibilities included assuring that all of our medical staff was in full compliance with all HRS and VHA safety standards. This included proper training on Universal Precautions, AIDS, CPR, etc. I was also responsible for assuring that the staff had bi-annual Tuberculosis screenings.

EDUCATION

Bachelor of Science Degree in Human Resources Management, Florida State University

MEMBER

Human Resources Association of Tallahassee
Alpha Kappa Psi, Professional Business Fraternity, Life Member.

CHRISTOPHER J. RICHARDS

AREAS OF INTEREST

Hydrostratigraphy
Ground Water Hydrology
Geophysics
Numerical Modeling

POSITIONS HELD

10/90 - present -- Associate Hydrogeologist. Northwest Florida Water Management District

12/85 - 10/90 -- Assistant Hydrogeologist. Northwest Florida Water Management District

08/80 - 08/84 -- Field Engineer. Dresser Atlas, Inc., San Angelo, Texas.

10/76 - 04/77 -- Geologist. State of Louisiana, Louisiana State Mineral Board, Baton Rouge, Louisiana.

08/74 - 05/76 -- Laboratory Assistant. Louisiana State University, Geology Department, Baton Rouge, Louisiana.

STATEMENT OF QUALIFICATIONS

For the past eleven years I have been involved in all aspects of borehole geophysics in both petroleum exploration and ground water investigations. Planning, data acquisition, log analysis and formation evaluation in a wide variety of geologic settings required the use of a variety of geophysical logs and many different analytical techniques. For the past seven years, I have been involved in a variety of ground water projects. Responsibilities included delineation and mapping of hydrostratigraphic units, aquifer testing and analysis, review of ground water monitoring networks associated with landfills and underground injection facilities, design and installation of ground water monitoring networks, log analysis, ground water availability studies and ground water flow modeling. Petroleum exploration work involved determination of the oil and gas potential of mineral leases.

EXPERIENCE

Regional Utility Authority Resource Assessment -- (Principle Investigator/Project Manager) Developed a quasi-three dimensional ground water flow model of the Floridan Aquifer for the western panhandle area of Florida utilizing the MODFLOW model and GIS technology. The purpose of the model was to analyze potential impacts of a regional well field, including the effect of the well field on the position of the saltwater interface, and to design the well field in a manner which will minimize the impact on the ground water resource. This proposed well field is intended to insure an adequate supply of potable water for the coastal area of Santa Rosa County and adjacent areas of southwestern Okaloosa County. Historical water use, projected water use through the year 2010 and the estimated potential safe yield of the areas existing well fields were analyzed in order to determine the volume of water required from the proposed well field.

Sand-and-Gravel Aquifer Modeling, Escambia County, Florida -- (Project Team Member) Development of a three dimensional flow and contaminant transport computer model of the Sand-and-Gravel Aquifer. Primary responsibilities included development of the conceptual model, delineation and mapping of the hydraulic units within the aquifer, aquifer testing (including design, analysis and coordination of all field activities), determination of hydraulic conductivity distribution of the various layers of the aquifer, and, mapping the potentiometric surfaces associated with the Sand-and-Gravel Aquifer. Much of this work was accomplished utilizing GIS technology.

Availability of Ground Water at Selected Sites in Gadsden and Leon Counties, Northwest Florida -- (Principle Investigator) Conducted an investigation of the hydrogeology and availability of ground water at four sites being considered for a coal fired electric generating plant. Project included construction of wells for multi-well aquifer tests, aquifer testing at three sites, analysis of existing data, water quality considerations and predicting aquifer drawdown for various withdrawal rates.

Northwest Florida Water Management District Well Plugging Program -- (Project Manager) Responsibilities included identification of abandoned wells and prioritization for plugging based on the potential for aquifer contamination and possible impact to local populations. Other responsibilities include oversight of field plugging operations and sub-contractors.

Design and Installation of the Visa Monitoring Well Network -- Designed a monitoring well network for an industrialized portion of Pensacola, Fl. Managed the installation of monitor wells in the Pensacola and four other Very Intensely Studied Areas of Northwest Florida. The VISA areas were selected based on susceptibility to ground water contamination and land use analysis. The network consists of 75 newly constructed wells and approximately 50 existing wells.

Geophysical Logging -- Operated all types of geophysical logging equipment. Experience includes design of logging programs, extensive logging experience in both petroleum exploration and ground water investigations, troubleshooting logging operations, quality assurance and quality control of geophysical logging operations, quantitative analysis of logs, and managing all phases of logging operations.

Investigation of Ground Water Availability and Water Quality -- Planned a multi-well aquifer test in northern Calhoun County utilizing existing wells. Verified the heterogeneous nature of the carbonate aquifer by flow log analysis. Using porosity and resistivity logs, determined the water quality and degree of increasing mineralization within the lower, untested portion of the aquifer.

Ambient Ground Water Monitoring Project -- Mapped hydrogeologic units present in Northwest Florida. Participated in the design and installation of a regional background water quality monitoring network. Supervised field activities, monitor well installation and conducted well logging operations. Other responsibilities included updating the data base and data base management.

EDUCATION

Bachelor of Science in Geology, Louisiana State University.

PUBLICATIONS

Richards, Christopher J., Roaza, Honesto, and Roaza, Ruth Montgomery, 1993. Integrating Geographic Information System in Well Field Design and Aquifer Impact Analysis Using the MODFLOW Finite Difference Modeling Technique. Proceedings of the Symposium on Geographic Information Systems and Water Resources, American Water Resources Association, p. 413 - 422.

Richards, Christopher J., 1993. Preliminary Hydraulic Assessment of the Walton/Okaloosa/Santa Rosa Regional Utility Authority's Western Sub-Regional Well Field. Northwest Florida Water Management District, Water Resources Special Report 93-1.

Richards, Christopher J., 1993. Historical Water Use and Projected Demands for Southeastern Santa Rosa County. Northwest Florida Water Management District, Water Resources Technical File Report 93-1.

Wagner, Jeffry R., Richards, Christopher J., and Johnson, Jay L., 1991. Hydrogeology of the Northwest Florida Water Management District. Northwest Florida Water Management District, Water Resources Special Report 91-10 (at press).

Roaza, Honesto P., Pratt, Thomas R., Richards, Christopher J., Johnson, Jay L., and Wagner, Jeffry R., 1991. Conceptual Model of the Sand-and-Gravel Aquifer, Escambia County, Florida. Northwest Florida Water Management District, Water Resources Special Report 91-6.

