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TIME DOMAIN ELECTROMAGNETIC MAPPING OF SALT WATER IN THE FLORIDAN AQUIFER IN NORTHEAST & EAST-CENTRAL FLORIDA

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT

OCTOBER 1994

Prepared For

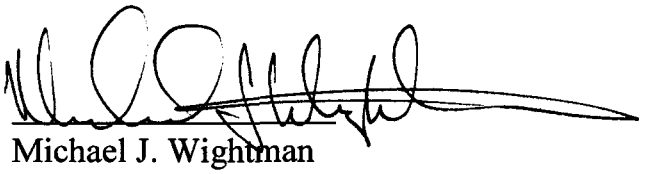
ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
P.O. Box 1429
Palatka, Florida
Contract Number 93G168

Prepared By

SUBSURFACE DETECTION INVESTIGATIONS, INC.
7381 114th Avenue North, Suite 405B
Largo, Florida
Project Number 94767

Contract Number 93G168
October 17, 1994

This is to certify that I, Michael J. Wightman, have reviewed the figures, tables, and text of the following report.

By: 

Michael J. Wightman
Professional Geologist
State of Florida
Registration #PG-0001423

SEAL

EXECUTIVE SUMMARY

A time domain electromagnetic (TDEM) survey was performed at 30 sites in the St. Johns River Water Management District during the months of April and May, 1994. The TDEM method is a geophysical technique which, through ground surface based measurement, enables description of the vertical distribution (one-dimensional depth layering) of formation electrical resistivity. As such, TDEM soundings provide a gross approximation of an electrical log as performed in a borehole without the significant expense of drilling, completing, and logging such a borehole. In comparing TDEM soundings to electric logs, the minimum thickness of an interval that can be resolved by TDEM is several orders of magnitude larger than what can be resolved by electric logs. The confidence in the conclusions from TDEM findings can be enhanced when water quality information from nearby wells is available. The objective of the TDEM survey was to determine the depths to the 250 mg/l and 5,000 mg/l isochlors.

The determination of the depth to the 5,000 mg/l isochlor was made at 25 of 30 sites. Depths ranged from 184 to 1,156 feet (ft) below land surface (bls). At two of the sites it was not possible to determine the depth to the 5,000 mg/l isochlor because the lower most geoelectric layer included sediments from above the limestones of the Floridan aquifer, thereby invalidating the assumptions used in the empirical model used to estimate a chloride concentration from an apparent resistivity value. At the other three sites, there was not a sufficient contrast in the resistivity of the geoelectric layers to confidently estimate the depth to the 5,000 mg/l isochlor.

The determination of the depth to the 250 mg/l isochlor was made at 11 of 30 sites. At twelve of the sites, waters above the 5,000 mg/l isochlor appeared to be brackish. At seven of the sites, the 250 mg/l isochlor could not be determined because the geoelectric model for the site could not distinguish the Holocene to Miocene deposits from the

Floridan aquifer. Accordingly, the assumptions used in the empirical relationships to determine the 250 mg/l isochlor were not valid. At several sites, water quality inferred from TDEM formation resistivities did not agree with results from previous water quality studies performed in the area of the site. This discrepancy is likely due to ground water chemistry or variations in the porosity of the limestones in these areas not meeting the assumptions of the empirical relationships for the determination of chloride concentration.

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1.0 INTRODUCTION

The St. Johns River Water Management District (SJRWMD) has contracted with Subsurface Detection Investigations, Inc. (SDII) to perform a series of Time Domain Electromagnetic (TDEM) survey measurements in northeast and east-central Florida during the time period April to May, 1994. This latest series of TDEM soundings is a continuation of similar TDEM programs funded by SJRWMD in previous years (Blackhawk, 1990; CEES, 1992; and SDII, 1993). The TDEM method is a geophysical technique which, through ground surface-based measurement, enables description of the vertical distribution (one-dimensional depth layering) of formation electrical resistivity. As such, TDEM soundings provide a gross approximation of an electrical log as performed in a borehole without the significant expense of drilling, completing, and logging such a borehole. In comparing TDEM soundings to electric logs, the minimum thickness of an interval that can be resolved by TDEM is several orders of magnitude larger than what can be resolved by electric logs. As formation resistivity is a direct function of formation lithology, porosity, and pore fluid conductivity, *in situ* determination of formation resistivity offers a means of inferring the water quality within given formations through empirical relationships between assumed porosity, pore-water chloride concentration, and the measured value of resistivity.

Given this background, SJRWMD has set the objectives of this TDEM survey as:

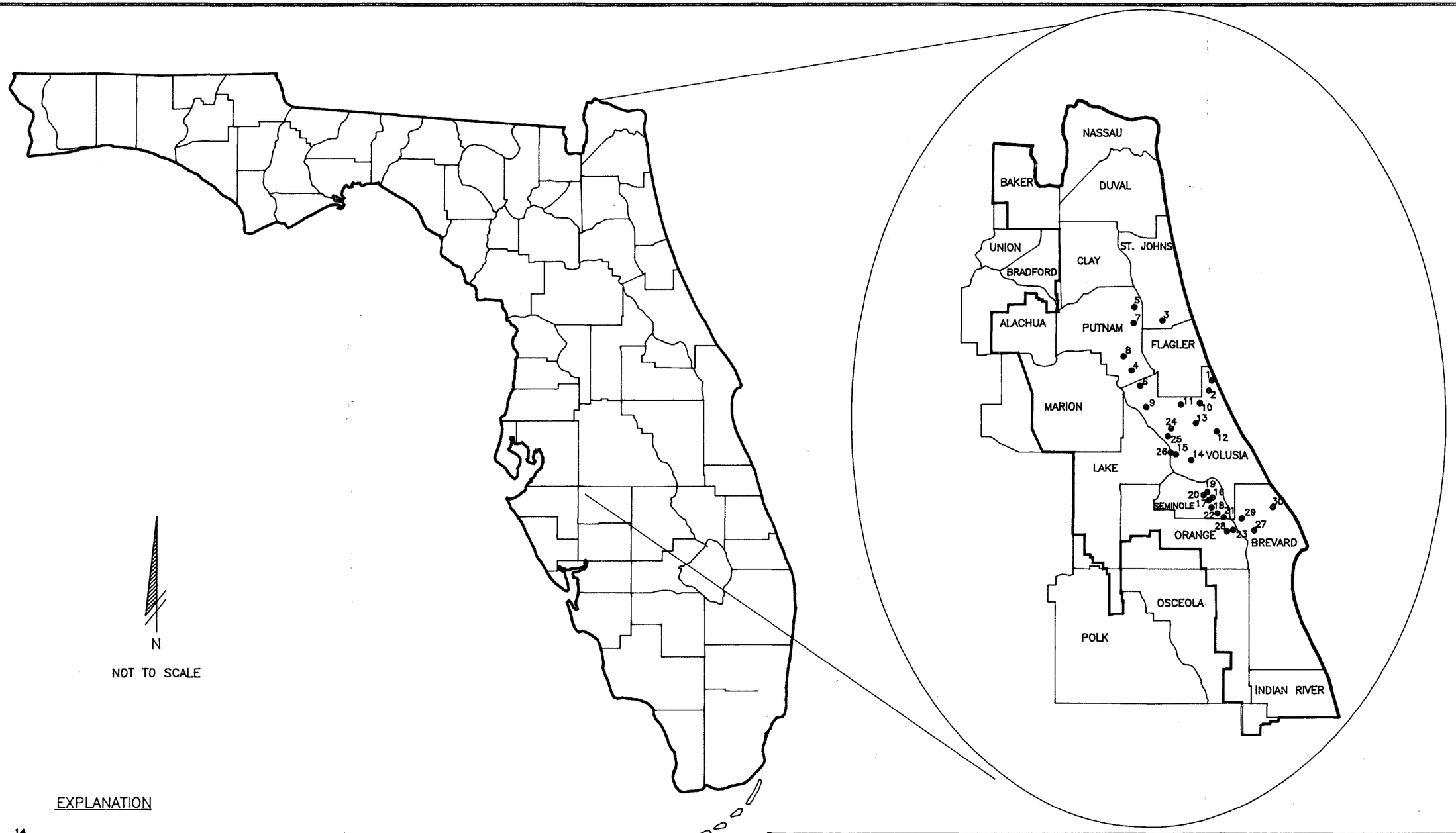
1. determination of the depth to the saltwater interface (water with chloride concentration greater than 5,000 milligrams per liter [mg/l]);

2. determination of the depth within the aquifer (above the saltwater interface) at which chloride concentration of pore waters equals 250 mg/l;

3. estimation of the chloride content of the saltwater layer assuming values of 25, 30, and 35 percent for porosity of that layer.

The principal strength of TDEM is the detection and mapping of depths to the top of a conductive layer within an otherwise resistive medium. As such, the first objective (chlorides greater than 5,000 mg/l) is the easiest to accomplish and is the best resolved. Determination of the second and third objectives relies on empirical relationships derived from studies of wells in Seminole County (in east-central Florida) and, therefore, is a less certain and less well-resolved determination.

This report details the field procedures, data quality control and analyses procedures from a total of 30 sites as selected by SJRWMD personnel. All the sites were within northeastern and east central Florida. Figure 1-1 presents the locations for the 30 TDEM sites.



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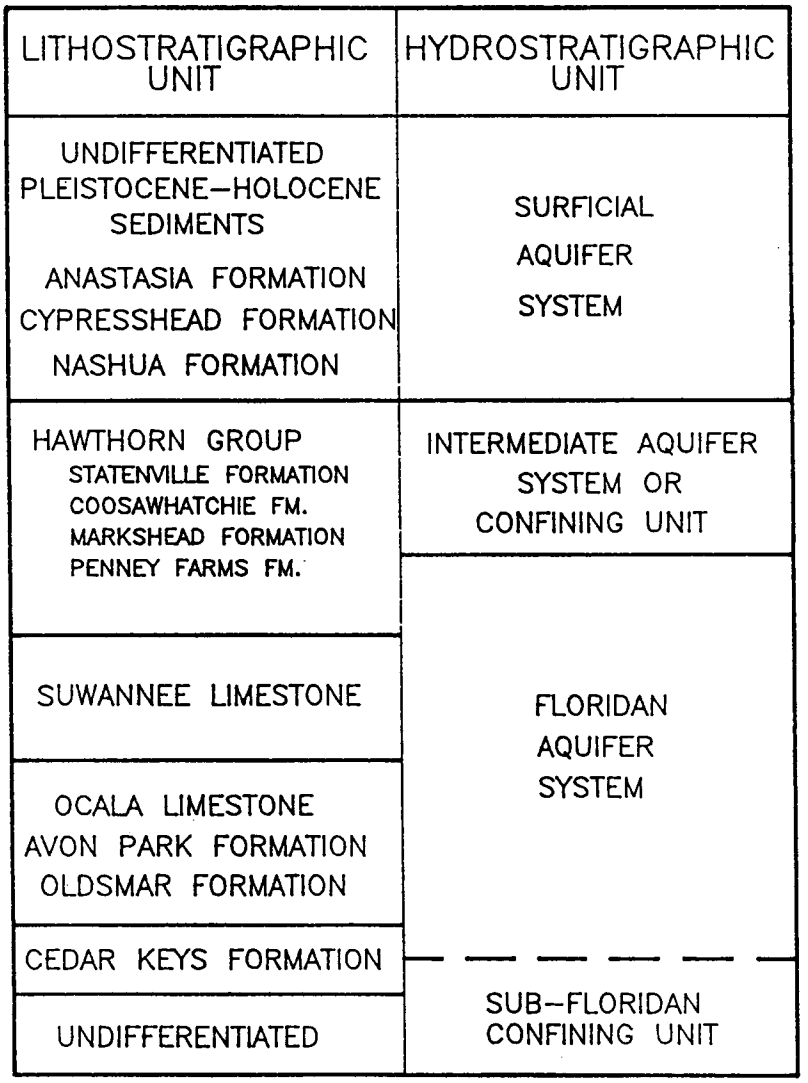
GENERAL SITE LOCATION MAP
TDEM MAPPING OF SALT WATER IN FLORIDAN
AQUIFER — NORTHEASTERN FLORIDA

Designed By:	JEB	Proj. No.	94769	Fig. No. 1–1
Checked By:	MJW	DWG	LOC–G	
Drawn By:	RBT	Date:	07/06/94	

2.0 HYDROGEOLOGIC SETTING

Ground water is drawn from three principal aquifers within SJRWMD (Figure 2-1). The three principal aquifers are the surficial aquifer system, the intermediate aquifer system and the Floridan Aquifer System (Scott et al., 1991). The surficial aquifer consists primarily of Upper Miocene to Holocene age consolidated to poorly indurated siliclastic sediments (Scott et al., 1991). Permeable interbeds within these sediments are locally significant sources of potable water near coastal areas and within St. Johns, Flagler, southern Brevard, Indian River, Seminole, western Clay, and Alachua counties (Fernald and Patton, 1985).

The Miocene-age Hawthorn Group separates the surficial aquifer from the Floridan aquifer and creates confining conditions within the Floridan aquifer. The intermediate aquifer system is comprised of high-transmissivity zones within the Hawthorn Group (Figure 2-1). Typically these high-transmissivity zones occur within sandy phosphatic limestone beds. The intermediate aquifer system is a significant source of potable water in southeastern Flagler and eastern Orange counties (Fernald and Patton, 1985). The primary source of potable water throughout the majority of the SJRWMD is the Floridan aquifer. The Floridan aquifer is composed of (from oldest to youngest) the Cedar Keys Formation, Oldsmar Formation, Avon Park Formation, Ocala Limestone (where present),the Suwannee Limestone and the lower formations of the Hawthorn Group (where present; Figure 2-1; Scott et al., 1991). The ages of these formations range from Paleocene to Miocene.



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LITHOSTRATIGRAPHIC AND HYDROSTRATIGRAPHIC UNITS
SJRWMD
FROM: SCOTT et al. 1991

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	LTH	2–1
DRAWN BY:	RBT	DATE:	07/05/94	

The Floridan aquifer is subdivided into the Upper and Lower Floridan aquifer by a middle semi-confining unit ranging in thickness from nearly 0 to over 1,000 ft. The middle semi-confining unit is leaky and the hydraulic connection between the Upper and Lower Floridan aquifers is variable (Tibbals, 1990). Depth to the division ranges from approximately 300 to 1,200 ft below mean sea level (bmsl) within SJRWMD (Miller, 1986).

The Ocala Limestone is the most productive aquifer within the Floridan aquifer. Along the east coast and southern portion of SJRWMD, the Cedar Keys or Oldsmar Formations typically contain salt water. Chloride concentrations within the Upper Floridan aquifer are usually less than 50 mg/l in the northern and west central portions of SJRWMD and exceed 250 mg/l in the east central and southern portions of SJRWMD (Fernald and Patton, 1985). Areas of mineralized water in the Floridan aquifer are present within the central and southern portion of SJRWMD. Sources of mineralized water include lateral seawater intrusion, seawater upwelling, and connate water (Scott et al., 1991).

3.0 FIELD ACQUISITION PARAMETERS, EQUIPMENT, AND DATA PROCESSING

3.1 Field Acquisition Parameters

Thirty sites were selected by SJRWMD for TDEM soundings. The TDEM method involves the laying of 12 gauge AWG wire in an approximately square or rectangular loop on the ground over a large area (on the order of 10^6 ft^2 or greater). This is the transmitter, or Tx loop. The Tx loop is energized by a bi-polar electrical current (up to a maximum of 30 amperes). The response of the ground is sensed by a centrally located (midpoint of the Tx loop) search coil (receiver, or Rx coil). The transient response seen by the receiver is recorded digitally by the data-logging module.

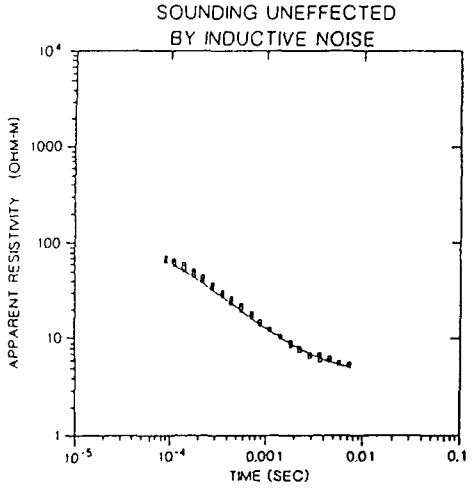
To attain the depth of exploration required to determine the depth to the saltwater interface within SJRWMD, Tx loop sizes ranging from 300 ft x 300 ft up to 1,500 ft x 1,500 ft were employed where possible. Tx loop sizes at individual sites were prescribed by SJRWMD personnel and adjusted in the field to accommodate field logistical constraints such as obvious metal structures, power lines, or limited areas of access. Tx loops were laid out using premarked cables and a compass. Loop dimensions, transmitter currents, and other site-specific information are included in the individual descriptions of the sounding results (Section 5.0).

In addition to the main sounding data set at a given site, SDII also collected quality control (QC) sounding data using an off-center Rx coil location. That is, if there was an obvious, possible source of noise (pipeline or power line, for example) to one side of a Tx loop, then the coupling of the incident pulse from the transmitter with that possible noise source would impart voltage gradients within the loop that would not exist otherwise. In the absence of noise sources, the voltage measured in the loop is very well behaved; it does not vary much with position of the Rx coil. To check for possible interference sources,

several soundings are performed 10-15 percent of the Tx loop length away from the initial Rx coil location. It can be shown that the maximum vertical EMF (electromotive force) occurs at the center of the Tx loop and that the EMF remains relatively flat to about 10 percent L (L being the length of one of the sides of the Tx loop) off center (Blackhawk, 1990). If a shallow noise source is affecting the data quality, it would impose a higher EMF gradient in one or more directions off center from the Tx loop. In Figure 3-1 examples of TDEM data that are; 1) unaffected by induction noise, 2) affected by induction noise (as from buried metal pipelines), and 3) affected by powerlines are provided. None of the TDEM sites surveyed during the SDII investigation appeared to have been affected by noise sources. However, it was necessary to perform two of the TDEM surveys using an off-center position for the receiver coil because of the presence of potential sources of interference near the center of the Tx loop.

QC measurements were generally performed at two to four different locations about the loop center. If the data from the off-center Rx location matches the central-loop data, then the data are not noise-affected. If they diverge significantly, the data are noise-affected and should not be used.

The SDII field crew consisted of one senior project geophysicist, Michael Wightman, P.G., and one project geophysicist, James Bock, who were assisted by two geophysical field technicians. Mr. Wightman was present during the first third of the project to ensure survey program objectives were being met by reviewing the field procedures, instrument settings, and resulting data. All data reductions and analysis was done by Mr. Wightman. A representative of SJRWMD, Dr. David Toth, was also present in the field. Table 3-1 summarizes the daily field activities.



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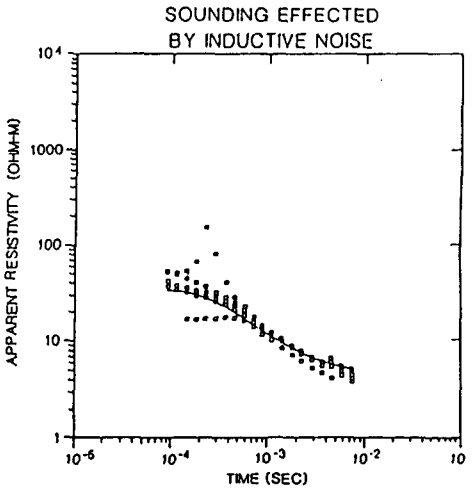

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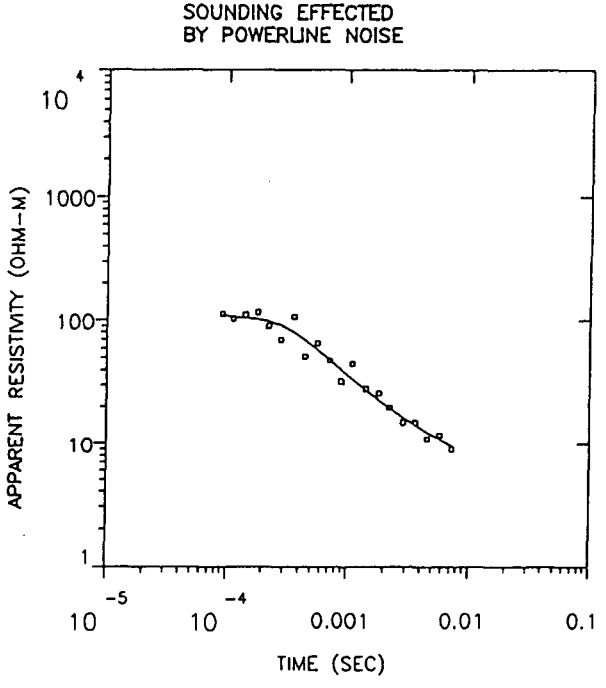


(3)

▫ Data Curve

——— Modeled Curve

SOURCE: CEES, 1992

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT PALATKA, FLORIDA	SDII SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED	EXAMPLES OF NOISE AFFECTS UPON TDEM DATA	
		DESIGNED BY: JEB CHECKED BY: MJW DRAWN BY: RBT	PROJECT NO.: 94767 DRAWING NO.: EXM-1 DATE: 07/06/94
			FIGURE 3-1

TABLE 3-1
DAILY LOG OF FIELD ACTITIES

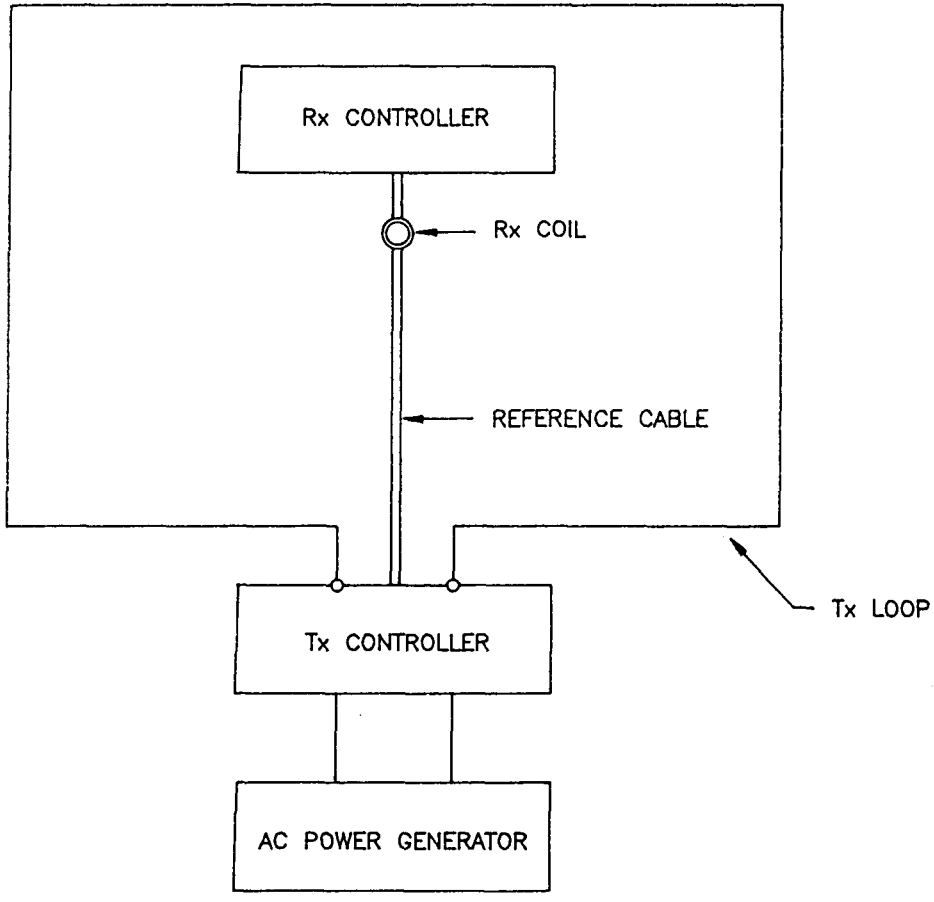
DATE	SITE	ACTIVITIES
4/30/94	Tomoka State Park	Read EM-37-3 TDEM sounding.
4/30/94	Ormond Beach Airport	Read EM-37-3 TDEM sounding.
5/1/94	Champion Paper Company	Read EM-37-3 TDEM sounding.
5/1/94	Georgetown Cove	Read EM-37-3 TDEM sounding.
5/2/94	Kelly Smith	Read EM-37-3 TDEM sounding.
5/4/94	Union Camp/Seville	Read EM-37 TDEM sounding.
5/4/94	Putnam County Fairgrounds	Read EM-37 TDEM sounding.
5/5/94	Forestry Service/Welaka	Read EM-37 TDEM sounding.
5/5/94	Pierson/West	Read EM-37 TDEM sounding.
5/6/94	Tomoka Land Company	Read EM-37 TDEM sounding.
5/6/94	Container Corporation	Read EM-37 TDEM sounding.
5/7/94	Spruce Creek	Read EM-37 TDEM sounding.
5/7/94	Little Tiger Bay	Read EM-37 TDEM sounding.
5/8/94	Deltona Environmental Restoration	Read EM-37 TDEM sounding.
5/8/94	Orange City	Read EM-37 TDEM sounding.
5/9/94	Geneva/Jungle Road	Read EM-37 TDEM sounding.
5/9/94	Geneva/Center	Read EM-37 TDEM sounding.
5/9/94	Geneva/Snow Hill	Read EM-37 TDEM sounding.
5/9/94	Geneva/Shawnee	Read EM-37 TDEM sounding.
5/10/94	Geneva/Irrigation	Read EM-37 TDEM sounding.
5/10/94	Lee Ranch #1	Read EM-37 TDEM sounding.
5/11/94	Lee Ranch #2	Read EM-37 TDEM sounding.
5/11/94	Seminole Ranch/Orange County	Read EM-37 TDEM sounding.
5/11/94	Glenwood/North	Read EM-37 TDEM sounding.
5/11/94	Glenwood/South	Read EM-37 TDEM sounding.
5/12/94	Blue Spring State Park/Orchard	Read EM-37 TDEM sounding.
5/12/94	Titusville	Read EM-37 TDEM sounding.
5/13/94	Christmas	Read EM-37 TDEM sounding.
5/13/94	Seminole Ranch/Brevard County	Read EM-37 TDEM sounding.
5/13/94	Merritt Island/NWR	Read EM-37 TDEM sounding.

3.2 Equipment

SDII employed the Geonics EM-37-3 system for Sites 1-5 and the EM-37 Protem system for the remaining sites. The principal components of the EM-37 systems are:

- Transmitter (Tx) loop (variable length 12 gauge AWG wire, insulated)
- Gasoline power generator/EM37 transmitter box (maximum 30 ampere, bi-polar square wave)
- Receiver (Rx) coil (100 square meter effective area)
- Protem or EM37-3 Receiver Module (system control and parameter selection)
- Polycorder digital notebook (data storage, used in conjunction with the EM37-3 system only)

A block diagram of the field setup of the system is given in Figure 3-2. Once setup is completed, a current waveform as depicted by Figure 3-3 is injected into the Tx loop. The rapid turn-on and turn-off of current in the loop creates a strong EMF which interacts with earth and man-made materials to generate eddy currents within conductive materials. These currents have an associated secondary magnetic field which is detected by the Rx coil as shown on Figure 3-3. Eddy currents close to the Tx coil are induced first and decay below detection limits before deeper currents. Currents in resistive materials also decay faster than currents in conductors. Deeper conductors contribute to responses at later times at the Rx coil than do shallower subsurface features. Thus, by measuring the rate and nature of the decaying magnetic field seen by the Rx coil after Tx shutoff, the distribution of subsurface resistivity can be determined.



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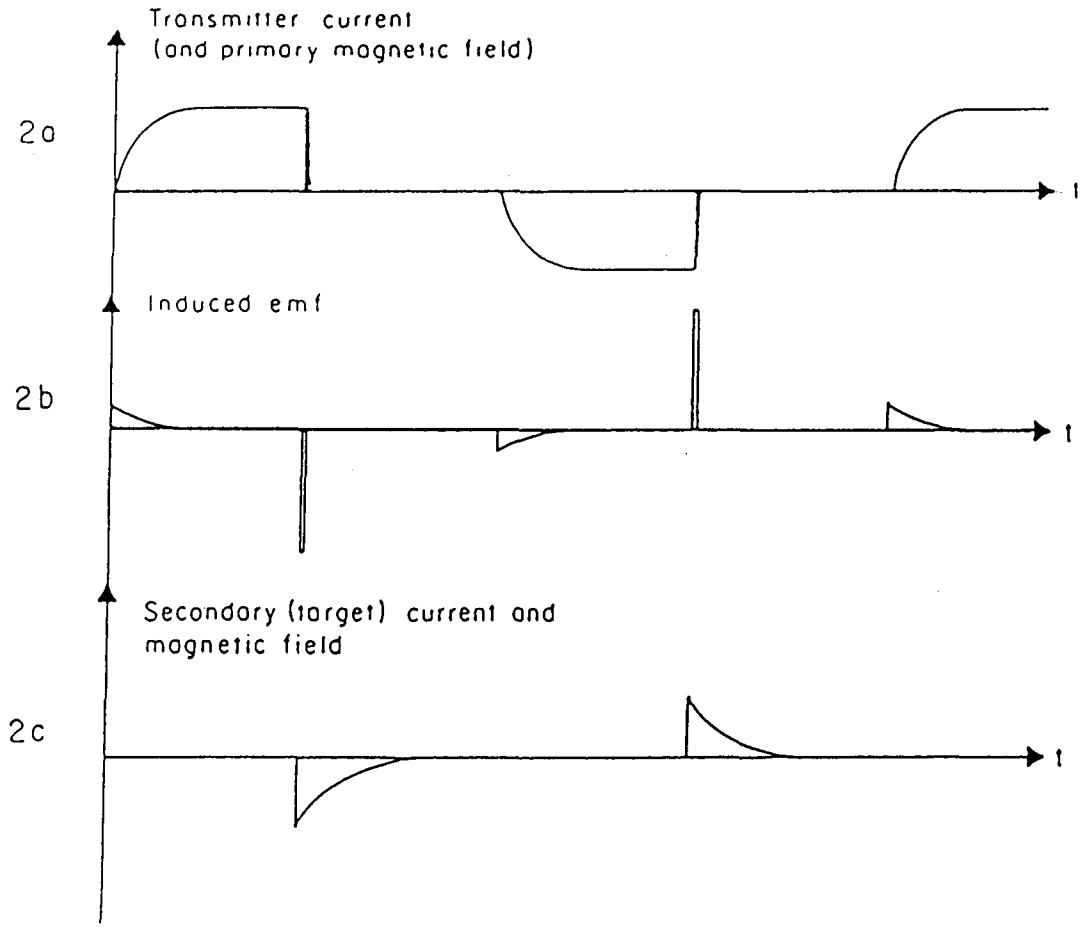
BLOCK DIAGRAM
EM37 FIELD SETUP

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	LAY	3-2
DRAWN BY:	RBT	DATE:	07/06/94	



ST. JOHNS RIVER WATER MANAGEMENT DISTRICT PALATKA, FLORIDA	SDII SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED	SYSTEM WAVEFORMS TDEM	
		DESIGNED BY: JEB CHECKED BY: MJW DRAWN BY: RBT	PROJECT NO.: 94767 DRAWING NO.: WVE-1 DATE: 07/06/94
			FIGURE 3-3

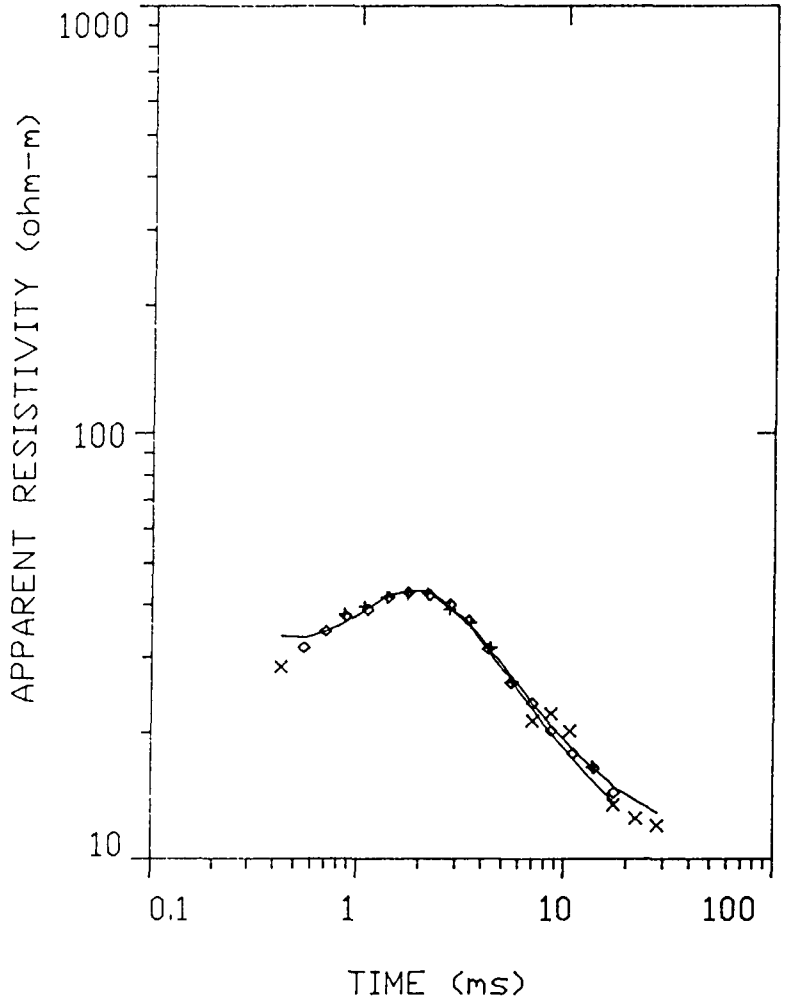
The survey variables that can be selected by the TDEM operator are the size of the Tx coil, Tx coil current (which controls the penetration depth), analog stacking (number of repetitions of summed tests in order to increase signal-to-noise ratio), gain at the receiver, and repetition rate (frequency) of the current cycles. For this investigation SDII used three different frequencies (3 Hz, 7.5 Hz, and 30 Hz) to acquire detailed and overlapping segments of the decay curve which enabled resolution of shallow (30 Hz data) and deeper (3, 7.5 Hz data) portions of the subsurface.

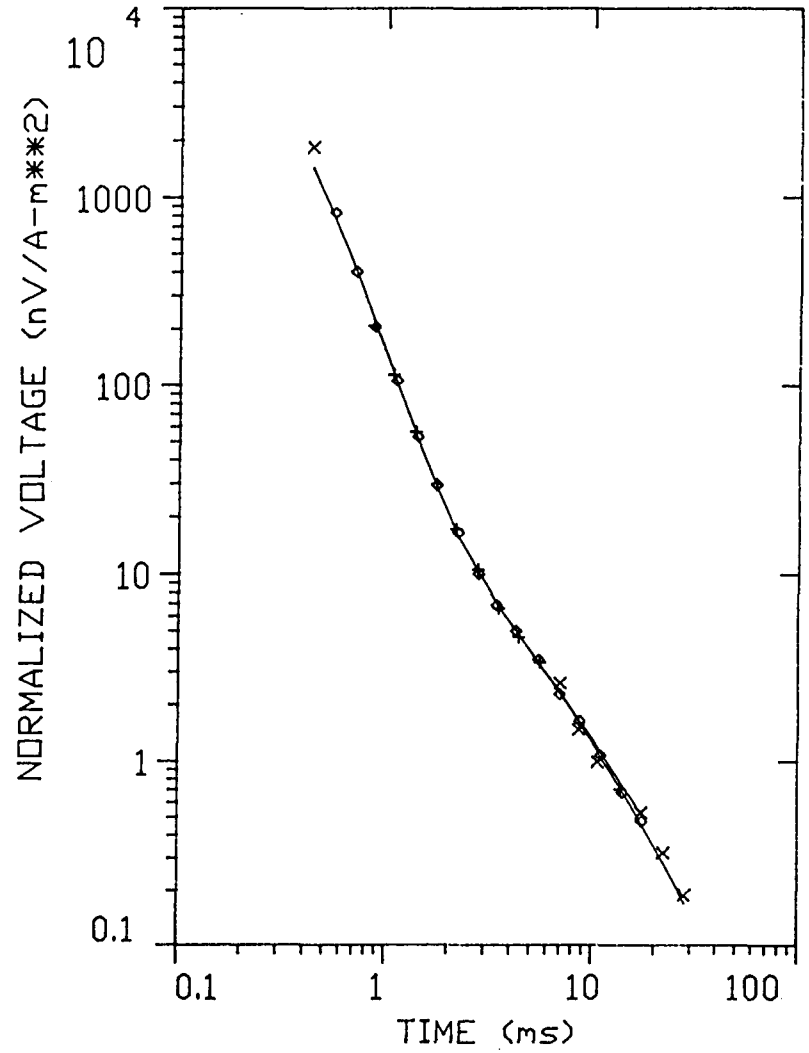
3.3 Data Processing

Data acquired by the EM37-3 were recorded by the Polycorder digital notebook logger and downloaded to a portable computer for data editing, processing, and interpretation (inversion). Data acquired using the Protem receiver was recorded on a data logger incorporated within the receiver console. The primary software program used to process the data was TEMIXGL (Interpex, Ltd.). This program accepts raw data from the Polycorder (EM37-3) or receiver console (Protem) and proceeds through the following general processing steps:

Data Edit - Modification of survey description information, for example, loop size, Tx coil amperage, which may have been entered improperly are performed here. Decay curves for all frequencies and gain values taken at a site are displayed; suspect data points can be deleted and the individual curves for different frequencies and gains are averaged and converted to a single, apparent resistivity versus time (after Tx turn-off) field curve (see Figure 3-4, for an example of voltage data and apparent resistivity versus time curves).

The field curve is comprised of 30 data points, where each data point represents an apparent voltage collected at a particular time or time gate. Each frequency has 20 time gates and each frequency overlaps the proceeding or preceding frequency by 10 time gates.





——— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

X APPARENT RESISTIVITY VALUES NOT USED IN MODEL

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DEMONSTRATION TDEM SURVEY RESULTS SHOWING NORMALIZED VOLTAGE AND APPARENT RESISTIVITY VERSUS TIME

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	EXM-2	3-4
DRAWN BY:	RBT	DATE:	07/06/94	

Combining data collected at the 30 Hz and 3 Hz frequencyproduces one sounding curve with 30 time gates, with an overlap between time gates 10 through 20. Data collected at 7.5 Hz provides apparent resistivity values for time gates 5 through 25. An advantage of using 30, 7.5, and 3 Hz frequencies for all the soundings is that different gains can be used for each frequency. Lower gains can be used at a frequency of 30 Hz to avoid saturating early channels, and higher gains can be used at 3 Hz to amplify weaker signals in later channels. The combined data is interpreted as one sounding curve. The modeled sounding curve does not always appear as a continuous single sounding curve (Figure 3-4). This is because during the modeling process, curves are developed for data collected at each frequency. The calculations for the final geoelectric model, however, are based upon a single average curve which is developed from the data collected at each frequency.