Richards, C. J. and Dalton, J. B., 1987. Availability of Ground Water at Selected Sites in Gadsden and Leon Counties, Northwest Florida. Northwest Florida Water Management District, Water Resources Special Report 87-2.

PROFESSIONAL REGISTRATION

Licensed Professional Geologist, Florida, No. 487

MEMBERSHIP

American Geophysical Union

RESUME

PAUL F. MCGINTY

AREAS OF INTEREST

Surface Water Hydrology
Water Pollution Management
Open Channel Hydraulics
Watershed Modeling

POSITIONS HELD

11/91 - Present -- Assistant Hydrologist, Northwest Florida Water Management District

10/89 - Present -- Assistant Hydro-Engineer, Northwest Florida Water Management District

STATEMENT OF QUALIFICATIONS

Experience in chemical analysis of water quality, computer-assisted stormwater design, appraisal of freshwater ecosystems: natural state and under impact of urban and agricultural development, technical writing and review of documents, environmental reporting for daily newspaper. Functions in the capacity of District Quality Assurance Officer.

Coursework with emphasis in surface water hydrology and hydraulics, water and waste water treatment, freshwater chemistry and ecology, and agricultural water management: irrigation and drainage.

EDUCATION

Master of Science in Environmental Engineering, University of Florida

Bachelor of Science in Agricultural Engineering, University of Florida.

RESUME

HONESTO P. ROAZA

AREAS OF INTEREST

Aqueous Geochemistry
Ground Water and Contaminant Hydrology
Numerical Modeling
Geographic Information System Applications

POSITIONS HELD

10/91 - present --	Associate Hydrogeologist. Bureau of Ground Water, Northwest Florida Water Management District. Tallahassee, Florida
9/88 - 10/91 --	Assistant Hydrogeologist. Bureau of Ground Water. Northwest Florida Water Management District. Tallahassee, Florida
9/87 - 9/88 --	Environmental Specialist. Bureau of Ground Water Protection. Florida Department of Environmental Regulation. Tallahassee, Florida
1/87 - 9/87 --	Hydrologic Field Technician. Water Resources Division. U. S. Geological Survey. Tallahassee, Florida
3/85 - 6/86 --	Instructor. Department of Geological Sciences. The Ohio University. Athens and Lancaster Campuses, Ohio
9/83 - 6/85 --	Graduate Teaching Associate. Department of Geological Sciences. The Ohio University. Athens, Ohio

STATEMENT OF QUALIFICATIONS

Professional experience has been in the technical fields of ground water hydrology, water quality and numerical modeling studies. Project participation included field data collection, interpretation of data, analyses of data, and development of methods and computer/GIS applications.

EXPERIENCE

Escambia County Sand and Gravel Aquifer Computer Model -- (Principle Investigator) Development of a flow and contaminant computer model of the Sand and Gravel Aquifer in Escambia County, Florida. Development of an integrated ground water management system using the computer model and a geographic information system.

Hydrogeology and Nonpoint Source Contamination of Ground Water in Northeast Jackson County, Florida -- (Principle Investigator) Assessment of the hydrogeology and the extent of ground water contamination by the pesticide Ethylene Dibromide. Included numerical flow modeling of the Floridan Aquifer.

Water Quality Study of the Apalachicola River Basin: SWIM -- (Principle Investigator) Assessment of historical water quality conditions of the Apalachicola River Basin.

Water Quality Study of the Pensacola Bay System: SWIM -- (Principle Investigator) Preliminary assessment of the historical water quality of the Escambia River Basin, Blackwater River Basin, Yellow River Basin and the East Bay River Basin for constituent loading estimations to the Pensacola Bay System.

Pesticide Monitoring and Data Review -- Agrichemical data analyses, technical support of agrichemical field studies and testing of nonpoint source numerical models.

Pensacola Superfund Creosote Contamination Study -- Field data collection and preliminary set up of contaminant transport model for the creosote contamination study at the American Creosote Works Superfund site.

Instructor -- Instructor/Lecturer for Oceanography/Marine Geology, Historical and Physical Geology classes at the Ohio University.

EDUCATION

Master of Science in the Geological Sciences
The Ohio University, Athens, Ohio

Bachelor of Science in Geology
Muskingum College, New Concord, Ohio

General Motors Institute
Mechanical Engineering Program, Fisher Body Division
Flint, Michigan

PUBLICATIONS

Integrating Geographic Information System in the Analysis of Ground Water Flow, Contaminant Transport and Salt Water Intrusion Using the SWICHA Finite Element Modeling Technique (with R.M. Roaza and J. Wagner). Proceedings of the symposium on Geographic Information Systems and Water Resources. American Water Resources Association. Mobile, Alabama 1993. pp. 397-404; 623-624.

Integrating Geographic Information System in Well Field Design and Aquifer Impact Analysis Using the MODFLOW Finite Difference Modeling Technique (with C. Richards and R. M. Roaza). Proceedings of the Symposium on Geographic Information Systems and Water Resources. American Water Resources Association. Mobile, Alabama 1993. pp. 413-422.

Ground Water Modeling of the Sand-and-Gravel Aquifer, Escambia County (with T.R. Pratt). Florida Water Management Research Conference, Orlando, Florida; March, 1992.

GIS Applications of a 3-dimensional Model for the Sand-and-Gravel Aquifer, Escambia County (with J.L. Johnson). Florida Water Management Research Conference, Orlando, Florida; March, 1992.

Conceptual Model of the Sand-and-Gravel Aquifer, Escambia County, Florida. (with J. Wagner, C. Richards, J. Johnson, and T. R. Pratt). Northwest Florida Water Management District Water Resources Special Report 91-6; 1991.

Analysis of the Suitability of Existing STORET Data for Loading Rate Calculations in the Pensacola Bay System. (with T.R. Pratt) Northwest Florida Water Management District Technical File Report 91-1; 1992.

Assessment of the Ambient Surface Water Quality in the Apalachicola River Basin: Phase I. Northwest Florida Water Management District Water Resources Special Report 91-5; 1991.

Hydrogeology and Nonpoint Source Contamination of Ground Water by Ethylene Dibromide in Northeast Jackson County, Florida. (with T.R. Pratt and W.B. Moore) Northwest Florida Water Management District Water Resources Special Report 89-5; 1990.

Ground Water Contamination of the Floridan Aquifer in Northeast Jackson County, Florida by Agriculture Chemicals. (with W.B. Moore) Geological Society of America abstracts, Southeast Section Annual Meeting; April, 1990.; American Institute of Hydrology International Conference, Orlando, Florida; November, 1991.