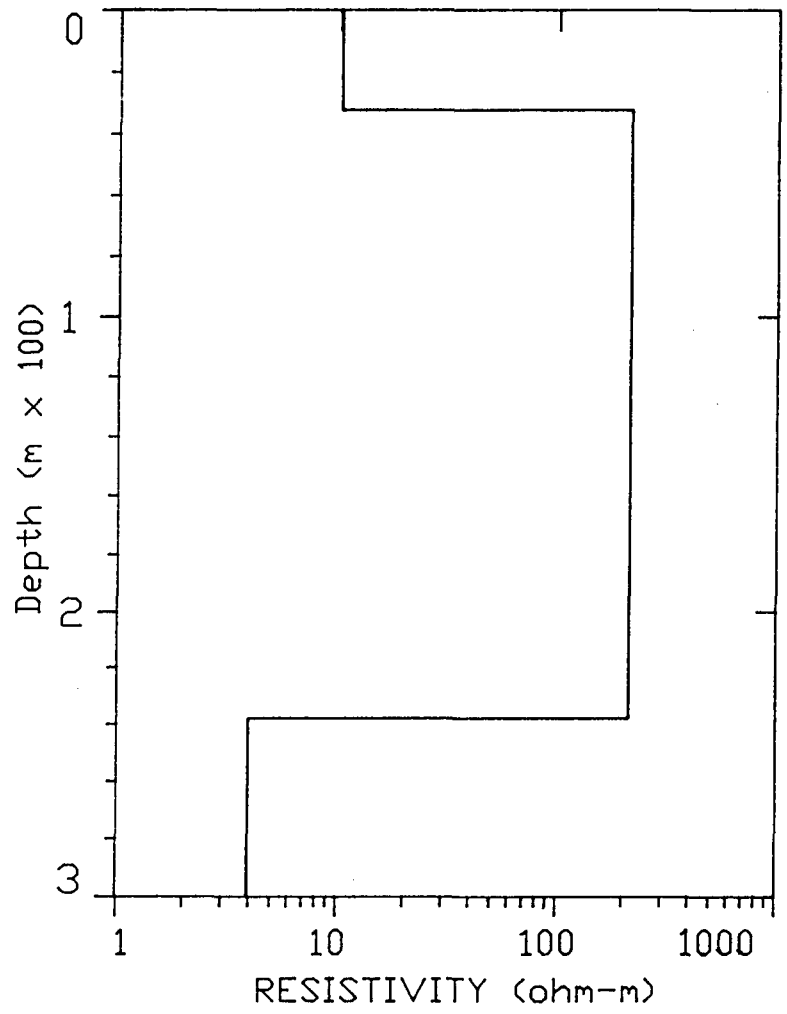
Initial Model - Review of the apparent resistivity curve shape allows a trained geophysicist to make an initial guess as to the true resistivity versus depth (layered) model which would produce the observed data set. After such a model is created, a field curve is calculated from the model and compared with the observed data. The degree of agreement between model and field data is measured statistically and expressed as the fitting error. The geophysicist may then, in an interactive mode, adjust the model to obtain a better fit or can modify the starting model.

As part of the modeling procedure early and late time data is commonly discarded. Typically, apparent resistivity values collected at early times are discarded because the data collected at these times is often not representative of geological conditions because of the affect of the Tx coil shut off not being truly instantaneous. In the final modeling of this data, in may appear that the model curve passes through several of these early time points, but not all the points. In such a case, all the early time data points are discarded because it is not good modeling practice to delete data points from the middle portion of a curve and utilize data points preceding them. Often, later time data is also not representative of

geological conditions because the primary EMF field strength has been too dissipated to provide a representative apparent resistivity value. Suspect late time data is also discarded. Poorly fitting data points are marked with a "x", utilized data points are marked with a square (Figure 3-4). Modeled curves quite often demonstrate an upward curvature during early times. This upward curvature is usually due the TDEM response not following theoretical behavior or the affect of the Tx coil shut off not being truly instantaneous. This deviation produces a distortion, however, this distortion has little or no affect on the results from the TDEM survey when the target depth is several hundred ft bls.

Automatic Inversion - Based upon the initial model, the program will attempt to create a better fit to the observed data using an iterative, Inman Ridge Regression routine to adjust layer thicknesses and resistivities until a minimum error of fit is realized; our goal was to produce models which fit the observed data within a 5% error of fit. This final model is termed the "best fit" model (see Figure 3-5). Only the data points utilized in the determination of the modeled curve are used in calculation of the fitting error.

Equivalence Analysis - Electrical resistivity methods are, as with other geophysical methods, plagued by the so-called "non-uniqueness" problem. That is, while a best-fit model produces an acceptable fit to field data curves, there are several other models having different thicknesses and resistivities which will also provide a "reasonable" fit to the same data. TEMIXGL will produce a suite of models, using the best-fit model as a start, which would produce a reasonably close fit (see Figure 3-6). If the equivalence model segments (layers and resistivities) are tightly constrained then the layering provided by the best-fit model is very good. Those parts of the equivalence models that scatter quite a bit around the best-fit model show less confidence in the absolute values of layer thickness and resistivity. A poorly constrained equivalence model for a given layer means either there are too few data points in the raw data to adequately describe that layer or the data is just not very sensitive to that specific layer.



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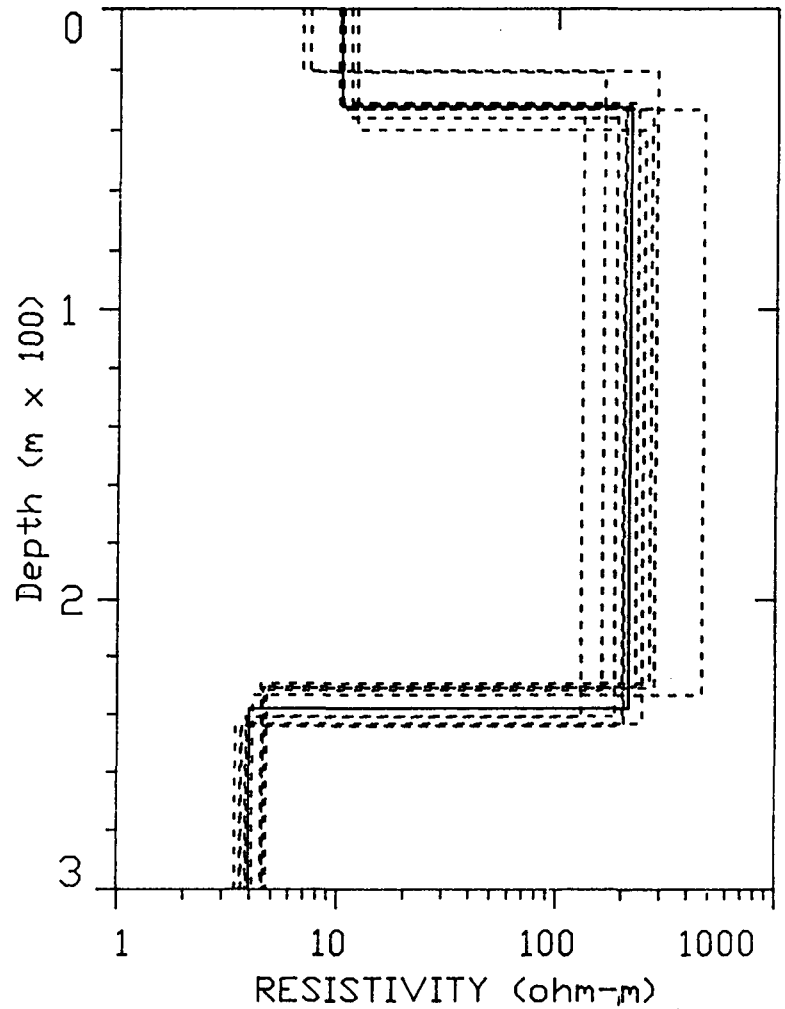
DEMONSTRATION TDEM SURVEY RESULTS
SHOWING BEST-FIT MODEL

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	EXM-3	3-5
DRAWN BY:	RBT	DATE:	07/06/94	



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DEMONSTRATION TDEM SURVEY RESULTS
SHOWING RESULTS OF EQUIVALENCE ANALYSIS

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	EXM-4	3-6
DRAWN BY:	RBT	DATE:	07/06/94	

It is important to note that the interpretations resulting from the TDEM data are, specifically, one-dimensional models of layer thickness and layer resistivity. That is, if the earth subsurface is not, effectively, a one-dimensional horizontal layer, then the produced model may have inherent error. Also, the depths to levels of chloride concentration and not resistivity rely on empirical relationships between resistivity and chloride concentration. This latter point will be detailed further in Section 4.0.

4.0 TECHNICAL APPROACH TO SATISFYING SURVEY OBJECTIVES

4.1 General

As stated previously, the final product of the *geophysical* investigation is a best-fit, one-dimensional model of layer resistivity versus depth. To satisfy the requirements of the survey, these models must be correlated with models of chloride concentration versus depth. Specifically, the resistivity structure must be viewed in terms of determining the depth of occurrence of the 250 mg/l isochlor and the depth to salt water as defined by the 5,000 mg/l isochlor. To ensure that the results from the 1994 TDEM survey are directly comparable to and compatible with the results of TDEM surveys performed in previous years (Blackhawk, 1990; CEES, 1992; and SDII, 1993), SDII will utilize the identical relationships between resistivity and isochlor depths for the Floridan aquifer. These relationships and assumptions are detailed in the following sections. However, it must be realized that correlations of TDEM-derived layer conductivities with specific chloride values are approximate and based on several simplifying assumptions.

4.2 Correlation of Inverted Geoelectrical (Resistivity) Profiles to Chloride Concentrations

In previous studies, it was presumed that the depth to salt water was such that this interface was inferred to occur within the Floridan aquifer system. The only noted exceptions to this were soundings in the area of Jacksonville where the great depth (>2,000 ft) and the very low resistivity (< 2 ohm-m) of the deep, low resistivity layer placed the interface below the Lower Floridan aquifer (CEES, 1992). For such deep sites with very low resistivities, the published relationships between resistivity and chloride concentration cannot be used; it is merely presumed that the chloride concentration at these sites exceeds 5,000 mg/l for the saltwater section.

In cases where the electrical response between the Floridan aquifer and overlying sediments are indistinguishable, the hydrostratigraphic units must be combined into a single geoelectric layer. Similar to the situation where the interface is below the Floridan aquifer, the published relationships between resistivity and chloride concentration are generally invalid and the chloride concentration in ground water above the geoelectric layer cannot be determined. However, if the resistivity of the first layer is greater than 80 ohm-m (see discussion below), the chloride concentration in the portion of the Floridan aquifer in this layer can be concluded to be below 250 mg/l, even though this layer contains sediments above the Floridan aquifer. The reason for this is because of the high resistivity. Surficial sediments, Holocene and Miocene deposits, and the Hawthorn Group have low resistivities. A high resistivity (greater than 80 ohm-m) can only be obtained if the chloride concentration were below 250 mg/l (assuming 25% porosity). Conversely, if the Floridan aquifer contains brackish to salt water and if the resistivity of a layer containing a portion of the Floridan aquifer were below 20 ohm-m, it can be concluded that the 250 mg/l isochlor is not present in the Floridan aquifer.

For the majority of soundings conducted previously, the saltwater interface positions were "inferred to occur within the Floridan aquifer system" (Blackhawk, 1990; CEES, 1992; and SDII, 1993) and, therefore, the published relationships between resistivity and chloride concentration are applicable. When the saltwater interface occurred within the Floridan aquifer, the following procedure was used in both this and previous studies (Blackhawk, 1990; CEES, 1992; and SDII, 1993).

The carbonate rocks of the Floridan aquifer system (as opposed to the highly variable lithologies of overlying formations) are expected to be uniform and, as such, their resistivities are determined principally by porosity and specific conductance of pore fluids. The governing empirical "law" relating formation resistivity (Ro), fluid resistivity (Rw) and porosity (ϕ) in a clay-free lithology is Archie's Law:

$$F = Ro/Rw = a\phi^{-m} \qquad (1)$$

where F = "formation factor" and "a" and "m" are empirically derived constants which are specific to a given formation in a given area. Previous TDEM reports have used the values of m = 1.6 and a = 1 from Kwader (1982) as being most appropriate for the Floridan aquifer. These values are from studies of wells completed in the Upper Floridan aquifer in Seminole County, Florida.

Kwader (1982) has also established the following relationship from his study of Seminole County wells:

$$Cl = (3500/Rw) - 153 \qquad (2)$$

where Cl is the equivalent chloride concentration in mg/l and Rw is fluid resistivity in ohm-meters. Extrapolating these expressions by Kwader outside of Seminole County presumes that the relative ionic chemistry (especially a chloride/sulfate ratio of 5:1) remains the same or reasonably close to conditions in that area. Significant chemical variation would cause Equation 2 to be, quite likely, invalid.

Because formation resistivity, Ro, is what the geophysical analysis of TDEM data has produced, a combination of equations (1) and (2) allows for determining a functional relationship between chloride concentration, inferred formation resistivity, and porosity:

$$Cl = (3500\phi^{-1.6}/Ro) - 153 \quad (3)$$

or, for an assumed 25% porosity for the Upper Floridan aquifer as per previous TDEM reports:

$$Cl = (32{,}163/Ro) - 153 \quad (4)$$

Linking this relationship to the cited survey objectives, we would expect that a Floridan aquifer with 25% porosity, similar water chemistry (5:1 chloride to sulfate ratio) to the Kwader study, and a 250 mg/l chloride concentration would yield a measured formation resistivity of 80 ohm-m. Higher resistivities than this would indicate fresher water. Chloride concentrations of 5,000 mg/l would correspond to formations resistivities of 6.2 ohm-m; higher concentrations would yield lower resistivities. These values, then, are what we should expect to see for the fresh and saltwater sections of the Floridan aquifer.

One final consideration, besides porosity and similar chemical species/ratios, is made by previous reports (Blackhawk, 1990; CEES, 1992; and SDII, 1993) and, again, will be adhered to in this 1994 study. The relationships cited are for a clearly defined, carbonate section within the Floridan aquifer (i.e., beneath Miocene deposits or the Hawthorn Group). If there is a clearly defined thickness of Holocene to Miocene deposits, the Hawthorn Group, or surficial sediments from the electrical sounding results and if that thickness is in agreement with published thicknesses of such deposits for the area of a specific site, then there is presumed to be no affect of the measured formation resistivity for the Floridan aquifer due to interfingering of clay stringers of the Hawthorn Group or Holocene to Miocene deposits. This means that the inversion resistivity results representing the Floridan aquifer layer are valid.

4.3 Determination of Depth to 250 mg/l and 5,000 mg/l Isochlors

The previous discussion of the relationship of formation conductivity to chloride content is particularly applicable to geoelectrical measurements made on a fine, highly resolved scale, such as a borehole electrical log, where an almost continuous measure of resistivity versus depth is available. As known from geophysical logs and water quality studies, the saltwater interface is not a knife-edge interface in the subsurface but is a gradational interface. Within the freshwater section, we would also expect the chloride concentration to follow a gradually increasing-downwards distribution. Therefore, the TDEM sounding, which presents the subsurface as a sequence of a few layers of presumed, uniform resistivity, is not an actual representation of the true subsurface but a low resolution version of it. The saltwater interface (chlorides greater than 5,000 mg/l), which exhibits a much higher gradient of chloride concentration than the overlying fresher water, comes closest to being a true interface. This is why depth to the saltwater interface from TDEM should be close to the low resistivity layer detected.

Actual reported depth to the 5,000 mg/l isochlor in previous reports (CEES, 1992; SDII, 1993) is determined by the contrast in resistivity of the layers above and below the geoelectrical interface. If the contrast is large (e.g., greater than 80 ohm-m above and less than 20 ohm-m below), then the depth to the 5,000 mg/l isochlor is assumed to be 50 ft below the interface depth determined from geoelectrical inversion. If the contrast is small (e.g., a 20-80 ohm-m layer above and less than 20 ohm-m layer below), the depth to the 5,000 mg/l isochlor is taken as equal to the depth to interface determined from the geoelectrical inversion. These adjustments are intended to correct for the existence of the transition zone.

The criterion used to define the depth to the 250 mg/l isochlor in previous TDEM surveys for SJRWMD (Blackhawk, 1990; CEES, 1992; and SDII, 1993) is also a data-based criterion. That is, the final reported position of this isochlor, relative to the boundary between the Floridan aquifer freshwater geoelectrical layer and the saltwater geoelectrical layer depends upon the layer resistivities above and below the interface as determined by the inversion. Four data classes have been defined based upon a reference value for resistivity of 80 ohm-m for a portion of the Floridan aquifer. We reproduce the following criteria for positioning the 250 mg/l isochlor (CEES, Table 4-2, 1992).

Summarizing Table 4-2 in CEES (1992), if the Floridan freshwater section is in excess of 80 ohm-m while the underlying layer is less than 20 ohm-m (so-called Class A geoelectrical section), then the 250 mg/l isochlor is placed at a position 50 ft higher than the saltwater interface depth defined from geoelectrical inversion.

If the Floridan freshwater section is in excess of 80 ohm-m while the underlying layer is between 20-40 ohm-m (so-called Class B section), then the 250 mg/l isochlor is placed 25 ft above the saltwater interface depth defined from geoelectrical inversion.

If the Floridan freshwater section is in excess of 80 ohm-m and the underlying layer is between 40-80 ohm-m (Class C), then the 250 mg/l isochlor is placed at the interface.

Finally, if there is no contrast (i.e., a uniform layer of > 80 ohm-m; Class D), then we are not seeing an expected saltwater interface within the depth of exploration of the field sounding. Also, there is no detectable/mappable 250 mg/l isochlor.

In the above determinations for the 250 mg/l isochlor, the "depth" to the saltwater interface referred to is the depth to the low resistivity layer taken directly from the TEMIXGL inversion and not the corrected 5,000 mg/l depth as discussed previously.

5.0 RESULTS AND DISCUSSION

5.1 Summary of Results

A summary of the 1993 TDEM investigation is presented in this section. The summary includes the resulting geoelectrical inversions, 250 mg/l isochlor depth and the 5000 mg/l isochlor depth. More detailed presentation of the individual site results are contained in the following sections 5.2 through 5.31. Each individual site section will present a site description, site map, apparent resistivity versus time (data) curves, the best-fit geoelectrical section with equivalence analysis, and inferred depths to the 5,000 mg/l (salt water) and 250 mg/l isochlors.

Table 5.1-1 lists the 30 sites with summary information describing site number, name, residing county, latitude, longitude and loop size.

Table 5.1-2 summarizes the results of the TEMIXGL geoelectrical inversion section (number of layers, layer thicknesses and resistivities, and range of equivalence models for each layer parameter).

Table 5.1-3 summarizes the estimated chloride content of the saltwater layer assuming porosities of 25, 30, and 35% for the Floridan Aquifer System.

Table 5.1-4 summarizes the interpreted depths to the 250 mg/l and the 5,000 mg/l isochlors at each site based upon the criteria outlined in Section 4.3 and as utilized in TDEM surveys performed for SJRWMD in previous years (Blackhawk, 1990; CEES, 1992; and SDII, 1993). As in previous years, these calculations are made assuming a 25% porosity for the Floridan Aquifer System and a 5:1 chloride-to-sulfate ratio for the ground water chemistry. The estimated chloride-to-sulfate ratios at each of the sites is provided in Table 5.1-4.

TABLE 5.1-1
SUMMARY OF TDEM SITE SURVEY INFORMATION

SITE NUMBER	SITE NAME	RESIDING COUNTY	LATITUDE	LONGITUDE	LOOP SIZE (in Feet)
1	Tomoka State Park	Volusia	29°20'08"N	81°04'56"W	965 x 700
2	Ormond Beach Airport	Volusia	29°17'47"N	81°06'55"W	1004 x 600
3	Champion Paper Company	St. Johns	29°39'37"N	81°24'15"W	1650 x 900
4	Georgetown Cove	Putnam	29°23'14"N	81°36'26"W	1300 x 970
5	Kelly Smith	Putnam	29°43'42"N	81°34'57"W	1000 x 1000
6	Union Camp/Seville	Volusia	29°20'00"N	81°32'12"W	500 x 1250
7	Putnam County Fairgrounds	Putnam	29°38'31"N	81°35'12"W	929 x 220
8	Forestry Service/Welaka	Putnam	29°28'24"N	81°39'02"W	1076 x 1000
9	Pierson/West	Volusia	29°13'08"N	81°29'46"W	850 x 456
10	Tomoka Land Company	Volusia	29°14'07"N	81°09'31"W	1125 x 600
11	Container Corporation	Volusia	29°13'49"N	81°18'07"W	1500 x 598
12	Spruce Creek	Volusia	29°04'30"N	81°04'16"W	998 x 607
13	Little Tiger Bay	Volusia	29°07'28"N	81°12'24"W	1000 x 1100
14	Deltona Environmental Restoration	Volusia	28°55'34"N	81°13'34"W	1000 x 1000
15	Orange City	Volusia	28°58'07"N	81°18'49"W	750 x 778
16	Geneva/Jungle Road	Seminole	28°44'02"N	81°05'09"W	300 x 300
17	Geneva/Center	Seminole	28°43'56"N	81°06'58"W	358 x 270
18	Geneva/Snow Hill	Seminole	28°41'12"N	81°06'41"W	300 x 300
19	Geneva/Shawnee	Seminole	28°46'06"N	81°07'29"W	315 x 220
20	Geneva/Irrigation	Seminole	28°45'00"N	81°08'28"W	300 x 300
21	Lee Ranch #1	Seminole	28°37'51"N	81°01'29"W	1000 x 1000
22	Lee Ranch #2	Seminole	28°38'18"N	81°03'21"W	1000 x 1000
23	Seminole Ranch/Orange County	Orange	28°33'26"N	80°59'35"W	1000 x 1000
24	Glenwood/North	Volusia	29°05'49"N	81°21'21"W	597 x 555
25	Glenwood/South	Volusia	29°03'30"N	81°21'34"W	1000 x 600
26	Blue Spring State Park/Orchard	Volusia	28°58'10"N	81°20'19"W	1000 x 561
27	Titusville	Brevard	28°33'06"N	80°50'26"W	500 x 482
28	Christmas	Orange	28°32'15"N	81°02'34"W	1000 x 600
29	Seminole Ranch/Brevard County	Brevard	28°36'55"N	80°55'23"W	500 x 500
30	Merritt Island/NWR	Brevard	28°39'27"N	80°42'57"W	300 x 300

TABLE 5.1-2
SUMMARY OF GEOELECTRICAL SECTIONS WITH RANGE OF EQUIVALENCE

SITE NAME	NUMBER OF MODELED LAYERS IN GEOELECTRICAL SECTION	LAYER 1 RESISTIVITY p_1 (ohm-m)			LAYER 1 THICKNESS h_1 (meters)*			LAYER 2 RESISTIVITY p_2 (ohm-m)			LAYER 2 THICKNESS h_2 (meters)*			LAYER 3 RESISTIVITY p_3 (ohm-m)			LAYER 3 THICKNESS h_3 (meters)*			TOTAL DEPTH TO DEEPEST CONDUCTOR WHICH IS INTERPRETED AS SALT WATER (Meters)*		
		Min	Best	Max	Min	Best	Max	Min	Best	Max	Min	Best	Max	Min	Best	Max	Min	Best	Max	Min	Best	Max
1 Tomoka State Park	3	10	12	14	35	48	59	23	111	1106	22	29	42	2.9	3.3	3.7	--	--	--	72	77	84
2 Ormond Beach Airport	3	3.3	3.6	4.1	48	56	71	24	173	1727	58	95	121	0.006	0.02	0.04	--	--	--	128	150	171
3 Champion Paper Company	3	4.7	5.3	6.0	46	46	46	5.7	8.7	16	65	81	93	0.005	0.009	0.012	--	--	--	111	127	139
4 Georgetown Cove	2	9.7	34	63	2	4	11	7.4	7.6	7.8	--	--	--	--	--	--	--	--	--	Cannot be determined		
5 Kelly Smith	2	16	17	17	288	315	342	0.5	0.8	1.4	--	--	--	--	--	--	--	--	--	288	315	342
6 Union Camp/Seville	2	46	51	53	205	224	231	0.2	0.3	0.4	--	--	--	--	--	--	--	--	--	205	224	231
7 Putnam County Fairgrounds	3	24	26	27	52	52	52	32	37	45	135	140	145	1.3	2.0	3.2	--	--	--	187	192	197
8 Forestry Service/Welaka	2	49	51	52	144	147	149	3.4	3.9	4.4	--	--	--	--	--	--	--	--	--	144	147	149
9 Pierson/West	3	42	46	50	24	24	24	160	177	197	277	285	290	2.1	3.0	4.0	--	--	--	301	309	314
10 Tomoka Land Company	2	70	70	71	269	272	274	3.1	3.5	4.0	--	--	--	--	--	--	--	--	--	269	272	274
11 Container Corporation[1/]	4	29	31	34	23	23	23	73	82	89	213	248	265	40	403	$4x10^5$	18	29	52	281	300	310
12 Spruce Creek	3	33	35	39	23	23	23	72	78	83	242	247	252	3.0	4.1	5.5	--	--	--	265	270	275
13 Little Tiger Bay	3	67	68	69	169	187	204	170	302	739	127	150	179	1.3	1.8	2.7	--	--	--	329	337	353
14 Deltona Environmental Restoration	3	379	675	2134	26	29	34	33	36	39	216	232	244	0.9	1.4	1.9	--	--	--	248	261	271
15 Orange City	2	82	97	119	84	97	110	17	19	22	--	--	--	--	--	--	--	--	--	84	97	110
16 Geneva/Jungle Road	2	41	43	45	110	114	117	2.9	3.4	3.9	--	--	--	--	--	--	--	--	--	110	114	117
17 Geneva/Center	2	122	217	687	62	64	67	3.8	4.2	4.6	--	--	--	--	--	--	--	--	--	62	64	67
18 Geneva/Snow Hill	2	92	158	344	62	65	70	6.5	6.9	7.2	--	--	--	--	--	--	--	--	--	62	65	70
19 Geneva/Shawnee	3	19	21	23	29	29	29	55	103	207	66	68	69	1.2	1.4	1.6	--	--	--	95	97	98

20 Geneva/Irrigation	3	46	56	66	30	30	30	57	79	112	66	70	73	4.5	4.9	5.4	--	--	--	96	100	103
21 Lee Ranch #1	1	8.7	9.1	9.4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Cannot be determined		
22 Lee Ranch #2	1	14	15	15	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Cannot be determined		
23 Seminole Ranch/Orange County	3	18	18	19	52	52	52	29	31	33	220	257	284	6.3	9.5	13.9	--	--	--	272	309	336
24 Glenwood/North	2	41	42	44	105	108	111	3.9	4.4	4.9	--	--	--	--	--	--	--	--	--	105	108	111
25 Glenwood/South	3	62	73	91	30	30	30	190	383	912	82	86	89	5.8	6.5	7.2	--	--	--	112	116	119
26 Blue Spring State Park/Orchard	2	25	26	27	108	111	114	1.7	2.0	2.2	--	--	--	--	--	--	--	--	--	108	111	114
27 Titusville	2	10	12	17	17	20	22	2.5	2.6	2.7	--	--	--	--	--	--	--	--	--	Cannot be determined		
28 Christmass	3	40	41	42	94	126	165	49	62	83	81	124	178	16	23	31	--	--	--	228	250	284
29 Seminole Ranch/Brevard County	1	4.9	5.1	5.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Cannot be determined		
30 Merritt Island/NWR	2	8.1	8.4	8.7	54	56	58	1.4	1.5	1.7	--	--	--	--	--	--	--	--	--	54	56	58

* 1 meter equals 3.28 ft.

1/ Layer 4 = Resistivity: Min (0.5); Best (0.9); Max (1.2)

TABLE 5.1-3
ESTIMATED DEPTHS TO SALT WATER AND ESTIMATED CHLORIDE CONCENTRATIONS AT THREE POROSITIES

SITE	FORMATION RESISTIVITY (ohm-m)	INTERPRETED DEPTH OF SALT WATER (ft)	CHLORIDE CONCENTRATION (mg/l) = 25%	CHLORIDE CONCENTRATION (mg/l) = 30%	CHLORIDE CONCENTRATION (mg/l) = 35%
1 Tomoka State Park	3.3	253	9594	7127	5536
2 Ormond Beach Airport	Less than 0.1	492	>20000	>20000	>20000
3 Champion Paper Company	Less than 0.1	417	>20000	>20000	>20000
4 Georgetown Cove	7.6	Cannot be determined	Cannot be determined	Cannot be determined	Cannot be determined
5 Kelly Smith	0.8	1034	>20000	>20000	>20000
6 Union Camp/Seville	0.3	735	>20000	>20000	>20000
7 Putnam County Fairgrounds	2.0	630	15929	11860	9234
8 Forestry Service/Welatka	3.9	481	8094	6007	4661
9 Pierson/West	3.0	1014	10568	7856	6105
10 Tomoka Land Company	3.5	892	9037	6711	5211
11 Container Corporation	0.9	984	>20000	>20000	>20000
12 Spruce Creek	4.1	886	7692	5707	4426
13 Little Tiger Bay	1.8	1106	17716	13195	10277
14 Deltona Environmental Restoration	1.4	856	22821	17008	13257
15 Orange City	19	318	1540	1112	835
16 Geneva/Jungle Road	3.4	374	9307	6913	5369
17 Geneva/Center	4.2	210	7505	5567	4317

18 Geneva/Snow Hill	6.9	213	4508	3329	2568
19 Geneva/Shawnee	1.4	318	22821	17008	13257
20 Geneva/Irrigation	4.9	328	6411	4750	3678
21 Lee Ranch #1	9.1	Cannot be determined	Cannot be determined	Cannot be determined	Cannot be determined
22 Lee Ranch #2	15	Cannot be determined	Cannot be determined	Cannot be determined	Cannot be determined
23 Seminole Ranch/Orange County	9.5	1014	3233	2376	1823
24 Glenwood/North	4.4	354	7157	5307	4114
25 Glenwood/South	6.5	381	4795	3543	2735
26 Blue Spring State Park/Orchard	2.0	364	15929	11860	9234
27 Titusville	2.6	Cannot be determined	Cannot be determined	Cannot be determined	Cannot be determined
28 Christmas	23.0	820	786	586	357
29 Seminole Ranch/Brevard County	5.1	Cannot be determined	Cannot be determined	Cannot be determined	Cannot be determined
30 Merritt Island/NWR	1.5	184	21289	15864	12363

TABLE 5.1-4
DEPTH TO 5,000 mg/l and 250 mg/l ISOCHLOR AS DETERMINED BY TIME DOMAIN ELECTROMAGNETICS

SITE	ESTIMATED CHLORIDE-TO-SULFATE RATIO[1]	INTERPRETED DEPTH 5,000 mg/l ISOCHLOR (ft bls)	INTERPRETED DEPTH 250 mg/l ISOCHLOR (ft bls)
1 Tomoka State Park	2:1	303	203
2 Ormond Beach Airport	2:1	542	442
3 Champion Paper Company	1:1	417	Not present
4 Georgetown Cove	2:1	Cannot be determined	Not present
5 Kelly Smith	3:1	1034	Cannot be determined
6 Union Camp/Seville	5:1	735	Cannot be determined
7 Putnam County Fairgrounds	5:1	630	Not present
8 Forestry Service/Welatka	2:1	481	Cannot be determined
9 Pierson/West	2:1	1064	964
10 Tomoka Land Company	5:1	892	Cannot be determined
11 Container Corporation	5:1	1034	934
12 Spruce Creek	5:1	886	Not present
13 Little Tiger Bay	5:1	1156	1056
14 Deltona Environmental Restoration	5:1	856	71
15 Orange City	5:1	368	268
16 Geneva/Jungle Road	5:1	374	Cannot be determined
17 Geneva/Center	5:1	260	160
18 Geneva/Snow Hill	5:1	263	163
19 Geneva/Shawnee	7:1	368	268
20 Geneva/Irrigation	7:1	328	Not present
21 Lee Ranch #1	7:1	Cannot be determined	Not present
22 Lee Ranch #2	7:1	Cannot be determined	Not present
23 Seminole Ranch/Orange County	2:1	1014	Not present
24 Glenwood/North	5:1	354	Cannot be determined
25 Glenwood/South	5:1	431	331
26 Blue Spring State Park/Orchard	5:1	364	Cannot be determined
27 Titusville	5:1	Cannot be determined	Not present
28 Christmass	3:1	820	Not present
29 Seminole Ranch/Brevard County	5:1	Cannot be determined	Not present
30 Merritt Island/NWR	5:1	184	Not present

1/ Chloride-to-Sulfate ratio for Sites 4, 8, and 9 from SJRWMD; for Site 3 from Spechler & Hampson, 1984; and for all other sites from Sprinkle, 1981.

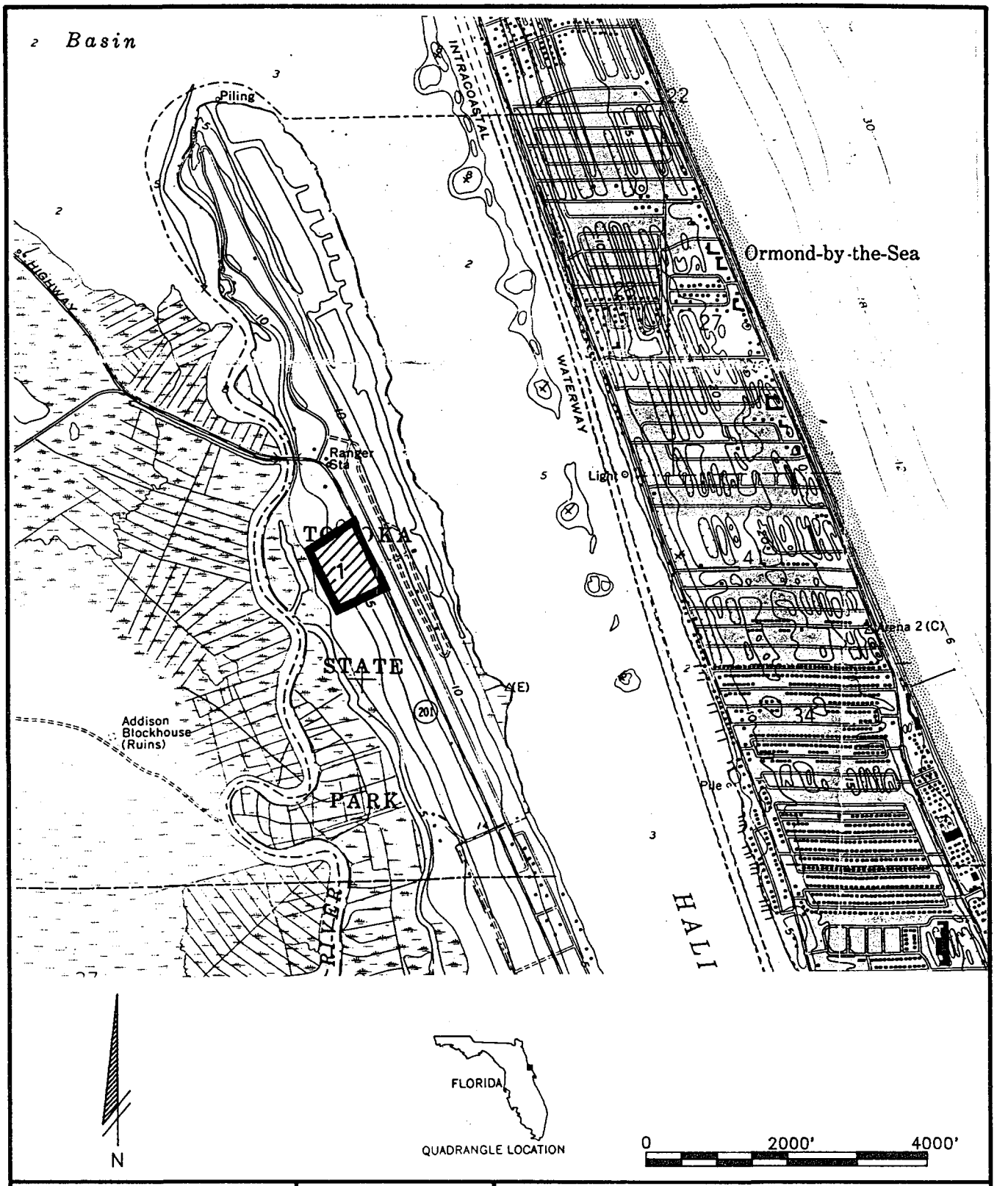
The effect of a CL/SO_4 ratio less than 5:1 would be for waters with equivalent conductivity to have different CL values. SO_4 is less conductive than CL for an equivalent mass volume. If for example the ratio is less than 5:1, it will take a higher conductivity (lower resistivity) to get a 250 mg/l chloride value. That is, for sites where the 5:1 ratio is 1:1, resistivities would have to be less than 80 ohm-m to reach a chloride content of 250 mg/l.

5.2 TDEM Site 1 - Tomoka State Park

5.2.1 Location Description and Geoelectrical Section

The site is located in northeast Volusia County within Tomoka State Park, Florida (Figure 5.2-1). The site is located within a wooded area. A potential source of interference (above ground debris, including metal fragments) was present near the center of the Tx loop. Due to the presence of the debris, the receiver coil was moved 75 ft to the west and 50 ft north from the center of the Tx loop. QA soundings were performed 75 ft south, east and west of the initial Rx coil location. Results from the QA soundings indicate that the apparent resistivity values were unaffected by any interference sources.

The Floridan aquifer occurs at an approximate depth of 80 ft bmsl or 95 ft bls (Rutledge, 1985) and is overlain by Holocene to Miocene deposits. The base of the Floridan aquifer occurs at an approximate depth of 2080 ft bmsl (Tibbals, 1990). The thickness of the Upper Floridan aquifer is approximately 805 ft and the depth to the top of the Lower Floridan aquifer is approximately 900 ft bls (Miller, 1986). A water quality study performed in the area of the site (Rutledge, 1985) indicates that the chloride concentration in the upper portion of the Floridan aquifer exceeds 250 mg/l. However, Tibbals (1990) indicates that the chloride concentration in the upper 100 ft of the Upper Floridan aquifer ranges from 100 to 250 mg/l just west of the site.



ST. JOHNS RIVER WATER MANAGEMENT DISTRICT PALATKA, FLORIDA	SDII SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED	TDEM SURVEY LOCATION MAP SOUNDING 1 – TOMOKA STATE PARK VOLUSIA COUNTY, FLORIDA		
		DESIGNED BY: JEB CHECKED BY: MJW DRAWN BY: RBT	PROJECT NO.: 94767 DRAWING NO.: LOC-1 DATE: 07/05/94	FIGURE 5.2-1

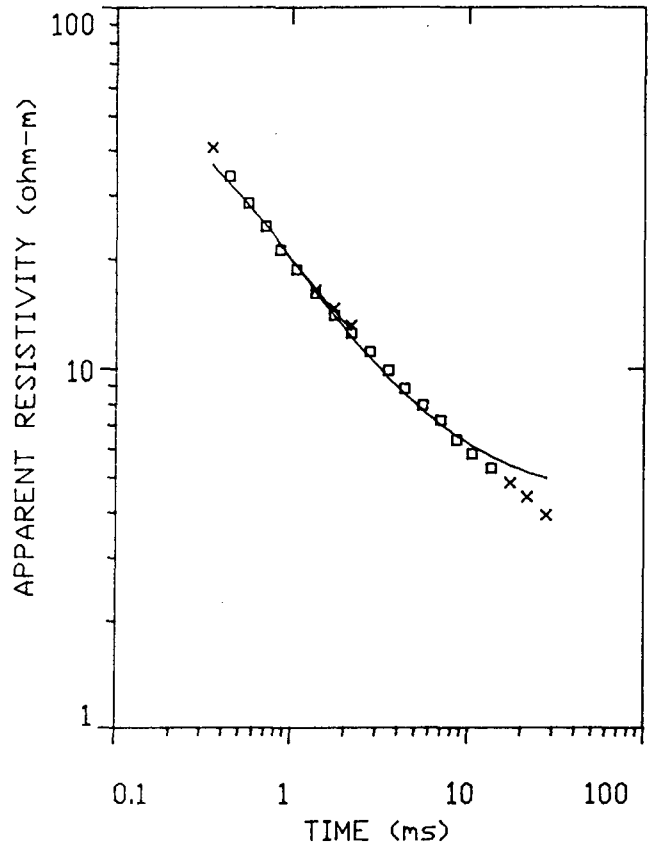
The resistivity sounding data and best-fit model inversion are presented on Figure 5.2-2. The interpreted geoelectrical section consists of a three-layer subsurface.

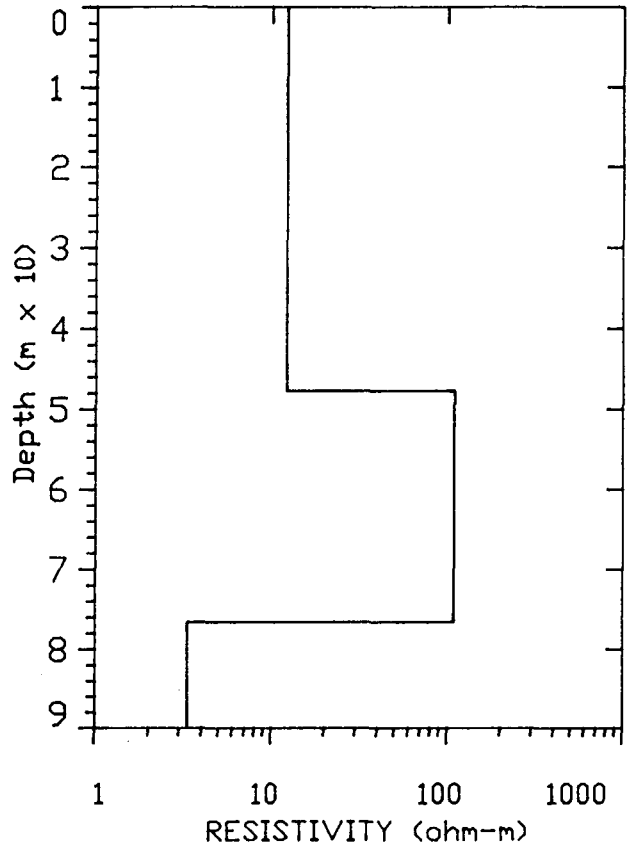
5.2.2 Geological Interpretation of Geoelectrical Model

There is a sufficient electrical resistivity contrast to distinguish two geological layers above the third saltwater saturated layer. The first layer occurs at a depth of 48 m (157 ft) and not at the hydrostratigraphic contact (95 ft bls) between the Holocene to Miocene deposits and the Floridan Aquifer System. The first layer has a low-resistivity value (12.2 ohm-m) and is considered to represent a combined thickness of the Holocene to Miocene deposits and upper portion of the Floridan aquifer. The second layer has a high-resistivity value (111 ohm-m) and a thickness of 29 m (95 ft). It is considered to represent a fresh water saturated Floridan aquifer. The third layer, with an apparent resistivity of 3.3 ohm-m, then is considered to represent a saltwater saturated Floridan aquifer at a depth of 77 m (253 ft). Alternatively, the site was modeled using a two-layer subsurface. The results from the two-layer modeling indicated that the depth to salt water was approximately 150 ft bls, and that the entire geoelectric layer was brackish. Because the fitting error for the two-layer model is relatively poor (11%), the three-layer model is preferred. Its fitting error is less than 5.7%.

5.2.3 Depth to Occurrence of Salt Water

The bottom (third) layer of the geoelectrical model, with a resistivity of 3.3 ohm-m, is interpreted to represent salt water. It occurs at a depth of 253 ft (-237 ft msl). Because the resistivity of Layer 2 (111 ohm-m) is greater than 80 ohm-m, the interpreted depth to the 5,000 mg/l isochlor is taken as 50 ft greater than the depth of the geoelectrical interface, or at a depth of 303 ft (-288 ft msl). The resistivity of Layer 3 (3.3 ohm-m) corresponds to a chloride content of 9,594 mg/l assuming a porosity of 25% and the validity and applicability of equation (4) of Section 4.2. It is presumed that because of the





—— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

X APPARENT RESISTIVITY VALUES NOT USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

MEASURED TDEM APPARENT RESISTIVITY AND 1-D INVERSION
SOUNDING 1 – TOMOKA STATE PARK
VOLUSIA COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	MDL-1	5.2-2
DRAWN BY:	RBT	DATE:	07/06/94	

expected high chlorinity gradients, this value is sufficiently close to the 5,000 mg/l isochlor that they represent the same effective depth.

5.2.4 Depth of Occurrence of the 250 mg/l Isochlor

The resistivity of Layer 2, 111 ohm-m, corresponds to a chloride content of less than 250 mg/l, assuming a 25% porosity and the validity and applicability of equation (4) of Section 4.2. The 250 mg/l isochlor is placed in the Floridan aquifer at a depth 50 ft above the Layer 3 interface or at 203 ft (-188 ft msl).

5.2.5 Accuracy of Measurement and Interpretation

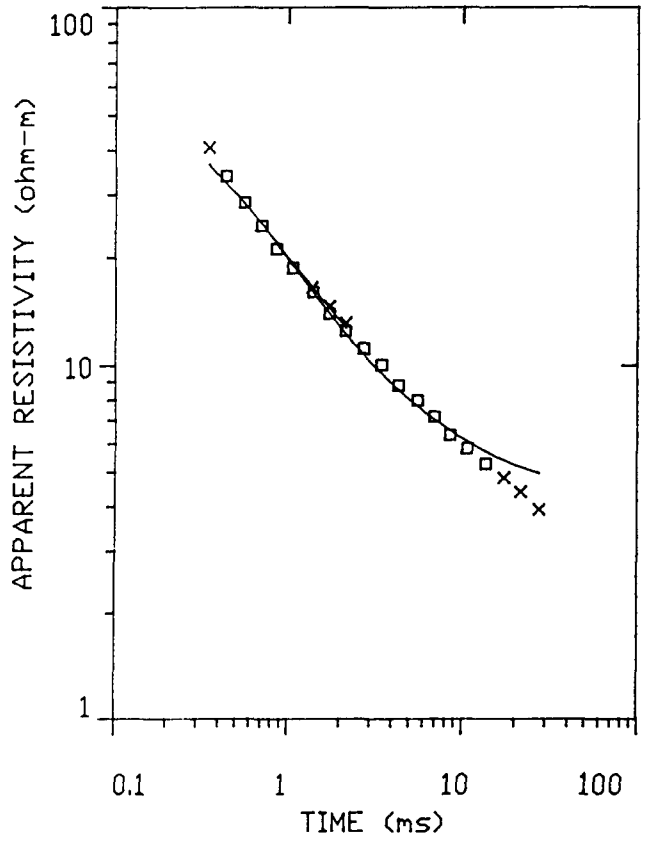
Figure 5.2-3 is the equivalence analysis at this site and the inversion table (Table 5.2-1) lists the upper and lower bounds of the inverted parameters of the geoelectrical model.

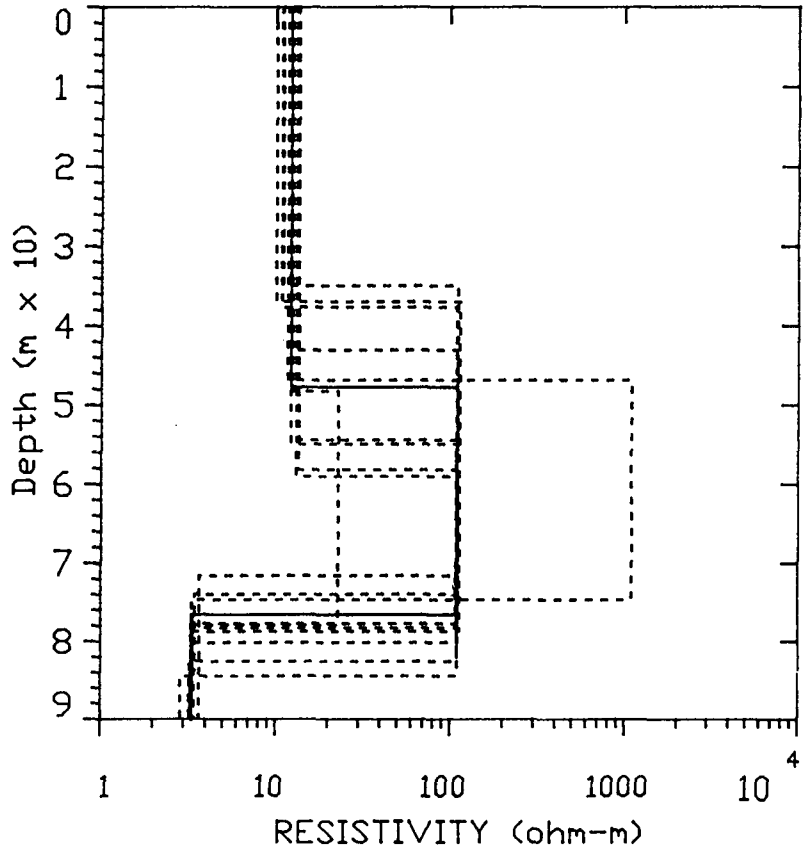
The range of equivalence in determining the depth to the low resistivity layer is about ±10 m (33 ft) which is 11% of the total depth. The resistivity of this layer has a range of from 2.9 to 3.7 ohm-m. This corresponds to a range in interpreted chloride content of from 10,938 mg/l to 8,540 mg/l, again subject to the same assumptions of porosity and validity of equation (4).

The equivalence range of the resistivity of Layer 2 is from 23 to 1,106 ohm-m which, over the majority of the range, corresponds to a chloride content of less than 250 mg/l. The results of the TDEM study are not in agreement with the results from Rutledge (1985), but are in agreement with Tibbals (1990). The chloride-to-sulfate ratio at the site is 2:1 (Table 5.1-4), rather than 5:1. Accordingly, equation (4) may not be valid.

5.2.6 Summary of TDEM Sounding at Tomoka State Park (Site 1)

- The depth to occurrence of salt water (5,000 mg/l isochlor) is interpreted to be 303 ft (-288 ft msl) and occur within the Upper Floridan aquifer.





—— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

X APPARENT RESISTIVITY VALUES NOT USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

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MEASURED TDEM APPARENT RESISTIVITY AND EQUIVALENCE FOR 1-D INVERSION
SOUNDING 1 - TOMOKA STATE PARK
VOLUSIA COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	EQU-1	5.2-3
DRAWN BY:	RBT	DATE:	08/25/94	

DATA SET: SITE 1

CLIENT: SJRWMD
LOCATION: TOMOKA STATE PARK
COUNTY: VOLUSIA, FLORIDA
PROJECT: SALT WATER INTERFACE DETECTION
LOOP SIZE: 294.000 m by 213.000 m
COIL LOC: 23.000 m (X), 15.000 m (Y)
SOUNDING COORDINATES: E: 0.0000 N: 0.0000

DATE: 30-APR-94
SOUNDING: 1
ELEVATION: 4.60 m
EQUIPMENT: EM 37-3
AZIMUTH:

FITTING ERROR: 5.704 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			4.60	
1	12.21	47.67	-43.07	3.90
2	110.5	28.89	-71.97	0.261
3	3.32			

ALL PARAMETERS ARE FREE

PARAMETER BOUNDS FROM EQUIVALENCE ANALYSIS

	LAYER	MINIMUM	BEST	MAXIMUM
RHO	1	10.021	12.213	13.537
	2	23.074	110.570	1105.696
	3	2.871	3.327	3.697
THICK	1	34.958	-0.723	58.998
	2	21.947	1.000	41.788
DEPTH	1	34.958	47.679	58.998
	2	71.558	76.579	84.436

CURRENT: 18.50 AMPS EM-37 COIL AREA: 100.00 sq m.
FREQUENCY: 30.00 Hz GAIN: 2 RAMP TIME: 202.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.351	31013.9	36740.9	-18.46 MASKED
2	0.438	23544.8	25207.4	-7.06
3	0.558	16578.9	16700.0	-0.729

ST. JOHNS RIVER
WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

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SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SOUNDING DATA TABLE
SOUNDING 1 – TOMOKA STATE PARK
VOLUSIA COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.2-1

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)	
4	0.702	11663.2	11435.8	1.94	
5	0.858	8849.3	8264.9	6.60	
6	1.06	6181.8	5874.1	4.97	
7	1.37	4005.5	3961.2	1.10	MASKED
8	1.74	2624.0	2687.7	-2.42	MASKED
9	2.17	1779.0	1862.6	-4.70	MASKED

CURRENT: 18.50 AMPS EM-37 COIL AREA: 100.00 sq m.
FREQUENCY: 3.00 Hz GAIN: 7 RAMP TIME: 202.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)	
10	0.857	8939.0	8437.6	5.60	
11	1.06	6332.6	6032.6	4.73	
12	1.37	4146.2	4110.0	0.874	
13	1.74	2795.9	2825.7	-1.06	
14	2.17	1905.0	1989.5	-4.43	
15	2.77	1238.3	1323.4	-6.87	
16	3.50	818.5	886.2	-8.27	
17	4.37	563.9	594.9	-5.48	
18	5.56	360.3	380.5	-5.59	
19	6.98	235.9	245.9	-4.24	
20	8.56	170.7	164.1	3.85	
21	10.64	112.5	105.6	6.18	
22	13.70	69.24	62.25	10.10	
23	17.40	43.94	37.21	15.31	MASKED
24	21.70	29.00	22.85	21.20	MASKED
25	27.70	18.74	13.13	29.90	MASKED

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	0.89				
P 2	0.02	0.00			
P 3	0.00	0.00	0.94		
T 1	-0.14	0.01	0.05	0.59	
T 2	0.20	0.02	0.01	0.40	0.45
	P 1	P 2	P 3	T 1	T 2

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WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

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SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SOUNDING DATA TABLE
SOUNDING 1 – TOMOKA STATE PARK
VOLUSIA COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.2–1

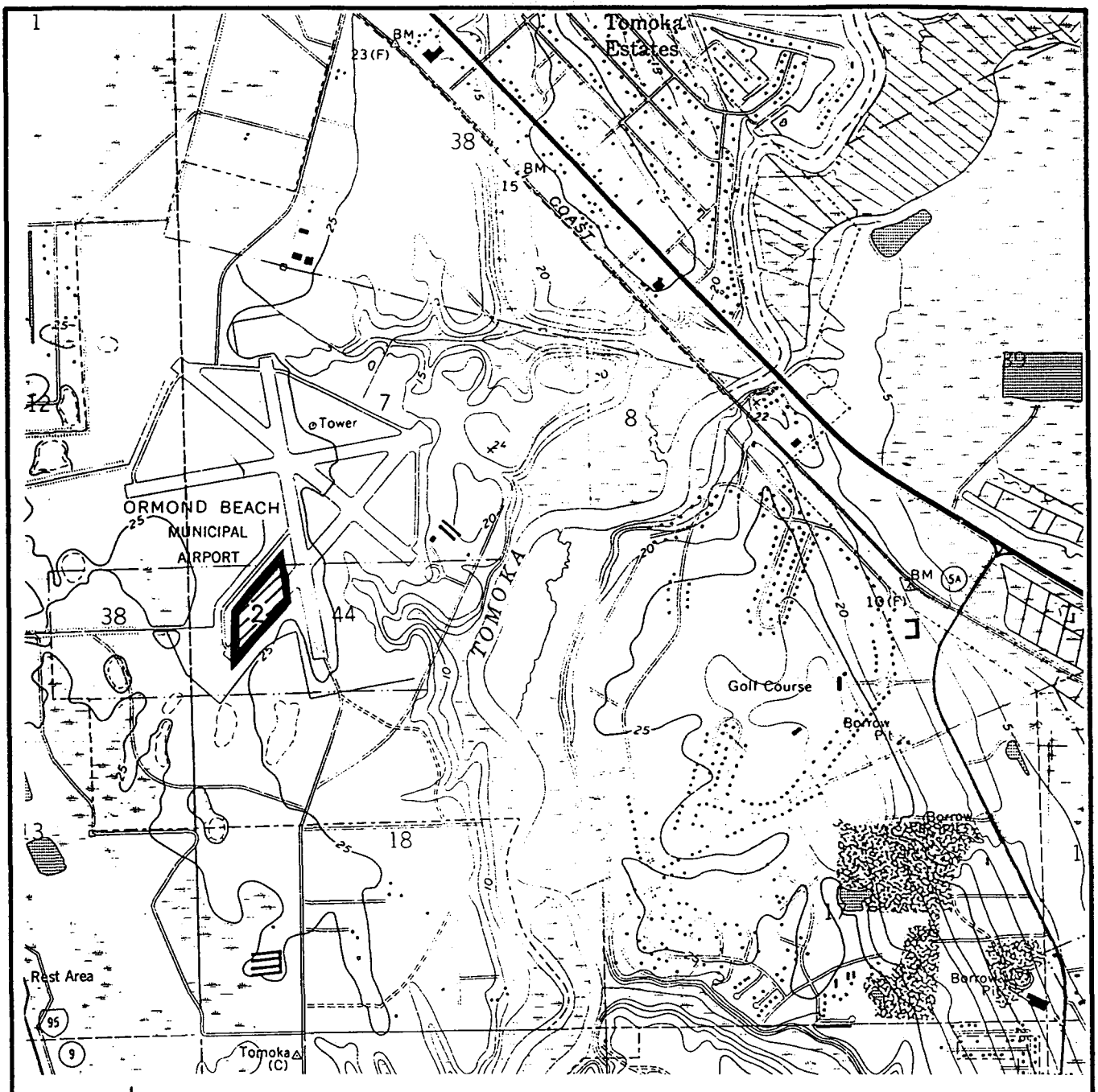
- The ground water within the upper 100 ft of the Floridan aquifer at this site is interpreted to contain an average chloride concentration of less than 250 mg/l. The 250 mg/l isochlor is interpreted to be present in the Floridan aquifer at a depth of 203 ft (-188 ft msl). The top of the Floridan aquifer occurs at a depth of 80 ft bmsl (Rutledge, 1985).
- The results of the TDEM survey do not agree with Rutledge (1985), who indicates that chloride concentrations in the Floridan aquifer are above 250 mg/l in the area immediately around the site. However, Tibbals (1990) indicates that the chloride concentrations in the upper 100 ft of the Upper Floridan aquifer in proximate areas west and south of the site are less than 250 mg/l.

5.3 TDEM Site 2 - Ormond Beach Airport

5.3.1 Location Description and Geoelectrical Section

The site is located at the City of Ormond Beach Airport in northeast Volusia County, Florida (Figure 5.3-1). The site is located within a grass field. Abandoned airport runways and taxiways (potential sources of interference) were present north, south and west of the Tx loop. QA soundings were performed 100 ft northeast and southwest and 50 ft northwest and southeast of the initial Rx coil location. Results from the QA soundings indicate that the apparent resistivity values were unaffected by any interference sources.

The Floridan aquifer occurs at an approximate depth of approximately 80 ft bmsl or 105 ft bls (Rutledge, 1985) and is overlain by Holocene to Miocene deposits. The base of the Floridan aquifer occurs at an approximate depth of 2080 ft bmsl (Tibbals, 1990). The thickness of the Upper Floridan aquifer is approximately 770 ft and the depth to the top of the Lower Floridan aquifer is approximately 875 ft bls (Miller, 1986). Rutledge (1985) indicates that the chloride concentration in the upper portion of the Floridan aquifer



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PALATKA, FLORIDA

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TDEM SURVEY LOCATION MAP
SOUNDING 2 – ORMOND BEACH AIRPORT
VOLUSIA COUNTY, FLORIDA

DESIGNED BY: JEB		PROJECT NO.:	94767	FIGURE
CHECKED BY: MJW		DRAWING NO.:	LOC-2	5.3-1
DRAWN BY: RBT		DATE:	07/05/94	

in the area of the site is less than 250 mg/l. In addition, Rutledge (1985) estimates a maximum thickness of 300 ft for water with a chloride concentration of less than 250 mg/l in the Floridan aquifer at this site.

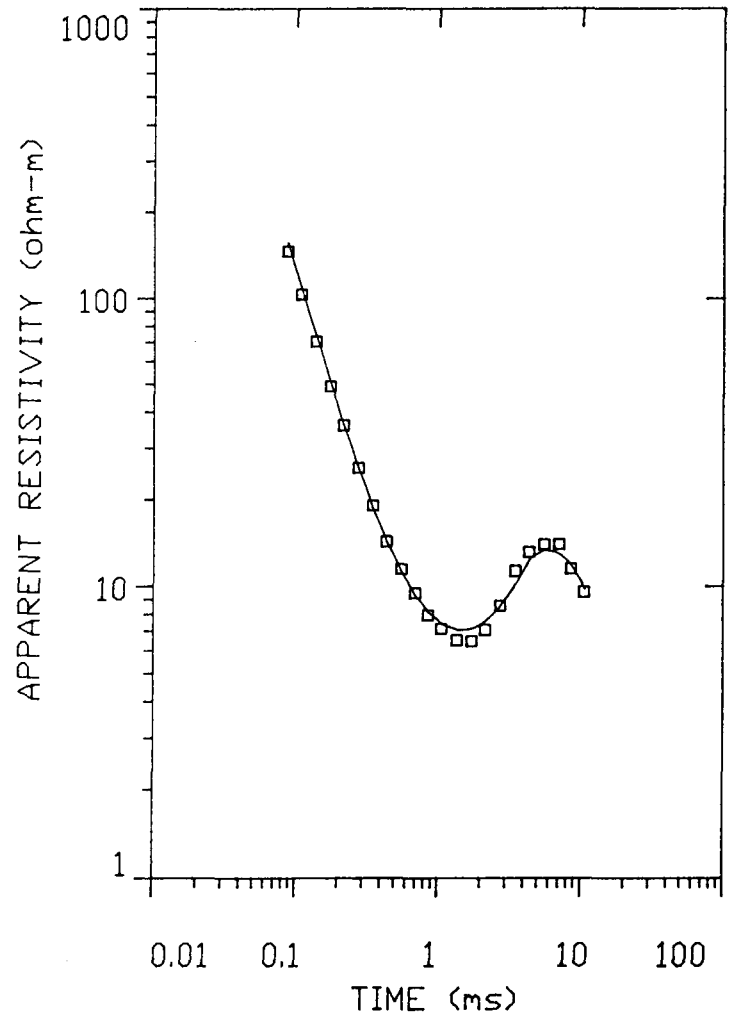
The resistivity sounding data and best-fit model inversion are presented on Figure 5.3-2. The interpreted geoelectrical section consists of a three-layer subsurface.

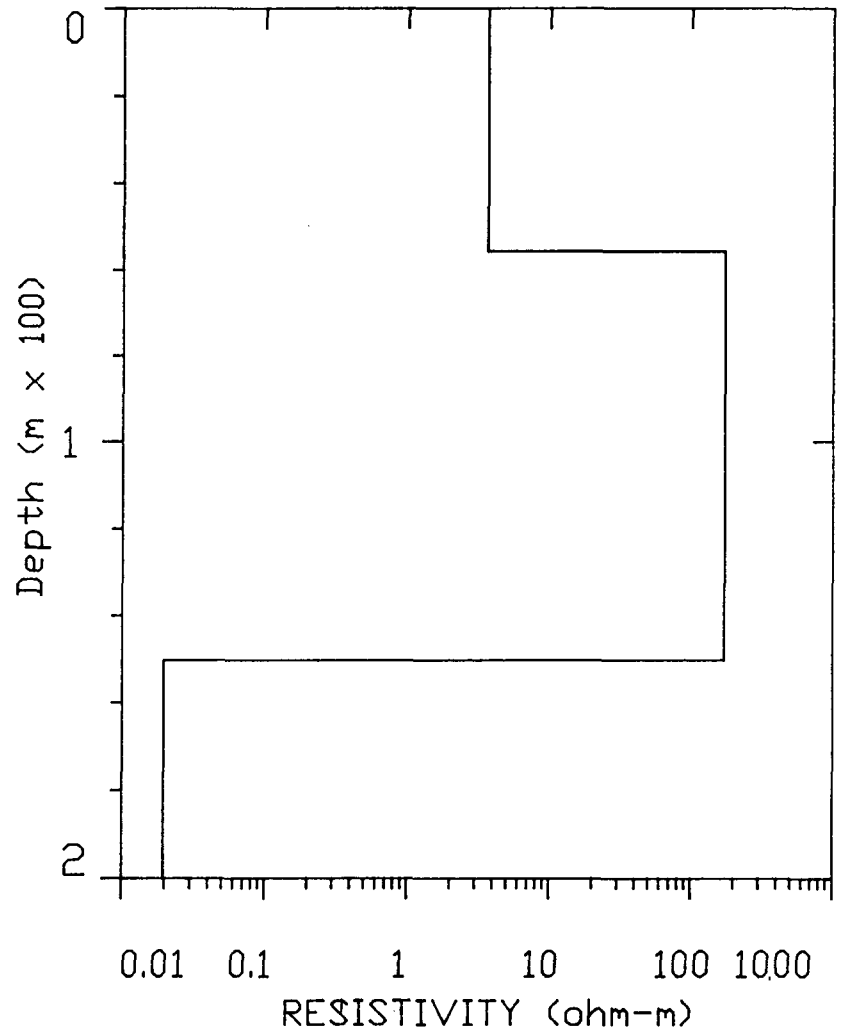
5.3.2 Geological Interpretation of Geoelectrical Model

There is a sufficient electrical resistivity contrast to distinguish two geological layers above the third saltwater saturated layer. The first layer occurs at a depth of 56 m (184 ft) and not at the hydrostratigraphic contact (105 ft bls) between the Holocene to Miocene deposits and the Floridan Aquifer System. The first layer has a low-resistivity value (3.6 ohm-m) and is considered to represent a combined thickness of Holocene to Miocene deposits and the upper portion of the Floridan aquifer. The second layer has a high-resistivity value (173 ohm-m) and a thickness of 95 m (312 ft). It is considered to represent a fresh water saturated Floridan aquifer. The third layer, with a apparent resistivity of less 0.1 ohm-m, is considered to represent a saltwater saturated Floridan aquifer at a depth of 150 m (492 ft).

5.3.3 Depth to Occurrence of Salt Water

The bottom (third) layer of the geoelectrical model, with a resistivity of less than 0.1 ohm-m, is interpreted to represent salt water. It occurs at a depth of 492 ft (-467 ft msl). Because the resistivity of Layer 2 (173 ohm-m) is greater than 80 ohm-m, the interpreted depth to the 5,000 mg/l isochlor is taken as 50 ft greater than the depth of the geoelectrical interface, or at a depth of 542 ft (-517 ft msl). The resistivity of Layer 3 (less than 0.1 ohm-m) corresponds to a chloride content greater that 20,000 mg/l assuming a porosity of 25% and the validity and applicability of equation (4) of Section 4.2. It is presumed that because of the expected high chlorinity gradients, this value is sufficiently close to the 5,000 mg/l isochlor that they represent the same effective depth.





—— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

MEASURED TDEM APPARENT RESISTIVITY AND 1-D INVERSION
SOUNDING 2 – ORMOND BEACH AIRPORT
VOLUSIA COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	MDL-2	5.3-2
DRAWN BY:	RBT	DATE:	07/06/94	

5.3.4 Depth of Occurrence of the 250 mg/l Isochlor

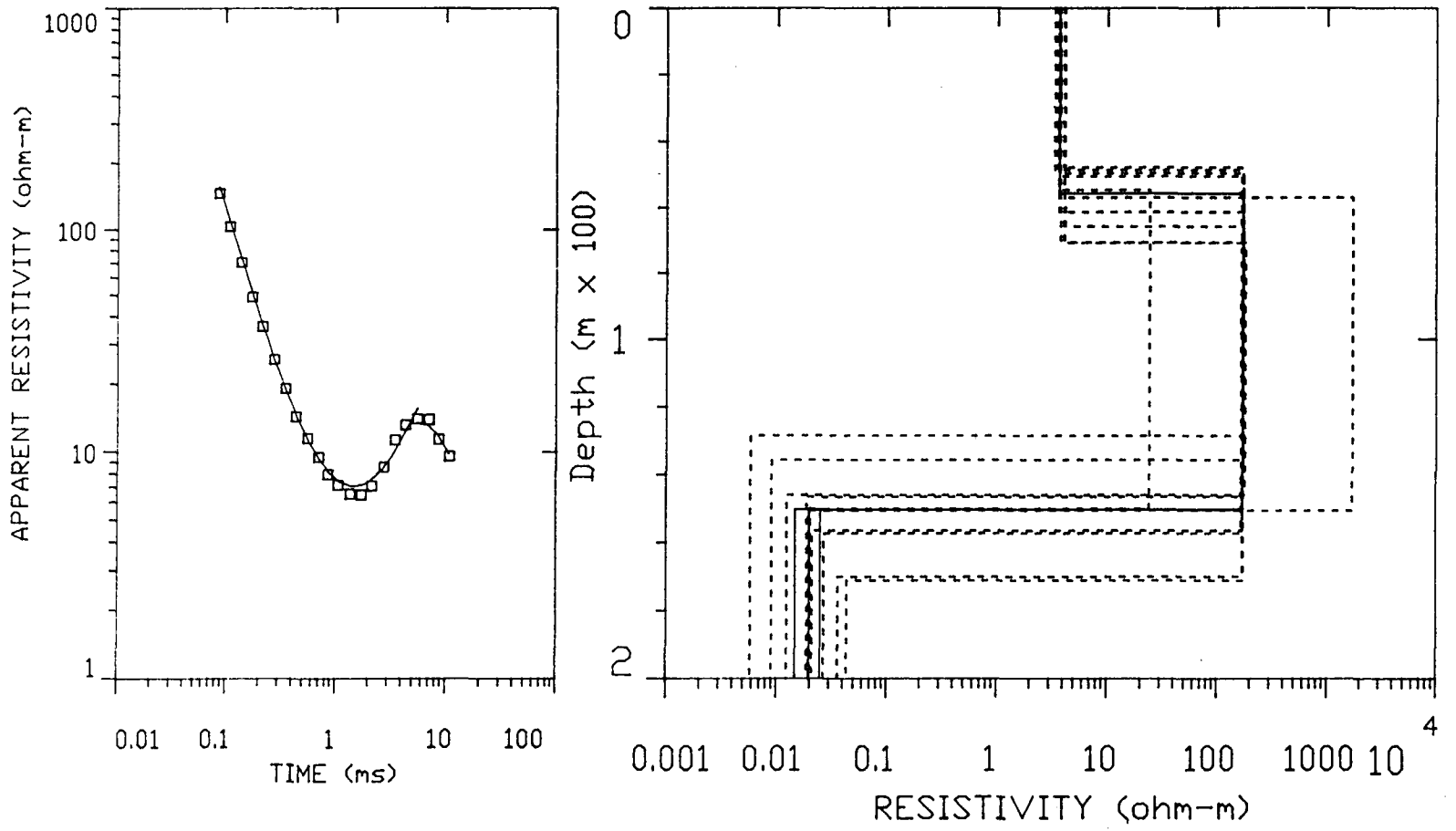
The resistivity of Layer 2, 173 ohm-m, corresponds to a chloride content of less than 250 mg/l, assuming a 25% porosity and the validity and applicability of equation (4) of Section 4.2. The 250 mg/l isochlor is placed in the Floridan aquifer at a depth 50 ft above the Layer 3 interface or at 442 ft (-417 ft msl). For comparison, Rutledge (1985) estimated a maximum thickness of approximately 300 ft for water with a chloride concentration less than 250 mg/l in the Floridan aquifer at this site. The top of the Floridan aquifer occurs at an approximate depth of 80 ft bmsl or 105 ft bls at this site (Rutledge, 1985).

5.3.5 Accuracy of Measurement and Interpretation

Figure 5.3-3 is the equivalence analysis at this site and the inversion table (Table 5.3-1) lists the upper and lower bounds of the inverted parameters of the geoelectrical model.

The range of equivalence in determining the depth to the low resistivity layer is about ±21 m (69 ft) which is 14% of the total depth. The resistivity of this layer has a range of less than 0.1 ohm-m. This range corresponds to an interpreted chloride content exceeding 20,000 mg/l, again subject to the same assumptions of porosity and validity of equation (4).

The equivalence range of the resistivity of Layer 2 is from 24 to 1727 ohm-m which, over the majority of the range, corresponds to a chloride content of less than 250 mg/l. The results of the TDEM study are in agreement with the results from Rutledge (1985). The chloride-to-sulfate ratio at the site is 2:1 (Table 5.1-4), rather than 5:1. Accordingly, equation (4) may not be valid. The estimated thickness of the freshwater-saturated Floridan aquifer (337 ft) compares well with the results of Rutledge (1985) which estimated the maximum thickness of water with a chloride concentration less than 250 mg/l to be 300 ft.



—— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

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SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

MEASURED TDEM APPARENT RESISTIVITY AND EQUIVALENCE FOR 1-D INVERSION
SOUNDING 2 - ORMOND BEACH AIRPORT
VOLUSIA COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE 5.3-3
CHECKED BY:	MJW	DRAWING NO.:	EQU-2	
DRAWN BY:	RBT	DATE:	08/25/94	

DATA SET: SITE2

CLIENT: SJRWMD DATE: 30-APR-94
LOCATION: ORMOND BEACH AIRPORT SOUNDING: 1
COUNTY: VOLUSIA COUNTY, FLORIDA ELEVATION: 7.50 m
PROJECT: SALT WATER INTERFACE DETECTION EQUIPMENT: EM 37-3
LOOP SIZE: 306.000 m by 183.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y)
SOUNDING COORDINATES: E: 0.0000 N: 0.0000

FITTING ERROR: 8.466 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			7.50	
1	3.64	55.70	-48.20	15.28
2	172.7	94.58	-142.7	0.547
3	0.0195			

ALL PARAMETERS ARE FREE

PARAMETER BOUNDS FROM EQUIVALENCE ANALYSIS

	LAYER	MINIMUM	BEST	MAXIMUM
RHO	1	3.306	3.645	4.103
	2	23.947	172.719	1727.186
	3	0.006	0.020	0.043
THICK	1	47.794	-0.484	70.712
	2	57.763	1.000	120.547
DEPTH	1	47.794	55.703	70.712
	2	128.475	150.291	171.078

CURRENT: 9.10 AMPS EM-57 COIL AREA: 100.00 sq m.
FREQUENCY: 30.00 Hz GAIN: 2 RAMP TIME: 107.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	emf (nV/m sqrd) SYNTHETIC	DIFFERENCE (percent)
1	0.0867	67580.3	61015.6	9.71
2	0.108	65545.8	60419.3	7.82
3	0.138	62891.0	59236.0	5.81

ST. JOHNS RIVER
WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SOUNDING DATA TABLE
SOUNDING 2 – ORMOND BEACH AIRPORT
VOLUSIA COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.3-1

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
4	0.175	59853.6	57290.8	4.28
5	0.218	55027.5	54521.5	0.919
6	0.278	49777.8	50142.1	-0.731
7	0.351	43403.9	44592.4	-2.73
8	0.438	38379.5	38202.0	0.462
9	0.558	29177.6	30320.3	-3.91
10	0.702	21965.5	22727.4	-3.46
11	0.858	17310.4	16672.0	3.68
12	1.06	11830.9	11169.2	5.59
13	1.37	7236.2	6426.1	11.19
14	1.74	4037.3	3493.1	13.47
15	2.17	2028.3	1838.0	9.37
16	2.77	825.6	825.2	0.0461
17	3.50	302.9	358.3	-18.29
18	4.37	138.2	149.8	-8.43
19	5.56	69.24	59.06	14.70

CURRENT: 18.50 AMPS EM-57 COIL AREA: 100.00 sq m.
FREQUENCY: 3.00 Hz GAIN: 5 RAMP TIME: 202.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
20	5.56	46.18	48.58	-5.18
21	6.98	79.54	88.22	-10.91
22	8.56	64.50	61.67	4.39
23	10.64	48.91	47.44	3.01

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

	P 1	P 2	P 3	T 1	T 2
P 1	0.99				
P 2	0.00	0.00			
P 3	-0.01	-0.01	0.30		
T 1	-0.02	-0.01	0.09	0.96	
T 2	0.00	0.00	-0.22	0.04	0.91

ST. JOHNS RIVER
WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SOUNDING DATA TABLE
SOUNDING 2 – ORMOND BEACH AIRPORT
VOLUSIA COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.3–1

5.3.6 Summary of TDEM Sounding at Ormond Beach Airport (Site 2)

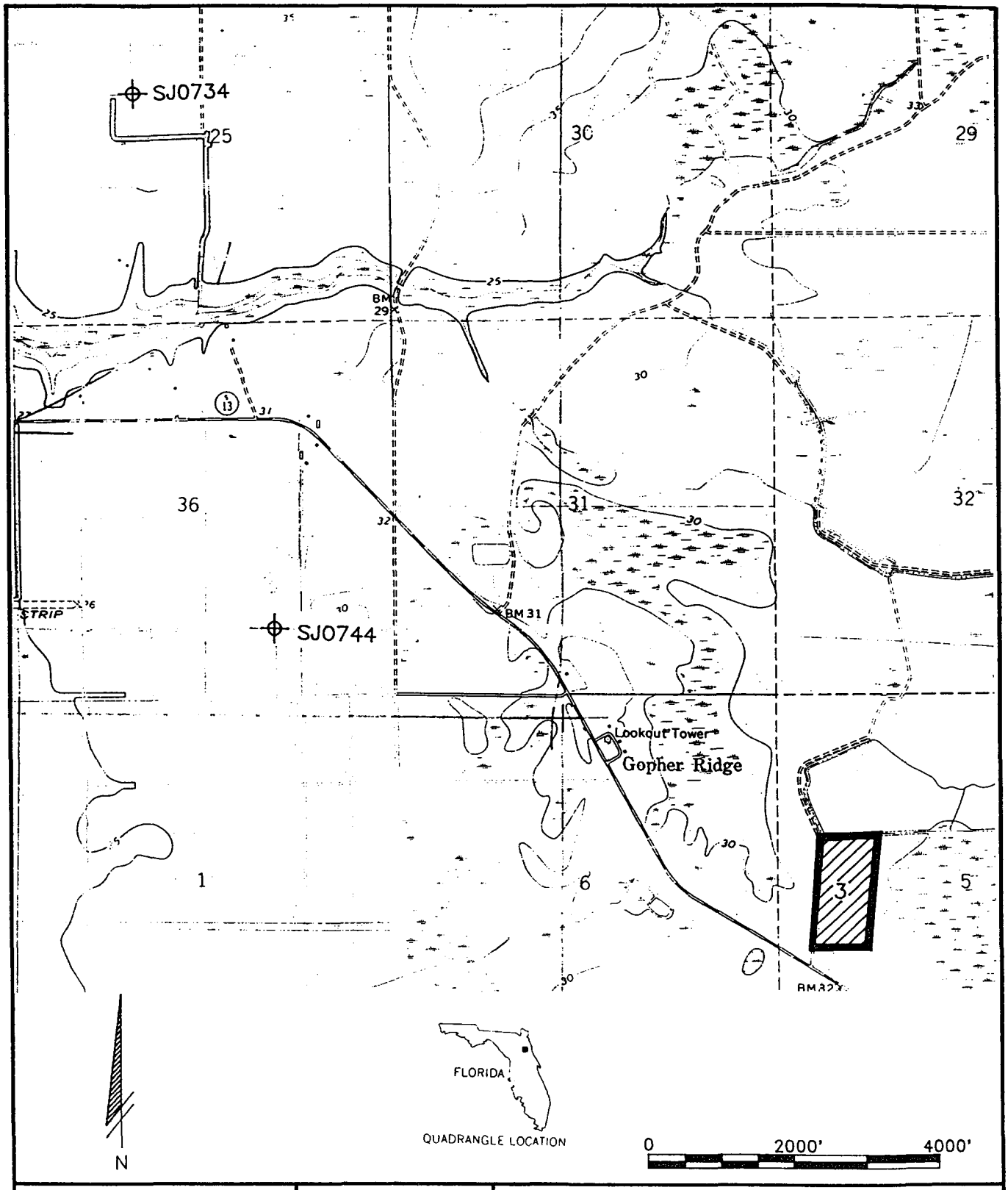
- The depth to occurrence of salt water (5,000 mg/l isochlor) is interpreted to be 542 ft (-517 ft msl) and occur within the Upper Floridan aquifer.
- The ground water within the Floridan aquifer at this site is interpreted to contain an average chloride concentration of less than 250 mg/l. The 250 mg/l isochlor is interpreted to be present in the Floridan aquifer at a depth of 442 ft (-417 ft msl).
- The results of the TDEM survey agree with Rutledge (1985) who indicates that chloride concentrations in the Floridan aquifer are below 250 mg/l in the area of the site. For comparison, Rutledge (1985) estimates the depth of the 250 mg/l isochlor to be 405 ft bls in the area of the site, which compares reasonably well to the results of the TDEM study which showed the 250 mg/l isochlor to be at 442 ft bls.

5.4 TDEM Site 3 - Champion Paper Company

5.4.1 Location Description and Geoelectrical Section

The site is located in southern St. Johns County, Florida (Figure 5.4-1). The site is located within a tree farm. No possible sources of interference were observed in the vicinity of the Tx loop. QA soundings were performed 100 ft north and south and 50 ft east and west of the initial Rx coil location. Results from the QA soundings indicate that the apparent resistivity values were unaffected by any interference sources.