The Significance of Maximum Contaminant Levels in Natural Aquifer Systems: Implications for Remediation of Nonpoint Source Pollution Via Dilution. (with W.B. Moore) Geological Society of America abstracts, Southeast Section Annual Meeting; April, 1990.

PreQuaternary Age Dating Using Electron Spin Resonance: Peroxy Radical Defects in Natural Quartz. Geological Society of America abstracts, Southeast Section Annual Meeting; April, 1990.

Effectiveness of Aquifers in the Dilution of Nonpoint Source Low MCL Contaminants. (with W.B. Moore) Abstracts of the Technical Sessions, U. S. Geological Survey Second National Symposium on Water Quality; November, 1989.

M.S. Thesis on Basic Research in the Magnetic Resonance Theory and Methods Towards Geological Applications with Primary Emphasis on Radiation Damages. The Ohio University, 1989.

MEMBER

Sigma Xi, The Research Society of America
Professional Geologist, State of Florida Licence # PG 0001518.

RESUME

NICHOLAS D. R. WOOTEN

AREAS OF INTEREST

Surface Water Hydrology
Data Acquisition Design and Management
Water Quality Sample Collection
Water Quality Interpretation

POSITIONS HELD

10/91 - Present -- Director - Field Services Section. Northwest Florida Water Management District.

04/89 - 09/91 -- Assistant Hydrologist. Northwest Florida Water Management District.

12/86 - 03/89 -- Assistant Field Representative. Northwest Florida Water Management District.

09/80 - 11/86 -- Vice President. Chapin & Associates, Inc.

10/77 - 08/80 -- Project Manager. Biddy, Chapin & Associates, Inc.

05/74 - 06/76 -- Student Assistant. Florida Resources and Environmental Analysis Center

STATEMENT OF QUALIFICATIONS

Recent experience encompasses stormwater drainage evaluation studies, ambient surface water evaluations and participation in limnological water quality and sediment assessments. Current responsibilities include management and coordination of hydrologic and water quality data collection networks. Surface water data management activities include: hydrologic and water quality data editing and verification, preliminary surface water data analysis, and surface water data base management. Additional responsibilities include supervision of surface water field personnel, and preliminary regression and water quality analysis. Previous experience in the water resource field includes nine years working on hydrologic and hydrographic projects in coastal and estuarine environments. Past positions include Principal in an oceanographic consulting firm specializing in hydrographic marine surveys, circulatory investigations and operation of hydrographic data collection networks. Responsibilities in the hydrographic field included data station design and construction, supervision of sub-contractors and field personnel, competitive bid preparation and bid negotiation, development of project operation and management procedures. Experience also involved operation and management of a consulting business.

EXPERIENCE - Project Manager

Stormwater Monitoring of Tallahassee and Leon County Basins
Monitoring program designed to collect stream discharge and rainfall data in major drainage basins in Leon County and Tallahassee. Monitoring data will provide information for improvements in stormwater drainage system and reductions of pollutant loads to receiving water bodies.

Ambient Surface Water Quality Monitoring
Stream, lake and estuary water quality monitoring program in northwest Florida intended to provide data for assessment of background water quality conditions. Water quality information is included in the Florida Department of Environmental Regulation's Florida Water Quality Assessment Report, 305B.

STORET Database Project
Water quality database management project to produce a user manual for management and storage of water quality data. Uploading of water quality data on District water quality database to EPA STORET database.

EXPERIENCE

Stormwater Assessment of the Bayou Chico Watershed
Study to identify and quantify existing non-point pollution problems in Bayou Chico watershed and design restoration alternatives to reduce pollutant loading into Bayou Chico. Assessment of circulation and flushing characteristics of Bayou Chico and identification of alternatives for improvement of water quality in bayou.

Stormwater Drainage Evaluation of Tallahassee and Leon County Basins
Study objectives are to provide information necessary for the development, evaluation and implementation of comprehensive stormwater management strategies in the study area. Application of three-dimensional hydrodynamic model utilizing extensive hydrologic and water quality data collection network.

Water Quality Evaluation of Lake Munson
Water quality and sediment chemistry data collection to aid in the application of water quality model of lake for testing various restoration alternatives.

Clearwater Bay Circulation Assessment
Hydrologic and hydraulic data collection for application of model to determine circulatory characteristics of bay system. Assessment of current and future development conditions on water quality of lagoon.

National Ocean Service Tide Station Monitoring Network
Operation and management of data collection network for National Ocean Service. Tide station network data utilized to determine hydrographic survey control,tide prediction, circulatory study applications, storm damage assessments, and establishment of marine boundaries.

National Data Buoy Center-Data Collection Project
Operation and management of hydrologic and meteorological equipment network in the Florida Gulf Stream. Study objectives to determine circulatory characteristics and heat transport dynamics of Gulf Stream and the effect on weather patterns.

Louisiana Marine Boundary Program
Three year marine boundary program to evaluate tidal characteristics, storm damage levels, and determine state jurisdictional marine boundary. A permanent marine boundary network was established during the program.

Mississippi Marine Boundary Program
Four year marine boundary program to study tidal influences, assess potential coastal storm damage, and establish permanent marine boundary network along coastlines and tributaries.

EDUCATION

Bachelor of Science in Geography, Minor in Biology. Florida State University.

Water Boundary Survey Seminar. Florida Society of Professional Land Surveyors.
Instrumentation Seminar. National Ocean Service, NOAA.
Stream, Lake and Estuarine Pollution, Florida Atlantic University, Dept. of Engineering

PUBLICATIONS

Wooten, N.R. and Barton D.L., 1992. Northwest Florida Water Management District Water Quality Database and EPA STORET System User Manual.

Bartel, R.L., Arteaga, R., Wooten, N.R., et al., 1991. City of Tallahassee and Leon County Stormwater Management Plan Vol. 1-6.

MEMBERSHIPS

American Water Resources Association
American Geophysical Union

RESUME

ERIC F. SONGER

AREAS OF INTEREST

Satellite Image Analysis
Spatial Analysis
Ecological Applications of GIS

POSITIONS HELD

07/90 - Present	--	Assistant GIS Analyst. Northwest Florida Water Management District
08/88 - 07/90	--	Research Assistant I. Mississippi Agriculture and Forestry Experiment Station
08/87 - 07/88	--	Forestry Technician. Mississippi Agriculture and Forestry Experiment Station
01/85 - 08/87	--	Graduate Research Assistant. Mississippi Agricultural and Forestry Experiment Station
11/84 - 12/84	--	Student Conservation Association Volunteer. U. S. Fish and Wildlife Service.