The Floridan aquifer occurs at an approximate depth of 120 ft bmsl (Spechler and Hampson, 1984) or 150 ft bls and is overlain by the surficial aquifer system and the Hawthorn Group. The base of the Floridan aquifer occurs at an approximate depth of 2000 ft bmsl (Tibbals, 1990). The thickness of the Upper Floridan aquifer is approximately 810



ST. JOHNS RIVER
WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SURVEY LOCATION MAP
SOUNDING 3 – CHAMPION PAPER COMPANY
ST. JOHNS COUNTY, FLORIDA

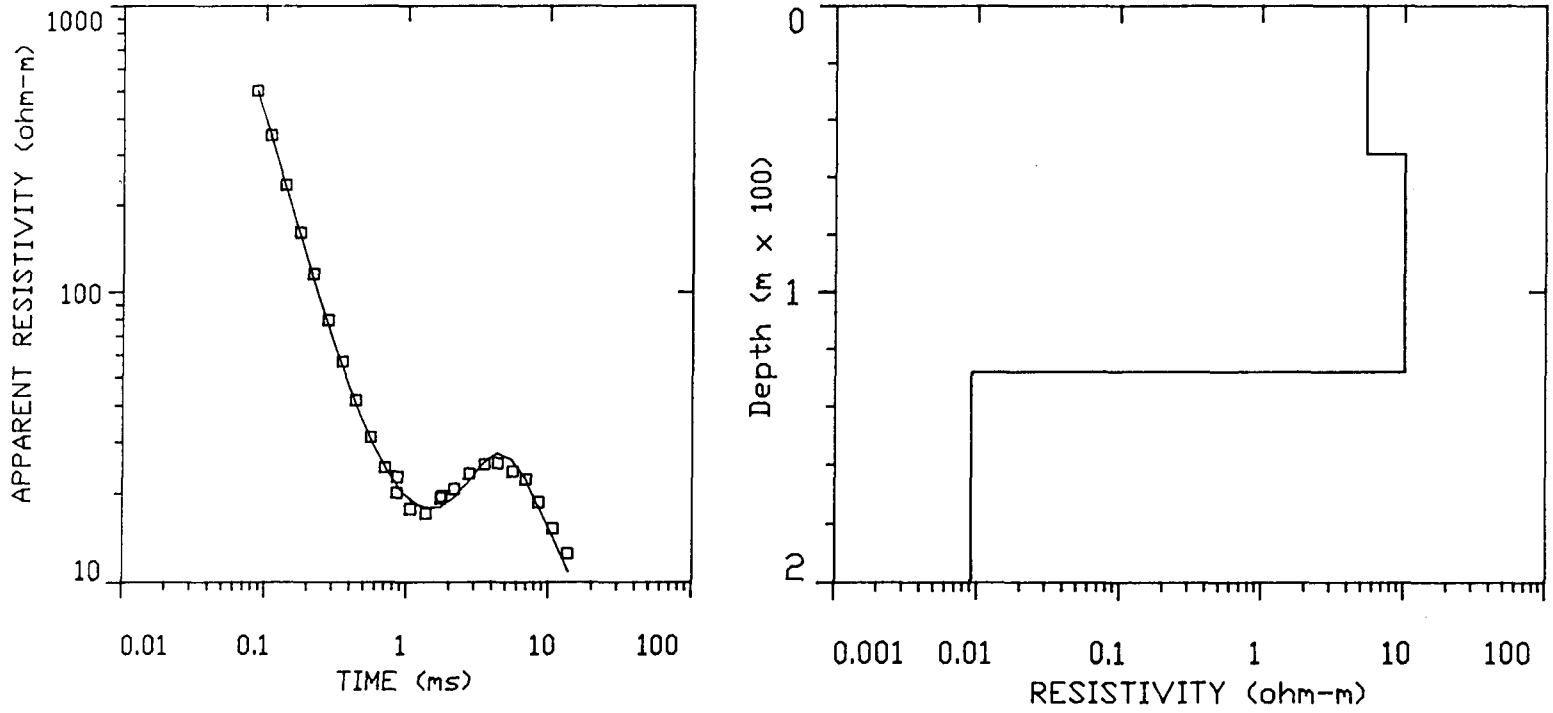
DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	LOC-3	5.4-1
DRAWN BY:	RBT	DATE:	07/05/94	

ft and the depth to the top of the Lower Floridan aquifer is approximately 930 ft bls (Miller, 1986). Monitor Wells SJ0744 and SJ0734 are approximately 1.7 miles and 2.9 miles northwest of the site, respectively (Figure 5.4-1). Water quality results from both of these wells indicate that the chloride concentration of ground water in the Floridan aquifer exceeds 250 mg/l. The chloride-to-sulfate ratio ranged from approximately 1:1 to 1:2 (SJRWMD, personal communication).

The resistivity sounding data and best-fit model inversion are presented on Figure 5.4-2. The interpreted geoelectrical section consists of a three-layer subsurface.

5.4.2 Geological Interpretation of Geoelectrical Model

The three-layered geoelectrical section consists of a low resistivity (5.3 ohm-m), upper layer which is considered to be the Hawthorn Group and surficial sediments above the Floridan aquifer. The thickness of Layer 1 was fixed at a 46 m (150 ft) value based on published information (Spechler and Hampson, 1984). The second layer has only intermediate resistivity (8.7 ohm-m) which, because it is less than 80 ohm-m, suggests the Floridan aquifer at this site contains brackish water. The thickness of the brackish section is 81 m (266 ft), placing the depth to the low resistivity (saltwater) layer at 127 m (417 ft) below ground surface. The resistivity of the saltwater saturated layer is less than 0.1 ohm-m. Layer 1 is considered to be the Hawthorn Group and surficial sediments, Layer 2 to be the Floridan aquifer (brackish) and Layer 3 to be the salt water within the Floridan aquifer.



—— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

MEASURED TDEM APPARENT RESISTIVITY AND 1-D INVERSION
SOUNDING 3 - CHAMPION PAPER COMPANY
ST. JOHNS COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	MDL-3	5.4-2
DRAWN BY:	RBT	DATE:	07/06/94	

5.4.3 Depth to Occurrence of Salt Water

The bottom (third) layer of the geoelectrical model, with a resistivity of less than 0.1 ohm-m, is interpreted to represent salt water. It occurs at a depth of 417 ft (-387 ft msl). Because the resistivity of Layer 2 (8.7 ohm-m) is interpreted to represent brackish water within the Floridan aquifer (i.e., is less than 80 ohm-m), the interpreted depth to the 5,000 mg/l isochlor is equal to the depth of the geoelectrical interface, or at 417 ft depth (-387 ft msl). The resistivity of Layer 3 (less than 0.1 ohm-m) corresponds to a chloride content exceeding 20,000 mg/l assuming a porosity of 25% and the validity and applicability of equation (4) of Section 4.2. It is presumed that because of the expected high chlorinity gradients, this value is sufficiently close to the 5,000 mg/l isochlor that they represent the same effective depth.

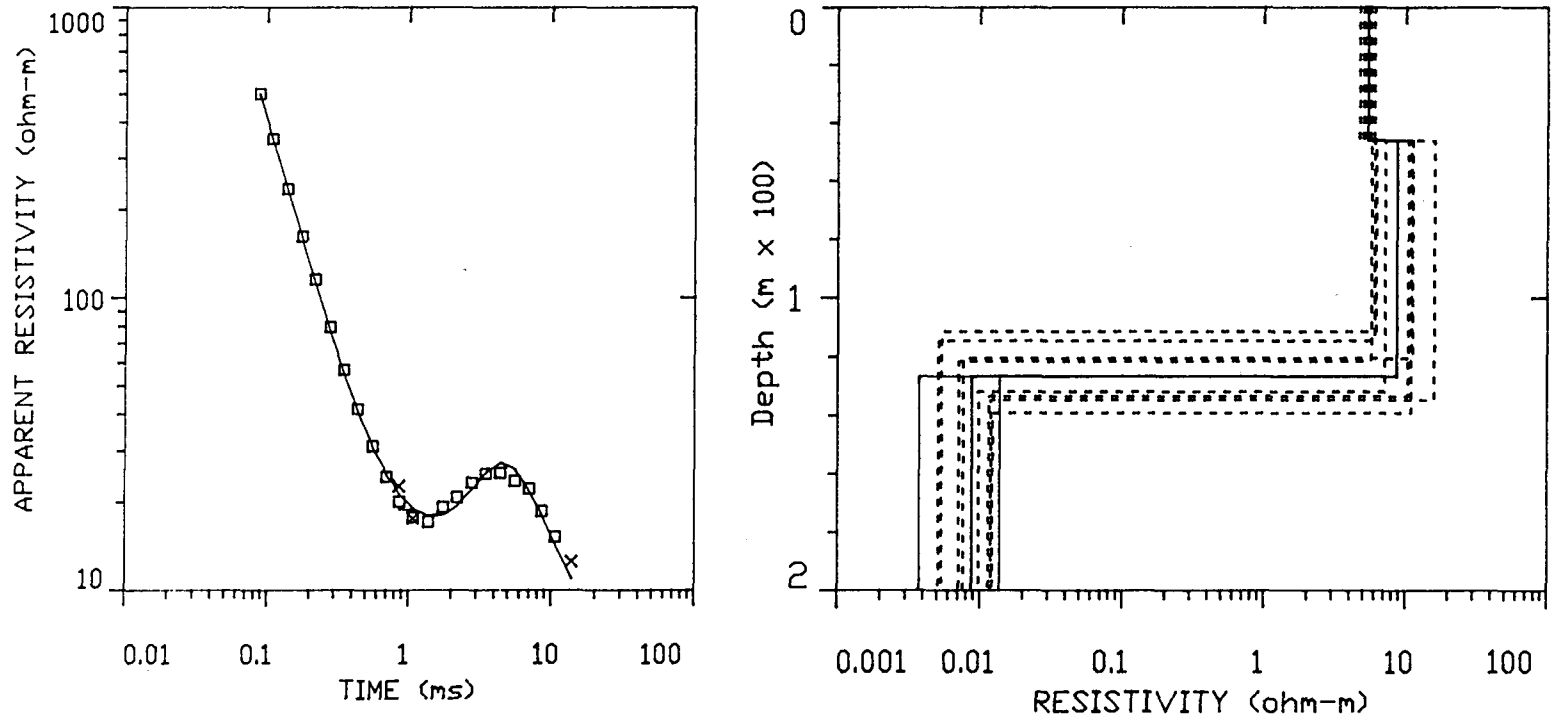
5.4.4 Depth of Occurrence of the 250 mg/l Isochlor

The resistivity of Layer 2, 8.7 ohm-m, corresponds to a chloride content above 250 mg/l, assuming a 25% porosity and the validity and applicability of equation (4) of Section 4.2. As the interpreted chloride content exceeds 250 mg/l, the 250 mg/l isochlor does not occur within the Floridan aquifer at this site.

5.4.5 Accuracy of Measurement and Interpretation

Figure 5.4-3 is the equivalence analysis at this site and the inversion table (Table 5.4-1) lists the upper and lower bounds of the inverted parameters of the geoelectrical model.

The range of equivalence in determining the depth to the low resistivity layer is about ±14 m (46 ft) which is 11% of the total depth. The resistivity of this layer has a range of less than 0.1 ohm-m. This corresponds to a range in interpreted chloride content exceeding 20,000 mg/l, again subject to the same assumptions of porosity and validity of equation (4).



—— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

MEASURED TDEM APPARENT RESISTIVITY AND EQUIVALENCE FOR 1-D INVERSION
SOUNDING 3 – CHAMPION PAPER COMPANY
ST. JOHNS COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	EQU-3	5.4-3
DRAWN BY:	RBT	DATE:	08/25/94	

DATA SET: SITE3

CLIENT: SJRWMD DATE: 30-APR-94
LOCATION: CHAMPION PAPER COMPANY SOUNDING: 1
COUNTY: ST.JOHNS COUNTY, FLORIDA ELEVATION: 9.00 m
PROJECT: SALT WATER INTERFACE DETECTION EQUIPMENT: EM 37-3
LOOP SIZE: 503.000 m by 274.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y)
SOUNDING COORDINATES: E: 0.0000 N: 0.0000

FITTING ERROR: 7.746 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)		ELEVATION (meters)	CONDUCTANCE (Siemens)
				9.00	
1	5.34	46.00	*	-37.00	8.60
2	8.71	80.68		-117.6	9.26
3	0.00874				

"*" INDICATES FIXED PARAMETER

PARAMETER BOUNDS FROM EQUIVALENCE ANALYSIS

LAYER		MINIMUM	BEST	MAXIMUM
RHO	1	4.667	5.349	5.958
	2	5.698	8.713	16.075
	3	0.005	0.009	0.012
THICK	1	46.000	0.000	46.000
	2	65.350	1.000	93.292
DEPTH	1	46.000	46.000	46.000
	2	111.350	126.688	139.292

CURRENT: 16.70 AMPS EM-57 COIL AREA: 100.00 sq m.
FREQUENCY: 30.00 Hz GAIN: 2 RAMP TIME: 290.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.0867	48488.4	48319.7	0.348
2	0.108	47903.0	48197.6	-0.614
3	0.138	47197.6	47906.8	-1.50

ST. JOHNS RIVER
WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SOUNDING DATA TABLE
SOUNDING 3 – CHAMPION PAPER COMPANY
ST. JOHNS COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.4-1

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)	
4	0.175	45940.5	47323.3	-3.01	
5	0.218	43757.1	46294.5	-5.79	
6	0.278	41703.4	44234.3	-6.06	
7	0.351	38571.2	40966.2	-6.20	
8	0.438	35308.3	36516.7	-3.42	
9	0.558	29757.6	30326.1	-1.91	
10	0.702	24124.2	23720.6	1.67	
11	0.858	19648.2	17972.4	8.52	
12	1.06	13782.6	12375.9	10.20	
13	1.37	7758.6	7231.9	6.78	
14	1.74	3576.2	3880.9	-8.51	

CURRENT: 16.70 AMPS EM-57 COIL AREA: 100.00 sq m.
FREQUENCY: 3.00 Hz GAIN: 5 RAMP TIME: 290.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)	
15	0.857	4912.4	6486.6	-32.04	MASKED
16	1.06	13923.9	12454.3	10.55	MASKED
17	1.37	7768.7	7308.2	5.92	
18	1.74	3486.6	3954.8	-13.42	
19	2.17	1835.4	2048.9	-11.63	
20	2.77	839.7	905.2	-7.79	
21	3.50	419.8	411.7	1.94	
22	4.37	238.1	210.5	11.59	
23	5.56	143.8	125.2	12.93	
24	6.98	88.77	92.29	-3.96	
25	8.56	69.63	73.59	-5.68	
26	10.64	54.76	61.24	-11.84	
27	13.70	39.22	48.05	-22.50	MASKED

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	0.99				
P 2	0.02	0.78			
P 3	-0.01	-0.11	0.84		
F 1	0.00	0.00	0.00	0.00	
T 2	-0.01	-0.03	-0.05	0.00	0.98
	P 1	P 2	P 3	F 1	T 2

ST. JOHNS RIVER
WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SOUNDING DATA TABLE
SOUNDING 3 – CHAMPION PAPER COMPANY
ST. JOHNS COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.4–1

The equivalence range of the resistivity of Layer 2 is from 5.7 to 16 ohm-m which corresponds to chloride content above 250 mg/l. The chloride-to-sulfate ratio at the site ranges from 1:1 to 1:2, rather than 5:1. Accordingly, equation (4) may not be valid. Water quality results from Monitor Wells SJ0744 and SJ0734, where chloride concentration in the Floridan aquifer exceeds 250 mg/l, agree with the results from the TDEM study.

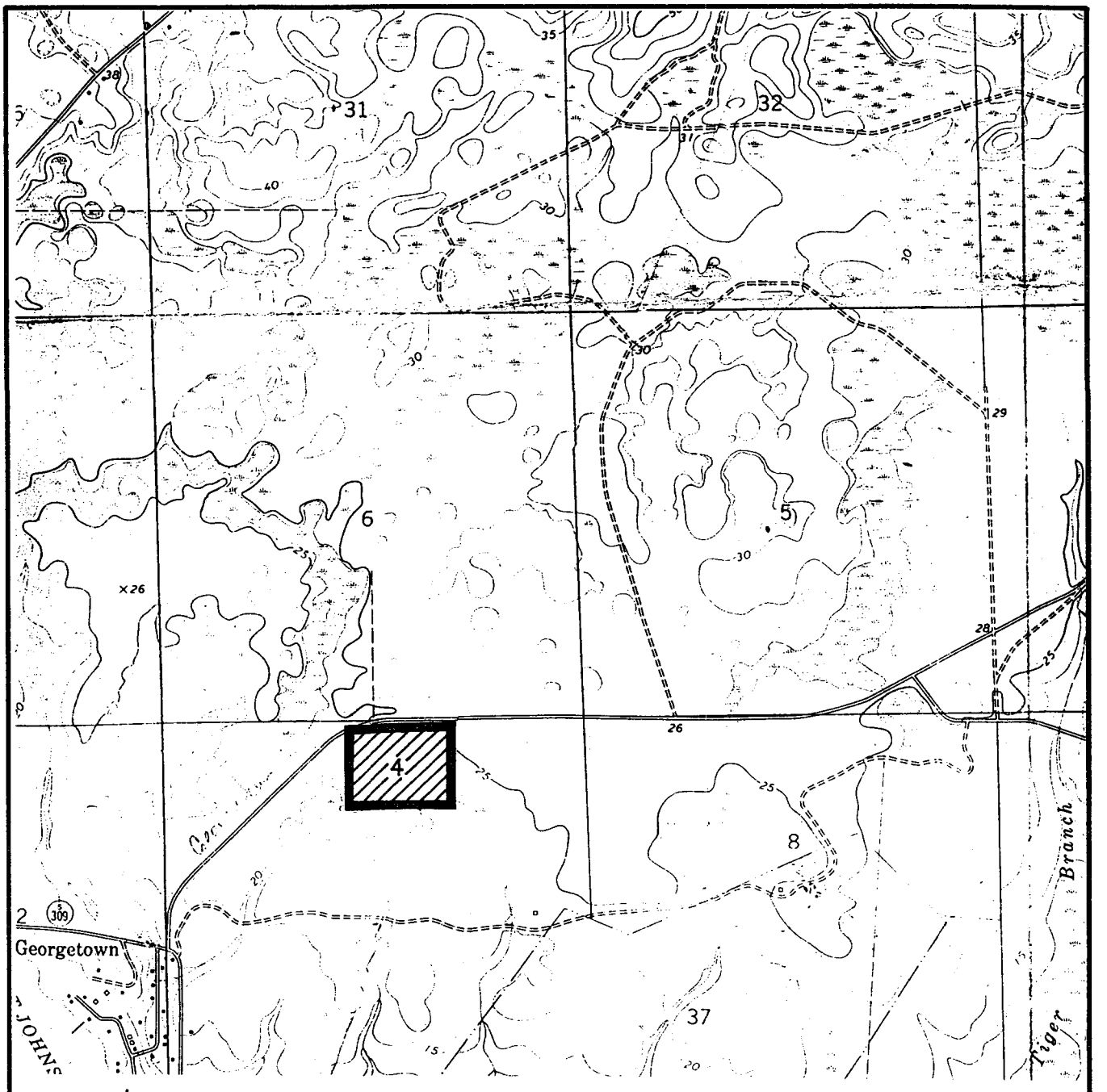
5.4.6 Summary of TDEM Sounding at Champion Paper Company (Site 3)

- The depth to occurrence of salt water (5,000 mg/l isochlor) is interpreted to be 417 ft (-387 ft msl) and occur within the Upper Floridan aquifer.
- The ground water within the Floridan aquifer at this site is interpreted to contain an average chloride concentration above 250 mg/l. The 250 mg/l isochlor is not interpreted to be present within the Floridan aquifer.
- The results of the TDEM survey agree with water quality data from two monitor wells (SJ0734 and SJ0744) near the site which indicate that the chloride concentration of the ground water in the Floridan aquifer exceeds 250 mg/l.

5.5 TDEM Site 4 - Georgetown Cove

5.5.1 Location Description and Geoelectrical Section

The site is located in southern Putnam County near Georgetown, Florida (Figure 5.5-1). The site is located within a wooded area. A possible interference source (a wire fence) existed 200 ft south of the Tx loop. QA soundings were performed 100 ft north and west of the initial Rx coil location. Results from the QA soundings indicate that the apparent resistivity values were unaffected by any interference sources.



ST. JOHNS RIVER
WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SURVEY LOCATION MAP
SOUNDING 4 – GEORGETOWN COVE
PUTNAM COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	LOC-4	5.5-1
DRAWN BY:	RBT	DATE:	07/05/94	

The Floridan aquifer occurs at an approximate depth of 80 ft bmsl or 105 ft bls (SJRWMD, personal communication) and is overlain by the surficial aquifer system and the Hawthorn Group. The base of the Floridan aquifer occurs at an approximate depth of 1950 ft bmsl (Tibbals, 1990). The thickness of the Upper Floridan aquifer is approximately 665 ft and the depth to the top of the Lower Floridan aquifer is approximately 795 ft bls (Miller, 1986). Water quality results near the area of the site indicate that the chloride concentration in the Upper Floridan aquifer ranges from 0 to 50 mg/l (SJRWMD, personal communication).

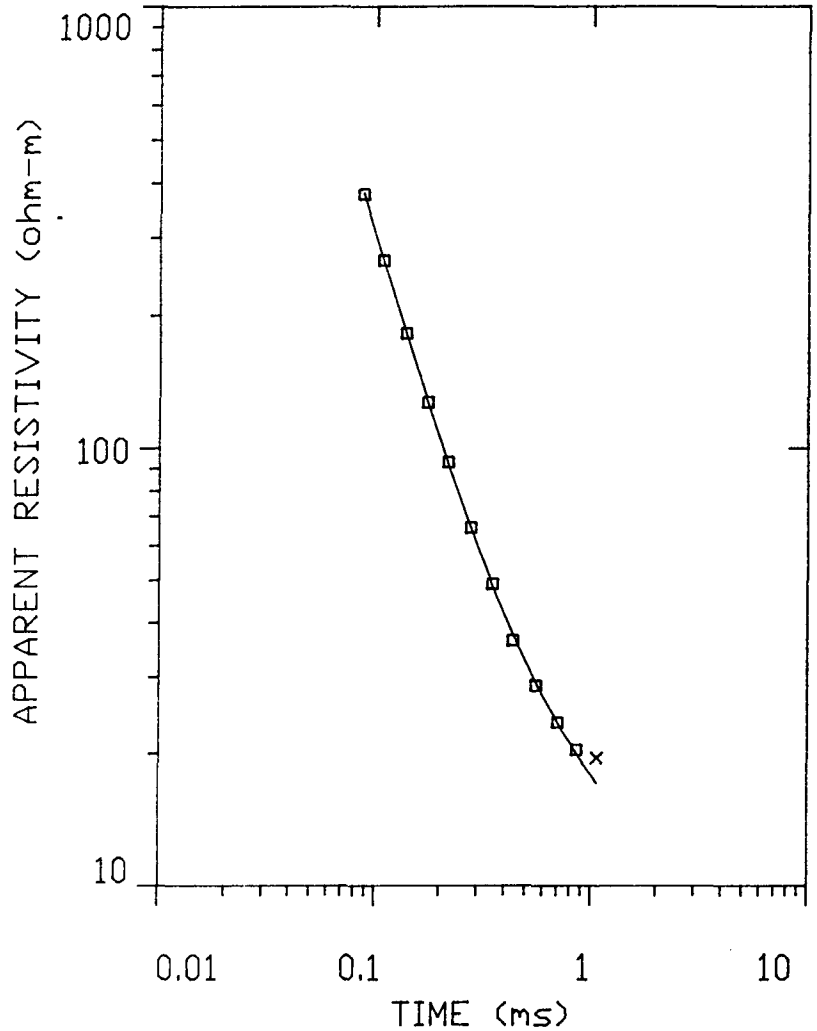
The resistivity sounding data and best-fit model inversion are presented on Figure 5.5-2. The interpreted geoelectrical section consists of a two-layer subsurface.

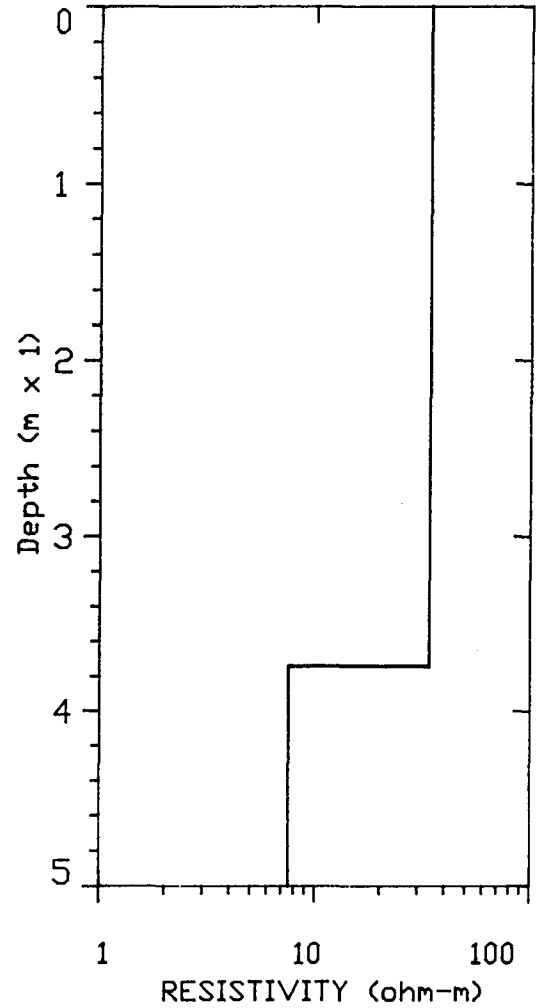
5.5.2 Geological Interpretation of Geoelectrical Model

The first layer occurs at 4 m (13 ft) bls and not at the hydrostratigraphic contact between the Holocene to Miocene deposits (105 ft bls) and the Floridan Aquifer system. Therefore, it can be interpreted that there exists a two-layer geoelectrical section with a relatively thin (13 ft) surface layer of intermediate resistivity (34 ohm-m) overlying a low resistivity layer (7.6 ohm-m). It can be interpreted that the upper portion of the Holocene to Miocene deposits exist as a geoelectrical layer, overlying a low-resistivity layer consisting of the lower portion of the Holocene to Miocene deposits and Floridan aquifer. The resistivity of this layer (7.6 ohm-m) suggests the Floridan aquifer at this site contains brackish to salt water.

5.5.3 Depth to Occurrence of Salt Water

Based upon the TDEM results, all the sediments within the geoelectric section appeared to be saturated with brackish to salt water. Accordingly, it was not possible to determine the depth to the 5,000 mg/l isochlor.





——— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

X APPARENT RESISTIVITY VALUES NOT USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

MEASURED TDEM APPARENT RESISTIVITY AND 1-D INVERSION
SOUNDING 4 - GEORGETOWN COVE
PUTNAM COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	MDL-4	5.5-2
DRAWN BY:	RBT	DATE:	07/06/94	

5.5.4 Depth of Occurrence of the 250 mg/l Isochlor

Based upon the TDEM results, all the sediments within the geoelectric section appeared to be saturated with brackish to salt water. Accordingly, the 250 mg/l isochlor is not present in the Floridan aquifer at this site. However, water quality results near the area of the site (SJRWMD, personal communication) indicate that the chloride concentration in the Upper Floridan aquifer ranges from 0 to 50 mg/l.

5.5.5 Accuracy of Measurement and Interpretation

Figure 5.5-3 is the equivalence analysis at this site and the inversion table (Table 5.5-1) lists the upper and lower bounds of the inverted parameters of the geoelectrical model. The range of equivalence in determining the resistivity of Layer 2 is 7.3 to 7.8 ohm-m. It is not possible to determine an associated chloride concentration because layer 2 in part contains sediments from the Holocene to Miocene deposits which invalidates the assumptions of porosity and validity of equation (4).

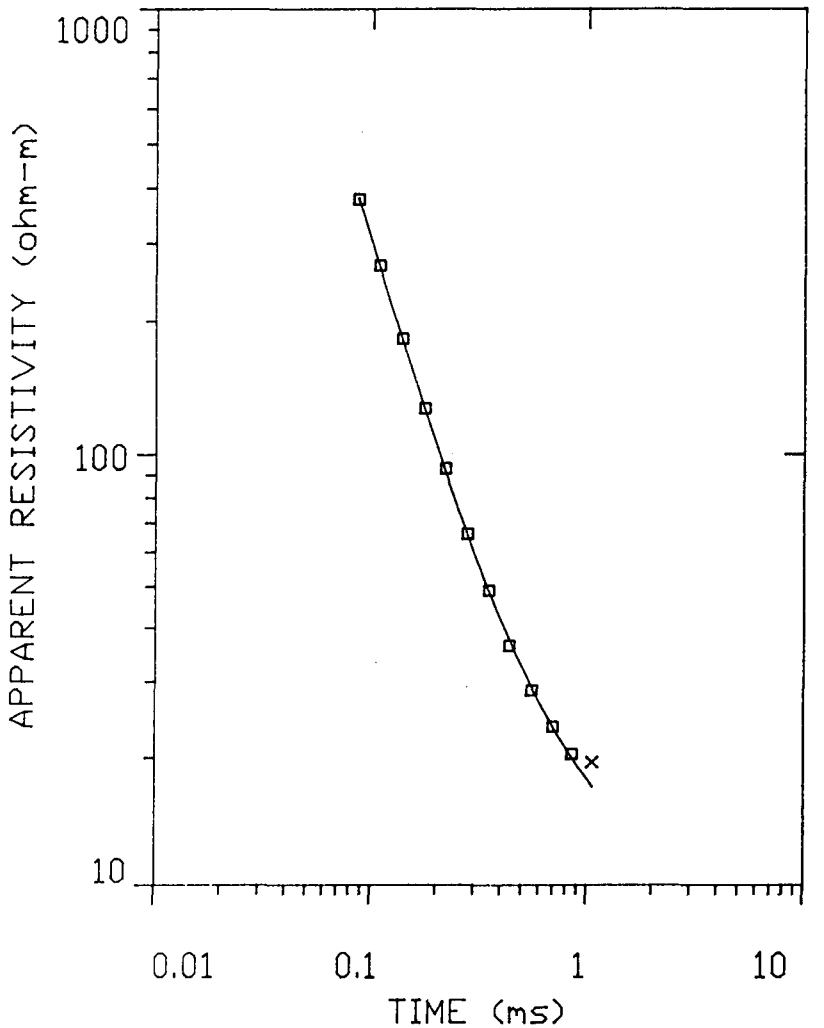
5.5.6 Summary of TDEM Sounding at Georgetown Cove (Site 4)

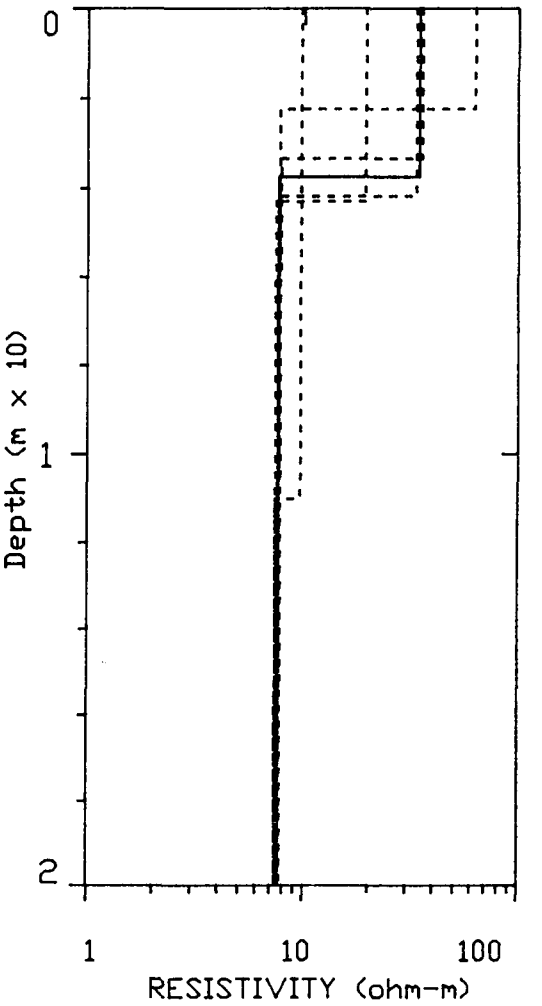
- It is not possible to determine the depth to salt water (5,000 mg/l isochlor) because based on the TDEM results the entire Floridan aquifer appears to be saturated with brackish to salt water.
- The 250 mg/l isochlor is not present in the Floridan aquifer at this site.

5.6 TDEM Site 5 - Kelly Smith

5.6.1 Location Description and Geoelectrical Section

The site is located in eastern Putnam County, Florida (Figure 5.6-1). The site is located within a pasture. A possible interference source (powerline) existed 700 ft east of the Tx loop. QA soundings were performed 100 ft north and east of the initial Rx coil location. Results from the QA soundings indicate that the apparent resistivity values were unaffected by any interference sources.





5-37

—— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

X APPARENT RESISTIVITY VALUES NOT USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

MEASURED TDEM APPARENT RESISTIVITY AND EQUIVALENCE FOR 1-D INVERSION
SOUNDING 4 - GEORGETOWN COVE
PUTNAM COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	EQU-4	5.5-3
DRAWN BY:	RBT	DATE:	07/06/94	

DATA SET: SITE 4

CLIENT: SJRWMD DATE: 01-MAY-94
LOCATION: GEORGETOWN COVE SOUNDING: 1
COUNTY: PUTNAM COUNTY, FLORIDA ELEVATION: 7.50 m
PROJECT: SALT WATER INTERFACE DETECTION EQUIPMENT: EM 37-3
LOOP SIZE: 396.000 m by 296.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y)
SOUNDING COORDINATES: E: 0.0000 N: 0.0000

FITTING ERROR: 1.952 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			7.50	
1	34.32	3.74	3.75	0.108
2	7.57			

ALL PARAMETERS ARE FREE

PARAMETER BOUNDS FROM EQUIVALENCE ANALYSIS

	LAYER	MINIMUM	BEST	MAXIMUM
RHO	1	9.668	34.330	62.817
	2	7.375	7.577	7.789
THICK	1	2.237	1.000	10.999
DEPTH	1	2.237	3.742	10.999

CURRENT: 18.50 AMPS EM-57 COIL AREA: 100.00 sq m.
FREQUENCY: 30.00 Hz GAIN: 3 RAMP TIME: 257.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.0867	67911.4	67590.4	0.472
2	0.108	65683.7	65865.7	-0.277
3	0.138	63001.4	63343.3	-0.542
4	0.175	59979.6	60083.8	-0.173
5	0.218	55232.7	56154.9	-1.66
6	0.278	50311.9	50669.4	-0.710
7	0.351	43878.3	44354.0	-1.08

* S.D.I.I. *

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT PALATKA, FLORIDA	SDII SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED	TDEM SOUNDING DATA TABLE SOUNDING 4 – GEORGETOWN COVE PUTNAM COUNTY, FLORIDA
		PROJECT NO.: 94767
		TABLE: 5.5–1

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
8	0.438	39455.9	37694.1	4.46
9	0.558	30823.7	30187.6	2.06
10	0.702	23231.4	23404.1	-0.743
11	0.858	17519.6	18092.0	-3.26
12	1.06	10865.7	13225.6	-21.71 MASKED

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	0.06		
P 2	0.00	1.00	
T 1	0.22	0.00	0.81
	P 1	P 2	T 1

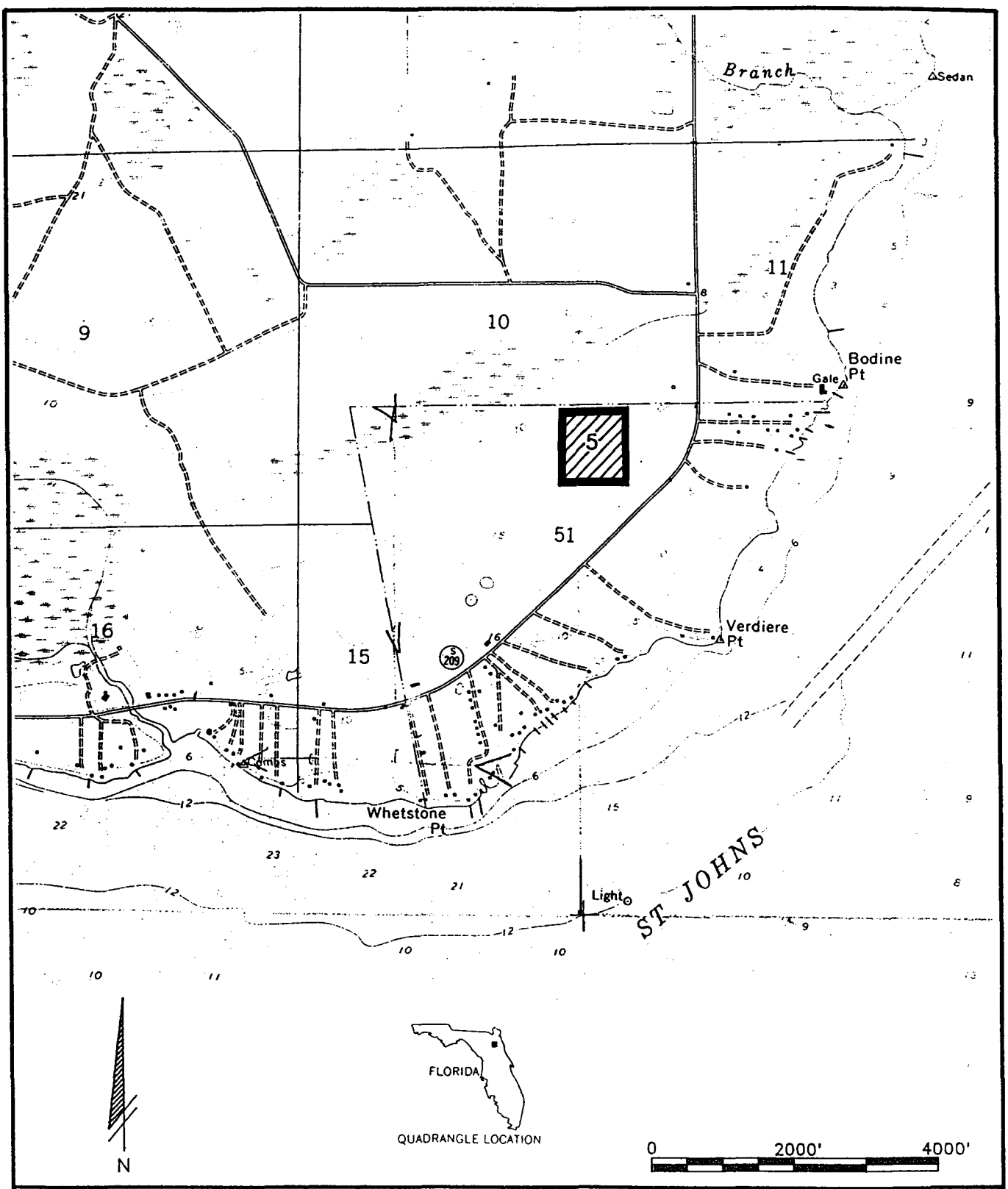
* S.D.I.I. *

ST. JOHNS RIVER
WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SOUNDING DATA TABLE
SOUNDING 4 – GEORGETOWN COVE
PUTNAM COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.5–1



ST. JOHNS RIVER
WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SURVEY LOCATION MAP
SOUNDING 5 – KELLY SMITH
PUTNAM COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	LOC-5	5.6-1
DRAWN BY:	RBT	DATE:	07/05/94	

The Floridan aquifer occurs at an approximate depth of 200 ft bls (Tibbals, 1990) and is overlain by the surficial aquifer system and the Hawthorn Group. The base of the Floridan aquifer occurs at an approximate depth of 1900 ft bmsl (Tibbals, 1990). The thickness of the Upper Floridan aquifer is approximately 550 ft and the depth to the top of the Lower Floridan aquifer is approximately 750 ft bls (Miller, 1986).