STATEMENT OF QUALIFICATIONS

Since May 1985, I have been working with all aspects of GIS database creation including: digitizing manuscript maps; creation of manuscripts from aerial photo interpretation; conversion of existing digital data from disparate GIS systems; creation of GIS from existing database information, property descriptions, and satellite imagery classification. In addition, I have been responsible for the creation of GIS products, ranging from spatial analyses to final maps and figures, teaching GIS to both students and new employees, and writing AML (Arc Macro Language) programs.

I have been fortunate to work in environments that have allowed me to work on a numerous projects with a variety of inputs and outputs. The variety of work performed has provided many opportunities to solve problems and translate project assignments into GIS related tasks. In particular, the last 3 years have been spent intensively using ARC/INFO GIS and ERDAS image processing software.

EXPERIENCE

Franklin County Nonpoint Assessment - Wrote AML programs to calculate nonpoint source loads based on loading rates from the literature. Prepared final maps and figures for report.

Karst Characterization for Wellhead Protection - Helped determine how to spatially represent required model elements for incorporation into the potential for aquifer contamination model. Combined elements and their weights into spatial analysis coverage used in the final evaluation. Created large format plots for a poster session presentation.

Apalachicola River Basin Land Use Assessment - Geo-corrected 2 full scenes of Landsat Thematic Mapper imagery into UTM zone 16 to correspond with district GIS data. Classified satellite imagery into Florida Land Use and Cover Forms Classification System (FLUCCS) level 2 designations. Combined basin-wide landuse coverage with county and subbasin coverages to create an analysis coverage. Reported landuse acreage by county or basin as required.

Pensacola Bay Impervious Surface Analysis - Geocorrected a single scene of SPOT multispectral imagery. Subset and classified an area corresponding to the urban area of the city of Pensacola, FL to identify impervious surfaces. Converted the classified file into an ARC/INFO coverage, which was overlaid with a basins coverage to determine area of impervious surface by basin.

Forest Type Mapping - Project areas of the U.S Army Corps of Engineers, Mobile District were mapped for landuse and forest type from large scale color and color-infrared aerial imagery. Type information was corrected to 1:12,000 scale maps and prepared for digitizing.

Habitat Capability Model - Contracted through Department of Wildlife and Fisheries, Mississippi State University with U. S. Forest Service for the development of a habitat capability model for the eastern wild turkey on the Southeastern Coastal Plains

Life History Summaries - Contracted with SAIC, Oakridge, Tennessee for life history summaries of economically important species in the area of the proposed Super Conducting Super Collider site.

Determination of Habitat Quality for the Eastern Wild Turkey - Used GIS and habitat diversity indicators to characterize habitat quality. Developed a GIS with MRSC software. Developed habitat diversity indicators for the landcover variables and integrated them into a spatial model. Used telemetry locations to test the validity of the model.

PUBLICATIONS

Benoit, A. T., J. L. Johnson, I. L. Rains, E. F. Songer, and P. L. O'Rourke. 1992. Characterization of Karst Development in Leon County, Florida, for the delineation of wellhead protection areas. Water Resources Special Report 92-8, 83 p.

Pratt, T. R., P. F. McGinty, G. Z. Guo, W. C. Hunner 1991. Stormwater assessment of the Bayou Chico watershed, Escambia County, Florida (Preliminary Draft). Northwest Florida Water Management District. Water Resources Special Report 91-8, 199 p.

Rains, I. L., E. F. Songer, T. L. Macmillian, P. Gremillion, D. J. Cairns, G. Lewis, and D. Tonsmeire. 1991. Apalachicola River and Bay Drainage Basin: Preliminary Franklin County Land Use/Cover Assessment. p.53.

Songer, E. F., R. L. Kelley, and G. A. Hurst. 1988. Testing wild turkey use of habitats ranked by spatial estimators. in Amelaner, C. J. Jr. ed. Proc. of Tenth International Symp. on Biotelemetry. Univ. of Arkansas Press, Fayetteville, AR., pp. 244-253.

Songer, E. F. 1987. Habitat Suitability Indices for the Eastern Wild Turkey in East Central Mississippi, including estimates of the habitat variables: juxtaposition, interspersion. and edge. Master's Thesis, Mississippi State University. 56 pp.

Wynn, T. S., E. F. Songer, and G. A. Hurst. 1990. Managing telemetry data sets: a GIS-based approach. Proc. Nat'l Wild Turkey Symp. 6:(in press).

Songer, E. F. 1992. An Analysis of the Impervious Surface of the Urban Watersheds of Pensacola Bay using SPOT Imagery. 1992. Florida Water Management District Research Conference. Orlando, FL. March 16-17, 1992.

Songer, E. F., R. L. Kelley, and G. A. Hurst. 1988. Testing wild turkey use of habitats ranked by spatial estimators. in Amelaner, C. J. Jr. ed. Proc. of Tenth International Symp. on Biotelemetry. Univ. of Arkansas Press, Fayetteville, AR., pp. 244-253.

Wynn, T. S., E. F. Songer, and G. A. Hurst. 1990. Managing telemetry data sets: a GIS-based approach. Proc. Sixth Nat'l Wild Turkey Symposium. Charleston,WV

EDUCATION

West Virginia University, Morgantown, WV 26506. Bachelor of Science in Wildlife Resources. May 1984.

Mississippi State University, Starkville, MS 39762. Master of Science in Wildlife Ecology. August 1987.

MEMBERSHIPS

National Wildlife Federation
Nature Conservancy
National Rifle Association
The Wildlife Society
American Society for Photogrammetry and Remote Sensing
American Museum of Natural History

CERTIFICATIONS

Associate Wildlife Biologist, April 1989

U. S. Fish and Wildlife Service, Certified in Habitat Evaluation Procedure (HEP).

RESUME

JUSTIN E. STRICKLAND

AREAS OF INTEREST

Water Resources Regulation
Consumptive use of ground water and surface water systems
Numerical and analytical modeling of ground water and surface water systems
Ground water contamination investigations
Optimization of water resource systems

POSITIONS HELD

1/93 - present	--	Assistant Hydrogeologist. Northwest Florida Water Management District.
1/91 - 1/93	--	Hydrogeologist/Geologist. Woodward-Clyde Consultants
6/89 - 1/91	--	Hydrogeologist/Geologist. Ecology and Environment, Inc.
8/88 - 6/89	--	Hydraulic Aid. United States Geological Survey.
6/88 - 6/89	--	Student Laboratory Assistant. Florida State University.