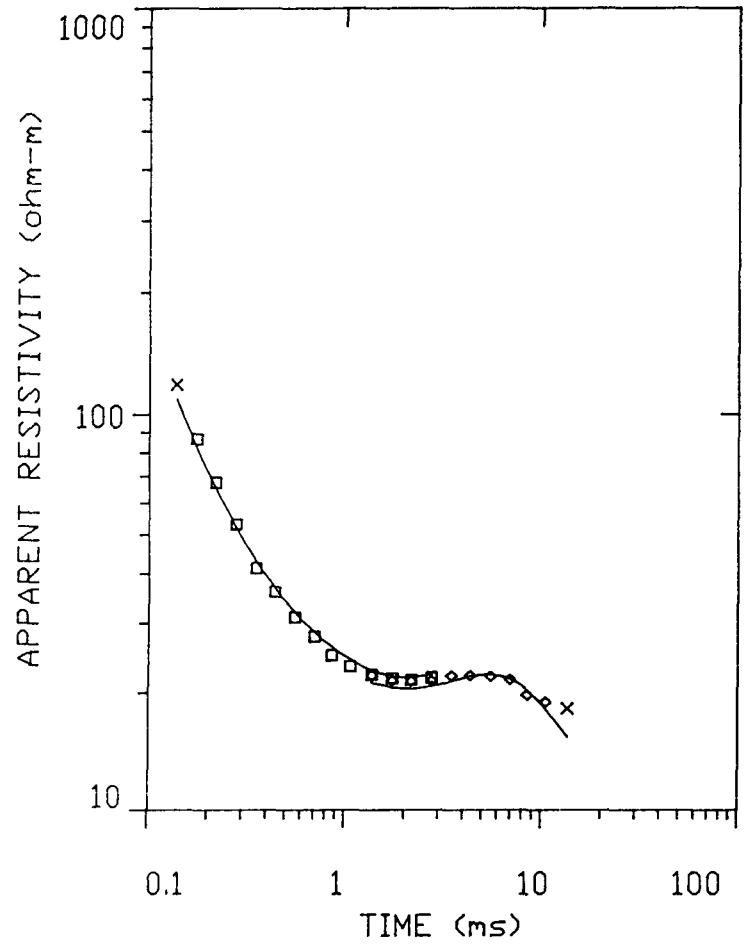
The resistivity sounding data and best-fit model inversion are presented on Figure 5.6-2. The interpreted geoelectrical section consists of a two-layer subsurface.

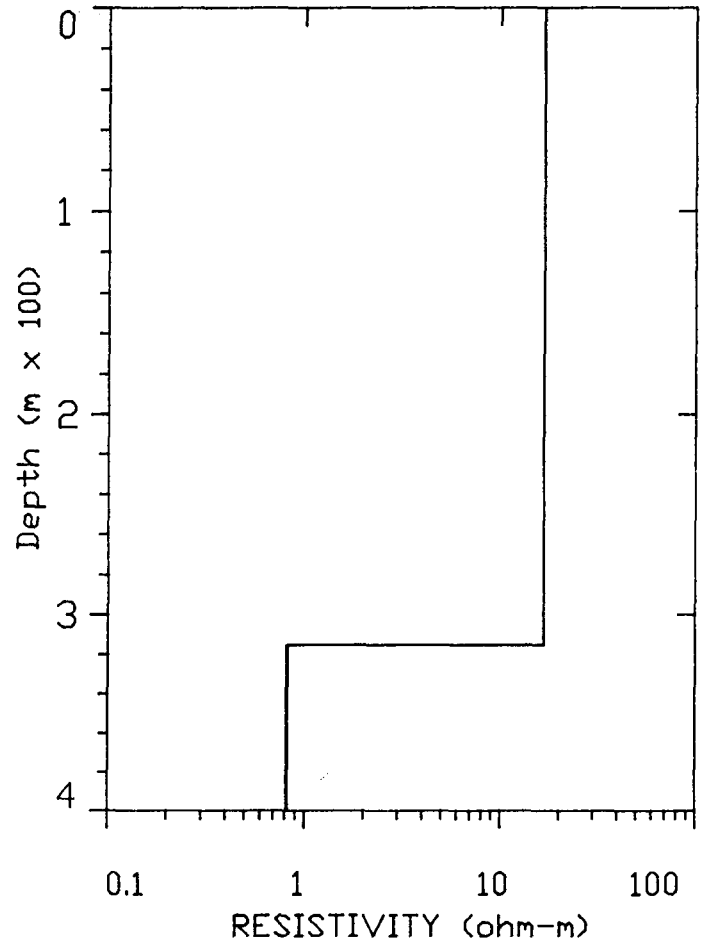
5.6.2 Geological Interpretation of Geoelectrical Model

There is insufficient electrical resistivity contrast between the surficial aquifer system layer, the Hawthorn Group and the underlying Floridan aquifer to distinguish the three. Fixing the thickness of the upper layer does not resolve this dilemma; therefore it can be interpreted that there exists a two-layer geoelectrical section with a relatively thick (315 m = 1034 ft) surface layer of intermediate resistivity (17 ohm-m) overlying a low resistivity layer (0.8 ohm-m). It can be interpreted that the surficial aquifer system, the Hawthorn Group, and the upper part of the Floridan aquifer system exist as a combined but indistinguishable (geoelectrical) layer, overlying a saltwater saturated Floridan aquifer at a depth of 1034 ft bls.

5.6.3 Depth to Occurrence of Salt Water

The bottom (second) layer of the geoelectrical model, with a resistivity of 0.8 ohm-m, is interpreted to represent salt water. It occurs at a depth of 1034 ft (-1023 ft msl). Because the resistivity of Layer 1 (17 ohm-m) is less than 80 ohm-m, the interpreted depth to the 5,000 mg/l isochlor is taken at the depth of the geoelectrical interface, or at 1034 ft depth (-1023 ft msl). The resistivity of Layer 2 (0.8 ohm-m) corresponds to a chloride





——— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

X APPARENT RESISTIVITY VALUES NOT USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

MEASURED TDEM APPARENT RESISTIVITY AND 1-D INVERSION
SOUNDING 5 – KELLY SMITH
PUTNAM COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	MDL-5	5.6-2
DRAWN BY:	RBT	DATE:	07/06/94	

content exceeding 20,000 mg/l assuming a porosity of 25% and the validity and applicability of equation (4) of Section 4.2. It is presumed that because of the expected high chlorinity gradients, this value is sufficiently close to the 5,000 mg/l isochlor that they represent the same effective depth.

5.6.4 Depth of Occurrence of the 250 mg/l Isochlor

Because of the inability to segregate the Floridan aquifer from the overlying surficial aquifer system and the Hawthorn Group, the effective chloride concentration of Layer 1 cannot be calculated.

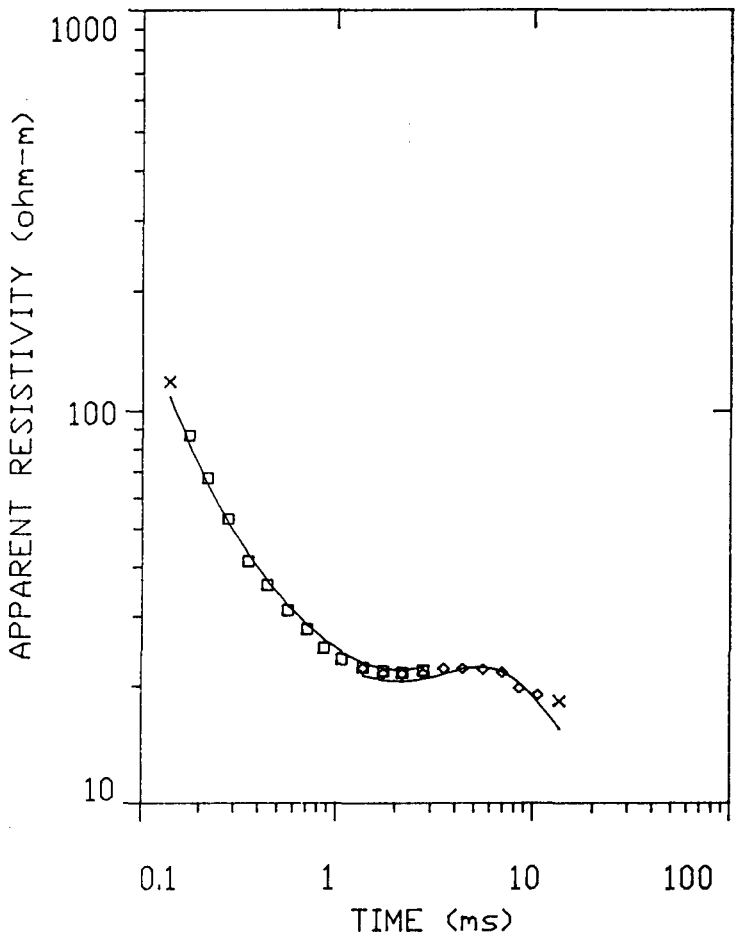
5.6.5 Accuracy of Measurement and Interpretation

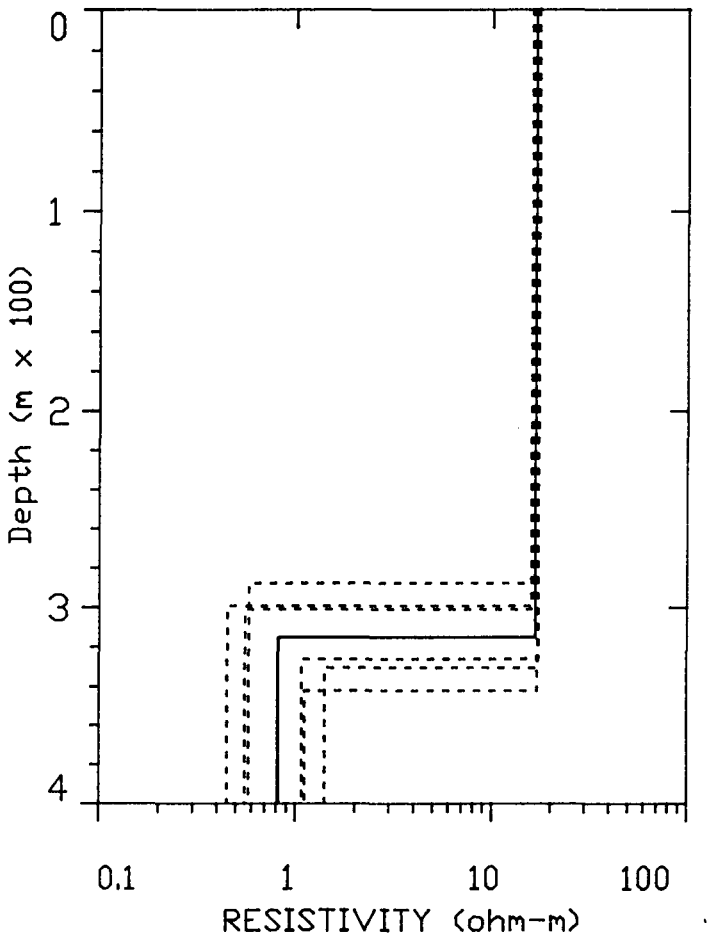
Figure 5.6-3 is the equivalence analysis at this site and the inversion table (Table 5.6-1) lists the upper and lower bounds of the inverted parameters of the geoelectrical model. The range of equivalence in determining the depth to the low resistivity layer is about ±27 m (89 ft) which is 9% of the total depth. The resistivity of this layer has a range from 0.5 to 1.4 ohm-m. This corresponds to a range in interpreted chloride content exceeding 20,000 mg/l, again subject to the same assumptions of porosity and validity of equation (4).

The equivalence range of the resistivity of Layer 1 is from 16 to 17 ohm-m. A corresponding chloride concentration cannot be determined because Layer 1 is in part comprised of the Hawthorn Group and surficial sediments. Accordingly, equation (4) may not be valid.

5.6.6 Summary of TDEM Sounding at Kelly Smith (Site 5)

- The depth of occurrence of salt water (5,000 mg/l isochlor) is interpreted to be 1,034 ft (-1,023 ft msl) and occur within the Lower Floridan aquifer.
- The quality of ground water within the Floridan aquifer at this site cannot be interpreted because the analysis of the TDEM data does not allow the Hawthorn Group and surficial aquifer system to be distinguished from the Floridan Aquifer System.





—— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

X APPARENT RESISTIVITY VALUES NOT USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

MEASURED TDEM APPARENT RESISTIVITY AND EQUIVALENCE FOR 1-D INVERSION
SOUNDING 5 - KELLY SMITH
PUTNAM COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	EQU-5	5.6-3
DRAWN BY:	RBT	DATE:	07/06/94	

DATA SET: SITE 5

CLIENT: SJRWMD DATE: 02-MAY-94
LOCATION: KELLY SMITH SOUNDING: 1
COUNTY: PUTNAM COUNTY, FLORIDA ELEVATION: 3.50 m
PROJECT: SALT WATER INTERFACE DETECTION EQUIPMENT: EM 37-3
LOOP SIZE: 304.000 m by 304.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y)
SOUNDING COORDINATES: E: 0.0000 N: 0.0000

FITTING ERROR: 4.950 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			3.50	
1	16.88	315.1	-311.6	18.66
2	0.817			

ALL PARAMETERS ARE FREE

PARAMETER BOUNDS FROM EQUIVALENCE ANALYSIS

	LAYER	MINIMUM	BEST	MAXIMUM
RHO	1	16.108	16.883	17.484
	2	0.450	0.817	1.416
THICK	1	287.659	1.000	342.322
DEPTH	1	287.659	315.114	342.322

CURRENT: 16.00 AMPS EM-57 COIL AREA: 100.00 sq m.
FREQUENCY: 30.00 Hz GAIN: 3 RAMP TIME: 202.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.138	81324.3	92429.7	-13.65 MASKED
2	0.175	71836.6	77570.6	-7.98
3	0.218	60309.5	63430.8	-5.17
4	0.278	47158.1	48547.2	-2.94
5	0.351	38302.1	35979.5	6.06
6	0.438	27060.5	26088.7	3.59
7	0.558	18411.1	17672.7	4.01

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WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

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SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SOUNDING DATA TABLE
SOUNDING 5 – KELLY SMITH
PUTNAM COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.6–1

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
8	0.702	12240.5	11815.2	3.47
9	0.858	8738.8	8109.1	7.20
10	1.06	5592.7	5265.8	5.84
11	1.37	3208.3	3093.3	3.58
12	1.74	1824.6	1794.6	1.64
13	2.17	1065.1	1045.7	1.81
14	2.77	566.2	551.2	2.64

CURRENT: 16.00 AMPS EM-57 COIL AREA: 100.00 sq m.
FREQUENCY: 3.00 Hz GAIN: 3 RAMP TIME: 75.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
15	1.37	3236.4	3446.8	-6.49
16	1.74	1868.0	1984.0	-6.21
17	2.17	1077.7	1154.8	-7.15
18	2.77	585.1	614.2	-4.97
19	3.50	311.0	327.0	-5.12
20	4.37	178.5	178.8	-0.129
21	5.56	98.45	96.08	2.40
22	6.98	57.34	56.70	1.10
23	8.56	39.49	37.59	4.82
24	10.64	24.35	25.93	-6.49
25	13.70	13.70	17.61	-28.53 MASKED

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

	P 1	P 2	T 1
P 1	1.00		
P 2	-0.02	0.64	
T 1	0.00	-0.03	0.99

ST. JOHNS RIVER
WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SOUNDING DATA TABLE
SOUNDING 5 – KELLY SMITH
PUTNAM COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.6–1

5.7 TDEM Site 6 - Union Camp/Seville

5.7.1 Location Description and Geoelectrical Section

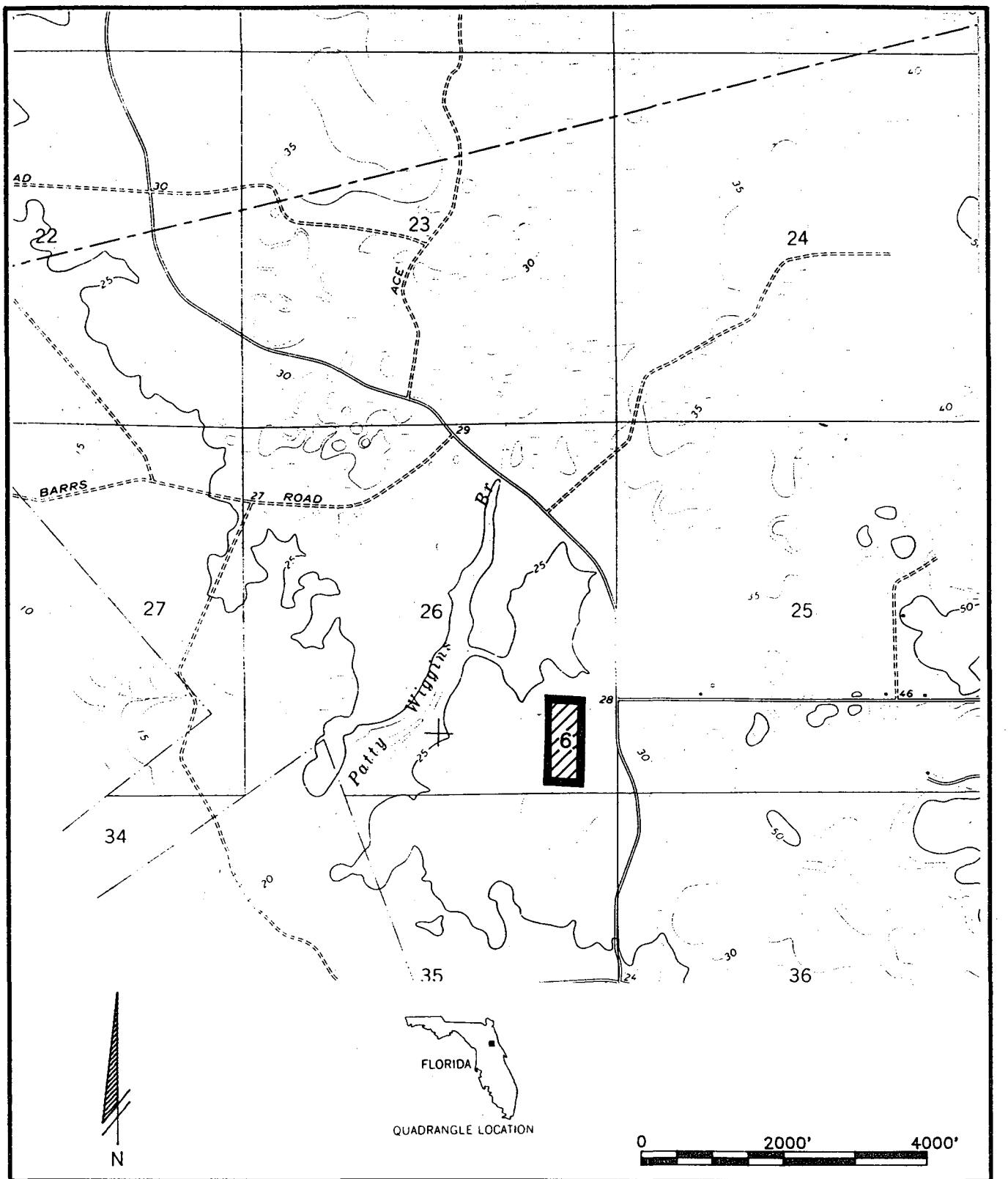
The site is located in northwest Volusia County near Seville, Florida (Figure 5.7-1). The site is located within a pasture. A possible interference source (barbed wire fence) existed 50 ft west of the Tx loop. QA soundings were performed 100 ft north, east and west of the initial Rx coil location. Results from the QA soundings indicate that the apparent resistivity values were unaffected by any interference sources.

The Floridan aquifer occurs at an approximate depth of 105 ft bmsl or 133 ft bls at this site (Rutledge, 1982) and is overlain by Holocene to Miocene deposits. The base of the Floridan aquifer occurs at approximately 1960 ft bmsl (Tibbals, 1990). The thickness of the Upper Floridan aquifer is approximately 670 ft and the depth to the top of the Lower Floridan aquifer is approximately 800 ft. A water quality study performed in the area of the site (Rutledge, 1982) indicates that the chloride concentration in the upper portion of the Floridan aquifer ranges from 26 to 250 mg/l.

The resistivity sounding data and best-fit model inversion are presented on Figure 5.7-2. The interpreted geoelectrical section consists of a two-layer subsurface.

5.7.2 Geological Interpretation of Geoelectrical Model

The first layer occurs at 224 m (735 ft) bls and not at the hydrostratigraphic contact between the Holocene to Miocene deposits (133 ft bls). Therefore, it can be interpreted that there exists a two-layer geoelectrical section with a relatively thick 735 ft surface layer of intermediate resistivity (51 ohm-m) overlying a low resistivity layer (0.3 ohm-m). It can be interpreted that the Holocene to Miocene deposits overlying the Floridan aquifer and the upper part of the Floridan Aquifer System exist as a combined but indistinguishable (geoelectrical) layer, overlying a saltwater saturated Floridan aquifer at a depth of 735 ft bls.



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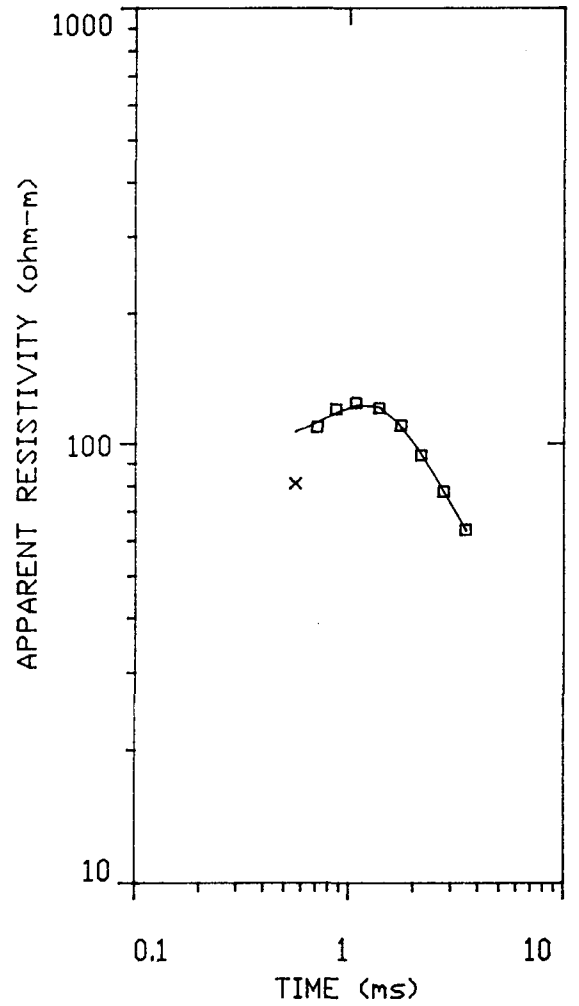
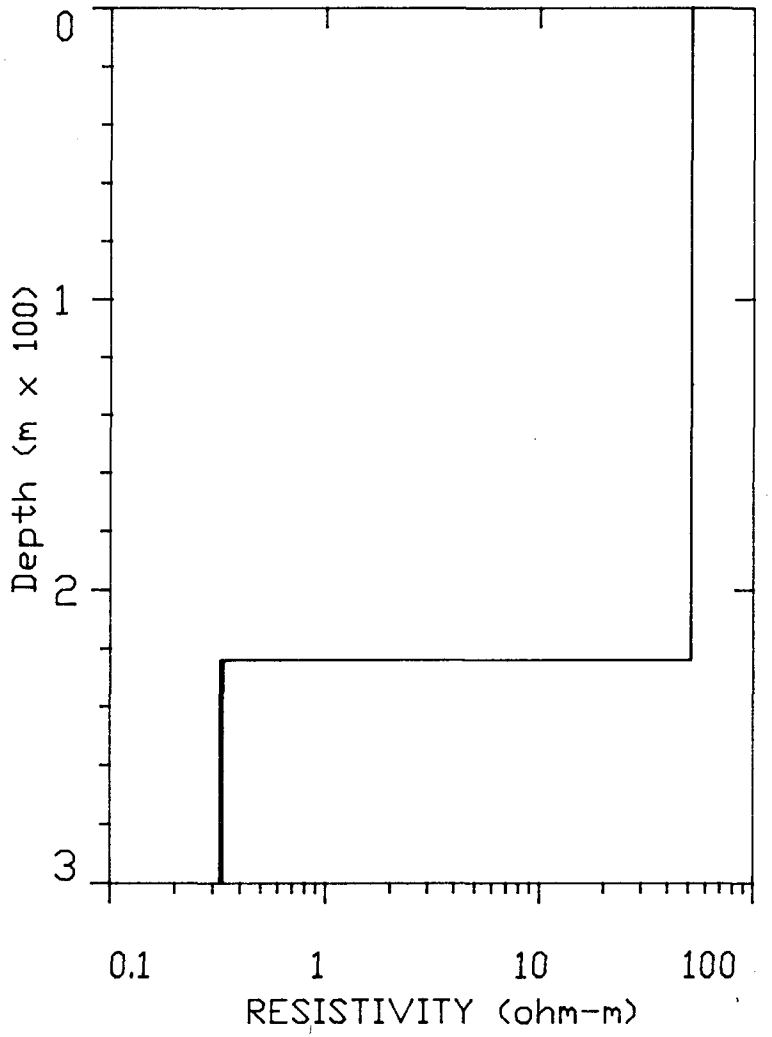
TDEM SURVEY LOCATION MAP
SOUNDING 6 – UNION CAMP/SEVILLE
VOLUSIA COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	LOC-6	5.7-1
DRAWN BY:	RBT	DATE:	07/05/94	





—— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

X APPARENT RESISTIVITY VALUES NOT USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

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SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

MEASURED TDEM APPARENT RESISTIVITY AND 1-D INVERSION
SOUNDING 6 - UNION CAMP/SEVILLE
VOLUSIA COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	MDL-6	5.7-2
DRAWN BY:	RBT	DATE:	07/06/94	

5.7.3 Depth to Occurrence of Salt Water

The bottom (second) layer of the geoelectrical model, with a resistivity of 0.3 ohm-m, is interpreted to represent salt water. It occurs at a depth of 735 ft (-707 ft msl). Because the resistivity of Layer 1 (51 ohm-m) is less than 80 ohm-m, the interpreted depth to the 5,000 mg/l isochlor is taken at the depth of the geoelectrical interface, or at 735 ft depth (-707 ft msl).

For comparison, Rutledge (1982) calculated an approximate depth of 800 ft bmsl for the freshwater-saltwater interface at this site. The interface calculated by Rutledge (1982) is based on a modified Ghyben-Herzberg principle.

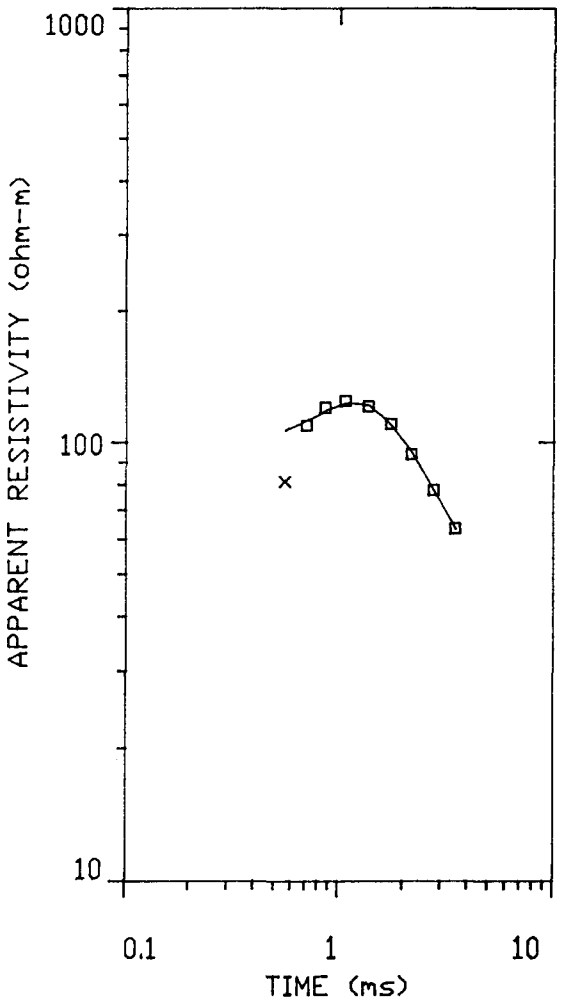
The resistivity of Layer 2 (0.3 ohm-m) corresponds to a chloride content in excess of 20,000 mg/l assuming a porosity of 25% and the validity and applicability of equation (4) of Section 4.2. It is presumed that because of the expected high chlorinity gradients, this value is sufficiently close to the 5,000 mg/l isochlor that they represent the same effective depth.

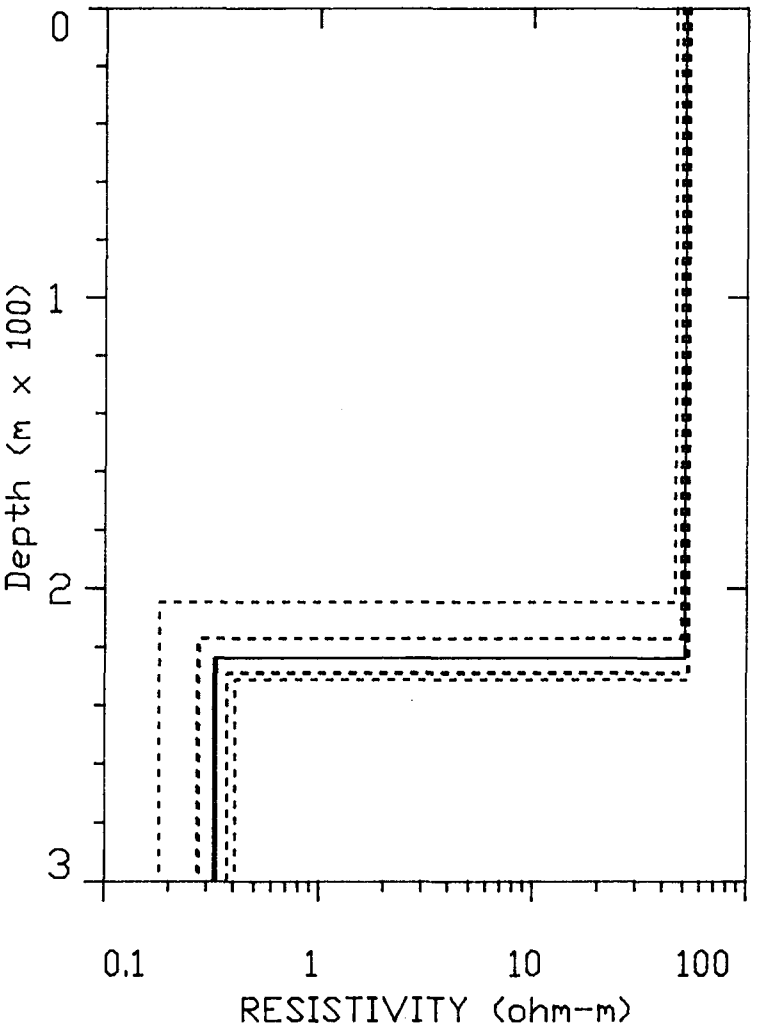
5.7.4 Depth of Occurrence of the 250 mg/l Isochlor

Because of the inability to segregate the Floridan aquifer from the overlying Holocene to Miocene deposits, the effective chloride concentration of Layer 1 cannot be calculated. For comparison, Rutledge (1985) estimated a maximum thickness of approximately 300 ft for water with a chloride concentration less than 250 mg/l in the Floridan aquifer at this site. The top of the Floridan aquifer occurs at an approximate depth of 105 ft bmsl or 133 ft bls at this site (Rutledge, 1982).

5.7.5 Accuracy of Measurement and Interpretation

Figure 5.7-3 is the equivalence analysis at this site and the inversion table (Table 5.7-1) lists the upper and lower bounds of the inverted parameters of the geoelectrical model. The range of equivalence in determining the depth to the low resistivity layer is about ±13 m (43 ft) which is 6% of the total depth.





BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

X APPARENT RESISTIVITY VALUES NOT USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

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SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

MEASURED TDEM APPARENT RESISTIVITY AND EQUIVALENCE FOR 1-D INVERSION
SOUNDING 6 – UNION CAMP/SEVILLE
VOLUSIA COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	EQU-6	5.7-3
DRAWN BY:	RBT	DATE:	07/06/94	

DATA SET: SITE 6

CLIENT: SJRWMD DATE: 30-APR-94
LOCATION: UNION CAMP/SEVILLE SOUNDING: 1
COUNTY: VOLUSIA COUNTY, FLORIDA ELEVATION: 8.50 m
PROJECT: SALT WATER INTERFACE DETECTION EQUIPMENT: Geonics PROTEM
LOOP SIZE: 152.000 m by 381.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y)
SOUNDING COORDINATES: E: 0.0000 N: 0.0000

FITTING ERROR: 1.845 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			8.50	
1	51.43	223.8	-215.3	4.35
2	0.327			

ALL PARAMETERS ARE FREE

PARAMETER BOUNDS FROM EQUIVALENCE ANALYSIS

	LAYER	MINIMUM	BEST	MAXIMUM
RHO	1	46.179	51.435	53.498
	2	0.181	0.328	0.407
THICK	1	204.681	1.000	231.330
DEPTH	1	204.681	223.883	231.330

CURRENT: 15.00 AMPS EM-37 COIL AREA: 100.00 sq m.
FREQUENCY: 30.00 Hz GAIN: 3 RAMP TIME: 202.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.558	2842.7	1892.5	33.42 MASKED
2	0.702	1024.4	989.2	3.43
3	0.858	538.5	553.6	-2.80
4	1.06	296.7	301.8	-1.70
5	1.37	165.4	163.7	0.984
6	1.74	104.7	105.3	-0.641
7	2.17	76.41	75.33	1.41

* S.D.I.I. *

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WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

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TDEM SOUNDING DATA TABLE
SOUNDING 6 – UNION CAMP/SEVILLE
VOLUSIA COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.7–1

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
8	2.77	55.24	55.43	-0.343
9	3.50	41.62	41.89	-0.636

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

	P 1	P 2	T 1
P 1	0.98		
P 2	-0.09	0.53	
T 1	-0.01	-0.07	0.99

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PALATKA, FLORIDA

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SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SOUNDING DATA TABLE
SOUNDING 6 – UNION CAMP/SEVILLE
VOLUSIA COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.7–1

The resistivity of this layer has a range of from 0.2 to 0.4 ohm-m. This corresponds to an interpreted chloride content in excess of 20,000 mg/l, again subject to the same assumptions of porosity and validity of equation (4).

The equivalence range of the resistivity of Layer 1 is from 46 to 53 ohm-m. A corresponding chloride concentration cannot be determined because Layer 1 is in part comprised of Holocene to Miocene deposits. Accordingly, equation (4) may not be valid.

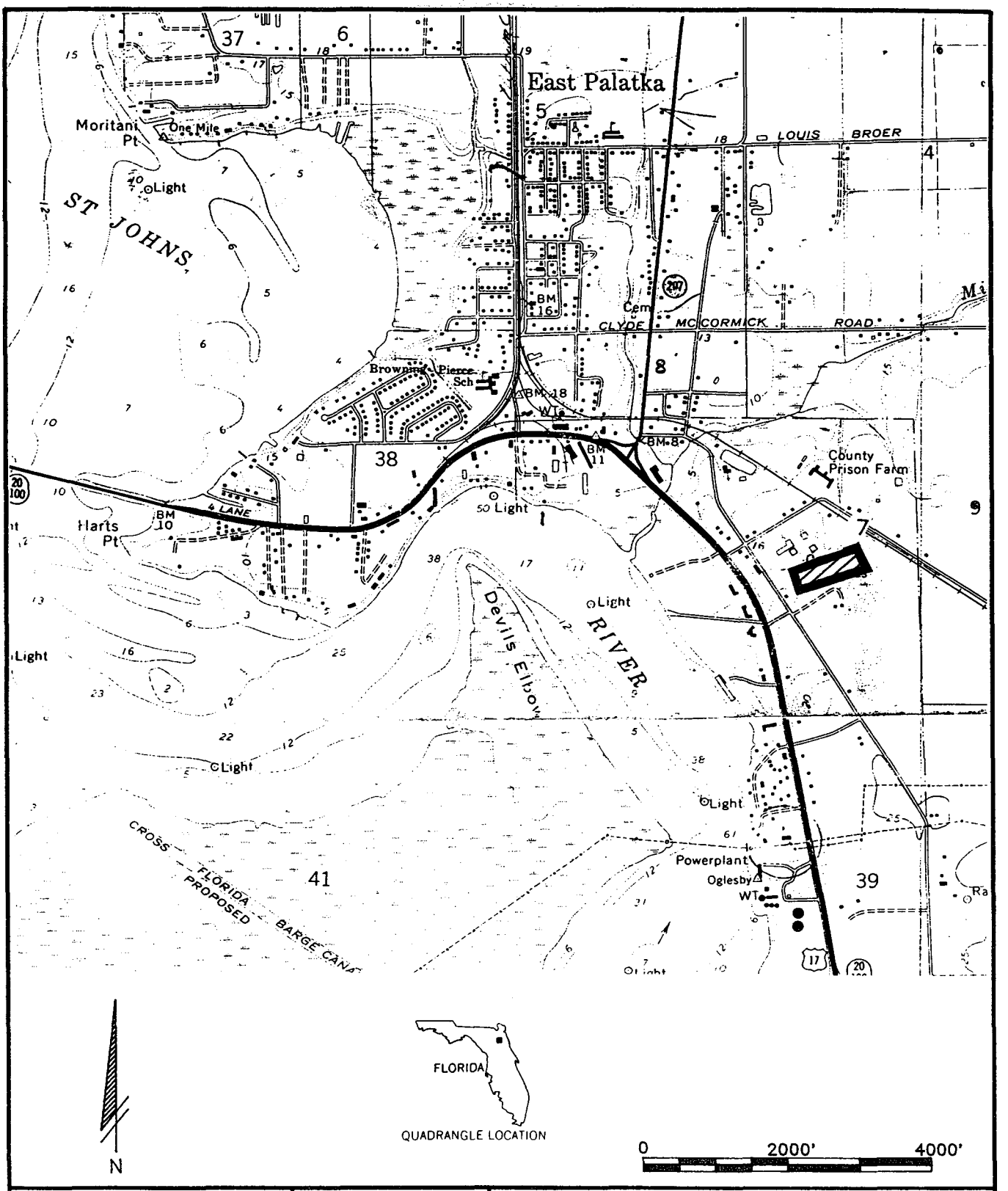
5.7.6 Summary of TDEM Sounding at Union Camp/Seville (Site 6)

- The depth of occurrence of salt water (5,000 mg/l isochlor) is interpreted to be 735 ft (-707 ft msl) and occur within the Floridan aquifer. Results of the TDEM study are in good agreement with other water quality studies (Rutledge, 1982) in the area of the site.
- The quality of ground water within the Floridan aquifer at this site cannot be interpreted because the analysis of the TDEM data does not allow the Holocene to Miocene deposits to be distinguished from the Floridan Aquifer System.

5.8 TDEM Site 7 - Putnam County Fairgrounds

5.8.1 Location Description and Geoelectrical Section

The site is located at the Putnam County Fairgrounds, in East Palatka, Florida (Figure 5.8-1). The site is located within a parking lot for the fairgrounds. Several sources of possible interference (chain link fences and powerlines) were located within 150 ft of the Tx loop. QA soundings were performed 100 ft north, east and west of the initial Rx coil location. Results from the QA soundings indicate that the apparent resistivity values were unaffected by any interference sources.



ST. JOHNS RIVER
WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SURVEY LOCATION MAP
SOUNDING 7 – PUTNAM COUNTY FAIRGROUNDS
PUTNAM COUNTY, FLORIDA

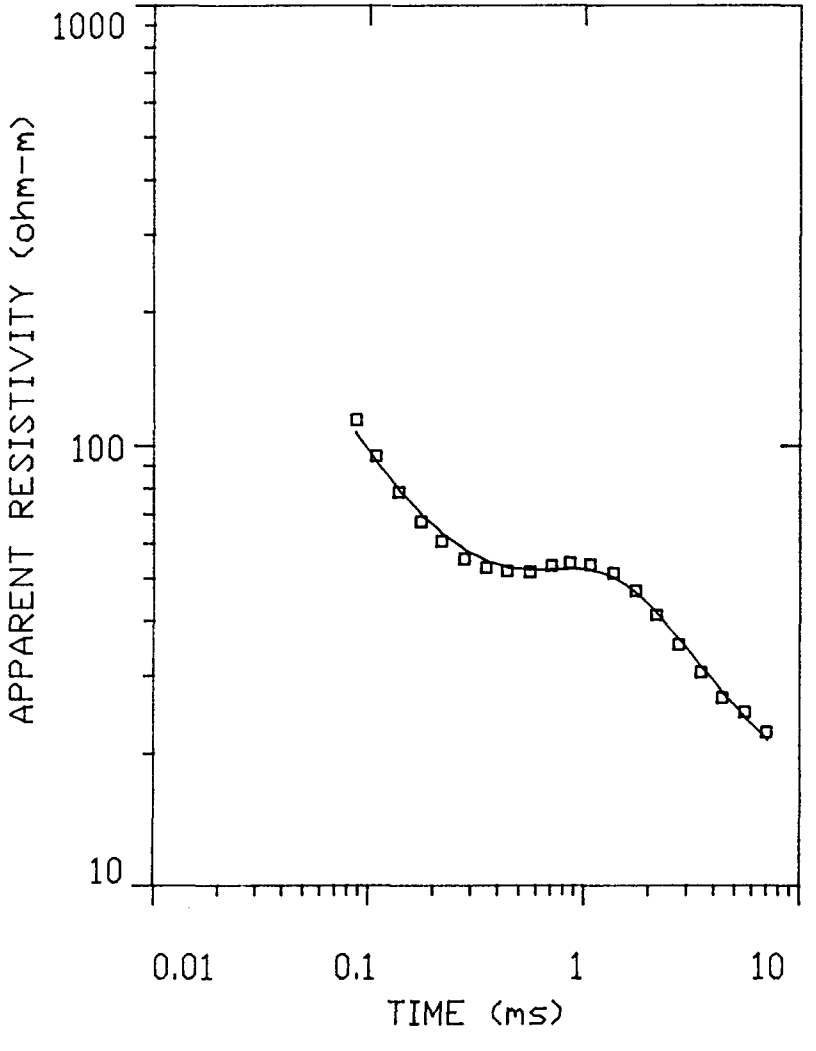
DESIGNED BY:	JEB	PROJECT. NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	LOC–7	5.8–1
DRAWN BY:	RBT	DATE:	07/05/94	

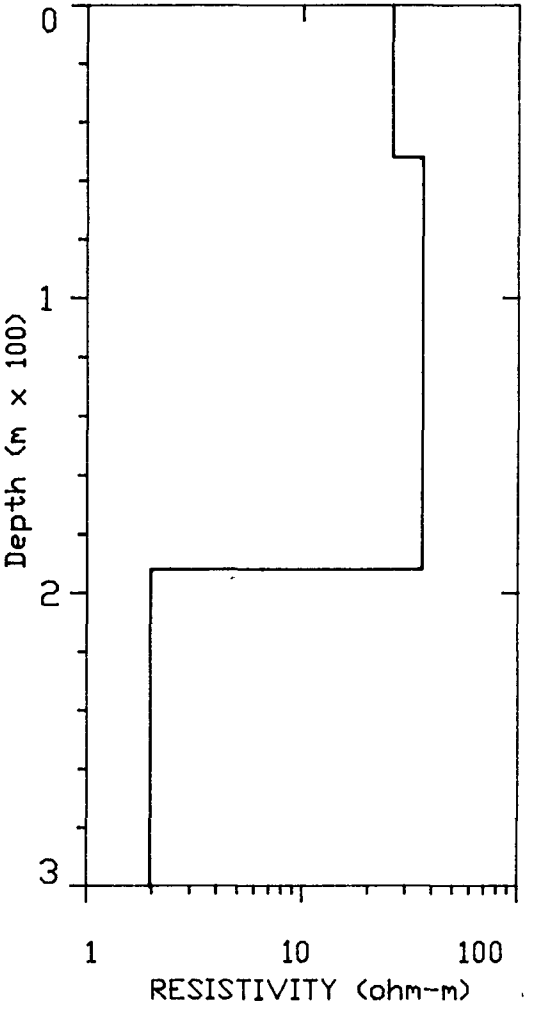
The Floridan aquifer occurs at an approximate depth of 150 ft bmsl or 170 ft bls and is overlain by the surficial aquifer system and the Hawthorn Group. The base of the Floridan aquifer occurs at approximately 1,900 ft bmsl (Tibbals, 1990). The thickness of the Upper Floridan aquifer is approximately 630 ft and the depth to the top of the Lower Floridan aquifer is approximately 800 ft bls (Miller, 1986). A water quality study in the area of the site (Tibbals, 1990) found the chloride concentration in the Upper Floridan aquifer to exceed 250 mg/l.

The resistivity sounding data and best-fit model inversion are presented on Figure 5.8-2. The interpreted geoelectrical section consists of a three-layer subsurface.

5.8.2 Geological Interpretation of Geoelectrical Model

The three-layered geoelectrical section consists of a low resistivity (26 ohm-m), upper layer which is considered to be the Hawthorn Group and surficial sediments above the Floridan aquifer. The thickness of Layer 1 was fixed at a 52 m (170 ft) value based on published information (Tibbals, 1990). The second layer has only intermediate resistivity (37 ohm-m) which, because it is less than 80 ohm-m, suggests the Floridan aquifer at this site contains brackish water. The thickness of the brackish section is 140 m (459 ft), placing the depth to the low resistivity (saltwater) layer at 192 m (630 ft) below ground surface. The resistivity of the saltwater saturated layer is 2.0 ohm-m. Layer 1 is considered to be the Hawthorn Group and surficial sediments, Layer 2 to be the Floridan aquifer (brackish) and Layer 3 to be the salt water within the Floridan aquifer.





—— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

MEASURED TDEM APPARENT RESISTIVITY AND 1-D INVERSION
SOUNDING 7 - PUTNAM COUNTY FAIRGROUNDS
PUTNAM COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	MDL-7	5.8-2
DRAWN BY:	RBT	DATE:	08/25/94	

5.8.3 Depth to Occurrence of Salt Water

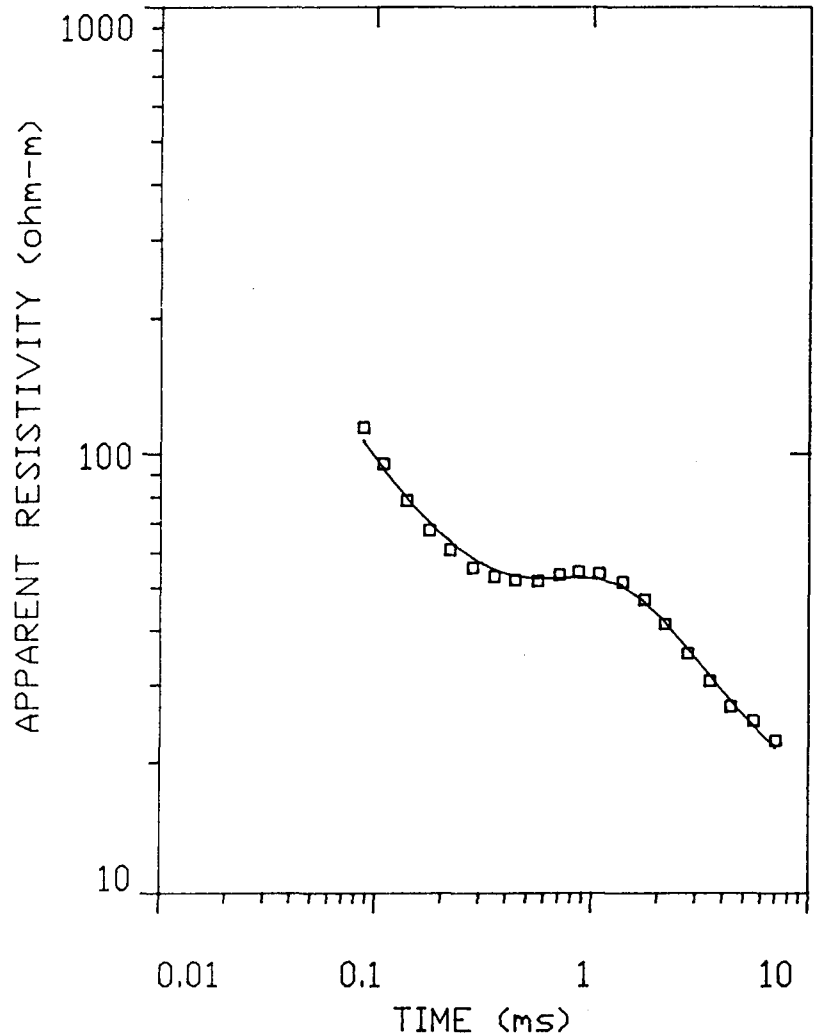
The bottom (third) layer of the geoelectrical model, with a resistivity of 2.0 ohm-m, is interpreted to represent salt water. It occurs at a depth of 630 ft (-610 ft msl). Because the resistivity of Layer 2 (37 ohm-m) is interpreted to represent brackish water within the Floridan aquifer (i.e., is less than 80 ohm-m), the interpreted depth to the 5,000 mg/l isochlor is equal to the depth of the geoelectrical interface, or at 630 ft depth (-610 ft msl). The resistivity of Layer 3 (2.0 ohm-m) corresponds to a chloride content of 15,929 mg/l assuming a porosity of 25% and the validity and applicability of equation (4) of Section 4.2. It is presumed that because of the expected high chlorinity gradients, this value is sufficiently close to the 5,000 mg/l isochlor that they represent the same effective depth.

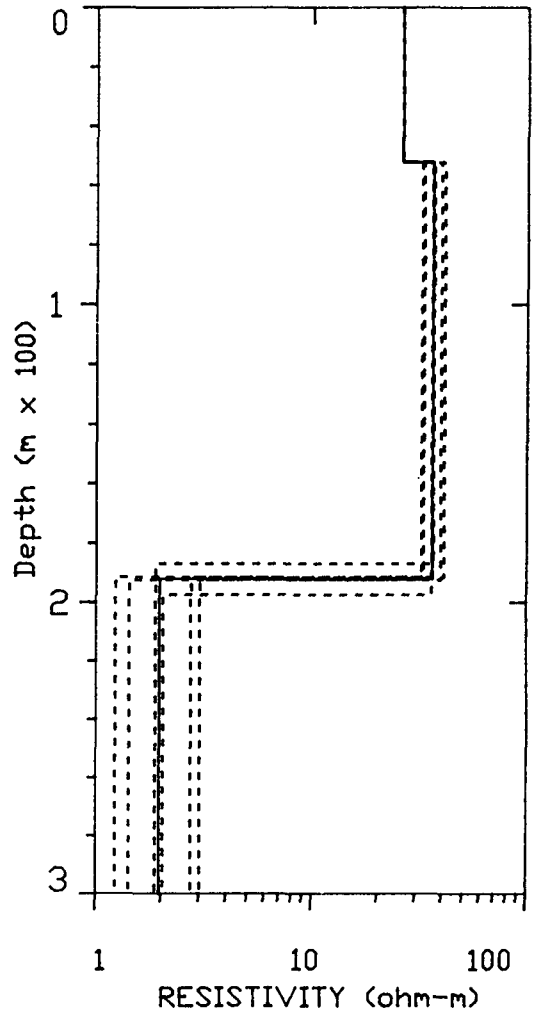
5.8.4 Depth of Occurrence of the 250 mg/l Isochlor

The resistivity of Layer 2, 37 ohm-m, corresponds to a chloride content above 250 mg/l, assuming a 25% porosity and the validity and applicability of equation (4) of Section 4.2. As the interpreted chloride content exceeds 250 mg/l, the 250 mg/l isochlor does not occur within the Floridan aquifer at this site. This conclusion is consistent with chloride concentrations in the Upper Floridan aquifer in Tibbals (1990).

5.8.5 Accuracy of Measurement and Interpretation

Figure 5.8-3 is the equivalence analysis at this site and the inversion table (Table 5.8-1) lists the upper and lower bounds of the inverted parameters of the geoelectrical model.





——— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

MEASURED TDEM APPARENT RESISTIVITY AND EQUIVALENCE FOR 1-D INVERSION
SOUNDING 7 – PUTNAM COUNTY FAIRGROUNDS
PUTNAM COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	EQU-7	5.8-3
DRAWN BY:	RBT	DATE:	08/25/94	

DATA SET: SITE 7

CLIENT: SJRWMD DATE: 04-MAY-94
LOCATION: PUTNAM COUNTY FAIRGROUNDS SOUNDING: 1
COUNTY: PUTNAM COUNTY, FLORIDA ELEVATION: 6.00 m
PROJECT: SALT WATER INTERFACE DETECTION EQUIPMENT: Geonics PROTEM
LOOP SIZE: 67.000 m by 283.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y)
SOUNDING COORDINATES: E: 0.0000 N: 0.0000

FITTING ERROR: 4.772 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)		ELEVATION (meters)	CONDUCTANCE (Siemens)
				6.00	
1	25.68	52.00	*	-46.00	2.02
2	37.47	139.6		-185.6	3.72
3	2.02				

"*" INDICATES FIXED PARAMETER

PARAMETER BOUNDS FROM EQUIVALENCE ANALYSIS

	LAYER	MINIMUM	BEST	MAXIMUM
RHO	1	24.367	25.688	27.110
	2	32.004	37.474	45.336
	3	1.299	2.021	3.184
THICK	1	52.000	0.000	52.000
	2	134.662	1.000	145.041
DEPTH	1	52.000	52.000	52.000
	2	186.662	191.657	197.041

CURRENT: 23.00 AMPS EM-57 COIL AREA: 100.00 sq m.
FREQUENCY: 30.00 Hz GAIN: 3 RAMP TIME: 177.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.0867	102689.5	115181.2	-12.16
2	0.108	78568.8	83186.3	-5.87
3	0.138	56507.9	56350.6	0.278

* S.D.I.I. *

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT PALATKA, FLORIDA	SDII SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED	TDEM SOUNDING DATA TABLE SOUNDING 7 – PUTNAM COUNTY FAIRGROUNDS PUTNAM COUNTY, FLORIDA PROJECT NO.: 94767 TABLE: 5.8–1

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
4	0.175	39274.2	37549.2	4.39
5	0.218	26475.5	25083.6	5.25
6	0.278	16554.4	15509.4	6.31
7	0.351	9890.5	9431.2	4.64
8	0.438	5846.9	5685.0	2.76
9	0.558	3215.2	3157.6	1.79
10	0.702	1726.2	1770.0	-2.53
11	0.858	1020.5	1063.6	-4.22
12	1.06	601.8	623.4	-3.58
13	1.37	343.5	353.7	-2.96
14	1.74	216.7	219.9	-1.44
15	2.17	150.9	148.6	1.52
16	2.77	103.4	99.90	3.41
17	3.50	71.55	68.79	3.85
18	4.37	50.23	48.17	4.09
19	5.56	30.80	32.15	-4.39
20	7.03	20.06	21.23	-5.83

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	0.99				
P 2	0.01	0.94			
P 3	0.01	-0.09	0.68		
F 1	0.00	0.00	0.00	0.00	
T 2	0.00	0.00	0.00	0.00	1.00
	P 1	P 2	P 3	F 1	T 2

* S.D.I.I. *

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT PALATKA, FLORIDA	SDII SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED	TDEM SOUNDING DATA TABLE SOUNDING 7 – PUTNAM COUNTY FAIRGROUNDS PUTNAM COUNTY, FLORIDA PROJECT NO.: 94767 TABLE: 5.8–1

The range of equivalence in determining the depth to the low resistivity layer is about ±5 m (16 ft) which is 3% of the total depth. The resistivity of this layer has a range from 1.2 to 3.0 ohm-m. This corresponds to a range in interpreted chloride content of from 26,650 to 10,568 mg/l, again subject to the same assumptions of porosity and validity of equation (4).

The equivalence range of the resistivity of Layer 2 is from 32 to 41 ohm-m which corresponds to a chloride content above 250 mg/l. This conclusion is consistent with the chloride concentration in the Upper Floridan aquifer in Tibbals (1990). The chloride-to-sulfate ratio at the site is 5:1 (Table 5.1-4). Accordingly, the implicit equation (4) is valid.

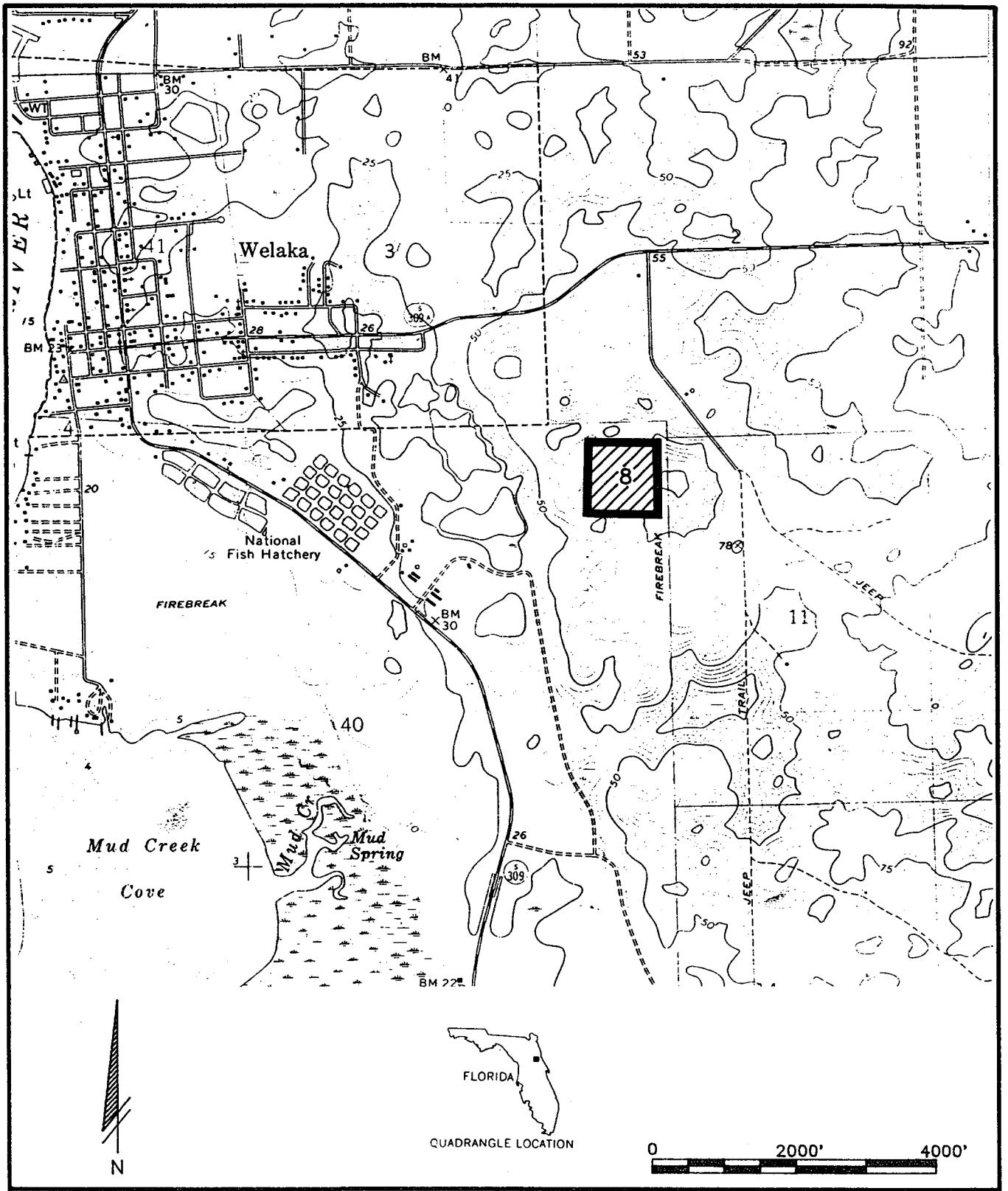
5.8.6 Summary of TDEM Sounding at Putnam County Fairgrounds (Site 7)

- The depth to occurrence of salt water (5,000 mg/l isochlor) is interpreted to be 630 ft (-610 ft msl) and occur within the Upper Floridan aquifer.
- The ground water within the Floridan aquifer at this site is interpreted to contain an average chloride concentration above 250 mg/l. The 250 mg/l isochlor is not interpreted to be present within the Floridan aquifer. This conclusion is consistent with the results of Tibbals (1990) which also found the chloride concentration in the Upper Floridan aquifer to exceed 250 mg/l.

5.9 TDEM Site 8 - Forestry Service/Welaka

5.9.1 Location Description and Geoelectrical Section

The site is located in southeast Putnam County near Welaka, Florida (Figure 5.9-1). The site is located in a wooded area. Overhead powerlines were present south and east of the Tx loop. QA soundings were performed 100 ft south and east of the initial Rx coil location. Results from the QA soundings indicate that the apparent resistivity values were unaffected by any interference sources.



ST. JOHNS RIVER
WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SURVEY LACATION MAP
SOUNDING 8 – FORESTRY SERVICE/WELAKA
PUTNAM COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	LOC-8	5.9-1
DRAWN BY:	RBT	DATE:	07/05/94	

The Floridan aquifer occurs at an approximate depth of 50 ft bmsl or 100 ft bls (Tibbals, 1990) and is overlain by the surficial aquifer system and the Hawthorn Group. The base of the Floridan aquifer occurs at approximately 1,900 ft bmsl (Tibbals, 1990). The thickness of the Upper Floridan aquifer is approximately 650 ft and the depth to the top of the Lower Floridan aquifer is approximately 750 ft bls (Miller, 1986). Water quality results near the area of the site indicate that the chloride concentration in the Upper Floridan aquifer ranges from 0 to 50 mg/l (SJRWMD, personnal communication).

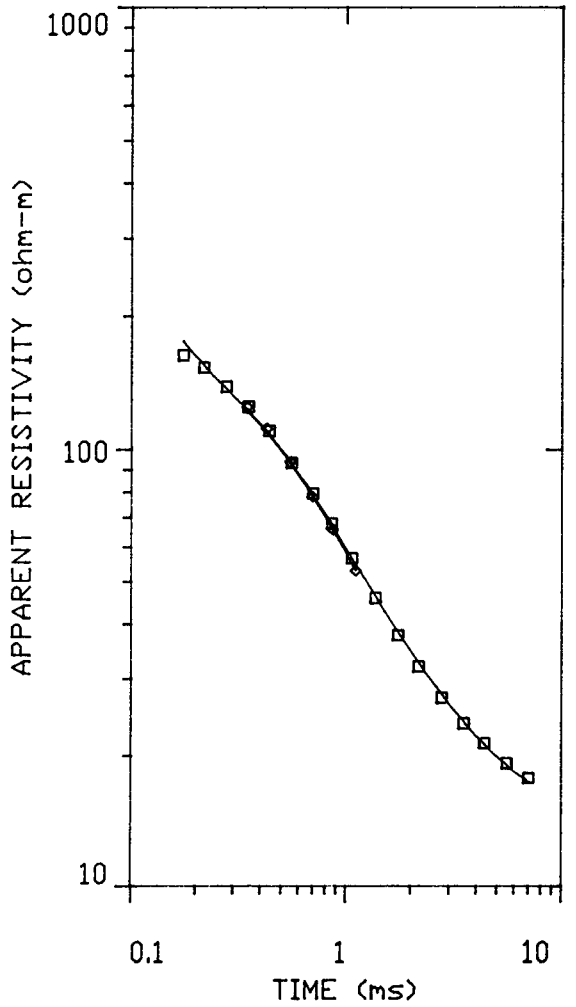
The resistivity sounding data and best-fit model inversion are presented on Figure 5.9-2. The interpreted geoelectrical section consists of a two-layer subsurface.

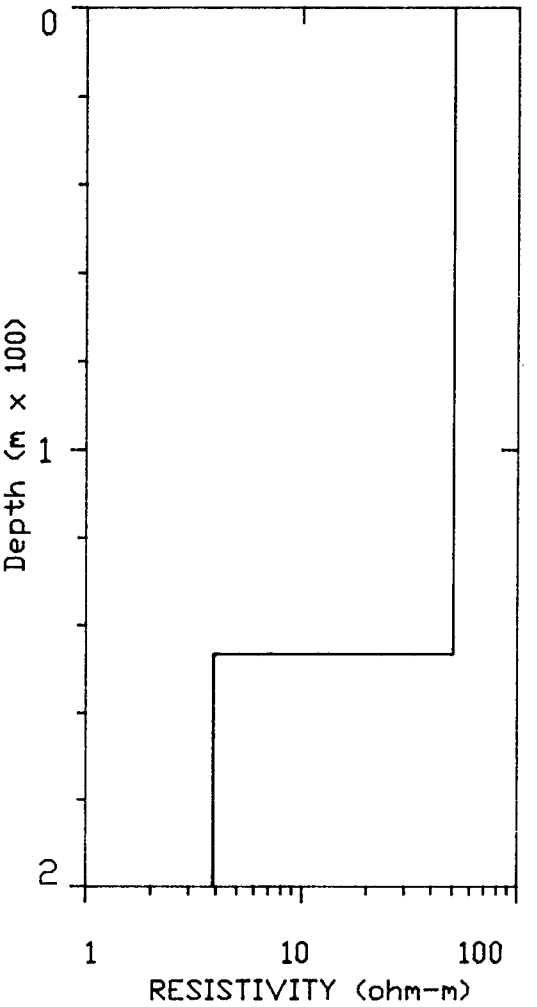
5.9.2 Geological Interpretation of Geoelectrical Model

There is insufficient electrical resistivity contrast between the surficial aquifer system layer, the Hawthorn Group and the underlying Floridan aquifer to distinguish the three. Fixing the thickness of the upper layer does not resolve this dilemma; therefore it can be interpreted that there exists a two-layer geoelectrical section with a 481 ft (146.5 m) thick surface layer of intermediate resistivity (50.6 ohm-m) overlying a low resistivity layer (3.9 ohm-m). It can be interpreted that the surficial aquifer system, the Hawthorn Group, and the upper part of the Floridan Aquifer System exist as a combined but indistinguishable (geoelectrical) layer, overlying a saltwater saturated Floridan aquifer at a depth of 481 ft bls.

5.9.3 Depth to Occurrence of Salt Water

The bottom (second) layer of the geoelectrical model, with a resistivity of 3.9 ohm-m, is interpreted to represent salt water. It occurs at a depth of 481 ft (-431 ft msl). Because the resistivity of Layer 1 (50.6 ohm-m) is less than 80 ohm-m, the interpreted depth to the 5,000 mg/l isochlor is taken at the depth of the geoelectrical interface, or at 481 ft depth (-431 ft msl). The resistivity of Layer 2 (3.9 ohm-m) corresponds to a





—— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

MEASURED TDEM APPARENT RESISTIVITY AND 1-D INVERSION
SOUNDING 8 - FORESTRY SERVICE/WELAKA
PUTNAM COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	MDL-8	5.9-2
DRAWN BY:	RBT	DATE:	07/06/94	

chloride content of 8,094 mg/l assuming a porosity of 25% and the validity and applicability of equation (4) of Section 4.2. It is presumed that because of the expected high chlorinity gradients, this value is sufficiently close to the 5,000 mg/l isochlor that they represent the same effective depth.

5.9.4 Depth of Occurrence of the 250 mg/l Isochlor

Because of the inability to segregate the Floridan aquifer from the overlying surficial aquifer system and the Hawthorn Group, the effective chloride concentration of Layer 1 cannot be calculated. Results from a water quality study performed near the area of the site indicate that the chloride concentration in the Upper Floridan aquifer ranges from 0 to 50 mg/l.

5.9.5 Accuracy of Measurement and Interpretation

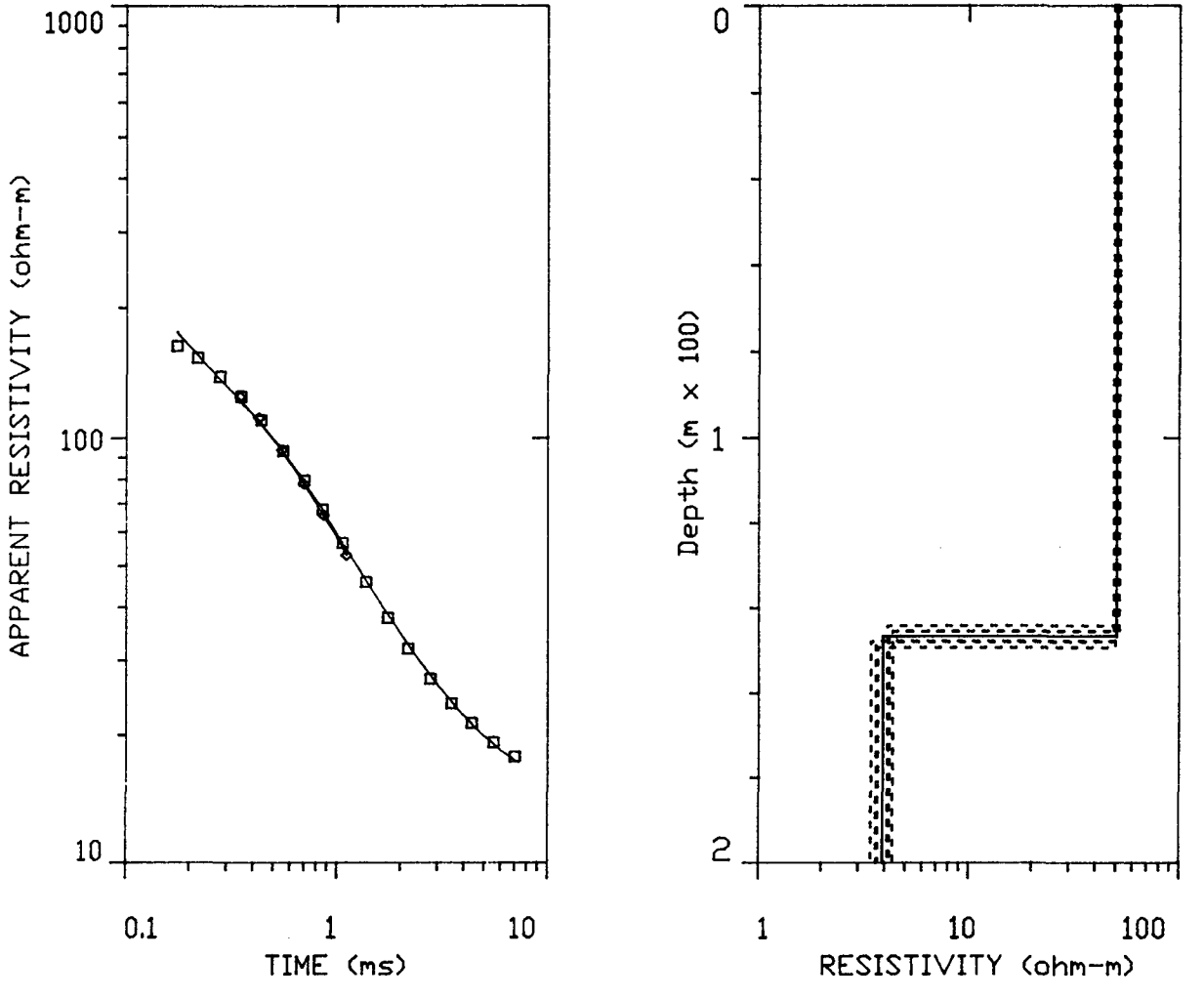
Figure 5.9-3 is the equivalence analysis at this site and the inversion table (Table 5.9-1) lists the upper and lower bounds of the inverted parameters of the geoelectrical model. The range of equivalence in determining the depth to the low resistivity layer is about ±2.5 m (8 ft) which is 2% of the total depth.

The resistivity of this layer has a range of from 3.4 to 4.4 ohm-m. This corresponds to a range in interpreted chloride content of from 9,307 mg/l to 7,157 mg/l, again subject to the same assumptions of porosity and validity of equation (4).

The equivalence range of the resistivity of Layer 1 is from 49 to 52 ohm-m. A corresponding chloride concentration cannot be determined because Layer 1 is in part comprised of the Hawthorn Group and surficial sediments. Accordingly, equation (4) may not be valid.

5.9.6 Summary of TDEM Sounding at Forestry Service/Welaka (Site 8)

- The depth of occurrence of salt water (5,000 mg/l isochlor) is interpreted to be 481 ft (-431 ft msl) and occur within the Upper Floridan aquifer.



—— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

MEASURED TDEM APPARENT RESISTIVITY AND EQUIVALENCE FOR 1-D INVERSION
SOUNDING 8 - FORESTRY SERVICE/WELAKA
PUTNAM COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	EQU-8	5.9-3
DRAWN BY:	RBT	DATE:	07/06/94	

DATA SET: SITE 8

CLIENT: SJRWMD DATE: 05-MAY-94
LOCATION: FORESTRY SERVICE/WELAKA SOUNDING: 1
COUNTY: PUTNAM COUNTY, FLORIDA ELEVATION: 15.00 m
PROJECT: SALT WATER INTERFACE DETECTION EQUIPMENT: Geonics PROTEM
LOOP SIZE: 328.000 m by 305.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y)
SOUNDING COORDINATES: E: 0.0000 N: 0.0000

FITTING ERROR: 3.040 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			15.00	
1	50.56	146.5	-131.5	2.89
2	3.89			

ALL PARAMETERS ARE FREE

PARAMETER BOUNDS FROM EQUIVALENCE ANALYSIS

	LAYER	MINIMUM	BEST	MAXIMUM
RHO	1	49.094	50.564	52.203
	2	3.442	3.897	4.365
THICK	1	144.015	1.000	149.195
DEPTH	1	144.015	146.549	149.195

CURRENT: 20.00 AMPS EM-57 COIL AREA: 100.00 sq m.
FREQUENCY: 30.00 Hz GAIN: 3 RAMP TIME: 272.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.175	37552.1	33693.7	10.27
2	0.218	23820.1	23417.7	1.68
3	0.278	15046.1	15307.4	-1.73
4	0.351	9837.7	10155.2	-3.22
5	0.438	6839.4	6981.9	-2.08
6	0.558	4789.6	4789.6	3.262E-04
7	0.702	3435.1	3458.8	-0.692

ST. JOHNS RIVER
WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SOUNDING DATA TABLE
SOUNDING 8 – FORESTRY SERVICE/WELAKA
PUTNAM COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.9–1

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
8	0.858	2634.4	2643.4	-0.341
9	1.06	2009.2	2000.7	0.423
10	1.37	1469.6	1449.5	1.36
11	1.74	1082.9	1052.6	2.80
12	2.17	799.4	775.9	2.93
13	2.77	554.9	540.2	2.64
14	3.50	378.2	374.1	1.08
15	4.37	254.3	257.6	-1.29
16	5.56	163.6	166.9	-2.02
17	7.03	102.3	106.1	-3.68

CURRENT: 20.00 AMPS EM-57 COIL AREA: 100.00 sq m.
FREQUENCY: 7.50 Hz GAIN: 6 RAMP TIME: 272.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
18	0.346	10237.0	10527.0	-2.83
19	0.427	7154.9	7393.3	-3.33
20	0.550	4935.8	5003.7	-1.37
21	0.698	3583.5	3593.4	-0.276
22	0.869	2678.1	2703.5	-0.948
23	1.10	2015.6	2004.1	0.571

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	0.99		
P 2	-0.01	0.92	
T 1	0.00	0.01	1.00
	P 1	P 2	T 1

ST. JOHNS RIVER
WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SOUNDING DATA TABLE
SOUNDING 8 – FORESTRY SERVICE/WELAKA
PUTNAM COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.9-1

- The quality of ground water within the Floridan aquifer at this site cannot be interpreted because the analysis of the TDEM data does not allow the Hawthorn Group and surficial aquifer system to be distinguished from the Floridan Aquifer System.

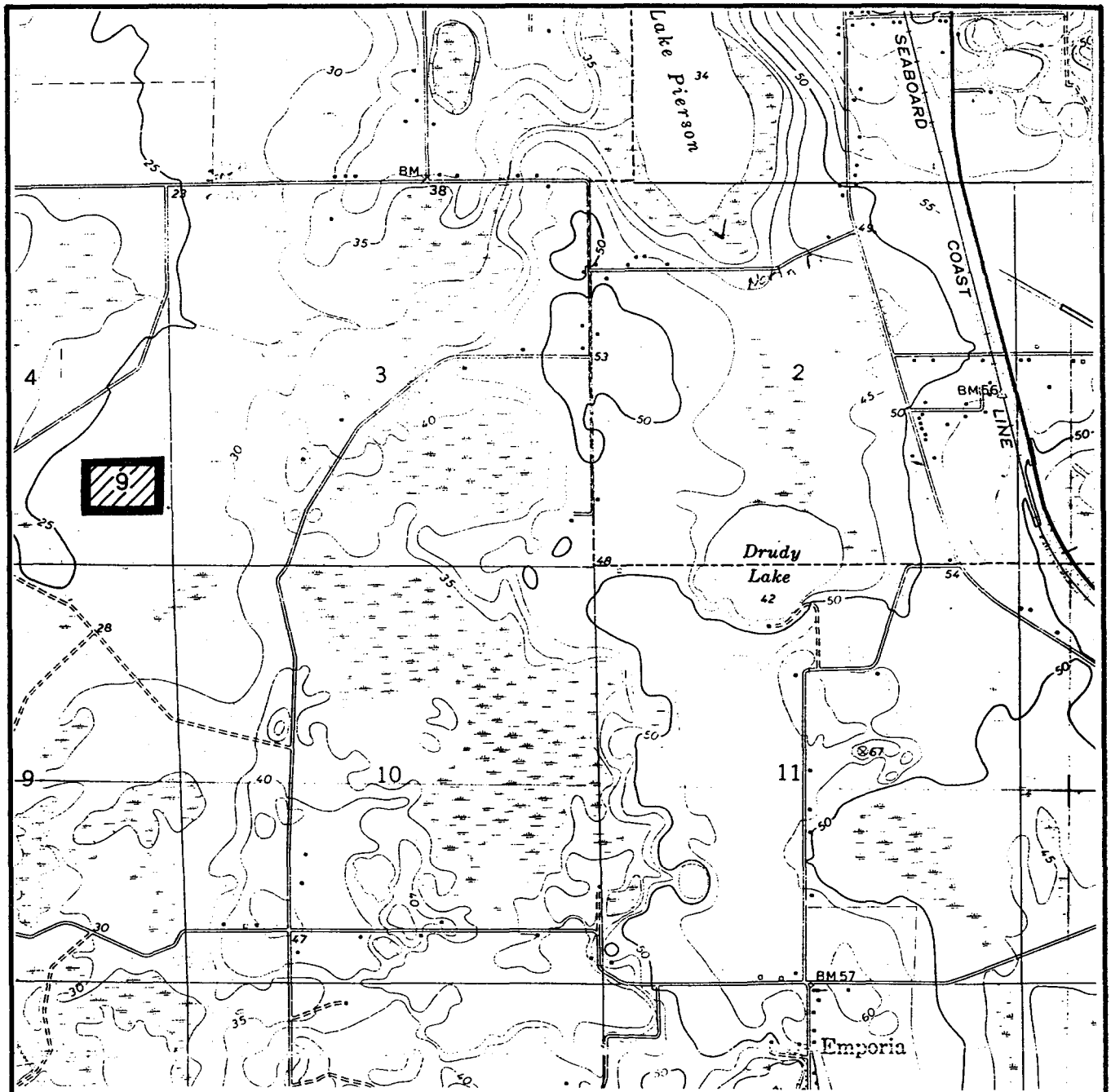
5.10 TDEM Site 9 - Pierson/West

5.10.1 Location Description and Geoelectrical Section

The site is located in northwestern Volusia County near Pierson, Florida (Figure 5.10-1). The site is used as a pasture. A possible interference source (a barbed wire fence) was present approximately 100 ft away from the north, south, and west boundaries of the Tx loop. QA soundings were performed 80 ft north, south, east and west of the initial Rx coil location. Results from the QA soundings indicate that the apparent resistivity values were unaffected by any interference sources.

The Floridan aquifer occurs at an approximate depth of 54 ft bmsl or 80 ft bls and is overlain by Holocene to Miocene deposits (Rutledge, 1982). The base of the Floridan aquifer occurs at approximately 1,960 ft bmsl (Tibbals, 1990). The thickness of the Upper Floridan aquifer is approximately 670 ft and the depth to the top of the Lower Floridan aquifer is approximately 735 ft bls (Miller, 1986). A water quality study performed in the area of the site (Rutledge, 1982) indicates that the chloride concentration in the upper portion of the Floridan aquifer ranges from 0 to 25 mg/l.