STATEMENT OF QUALIFICATIONS

As hydrogeologist for the Bureau of Resource Regulation at the Northwest Florida Water Management District, my duties include; consumptive use application evaluation, ground water and surface water resource impacts, advisory to the regulation of wells program, compliance monitoring of Standard Water Use Permits, field inspections of consumptive use permittees and ground water well contractors (public supply/monitoring wells).

Technical experience includes a variety of hydrogeological projects directly related to ground water resources investigations, management, and analysis. The scale of these projects varies from ground water contamination investigations to regulatory management of ground water and surface water resources. Professional experience includes supervisory of hazardous waste site field work investigations and remedial contractors, application of analytical models to simulate ground water systems, and agriculture irrigational water usage. Such hazardous waste sites have included aquifer testing, various sampling, geophysical survey, elevation surveys, radiation surveys, air monitoring, health/safety coordination, and subcontractor coordination.

EXPERIENCE

Assessment and Remedial Investigations/Feasibility Field Studies

- **Hazardous Wastes -- Industrial Facilities -- UST's**
- Work Plan/Cost Estimate Development
- Subcontractor negotiator/coordinator/overseer
- Field Team Leader/Supervisor
- Monitoring Well Installation, Development, and Sampling
- Aquifer Testing and Data Evaluation
- Soil/Sediment Sampling
- Surface/Storm Water Sampling
- Draft Contamination Reports
- Resident gINT Applicator/Designer
- Geophysics
- Basic Groundwater Modeling
- Air Monitoring
- Stream Basin Characteristics
- Sediment Transport Experiments
- Stream Velocity Data Acquisition
- Topographic Map Correlation

EDUCATION

Bachelor of Science, Geology
The Florida State University, Tallahassee, Florida

CERTIFICATES

40-Hour O.S.H.A. Basic Health & Safety Training
40-Hour Radiation Methodology & Safety Training
8-Hour O.S.H.A. Waste Site Supervisor Training

MEMBERSHIPS

National Ground Water Association
gINT Technical Subscriber

RESUME

FRANK GRAHAM LEWIS, III

AREAS OF INTEREST

Estuarine Ecology
Invertebrate Ecology
Water and Sediment Quality Analysis
Experimental Design and Statistical Analysis

POSITIONS HELD

06/91-Present -- Senior Environmental Scientist, Resource Management Division, Northwest Florida Water Management District, Tallahassee, Florida

03/88-06/91 -- Project Ecologist, Environmental Services Division, Dames & Moore, Tallahassee, Florida

09/85-03/88 -- Environmental Specialist, Office of Coastal Management, Florida Department of Environmental Regulation, Tallahassee, Florida

09/84-09/85 -- Senior Scientist, Benthic Ecology, Applied Biology, Inc., Jensen Beach, Florida

10/82-09/84 -- Postdoctoral Fellowship, Benthic Ecology Section, Harbor Branch Institution, Inc., Fort Pierce, Florida

06/74-09/77 -- Research Biologist, Department of Biological Sciences, Florida State University, Tallahassee, Florida

STATEMENT OF QUALIFICATIONS

Dr. Lewis has spent the past twenty years developing his professional skills in the areas of aquatic ecology and surface water quality. His primary focus has been directed toward estuarine benthic ecology where he has specialized in the biology of crustacea and fishes. His early research examined aspects of the long-term variability of estuarine systems with emphasis on invertebrate and fish populations in Apalachicola Bay, Florida. Later work examined animal-plant relationships in subtropical and tropical seagrass beds; of particular interest were the crustacean essemblages associated with seagrass and macroalgae. This work was conducted in Apalachee Bay, the Indian River Lagoon, the Florida Keys, the Bahamas and several locations in the Caribbean.

Since joining the Water Management District, Dr. Lewis has concentrated on developing and implementing a biological research program to be coupled with a state-of-the-art, three-dimensional estuarine circulation model for Apalachicola Bay, Florida. The focus of the program is to estimate the freshwater needs of the Apalachicola River and Bay. The biological studies include investigations of nutrient transport and primary productivity, the coupling of primary and secondary production in the estuary, and an assessment of long-term variability of biological communities in the bay. The primary issue under investigation is the influence of river flow. The program is part of a large, multidisciplinary study being conducted by the States of Florida, Alabama and Georgia, and the U.S. Army Corps of Engineers on the Apalachicola-Chattahoochee-Flint River system.

In addition to his biological focus, he has been involved in numerous water and sediment quality monitoring programs including the development of a statewide interpretive tool for assessing metals concentrations in estuarine sediments (Florida Department of Environmental Regulation). Recently he designed and initiated a surface water monitoring project for the Pensacola Bay system being conducted jointly with the Escambia County Utility Authority.

Other responsibilities at the District include providing technical assistance on aquatic biology, water and sediment quality analysis, sampling design and statistical analysis for other District projects.

WORK EXPERIENCE

Northwest Florida Water Management District - Design, coordination and participation in multidisciplinary projects concerning the freshwater needs of Apalachicola Bay; directly responsible for biological aspects of this program, including nutrient and primary productivity studies, assessment of the coupling between primary and secondary production, and comprehensive statistical analysis of long-term biological data set. Development of water and sediment quality monitoring program for the Pensacola Bay system. Provides technical assistance to a variety of other projects on aquatic biology, water and sediment quality, sampling design and statistical analysis.

Dames & Moore - Assessment of environmental impacts on water, sediment and biological quality in association with a variety of types of development, including: municipal and industrial outfalls, bridge and roadway projects, and dredge and fill projects. Development of wasteload allocation studies for a variety of public and private wastewater treatment plants.

Department of Environmental Regulation - Coordination of a multidisciplinary research project assessing estuarine sediment pollution in Pensacola and Hillsborough Bays and its effect on micro- and macrofaunal communities. Development of a statewide interpretive tool for the assessment of metals and nutrient concentrations in estuarine sediments. Review of proposals, project design and implementation for coastal management programs. Assist permitting division with monitoring designs, data interpretation and project assessments.

Applied Biology, Inc. - Provided technical support, review and analysis for studies examining the effects of thermal effluent from a nuclear power station on fishes and benthic macroinvertebrates on the east coast of Florida, including work on the long-term variability in near shore benthic communities along the east coast of FL. Assisted in seaturtle nesting survey and a tag and recapture program along Hutchinson Island, FL.

Harbor Branch Institution, Inc. - Conducted research examining the community structure, habitat complexity, habitat preference and predation effects for seagrass and macroalgal assemblages in the Indian River Lagoon, the Florida Keys, Grand Bahamas Island and portions of the Caribbean.

Florida State University - Supervised and coordinated field sampling, laboratory analysis and data storage for two, large biomonitoring programs in Apalachicola and Apalachee Bays, FL. These studies examined the effects of selected pesticides, pulpmill effluent and stormwater runoff from timber clearcutting operations on estuarine fish and macrobenthic invertebrate communities. Assisted in seasonal and long-term distribution studies of epibenthic fishes and invertebrates in Apalachicola Bay, FL. Assisted in pesticide monitoring survey of fishes, invertebrates, water and sediments of Lake Seminole and Apalachicola Bay, FL.

EDUCATION

Florida State University, Tallahassee, FL

Degree: Ph.D., December 1982
Major: Ecology and Organismal Biology
Dissertation: Habitat complexity in a subtropical seagrass meadow: the effects of macrophytes on species composition and abundance in benthic crustacean assemblages.

Florida State University, Tallahassee, FL
Degree: M.S., June 1974
Major: Biological Oceanography
Thesis: Avoidance reactions of two species of marine fishes to kraft pulp mill effluent.

University of the South, Sewanee, TN
Degree: B.S., June 1971
Major: Biology

Gulf Coast Community College, Panama City, FL
Degree: A.S., June 1969
Major: General Biology

PUBLICATIONS

Schropp, S.J., F.G. Lewis, H.L. Windom, J.D. Ryan, F.D. Calder and L.C. Burney. 1990. Interpretation of Metals Concentrations in Estuarine Sediments of Florida using Aluminum as a Reference Element. Estuaries 13: 227-235.

Leitman, S., F.G. Lewis and R. McWilliams. 1989. The Downstream Perspective on Basin-wide Water Management in the Apalachicola-Chattahootchee-Flint River Basin, pp. 3241-3255. In Coastal Zone 89, Proceedings of the Sixth Symposium on Coastal and Ocean Management, Volume 4. O.T. Magoon, H. Converse, D. Miner, L.T. Tobin and D. Clark (Eds.), American Society of Engineers, New York.

Windom, H.L., S.J. Schropp, F.D. Calder, J.D. Ryan, R.G. Smith, Jr., L.C. Burney, F.G. Lewis and C.H. Rawlinson. 1989. Natural Trace Metal Concentrations in Estuarine and Coastal Marine Sediments of the Southeastern United States. Environ. Sci. Tech. 23: 314-320.

Schropp, S.J., F.G. Lewis, W. Eubanks, K. Carman and D.C. White. 1988. Biochemical Characterization of Estuarine Benthic Microbial Communities for Use in Assessing Pollution Impacts, pp. 311-325. In Proceedings of the EPA Workshop on Chemical and Biological Characterization of Sludge, Cincinnati, March 1986, ASTM STM 976. J.J. Lichtenberg, J.A. Winter, C.J. Weber and L. Fradkin (Eds.), American Society of Testing and Materials, Philadelphia.

Gotelli, N.J., F.G. Lewis and C.M. Young. 1987. Body-size Differences in a Colonizing Amphipod-mollusc Assemblage. Oecologia (Berlin) 72: 104-108.

Lewis, F.G. 1987. The Crustacean Epifauna of Seagrass and Macroalgae in Apalachee Bay, Florida, USA. Mar. Biol. 94: 219-229.

Stoner, A.W. and F.G. Lewis. 1985. The Influence of Quantitative and Qualitative Aspects of Habitat Complexity in Tropical Seagrass Meadows. J. Exp. Mar. Biol. Ecol. 94: 19-40.

Lewis, F.G. 1984. The Distribution of Macrobenthic Crustaceans Associated with Thalassia, Halodule and Bare Sand Substrata. Mar. Ecol. Prog. Ser. 19: 101-113.

Virnstein, R.W., W.G. Nelson, F.G. Lewis and R.K. Howard. 1984. Latitudinal Patterns in Seagrass Epifauna: Do Patterns Exist and Can They be Explained? Estuaries 7: 310-330.

Lewis, F.G. and A.W. Stoner. 1983. Distribution of Macrofauna within Seagrass Beds: an Explanation for Patterns of Abundance. Bull. Mar. Sci. 33: 296-304.

Lewis, F.G. and A.W. Stoner. 1981. An Examination of Methods for Sampling Macrobenthos in Seagrass Meadows. Bull. Mar. Sci. 31: 116-124.

Sheridan, P.F. and F.G. Lewis. 1981. A Comment upon the Distribution of Taphromysis louisianae (Crustacea: Mysidacea). Northeast Gulf Sci. 4: 141.

Lewis, F.G. and R.J. Livingston. 1977. Avoidance of Bleached Kraft Pulpmill Effluents by Pinfish (Lagodon rhomboides) and Gulf Killifish (Fundulus grandis). J. Fish. Res. Board Can. 34: 568- 570.

Livingston, R.J., P.F. Sheridan, B.G. McLane, F.G. Lewis and G.J. Kobylinski. 1977. The Biota of the Apalachicola Bay System: Functional Relationships. Florida Mar. Res. Publ. 26: 75-100.

Livingston, R.J., G.J. Kobylinski, F.G. Lewis and P.F. Sheridan. 1976. Long-term fluctuations of epibenthic fish and invertebrate populations in Apalachicola Bay, Florida. Fish. Bull. 74: 311-321.

Livingston, R.J., C.R. Cripe, R.A. Laughlin and F.G. Lewis. 1976. Avoidance Responses of Estuarine Organisms to Storm Water Runoff and Pulpmill Effluents, pp. 313-331. In Estuarine Processes. Vol. 1. Uses, Stresses and Adaptation to the Estuary, M. Wiley (Ed.), Academic Press, NY.

PROFESSIONAL SOCIETIES

Ecological Society of America
Southeast Estuarine Research Society

RESUME

PAMELA LATHAM

AREAS OF INTEREST

Systems ecology
Water resource management
Statistical design, sampling, and modelling
Environmental resource assessment

PROFESSIONAL WORK EXPERIENCE

1991-present -- Associate Environmental Engineer. Northwest Florida Water Management District, Tallahassee, Florida.

1991 -- Botanist. Environmental Services and Permitting. Alachua, Florida.