The resistivity sounding data and best-fit model inversion are presented on Figure 5.10-2. The interpreted geoelectrical section consists of a three-layer subsurface.

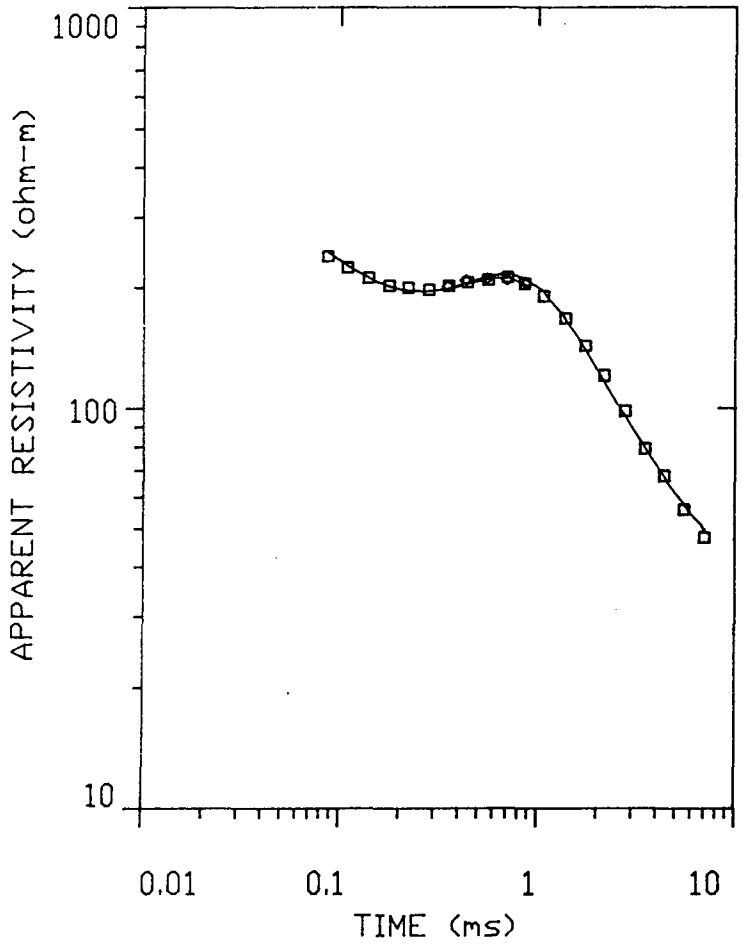


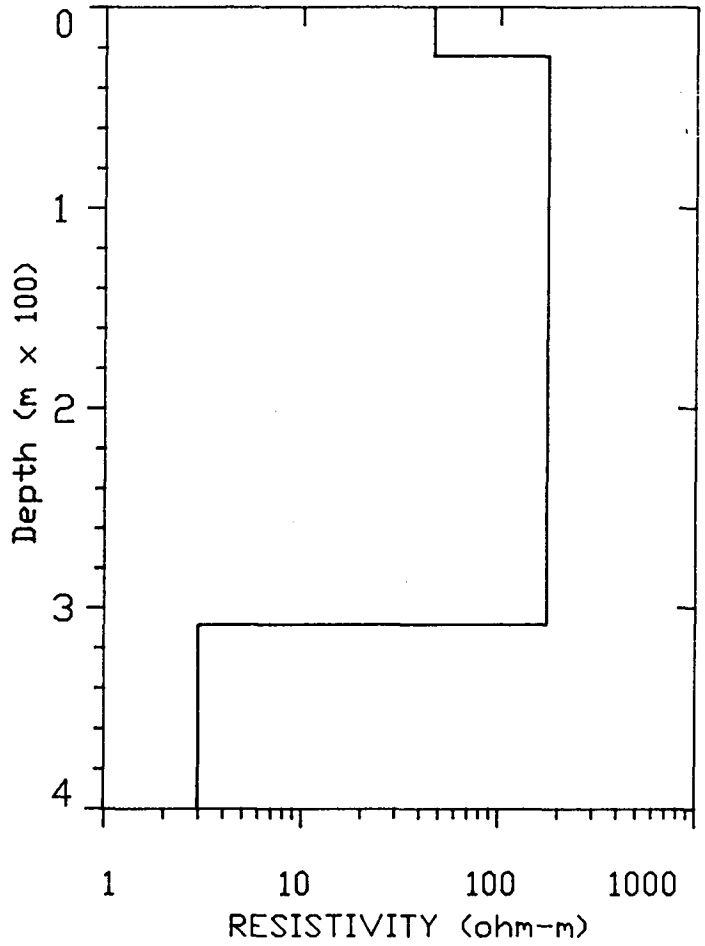
ST. JOHNS RIVER
WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SURVEY LOCATION MAP
SOUNDING 9 – PIERSON/WEST
VOLUSIA COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	LOC-9	5.10-1
DRAWN BY:	RBT	DATE:	07/05/94	





—— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

MEASURED TDEM APPARENT RESISTIVITY AND 1-D INVERSION
SOUNDING 9 - PIERSON/WEST
VOLUSIA COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	MDL-9	5.10-2
DRAWN BY:	RBT	DATE:	08/25/94	

5.10.2 Geological Interpretation of Geoelectrical Model

The three-layer geoelectrical section consists of a low resistivity (46 ohm-m), upper layer which correlates with the Holocene to Miocene deposits above the Floridan aquifer. The thickness of Layer 1 was fixed at 24 m (80 ft) based on the information from Rutledge (1982). The second layer has high resistivity (177 ohm-m) which means that because it is greater than 80 ohm-m the Floridan aquifer at this site contains fresh water. The thickness of the freshwater section is 285 m (935 ft) placing the depth to the low resistivity (saltwater) layer at 309 m (1,014 ft) below ground surface. The resistivity of the saltwater layer is 3.0 ohm-m. Layer 1 is considered to be the Holocene to Miocene deposits above the Floridan aquifer, Layer 2 to be the Floridan aquifer containing fresh water, and Layer 3 to be the salt water within the Floridan aquifer.

5.10.3 Depth to Occurrence of Salt Water

The bottom (third) layer of the geoelectrical model, with a resistivity of 3.0 ohm-m, is interpreted to represent salt water. It occurs at a depth of 1,014 ft (-988 ft msl). Because the resistivity of Layer 2 (177 ohm-m) is greater than 80 ohm-m, the interpreted depth to the 5,000 mg/l isochlor is taken as 50 ft greater than the depth of the geoelectrical interface, or at a depth of 1,064 ft (-1,038 ft bmsl). For comparison, Rutledge (1982) calculated an approximate depth of 750 ft bmsl for the freshwater-saltwater interface at this site. The interface calculated by Rutledge (1982) is based on a modified Ghyben-Herzberg principal.

The resistivity of Layer 3 (3.0 ohm-m) corresponds to a chloride content of 10,568 mg/l, assuming a porosity of 25% and the validity and applicability of equation (4) of Section 4.2. It is presumed that because of the expected high chlorinity gradients, this value is sufficiently close to the 5,000 mg/l isochlor that they represent the same effective depth.

5.10.4 Depth of Occurrence of the 250 mg/l Isochlor

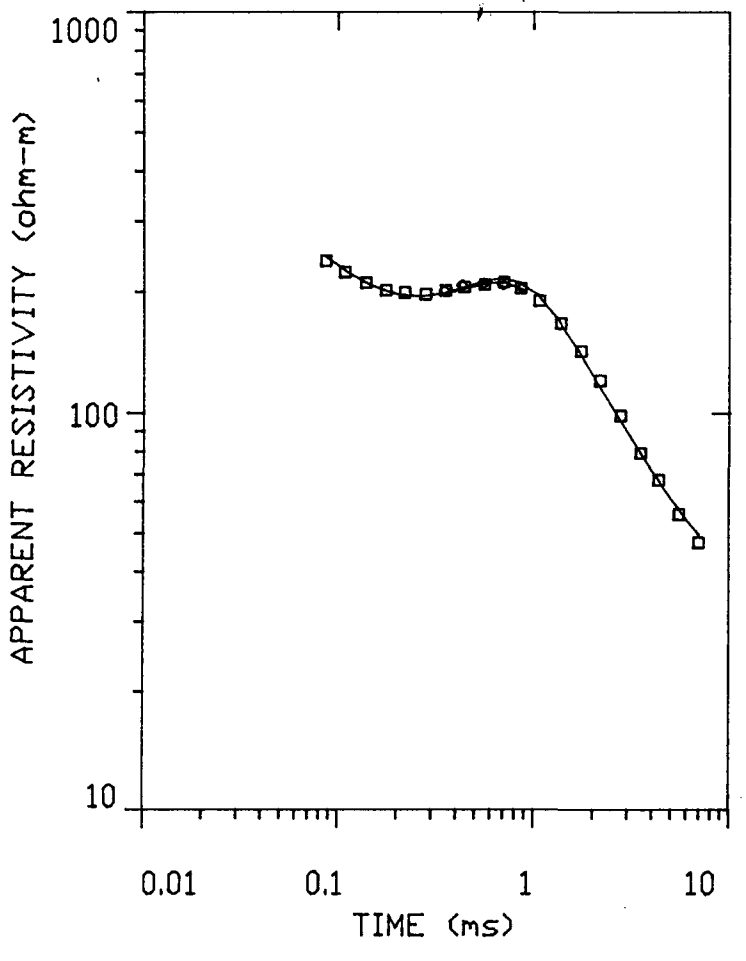
The resistivity of Layer 2, 177 ohm-m, corresponds to a chloride content of less than 250 mg/l, assuming a 25% porosity and the validity and applicability of equation (4) of Section 4.2. The 250 mg/l isochlor is placed in the Floridan aquifer at a depth 50 ft above the Layer 3 interface or at 964 ft (-948 ft msl). For comparison, Rutledge (1985) estimated a maximum thickness of 600 ft for water with a chloride concentration less than 250 mg/l in the Floridan aquifer at this site. The top of the Floridan aquifer occurs at an approximate depth of 54 ft bmsl or 80 ft bls at this site (Rutledge, 1982).

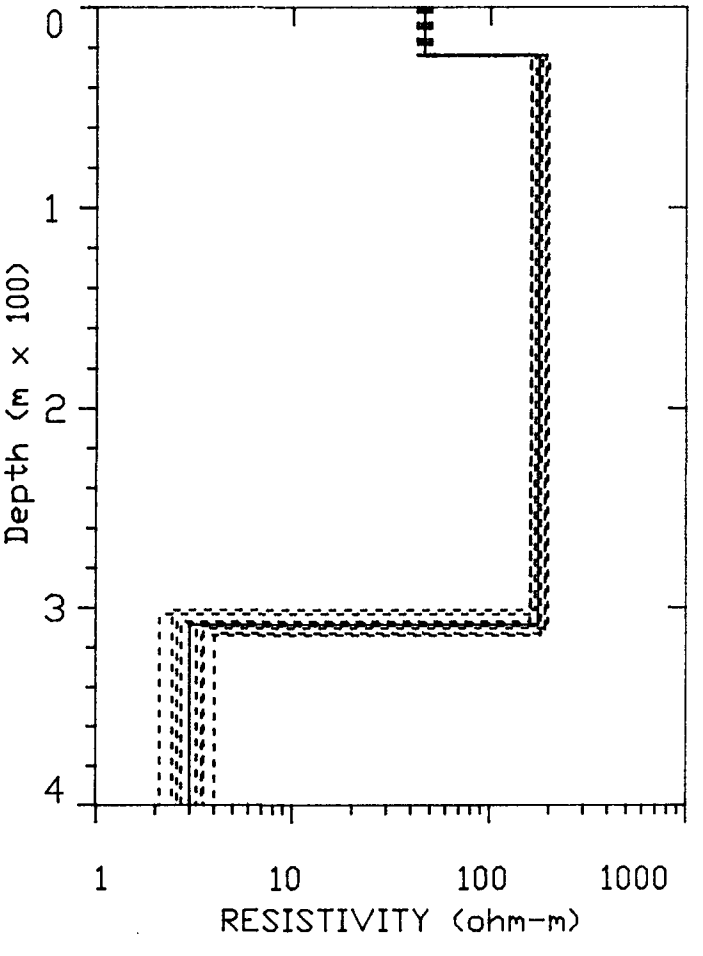
5.10.5 Accuracy of Measurement and Interpretation

Figure 5.10-3 is the equivalence analysis at this site andthe inversion table (Table 5.10-1) lists the upper and lower bounds of the inverted parameters of the geoelectrical model.

The range of equivalence in determining the depth to the low resistivity layer is about ±6 m (20 ft) which is 2% of the total depth. The resistivity of this layer has a range of from 2.1 to 4.0 ohm-m. This corresponds to a range in interpreted chloride content of from 15,163 mg/l to 7,880 mg/l, again subject to the same assumptions of porosity and validity of equation (4).

The equivalence range of the resistivity of Layer 2 is from 160 to 197 ohm-m which corresponds to a chloride content of less than 250 mg/l. The results from the TDEM study agree with the water quality results from Rutledge (1982). The chloride-to-sulfate ratio at the site is 2:1 (Table 5.1-4). Accordingly, Equation (4) may not be valid.





BEST-FIT MODELED CURVE

APPARENT RESISTIVITY VALUES USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

MEASURED TDEM APPARENT RESISTIVITY AND EQUIVALENCE FOR 1-D INVERSION
SOUNDING 9 - PIERSON/WEST
VOLUSIA COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	EQU-9	5.10-3
DRAWN BY:	RBT	DATE:	08/25/94	

DATA SET: SITE 9

CLIENT: SJRWMD DATE: 05-MAY-94
LOCATION: PIERSON/WEST SOUNDING: 1
COUNTY: VOLUSIA COUNTY, FLORIDA ELEVATION: 8.00 m
PROJECT: SALT WATER INTERFACE DETECTION EQUIPMENT: Geonics PROTEM
LOOP SIZE: 259.000 m by 139.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y)
SOUNDING COORDINATES: E: 0.0000 N: 0.0000

FITTING ERROR: 3.139 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)		ELEVATION (meters)	CONDUCTANCE (Siemens)
				8.00	
1	45.99	24.00	*	-16.00	0.521
2	176.9	284.5		-300.5	1.60
3	2.98				

"*" INDICATES FIXED PARAMETER

PARAMETER BOUNDS FROM EQUIVALENCE ANALYSIS

LAYER		MINIMUM	BEST	MAXIMUM
RHO	1	42.346	45.996	49.995
	2	160.289	176.920	197.460
	3	2.094	2.983	3.993
THICK	1	24.000	0.000	24.000
	2	277.113	1.000	289.853
DEPTH	1	24.000	24.000	24.000
	2	301.113	308.500	313.853

CURRENT: 22.50 AMPS EM-57 COIL AREA: 100.00 sq m.
FREQUENCY: 30.00 Hz GAIN: 4 RAMP TIME: 182.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.0867	51924.1	49906.6	3.88
2	0.108	33047.6	32587.9	1.39
3	0.138	19610.7	19631.9	-0.108

ST. JOHNS RIVER
WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SOUNDING DATA TABLE
SOUNDING 9 – PIERSON/WEST
VOLUSIA COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.10–1

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
4	0.175	11566.0	11668.1	-0.882
5	0.218	6803.0	6994.6	-2.81
6	0.278	3766.4	3833.1	-1.76
7	0.351	2035.4	2083.5	-2.36
8	0.438	1134.5	1139.9	-0.478
9	0.558	606.2	587.9	3.02
10	0.702	334.2	322.7	3.44
11	0.858	213.6	204.2	4.38
12	1.06	138.4	132.7	4.14
13	1.37	89.55	89.66	-0.127
14	1.74	62.38	64.32	-3.11
15	2.17	46.36	48.96	-5.61
16	2.77	34.12	35.67	-4.52
17	3.50	26.36	26.33	0.0974
18	4.37	19.08	19.30	-1.10
19	5.56	14.02	13.53	3.44
20	7.03	9.95	9.33	6.26

CURRENT: 22.50 AMPS EM-57 COIL AREA: 100.00 sq m.
FREQUENCY: 7.50 Hz GAIN: 8 RAMP TIME: 182.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
21	0.346	2113.9	2177.5	-3.00
22	0.427	1191.8	1234.4	-3.58
23	0.550	624.0	623.6	0.0629
24	0.698	346.8	338.9	2.25
25	0.869	206.2	210.2	-1.90

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	0.95				
P 2	0.05	0.93			
P 3	0.06	-0.11	0.59		
F 1	0.00	0.00	0.00	0.00	
T 2	0.00	0.00	-0.02	0.00	1.00
	P 1	P 2	P 3	F 1	T 2

ST. JOHNS RIVER
WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SOUNDING DATA TABLE
SOUNDING 9 – PIERSON/WEST
VOLUSIA COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.10–1

5.10.6 Summary of TDEM Sounding at Pierson/West (Site 9)

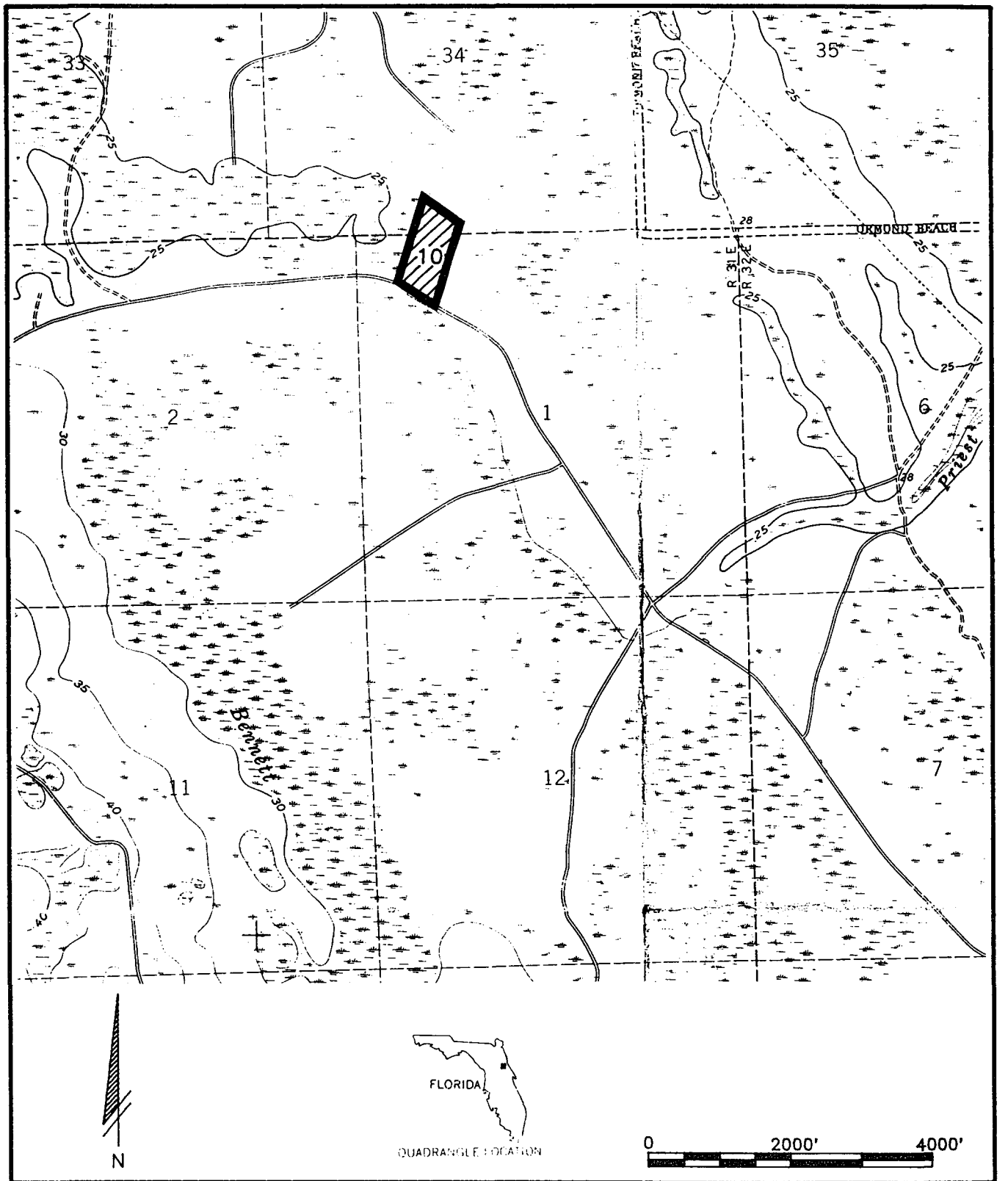
- The depth to occurrence of salt water (5,000 mg/l isochlor) is interpreted to be 1,064 ft (-1,038 ft msl) and occur within the Lower Floridan aquifer. For comparison, Rutledge (1982) calculated an approximate depth of 750 ft bmsl for the freshwater-saltwater interface at this site.
- The ground water within the Floridan aquifer at this site is interpreted to contain an average chloride concentration of less than 250 mg/l. The 250 mg/l isochlor is interpreted to be present in the Floridan aquifer at a depth of 964 ft (-948 ft msl). For comparison, Rutledge (1985) estimated a depth to the 250 mg/l isochlor of approximately 680 ft bls at this site.
- The results of the TDEM study agree with the results of a water quality study performed in the area of the site which indicate that the chloride content in the Upper Floridan aquifer is less than 250 mg/l.

5.11 TDEM Site 10 - Tomoka Land Corporation

5.11.1 Location Description and Geoelectrical Section

The site is located in northeastern Volusia County (Figure 5.11-1). The site is located within a tree farm. No visible sources of interference were observed within the area of the project site. QA soundings were performed 100 ft north and south of the initial Rx coil location. Results from the QA soundings indicate that the apparent resistivity values were unaffected by any interference sources.

The top of the Floridan aquifer occurs at an approximate depth of 75 ft bmsl or 100 ft bls (Rutledge, 1985) and is overlain by Holocene to Miocene deposits. The bottom of the Floridan aquifer occurs at approximately 2,100 ft bmsl (Tibbals, 1990). The thickness of the Upper Floridan aquifer is approximately 750 ft and the depth to the top of the Lower



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SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SURVEY LOCATION MAP
SOUNDING 10 – TOMOKA LAND COMPANY
VOLUSIA COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	LOC-10	5.11-1
DRAWN BY:	RBT	DATE:	07/05/94	

Floridan aquifer is approximately 850 ft bls (Miller, 1986). A water quality study performed in the area of the site (Rutledge, 1985) indicates that the chloride concentration in the upper portion of the Floridan aquifer ranges from 0 to 50 mg/l.

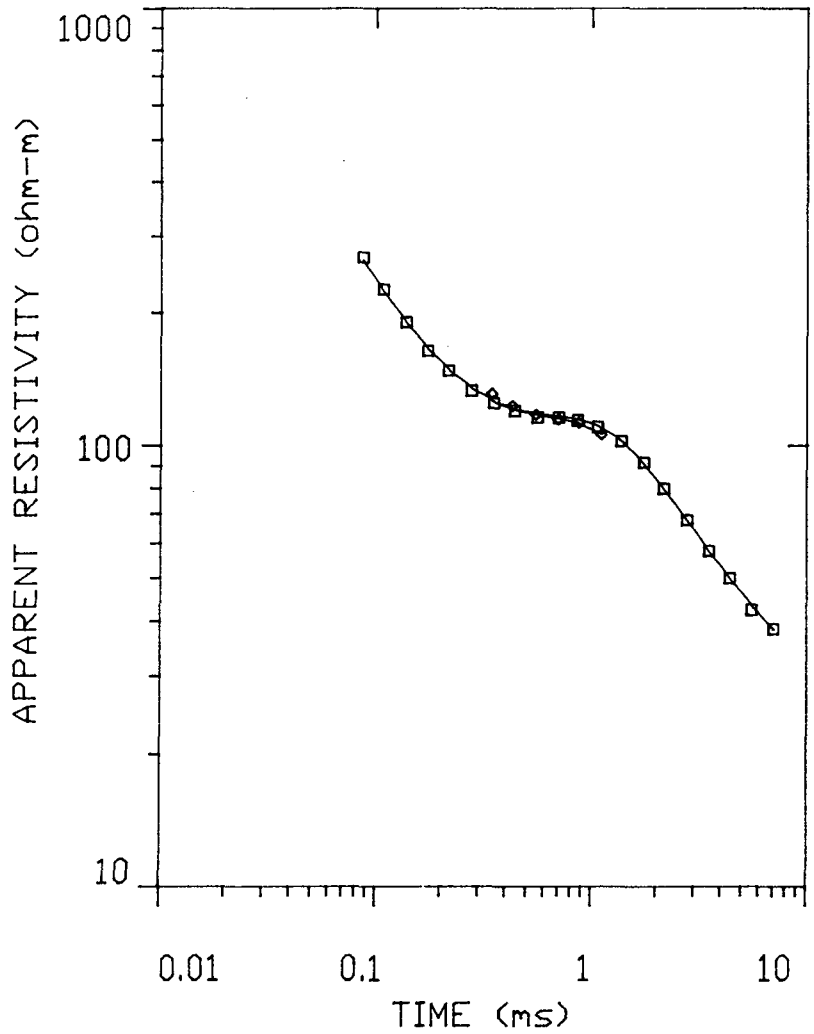
The resistivity sounding data and best-fit model inversion are presented on Figure 5.11-2. The interpreted geoelectrical section consists of a two-layer subsurface.

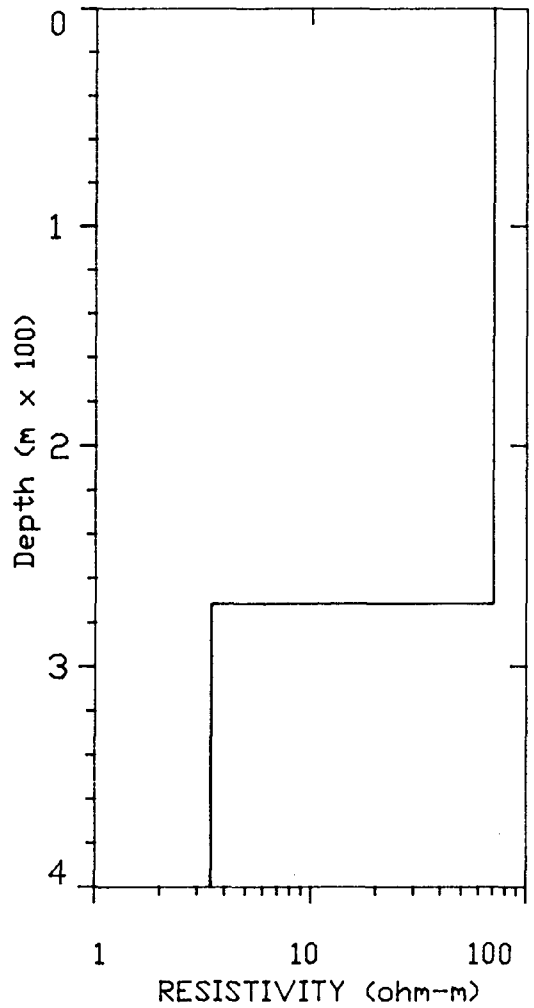
5.11.2 Geological Interpretation of Geoelectrical Model

The first layer occurs at a depth of 272 m (892 ft) bls and not at the hydrostratigraphic contact of the Floridan Aquifer system. Therefore, it can be interpreted that there exists a two-layer geoelectrical section with a relatively thick (892 ft) surface layer of intermediate resistivity (70 ohm-m) overlying a low resistivity layer (3.5 ohm-m). It can be interpreted that the Holocene to Miocene deposits overlying the Floridan aquifer and the upper part of the Floridan aquifer system exist as a combined but indistinguishable (geoelectrical) layer, overlying a saltwater saturated Floridan aquifer at a depth of 892 ft bls.

5.11.3 Depth to Occurrence of Salt Water

The bottom (second) layer of the geoelectrical model, with a resistivity of 3.5 ohm-m, is interpreted to represent salt water. It occurs at a depth of 892 ft (-867 ft msl). Because the resistivity of Layer 1 (70.4 ohm-m) is less than 80 ohm-m, the interpreted depth to the 5,000 mg/l isochlor is taken at the depth of the geoelectrical interface, or at 892 ft depth (-867 ft msl). The resistivity of Layer 2 (3.5 ohm-m) corresponds to a chloride content of 9,037 mg/l assuming a porosity of 25% and the validity and applicability of equation (4) of Section 4.2. It is presumed that because of the expected high chlorinity gradients, this value is sufficiently close to the 5,000 mg/l isochlor that they represent the same effective depth.





——— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

MEASURED TDEM APPARENT RESISTIVITY AND 1-D INVERSION
SOUNDING 10 – TOMOKA LAND COMPANY
VOLUSIA COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	MDL-10	5.11-2
DRAWN BY:	RBT	DATE:	07/06/94	

5.11.4 Depth of Occurrence of the 250 mg/l Isochlor

Because of the inability to segregate the Floridan aquifer from the overlying Holocene to Miocene deposits, the effective chloride concentration of Layer 1 cannot be calculated. Rutledge (1985) estimated a maximum thickness of approximately 600 ft for water with a chloride concentration less than 250 mg/l in the Floridan aquifer at this site. The top of the Floridan aquifer occurs at an approximate depth of 75 ft bmsl or 100 ft bls at this site (Rutledge, 1985).

5.11.5 Accuracy of Measurement and Interpretation

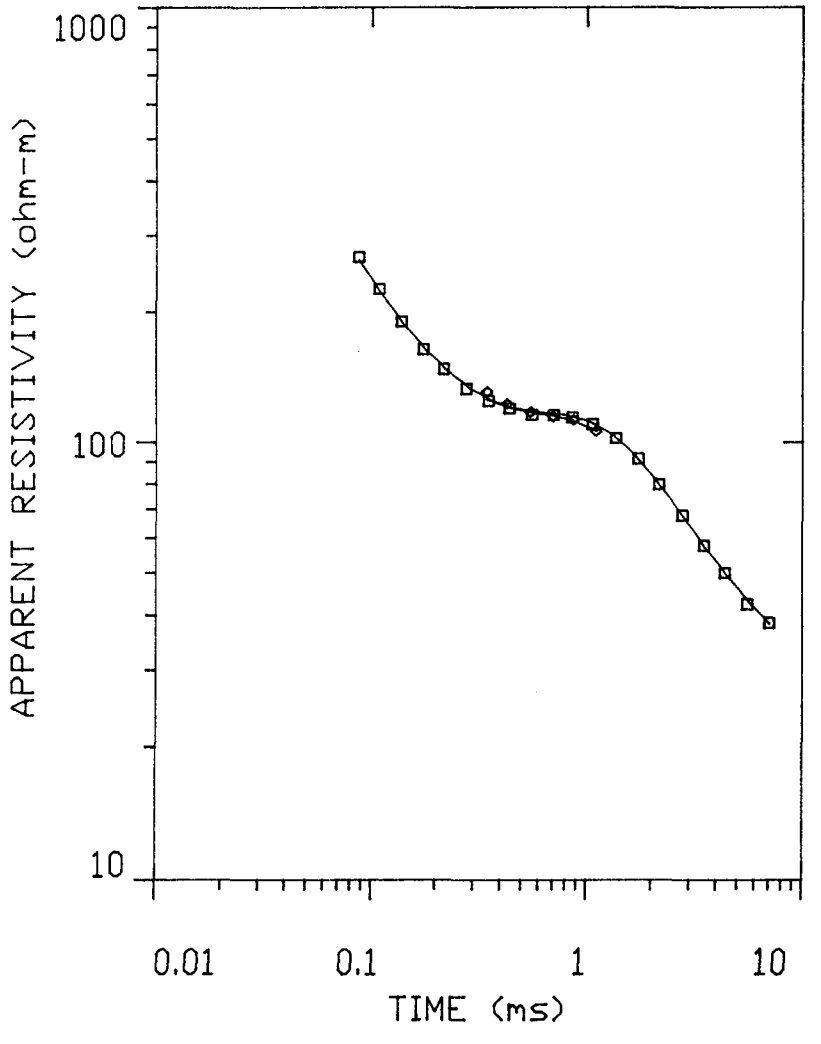
Figure 5.11-3 is the equivalence analysis at this site and the inversion table (Table 5.11-1) lists the upper and lower bounds of the inverted parameters of the geoelectrical model. The range of equivalence in determining the depth to the low resistivity layer is about ±3 m (10 ft) which is 1% of the total depth.

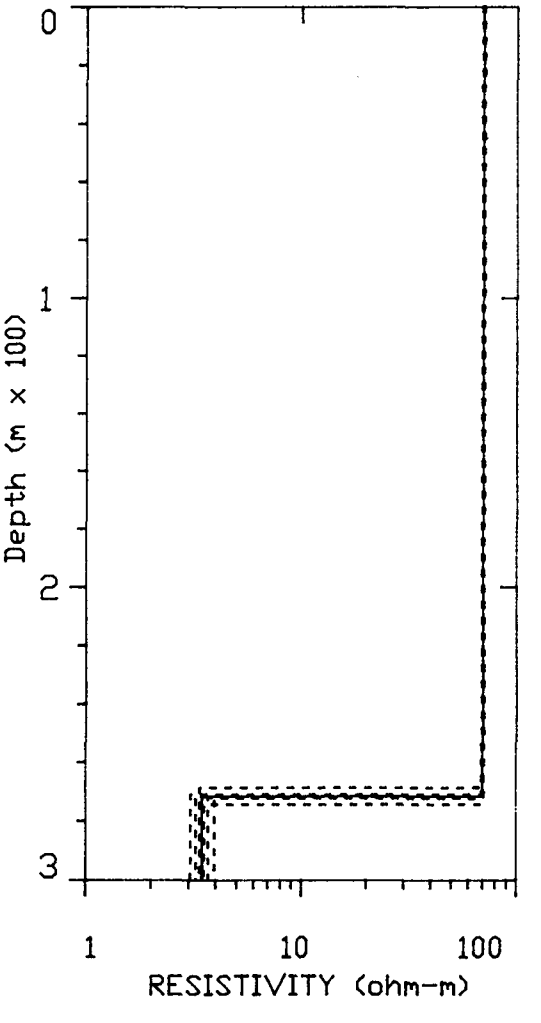
The resistivity of this layer has a range of from 3.1 to 4.0 ohm-m. This corresponds to a range in interpreted chloride content of from 10,222 mg/l to 7,888 mg/l, again subject to the same assumptions of porosity and validity of equation (4).

The equivalence range of the resistivity of Layer 1 is from 70 to 71 ohm-m. A corresponding chloride concentration cannot be determined because Layer 1 is in part comprised of the Holocene to Miocene deposits. Accordingly, equation (4) may not be valid.

5.11.6 Summary of TDEM Sounding at Tomoka Land Corporation (Site 10)

- The depth of occurrence of salt water (5,000 mg/l isochlor) is interpreted to be 892 ft (-867 ft msl) and occur within the Floridan aquifer. The chloride content below that depth is inferred to be 9,037 mg/l.
- The quality of ground water within the Floridan aquifer at this site cannot be interpreted because the analysis of the TDEM data does not allow the Holocene to Miocene deposits to be distinguished from the Floridan Aquifer System.





—— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

MEASURED TDEM APPARENT RESISTIVITY AND EQUIVALENCE FOR 1-D INVERSION
SOUNDING 10 - TOMOKA LAND COMPANY
VOLUSIA COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	EQU-10	5.11-3
DRAWN BY:	RBT	DATE:	07/06/94	

DATA SET: SITE 10

CLIENT: SJRWMD
DATE: 06-MAY-94
LOCATION: TOMOKO LAND COMPANY
SOUNDING: 1
COUNTY: VOLUSIA COUNTY, FLORIDA
ELEVATION: 7.50 m
PROJECT: SALT WATER INTERFACE DETECTION
EQUIPMENT: Geonics PROTEM
LOOP SIZE: 343.000 m by 183.000 m
AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y)
SOUNDING COORDINATES: E: 0.0000 N: 0.0000

FITTING ERROR: 1.757 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			7.50	
1	70.38	271.6	-264.1	3.85
2	3.46			

ALL PARAMETERS ARE FREE

PARAMETER BOUNDS FROM EQUIVALENCE ANALYSIS

	LAYER	MINIMUM	BEST	MAXIMUM
RHO	1	69.543	70.380	71.197
	2	3.059	3.467	3.969
THICK	1	268.593	1.000	274.384
DEPTH	1	268.593	271.612	274.384

CURRENT: 17.50 AMPS EM-57 COIL AREA: 100.00 sq m.
FREQUENCY: 30.00 Hz GAIN: 4 RAMP TIME: 202.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.0867	59667.1	60905.3	-2.07
2	0.108	44404.9	45006.9	-1.35
3	0.138	31187.0	31193.1	-0.0197
4	0.175	21535.5	21216.2	1.48
5	0.218	14545.3	14429.3	0.797
6	0.278	9250.8	9087.1	1.76
7	0.351	5686.1	5614.1	1.26

* S.D.I.I. *

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT PALATKA, FLORIDA	SDII SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED	TDEM SOUNDING DATA TABLE SOUNDING 10 - TOMOKO LAND COMPANY VOLUSIA COUNTY, FLORIDA
		PROJECT NO.: 94767
		TABLE: 5.11-1

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
8	0.438	3473.1	3434.6	1.10
9	0.558	1995.5	1942.5	2.65
10	0.702	1125.9	1112.7	1.17
11	0.858	695.7	689.5	0.888
12	1.06	426.1	422.8	0.780
13	1.37	254.9	253.7	0.462
14	1.74	165.3	167.1	-1.06
15	2.17	116.9	117.8	-0.731
16	2.77	81.33	81.55	-0.268
17	3.50	57.70	57.80	-0.172
18	4.37	41.05	40.98	0.176
19	5.56	28.79	27.87	3.19
20	7.03	18.53	18.63	-0.520

CURRENT: 17.50 AMPS EM-57 COIL AREA: 100.00 sq m.
FREQUENCY: 7.50 Hz GAIN: 8 RAMP TIME: 202.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
21	0.346	5487.3	5812.3	-5.92
22	0.427	3566.5	3662.7	-2.69
23	0.550	2024.7	2033.5	-0.436
24	0.698	1157.8	1150.0	0.670
25	0.869	688.1	690.5	-0.343
26	1.10	410.6	409.5	0.273

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

	P 1	P 2	T 1
P 1	1.00		
P 2	-0.02	0.74	
T 1	0.00	0.00	1.00

ST. JOHNS RIVER
WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SOUNDING DATA TABLE
SOUNDING 10 - TOMOKO LAND COMPANY
VOLUSIA COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.11-1

5.12 TDEM Site 11 - Container Corporation

5.12.1 Location Description and Geoelectrical Section

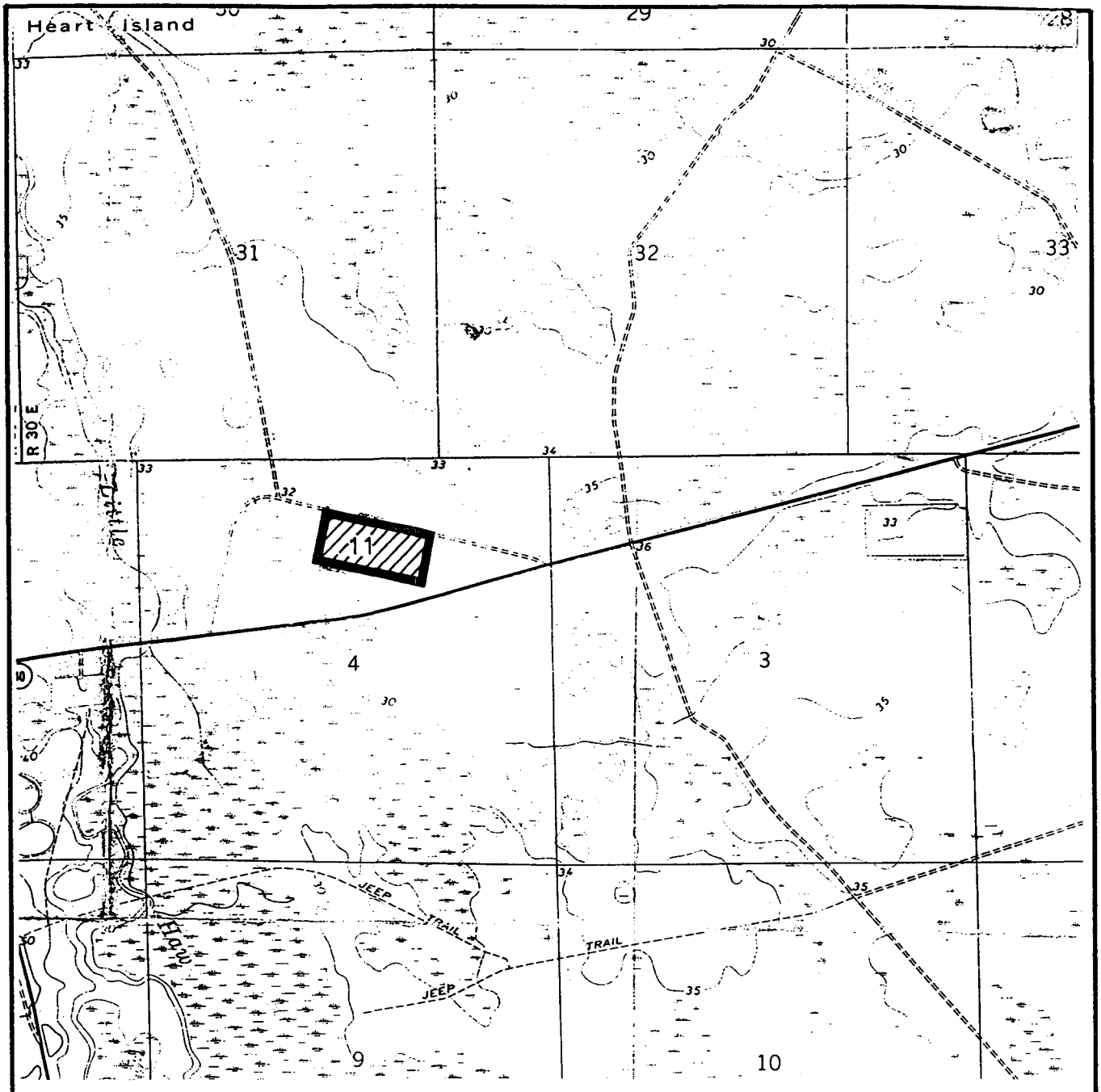
The site is located in northern Volusia County, Florida (Figure 5.12-1). The site is located within a tree farm. No visible sources of interference were observed in the area of the site. QA soundings were performed 150 ft to the east and west and 60 ft to the south of the initial Rx coil location. Results from the QA soundings indicate that the apparent resistivity values were unaffected by any interference sources.