1990 -- Research Assistant in plant ecology, Florida Cooperative Fish and Wildlife Research Unit, University of Florida, Gainesville, Florida.

1985-1990 -- Graduate Research Assistant in plant ecology, Florida Cooperative Fish and Wildlife Research Unit, University of Florida.

1981-1984 -- Instructor for Advanced Placement Biology, Chemistry, and Biology. Seminole County School Board, Sanford, Florida.

STATEMENT OF QUALIFICATIONS

Professional experience since 1979 has focused on the design and implementation of scientific research related to natural resources and systems ecology. *Ecological modelling, sampling and analyses of vegetation, hydrology and soil, statistical design and analysis, research design, and grant proposal writing have been an integral part of this experience. Responsibilities have included project management and supervision of field and laboratory staff. More recent experience has included use of imagery processing and geographic information systems in evaluating impacts to surface waters as well as pre-acquisition environmental resource assessments.*

RELATED WORK EXPERIENCE

Preacquisition environmental audits. Performed site evaluations regarding potential hazardous waste sites on lands planned for acquisition.

Nonpoint source assessment for Franklin County, Florida. Participated in analysis and evaluation of nonpoint source impacts to the Apalachicola River and Bay in Franklin County.

Phosphate mine reclamation in Hamilton County, Florida. Participated in vegetation sampling of reclaimed phosphate mines and performed statistical analysis designed to determine the effects of organic muck additions on reclamation.

Hydrologic characterization of the Savannah River in South Carolina and Georgia. Participated in organization and sampling on lower Savannah River designed to identify impacts of navigational structures on freshwater inflows to a marsh. Collected and analyzed salinity, conductivity, stage height, flow, dissolved oxygen and temperature data in conjunction with the Corps of Engineers and U.S. Fish and Wildlife Service.

Development and Application of a Habitat Succession Model for the Wetlands Complex of the Savannah National Wildlife Refuge. Designed and implemented vegetation sampling and analysis necessary for the development of a succession model. Performed statistical modelling of vegetation succession necessary to predict response of vegetation to various hydrologic regimes associated with navigational structures.

Quantitative analysis of sand pine scrubs of east central Florida. Participated in design and implementation of research designed to quantify the vegetation composition and structure of Central Florida sand pine scrubs. Performed vegetation sampling and analysis.

EDUCATION

Ph.D. 1990 Environmental Engineering Sciences - Systems Ecology. University of Florida, Gainesville, Florida. Dissertation title: *Plant Distributions and Competitive Interactions Along a Gradient of Tidal Freshwater and Brackish Marshes.*

M.S. 1985	Biological Sciences. University of Central Florida, Orlando, Florida. Thesis title: *A Quantitative Analysis of Sand Pine Scrubs of East Central Florida.*
B.S. 1979	Biological Sciences. University of Central Florida, Orlando, Florida.

PUBLICATIONS

Latham, P.J., L.G. Pearlstine and W.M. Kitchens. 1991. Spatial distributions of the softstem bulrush, *Scirpus validus*, across a salinity gradient. Estuaries. 14(2)192-198.

Latham, P.J., L.G. Pearlstine and W.M. Kitchens. 1989. Species association changes across a gradient of fresh, oligohaline, and mesohaline tidal marshes along the lower Savannah River. Wetlands. In press.

Latham, P.J., L.G. Pearlstine and W.M. Kitchens. 1987. Vegetation patterns in a Southeastern coastal tidal marsh. Proceedings of the 8th annual Meeting of the Society of Wetland Scientists. Seattle, WA.

Pearlstine, L.G., P.J. Latham, W.M. Kitchens, and R.D. Bartleson. 1990. Development and Application of a Habitat Succession Model for the Wetlands Complex of the Savannah National Wildlife Refuge. Volume II. Implications of tide gate operation on the marshes of the Savannah National Wildlife Refuge: a summary report. Report. USFWS RWO 30. 16 pp.

Pearlstine, L.G., P.J. Latham, W.M. Kitchens, and R.D. Bartleson. 1990. Development and Application of a Habitat Succession Model for the Wetlands Complex of the Savannah National Wildlife Refuge. Volume I: A Final Report. USFWS RWO 30. 123 pp.

Pearlstine, L.G., R.D. Bartleson, W.M. Kitchens, and P.J. Latham. 1989. Lower Savannah River hydrological characterization. Florida Cooperative Fish and Wildlife Research Unit. Technical Report No. 35. 139 pp.

Pearlstine, L.G., P.J. Latham, W.M. Kitchens, and R.D. Bartleson. 1993. Tide gate Influences on a tidal marsh. Pages 443-440 In Proceedings of the AWRA symposium on Geographic Information Systems and water resources, Mobile, Alabama. American Water Resources Association Technical Publication Series TPS-93-1. 640 pp.

Rains, L. and P. Latham. 1993. GIS modelling of land use and associated nonpoint sources. Pages 35-44 In Proceedings of the AWRA symposium on Geographic

Information Systems and water resources, Mobile, Alabama. American Water Resources Association Technical Publication Series TPS-93-1. 640 pp.

Segal, D.S., P.J. Latham and R.G. Best. 1987. Delineating a wetland boundary using vegetative, soil and hydrologic characteristics: a Florida cypress dome example. Wetlands 7:51-58.

Scientific Presentations

Latham, P.J., L.G. Pearlstine and W.M. Kitchens. 1989. Morphological variation in the softstem bulrush, *Scirpus validus*, along a salinity gradient. 1989 Ecological Society of America Annual Meeting. Toronto, Ontario, Canada.

Latham, P.J., L.G. Pearlstine and W.M. Kitchens. 1989. Changes in vegetation patterns along an environmental gradient: fine and coarse grained differences in spatial distribution and species composition. Proceeding of 10th Annual Meeting of the Society of Wetland Scientists. Orlando, FL.

Latham, P.J., L.G. Pearlstine and W.M. Kitchens. 1988. Plant community analysis of a freshwater tidal marsh under the influence of increasing salinities and hydroperiod. Proceedings of 9th Annual Meeting of the Society of Wetland Scientists. Washington D.C.

Latham, P.J., L.G. Pearlstine and W.M. Kitchens. 1987. Plant patterns and distribution of a South Atlantic Coast tidal marsh. Proceedings of the 8th Annual Meeting of the Society of Wetland Scientists. Seattle, WA.

Rains, L. and P. Latham. 1993. GIS modelling of land use and associated nonpoint sources. Proceedings of the AWRA symposium on Geographic Information Systems and water resources. Mobile, Alabama.

ABSTRACTS

Stout, I.J., P.J. Latham and C.L. Connery. 1986. Structure and species richness of sand pine scrubs of Central Florida. Program, IV International Congress of Ecology:324.

Stout, I.J., C.L. Connery and P.J. Latham. Preliminary findings on endangered plants in sand pine scrubs of East Central Florida. Florida Scientist 47 (Supplement 1): 45.

AWARDS

1989 - Center for International Programs and Tropical Agriculture International Travel Grant.

1982 - Florida Chapter of the Sierra Club Grant in Aid.

PROFESSIONAL SOCIETIES

Ecological Society of America
Estuarine Research Federation
Society of Wetland Scientists

RESUME

DAVID L. BARTON

AREAS OF INTEREST

Computer Systems Analysis and Design
Database Management
Geographic Information Systems

POSITIONS HELD

Oct. 1988 - present: Section Director, Information Systems. Northwest Florida Water Management District, Havana, Florida.

Jan. 1987-Oct. 1988: Associate Systems Analyst, NWFWMD

Oct. 1984-Jan. 1987: Assistant Systems Analyst, NWFWMD

Mar. 1982-Oct. 1984: Systems Specialist, NWFWMD

STATEMENT OF QUALIFICATIONS

For the past eleven years I have been involved in the analysis and design of water resource-related information systems. These duties have involved selection, acquisition, installation, implementation, end-user training, documentation, and maintenance of hardware and software systems. These systems have been based on minicomputer, workstation, and personal computer platforms. I have also directed and participated in the application of local-area networking technology to all three platforms. Since October, 1988, I have been responsible for supervising the Information Systems section staff and I have recently been assigned responsibility for supervising the Geographic Information System (GIS) staff.

EDUCATION

Bachelor of Science in Computer Systems Science, University of West Florida, 1981.

RESUME

RUBEN ARTEAGA

AREAS OF INTEREST

Water resources management
Numerical and analytical modeling of surface and subsurface water systems
Application of hydraulic and hydrologic analysis to solve real life problems related to water quality and quantity.
Optimization of water resources systems

POSITIONS HELD

9/90 - present	--	Associate Hydrologist. Northwest Florida Water Management District.
9/86 - 9/90	--	Assistant Hydrologist. Northwest Florida Water Management District.
1/84 - 8/86	--	Student Research Assistant. Kansas Geological Survey, The University of Kansas.
8/82 - 12/84	--	Student Teaching Assistant. Department of Civil Engineering, The University of Kansas.
8/80 - 8/81	--	Student Research Assistant. Institute of Engineering, The University of Mexico.
6/78 - 7/80	--	Engineer. Ministry of Water Resources of Mexico.

STATEMENT OF QUALIFICATIONS

Project management experience at the Northwest Florida Water Management District includes project planning and design, resource allocation and personnel supervision in the areas of hydrology, field and engineering design.

Technical experience include a variety of engineering projects directly related to water resources planning, analysis, management, and design. The scale of this projects varies from entire river basins to small urban areas. Professional experience include the application of analytical and numerical models to simulate surface and subsurface water systems. Application of computer simulation applied to water systems to identify existing and future problems related to water quality and quantity and application of structural and non-structural alternatives to mitigate the identified problems. Projects include surface water modeling with lumped parameter hydrologic models, urban runoff models, surface water profile models, two- and three-dimensional finite difference, finite element and curve-fitting unsteady state groundwater models. Most projects included water quality analysis and hydrologic field data collection. Data collection programs included installation of stream flow automated data acquisition instruments and monitoring wells.

EXPERIENCE

City of Quincy, Florida Stormwater Management Plan (in progress). Project Manager. Involved in the data collection, application and calibration of hydrologic models to obtain the long term response of the Quincy Creek and City of Quincy drainage basins. Flooding and water quality problems will be addressed for present and future development conditions.

Timberlane Creek Restoration, Leon County, Florida. Project manager. Application of hydrologic (SWMM) and hydraulic (HEC-2) models to evaluate the effects of the removal of an existing berm along the west bank of the channel. Computed flooding elevations were used to evaluate the impacts form removing the berm on flooding and water quality.

City of Tallahassee and Leon County Stormwater Management Plan. Calibration and application of the Stormwater Management Model (SWMM) to four drainage basins in the City of Tallahassee and Leon County area. Priority present and future flooding and water quality problems were mitigated using cost effective regional facilities.

City of Tallahassee and Leon County Backwater Analysis. Project manager. The main task of this project consisted in the application of the HEC-2 model for the development of the surface water profiles for the City of Tallahassee and Leon County Stormwater Management Plan.

Choctawhatchee River Basin, Florida and Alabama. Calibration and application of the Hydrologic Simulation Program-FORTRAN (HSPF) in the Choctawhatchee River basin. The calibrated model was applied to simulate the long term hydrologic and water quality response of the 4500 square mile river basin. An assessment was made of the current and future flooding and water quality problems of the basin.

Groundwater Flow Modeling. Worked as a research assistant at the Kansas Geological Survey for groundwater modeling studies. Experience include the application of groundwater models for steady state simulation of groundwater levels in confined aquifers and curve-fitting unsteady state models. Also, involved in the development of a groundwater parameter identification model as part of doctoral research.

Groundwater Parameter Identification in Jackson County, Florida. Project part of the requirements for a Ph.D. in civil engineering, University of Kansas. This study consisted in the development, testing and application of a 2-dimensional finite element groundwater model to identify aquifer parameters in a confined aquifer under steady state conditions. Model application and calibration was performed in part of the Floridan aquifer in northeast Jackson County, Florida.

Pesticide Transport Modeling from Agricultural Watersheds. Pesticide Transport Modeling in an Experimental Agricultural Watershed. Performed three-year simulation of surface runoff quantity and quality, in particular sediment and pesticide load using a calibrated version of the EPA-HSPF hydrologic model in a agricultural watershed in central Georgia. The fate of three pesticides were studied in the basin under different agricultural best management practices. This study was part of the requirements for a MS degree.

Hydraulic Model of the "La Angostura" Dam, Mexico. Participated in the prototype study to determine the causes of the "La Angostura" Dam's spillway failure. Collected and processed the prototype's flow velocities, pressure and air entraintment data over the spillway.

Sediment Transport and Flooding in Rivers of Central Mexico. Application of analytical methods to quantify sediment bed and suspended loads in small streams in south-central Mexico. Study the effects of sediment deposition on flooding. Design of flood protection structures such as levees and channel rip rap.