The Floridan aquifer occurs at an approximate depth of 47 ft bmsl or 77 ft bls (Rutledge, 1985) and is overlain by the Holocene to Miocene deposits. The base of the Floridan aquifer occurs at approximately 2,100 ft bmsl (Tibbals, 1990). The thickness of the Upper Floridan aquifer is approximately 740 ft and the depth to the top of the Lower Floridan aquifer is approximately 830 ft bls (Miller, 1986). A water quality study performed in the area of the site (Rutledge, 1985) indicates that the chloride concentration in the upper portion of the Floridan aquifer ranges from 0 to 50 mg/l.

The resistivity sounding data and best-fit model inversion are presented on Figure 5.12-2. The interpreted geoelectrical section consists of a four-layer subsurface.

5.12.2 Geological Interpretation of Geoelectrical Model

The four-layer geoelectrical section consists of a low resistivity (31 ohm-m), upper layer which correlates with the Holocene to Miocene deposits above the Floridan aquifer. The thickness of Layer 1 was fixed at 23 m (77 ft) based on the information from Rutledge (1985). The second and third layers have a high resistivity (82 and 403 ohm-m, respectively) which means that because they are greater than 80 ohm-m the Floridan aquifer at this site contains fresh water. The thickness of the freshwater section is estimated as the



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PALATKA, FLORIDA

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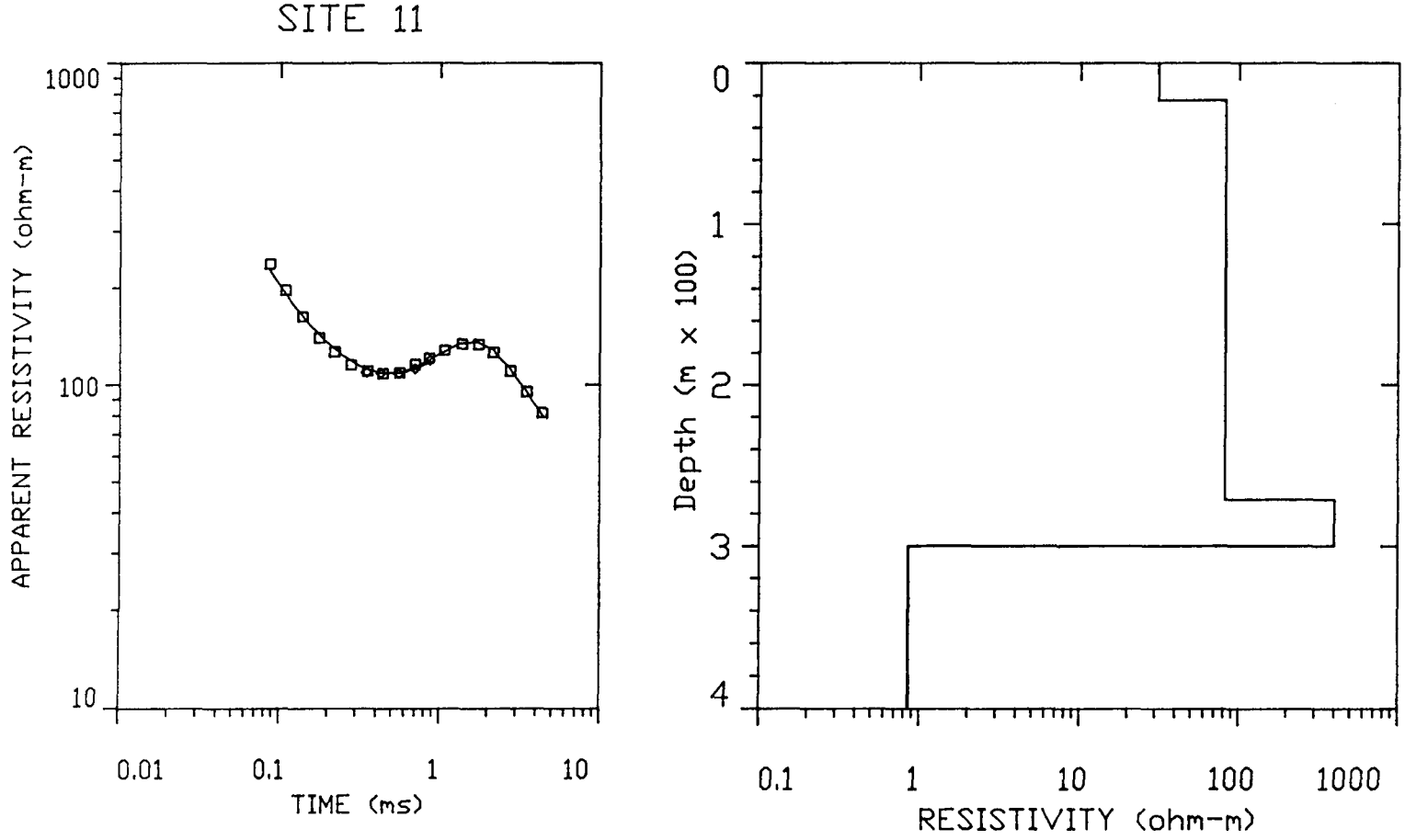
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SURVEY LOCATION MAP
SOUNDING 11 -- CONTAINER CORPORATION
VOLUSIA COUNTY, FLORIDA

DESIGNED BY: JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY: MJW	DRAWING NO.:	LOC-11	5.12-1
DRAWN BY: RBT	DATE:	07/05/94	



—— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

MEASURED TDEM APPARENT RESISTIVITY AND 1-D INVERSION
SOUNDING 11 – CONTAINER CORPORATION
VOLUSIA COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	MDL-11	5.12-2
DRAWN BY:	RBT	DATE:	07/06/94	

combined thickness of the second and third layers of 277 m (909 ft), placing the depth to the low resistivity (saltwater) layer at 300 m (984 ft) below ground surface. The resistivity of the saltwater layer is 0.9 ohm-m. Layer 1 is considered to be the Holocene to Miocene deposits above the Floridan aquifer, the combined layers 2 and 3 to be the Floridan aquifer containing fresh water. The contact between Layers 2 and 3 (889 ft bls) may correspond to a porosity change in the Lower Floridan aquifer. Layer 4 is considered to represent salt water within the Floridan aquifer.

5.12.3 Depth to Occurrence of Salt Water

The bottom (fourth) layer of the geoelectrical model, with a resistivity of 0.9 ohm-m, is interpreted to represent salt water. It occurs at a depth of 984 ft (-954 ft msl). Because the resistivities of layers 2 and 3 (82 and 403 ohm-m, respectively) are greater than 80 ohm-m, the interpreted depth to the 5,000 mg/l isochlor is taken as 50 ft greater than the depth of the geoelectrical interface, or at a depth of 1,034 ft (-1,004 ft msl). For comparison, Rutledge (1982) calculated an approximate depth of 1,000 ft bmsl for the freshwater-saltwater interface at this site. The interface calculated by Rutledge (1982) is based upon a modified Ghyben-Herzberg principle.

The resistivity of Layer 4 (0.9 ohm-m) corresponds to a chloride content in excess of 20,000 mg/l assuming a porosity of 25% and the validity and applicability of equation (4) of Section 4.2. It is presumed that because of the expected high chlorinity gradients, this value is sufficiently close to the 5,000 mg/l isochlor that they represent the same effective depth.

5.12.4 Depth of Occurrence of the 250 mg/l Isochlor

The resistivities of layers 2 and 3 (82 and 403 ohm-m, respectively) correspond to a chloride content of less than 250 mg/l, assuming a 25% porosity and the validity and applicability of equation (4) of Section 4.2. The 250 mg/l isochlor is placed in the Floridan aquifer at a depth 50 ft above the Layer 3 interface or at 934 ft (-904 ft msl).

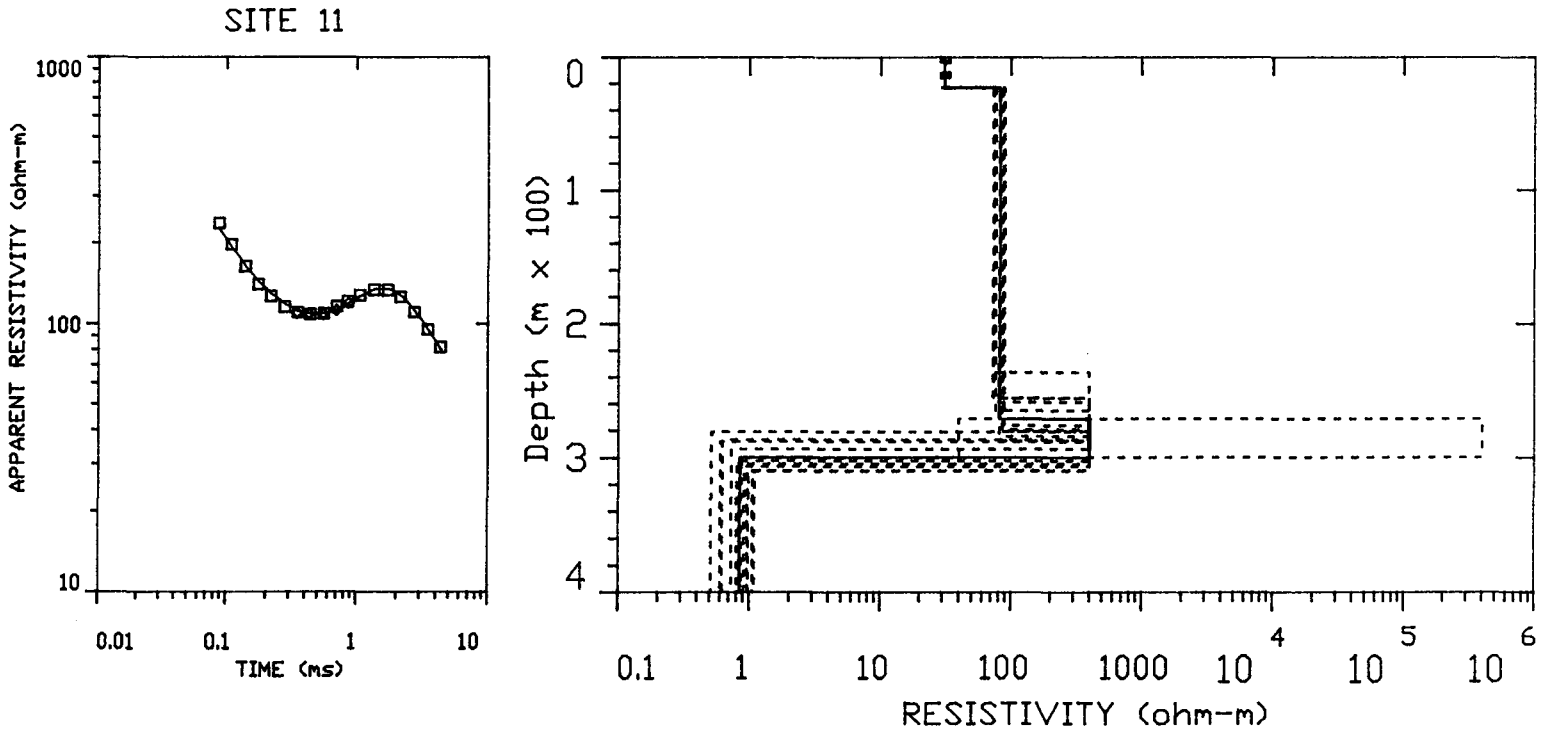
For comparison, Rutledge (1985) estimated a maximum thickness of approximately 800 ft for water with a chloride concentration less than 250 mg/l in the Floridan aquifer at this site. The top of the Floridan aquifer occurs at an approximate depth of 47 ft bmsl or 77 ft bls at this site (Rutledge, 1985).

5.12.5 Accuracy of Measurement and Interpretation

Figure 5.12-3 is the equivalence analysis at this site and the inversion table (Table 5.12-1) lists the upper and lower bounds of the inverted parameters of the geoelectrical model.

The range of equivalence in determining the depth to the low resistivity layer is about ±15 m (49 ft) which is 5% of the total depth. The resistivity of this layer has a range of from 0.5 to 1.1 ohm-m. This corresponds to a range in interpreted chloride content in excess of 20,000 mg/l, again subject to the same assumptions of porosity and validity of equation (4).

The equivalence ranges of the resistivities for layers 2 and 3 are for the most part over 80 ohm-m which corresponds to a chloride content of less than 250 mg/l. The results from the TDEM study agree with the results from Rutledge (1985). The chloride-to-sulfate ratio at the site is 5:1 (Table 5.1-4). Accordingly, equation (4) is valid.



BEST-FIT MODELED CURVE

APPARENT RESISTIVITY VALUES USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

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SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

MEASURED TDEM APPARENT RESISTIVITY AND EQUIVALENCE FOR 1-D INVERSION
SOUNDING 11 - CONTAINER CORPORATION
VOLUSIA COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	EQU-11	5.12-3
DRAWN BY:	RBT	DATE:	07/06/94	

DATA SET: SITE 11

CLIENT: SJRWMD DATE: 06-MAY-94
LOCATION: CONTAINER CORPORATION SOUNDING: 1
COUNTY: VOLUSIA COUNTY, FLORIDA ELEVATION: 9.00 m
PROJECT: SALT WATER INTERFACE DETECTION EQUIPMENT: Geonics PROTEM
LOOP SIZE: 457.000 m by 182.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y)
SOUNDING COORDINATES: E: 0.0000 N: 0.0000

FITTING ERROR: 2.725 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)		ELEVATION (meters)	CONDUCTANCE (Siemens)
				9.00	
1	30.87	23.00	*	-14.00	0.744
2	82.34	248.1		-262.1	3.01
3	402.7	28.68		-290.7	0.0712
4	0.853				

"*" INDICATES FIXED PARAMETER

PARAMETER BOUNDS FROM EQUIVALENCE ANALYSIS

LAYER		MINIMUM	BEST	MAXIMUM
RHO	1	28.907	30.879	33.852
	2	73.072	82.347	89.362
	3	40.277	402.768	402768.312
	4	0.518	0.854	1.096
THICK	1	23.000	0.000	23.000
	2	213.318	-0.112	264.817
	3	18.068	1.000	51.916
DEPTH	1	23.000	23.000	23.000
	2	236.318	271.107	287.817
	3	280.789	299.795	310.028

CURRENT: 16.00 AMPS EM-37 COIL AREA: 100.00 sq m.
FREQUENCY: 30.00 Hz GAIN: 3 RAMP TIME: 204.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)

ST. JOHNS RIVER
WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SOUNDING DATA TABLE
SOUNDING 11 – CONTAINER CORPORATION
VOLUSIA COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.12-1

1	0.0867	91152.8	97341.7	-6.78
2	0.108	69665.3	72043.0	-3.41
3	0.138	50022.8	49785.6	0.474
4	0.175	34761.2	33589.6	3.37
5	0.218	23406.9	22632.9	3.30
6	0.278	14650.3	14088.0	3.83
7	0.351	8754.4	8580.7	1.98
8	0.438	5155.9	5141.6	0.277
9	0.558	2791.8	2793.7	-0.0685
10	0.702	1439.2	1493.1	-3.74
11	0.858	815.3	836.8	-2.63
12	1.06	436.0	441.0	-1.15
13	1.37	217.2	214.1	1.42
14	1.74	120.0	117.1	2.40
15	2.17	75.33	73.54	2.37
16	2.77	49.90	49.20	1.40
17	3.50	34.72	34.99	-0.752
18	4.37	25.04	25.99	-3.81

CURRENT: 16.00 AMPS **EM-37** **COIL AREA:** 100.00 sq m.
FREQUENCY: 7.50 Hz **GAIN:** 6 **RAMP TIME:** 204.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
19	0.346	9180.8	8878.3	3.29
20	0.427	5479.2	5486.2	-0.127
21	0.550	2916.8	2921.7	-0.169
22	0.698	1530.1	1537.5	-0.488
23	0.869	806.4	825.8	-2.40

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	0.96						
P 2	0.03	0.96					
P 3	0.00	0.00	0.00				
P 4	0.07	-0.11	0.00	0.53			
F 1	0.00	0.00	0.00	0.00	0.00		
T 2	0.01	-0.02	0.00	-0.06	0.00	0.97	
T 3	0.00	-0.01	0.00	-0.12	0.00	0.11	0.04
	P 1	P 2	P 3	P 4	F 1	T 2	T 3

ST. JOHNS RIVER
WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SOUNDING DATA TABLE
SOUNDING 11 – CONTAINER CORPORATION
VOLUSIA COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.12-1

5.12.6 Summary of TDEM Sounding at Container Corporation (Site 11)

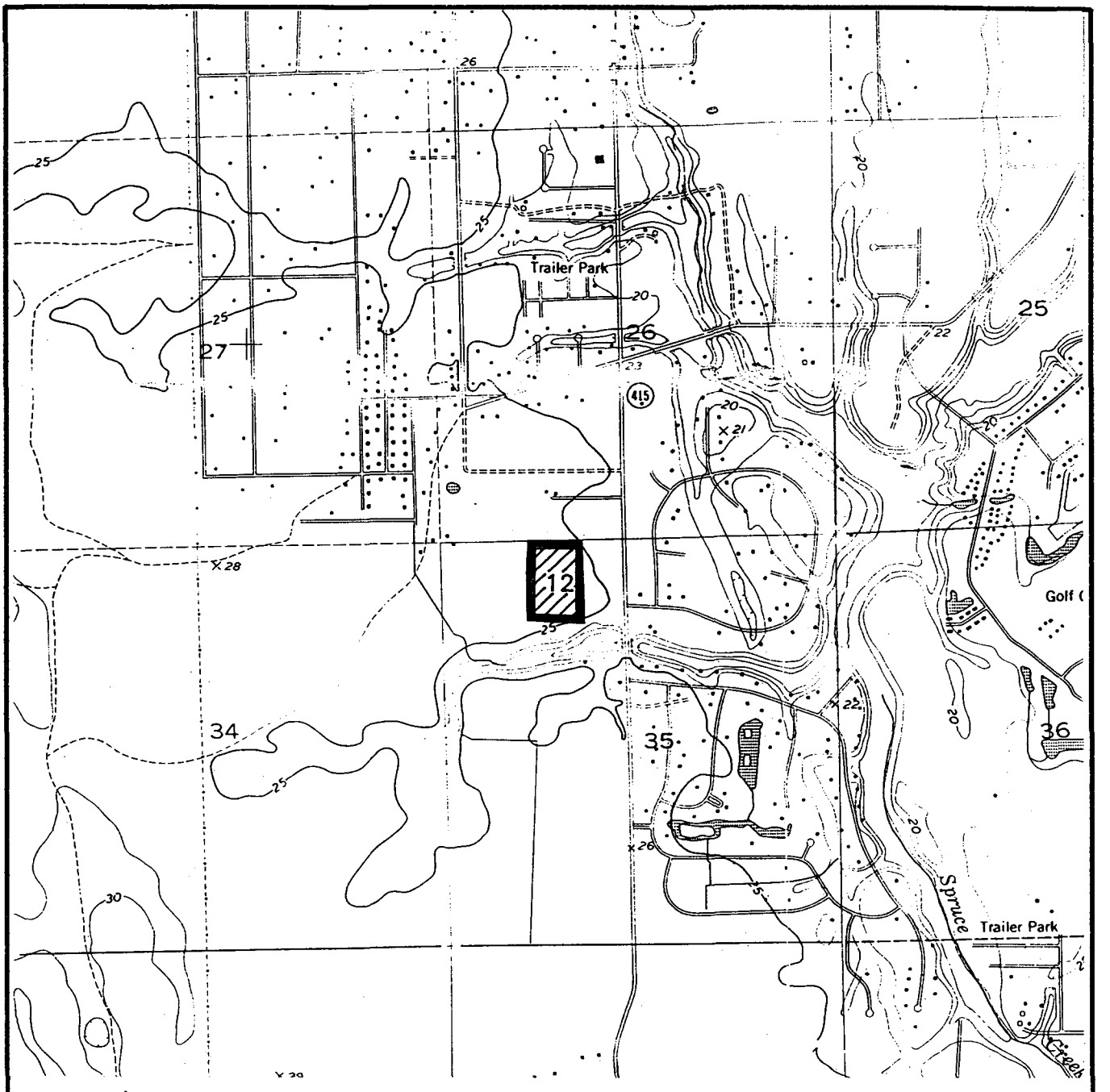
- The depth to occurrence of salt water (5,000 mg/l isochlor) is interpreted to be 1,034 ft (-1,004 ft msl) and occur within the Lower Floridan aquifer. This depth is consistent with Rutledge's (1982) estimate of the depth (-1,000 ft msl) to the freshwater/saltwater interface.
- The ground water within the Floridan aquifer at this site is interpreted to contain an average chloride concentration of less than 250 mg/l. The 250 mg/l isochlor is interpreted to be present in the Floridan aquifer at a depth of 934 ft (-904 ft msl). For comparison, Rutledge (1985) estimated an approximate depth of 877 ft bls for the 250 mg/l isochlor.
- The results of the TDEM study agree with the water quality results of Rutledge (1985) who indicates that the chloride content in the Upper Floridan aquifer is less than 250 mg/l at this site.

5.13 TDEM Site 12 - Spruce Creek

5.13.1 Location Description and Geoelectrical Section

The site is located in east-central Volusia County, Florida (Figure 5.13-1). The site is located within a pasture. A possible interference source (powerlines) existed 500 ft east of the Tx loop. QA soundings were performed 60 ft east and 100 ft north of the initial Rx coil location. Results from the QA soundings indicate that the apparent resistivity values were unaffected by any interference sources.

The Floridan aquifer occurs at an approximate depth of 50 ft bmsl or 75 ft bls (Rutledge, 1985) and is overlain by the Holocene to Miocene deposits. The base of the Floridan aquifer occur at approximately 2,220 ft bmsl (Tibbals, 1990). The thickness of the Upper Floridan aquifer is approximately 725 ft and the depth to the top of the Lower



ST. JOHNS RIVER
WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SURVEY LOCATION MAP
SOUNDING 12 – SPRUCE CREEK
VOLUSIA COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	LOC-12	5.13-1
DRAWN BY:	RBT	DATE:	07/05/94	

Floridan aquifer is approximately 750 ft bls (Miller, 1986). A water quality study performed in the area of the site (Rutledge, 1985) indicates that the chloride concentration in the upper portion of the Floridan aquifer ranges from 51 to 250 mg/l.

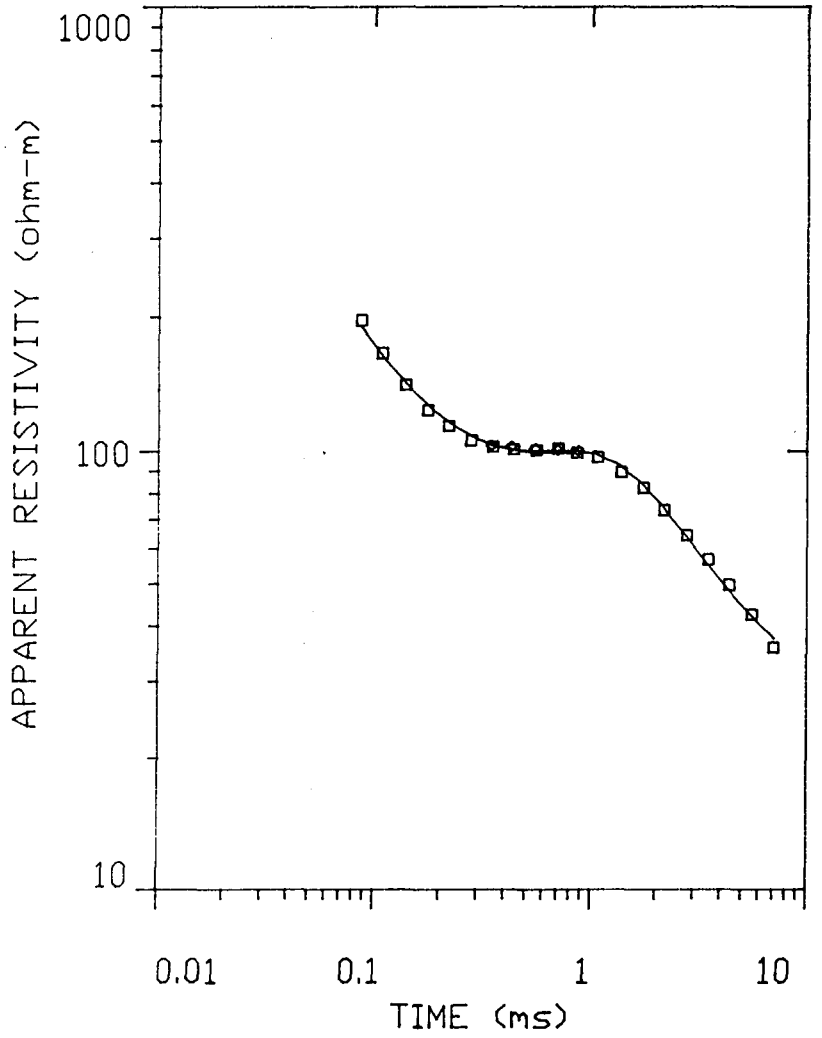
The resistivity sounding data and best-fit model inversion are presented on Figure 5.13-2. The interpreted geoelectrical section consists of a three-layer subsurface.

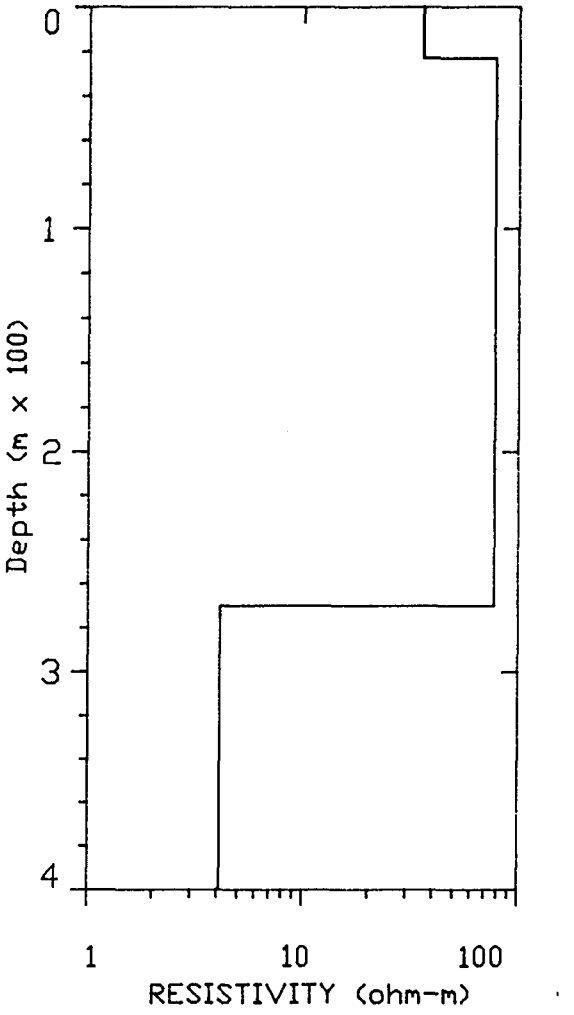
5.13.2 Geological Interpretation of Geoelectrical Model

The three-layered geoelectrical section consists of a low resistivity (35 ohm-m), upper layer which is considered to be the Holocene to Miocene deposits above the Floridan aquifer. The thickness of Layer 1 was fixed at a 23 m (75 ft) value based on published information (Rutledge, 1985). The second layer has only intermediate resistivity (78 ohm-m) which, because it is less than 80 ohm-m, suggests the Floridan aquifer at this site contains brackish water. The thickness of the brackish section is 247 m (810 ft), placing the depth to the low resistivity (saltwater) layer at 270 m (886 ft) below ground surface. The resistivity of the saltwater saturated layer is 4.1 ohm-m. Layer 1 is considered to be the Holocene to Miocene deposits above the Floridan aquifer, Layer 2 to be the Floridan aquifer (brackish), and Layer 3 to be the salt water within the Lower Floridan aquifer.

5.13.3 Depth to Occurrence of Salt Water

The bottom (third) layer of the geoelectrical model, with a resistivity of 4.1 ohm-m, is interpreted to represent salt water. It occurs at a depth of 886 ft (-861 ft msl). Because the resistivity of Layer 2 (78 ohm-m) is interpreted to represent brackish water within the Floridan aquifer (is less than 80 ohm-m), the interpreted depth to the 5,000 mg/l isochlor is equal to the depth of the geoelectrical interface, or at 886 ft depth (-861 ft msl). The resistivity of Layer 3 (4.1 ohm-m) corresponds to a chloride content of 7,692 mg/l assuming a porosity of 25% and the validity and applicability of equation (4) of Section 4.2. It is presumed that because of the expected high chlorinity gradients, this value is sufficiently close to the 5,000 mg/l isochlor that they represent the same effective depth.





BEST-FIT MODELED CURVE

APPARENT RESISTIVITY VALUES USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

MEASURED TDEM APPARENT RESISTIVITY AND 1-D INVERSION
SOUNDING 12 - SPRUCE CREEK
VOLUSIA COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	MDL-12	5.13-2
DRAWN BY:	RBT	DATE:	07/06/94	

5.13.4 Depth of Occurrence of the 250 mg/l Isochlor

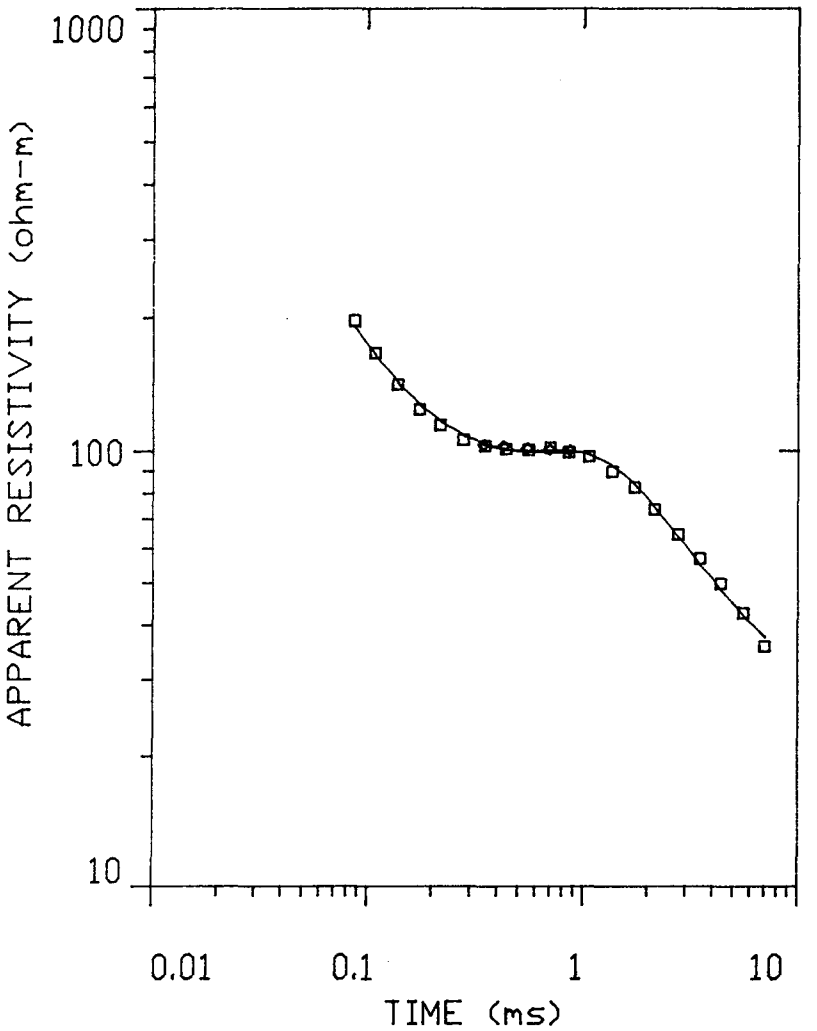
The resistivity of Layer 2, 78 ohm-m, corresponds to a chloride content above 250 mg/l, assuming a 25% porosity and the validity and applicability of equation (4) of Section 4.2. As the interpreted chloride content exceeds 250 mg/l, the 250 mg/l isochlor does not occur within the Floridan aquifer at this site. This conclusion does not agree with a water quality study conducted in the area of the site by Rutledge (1985). He estimated the maximum thickness of approximately 600 ft for water with a chloride concentration less than 250 mg/l in the Floridan aquifer at this site. The top of the Floridan aquifer occurs at an approximate depth of 50 ft bmsl or 75 ft bls at this site (Rutledge, 1985).

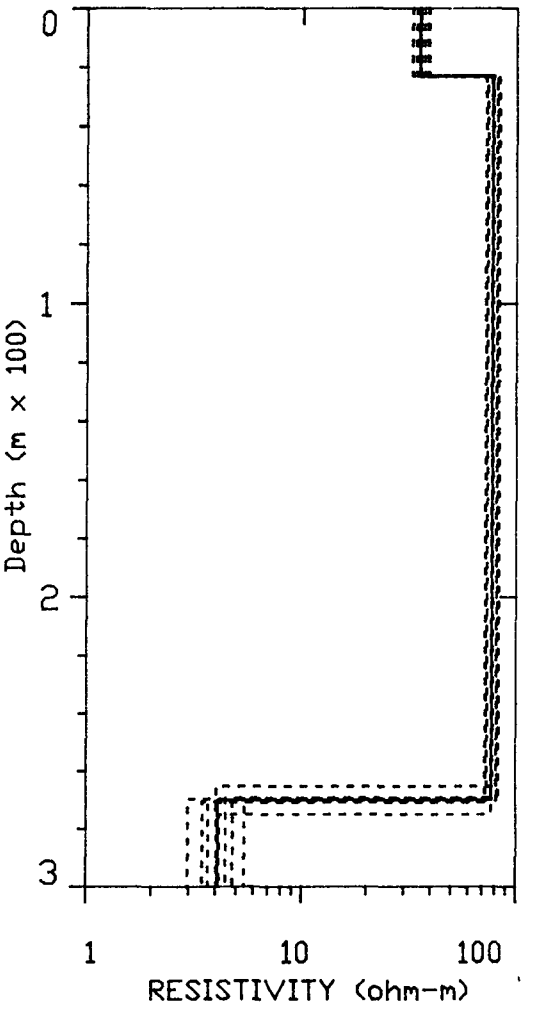
5.13.5 Accuracy of Measurement and Interpretation

Figure 5.13-3 is the equivalence analysis at this site and the inversion table (Table 5.13-1) lists the upper and lower bounds of the inverted parameters of the geoelectrical model.

The range of equivalence in determining the depth to the low resistivity layer is about ±10 m (33 ft) which is 4% of the total depth. The resistivity of this layer has a range from 3.0 to 5.5 ohm-m. This corresponds to a range in interpreted chloride content of from 10,568 mg/l to 5,695 mg/l, again subject to the same assumptions of porosity and validity of equation (4).

The equivalence range of the resistivity of Layer 2 is from 72 to 83 ohm-m which over the majority of the range corresponds to chloride content above 250 mg/l. The results of the TDEM study are not in agreement with the results from Rutledge (1985). The chloride-to-sulfate ratio at the site is 5:1 (Table 5.1-4). Accordingly, equation (4) is valid.





—— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

MEASURED TDEM APPARENT RESISTIVITY AND EQUIVALENCE FOR 1-D INVERSION
SOUNDING 12 - SPRUCE CREEK
VOLUSIA COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	EQU-12	5.13-3
DRAWN BY:	RBT	DATE:	07/06/94	

DATA SET: SITE 12

CLIENT: SJRWMD DATE: 07-MAY-94
LOCATION: SPRUCE CREEK SOUNDING: 1
COUNTY: VOLUSIA COUNTY, FLORIDA ELEVATION: 7.50 m
PROJECT: SALT WATER INTERFACE DETECTION EQUIPMENT: Geonics PROTEM
LOOP SIZE: 304.000 m by 185.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y)
SOUNDING COORDINATES: E: 0.0000 N: 0.0000

FITTING ERROR: 3.118 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)		ELEVATION (meters)	CONDUCTANCE (Siemens)
				7.50	
1	35.40	23.00	*	-15.50	0.649
2	77.52	247.0		-262.5	3.18
3	4.10				

"*" INDICATES FIXED PARAMETER

PARAMETER BOUNDS FROM EQUIVALENCE ANALYSIS

LAYER		MINIMUM	BEST	MAXIMUM
RHO	1	32.533	35.405	38.959
	2	72.069	77.523	83.389
	3	2.976	4.101	5.457
THICK	1	23.000	0.000	23.000
	2	242.352	1.000	252.019
DEPTH	1	23.000	23.000	23.000
	2	265.352	270.060	275.019

CURRENT: 18.20 AMPS EM-57 COIL AREA: 100.00 sq m.
FREQUENCY: 30.00 Hz GAIN: 3 RAMP TIME: 202.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.0867	86564.2	90674.7	-4.74
2	0.108	64203.4	65387.2	-1.84
3	0.138	44484.1	43833.7	1.46

ST. JOHNS RIVER
WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SOUNDING DATA TABLE
SOUNDING 12 – SPRUCE CREEK
VOLUSIA COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.13-1

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
4	0.175	29922.0	28782.8	3.80
5	0.218	19535.7	18951.2	2.99
6	0.278	11934.0	11530.6	3.38
7	0.351	6991.0	6918.2	1.04
8	0.438	4111.3	4123.8	-0.304
9	0.558	2260.0	2279.2	-0.849
10	0.702	1252.0	1276.2	-1.93
11	0.858	786.5	774.8	1.48
12	1.06	472.6	463.2	1.99
13	1.37	284.6	270.8	4.84
14	1.74	176.9	173.1	2.13
15	2.17	121.4	119.6	1.43
16	2.77	80.28	81.50	-1.52
17	3.50	54.13	56.63	-4.61
18	4.37	37.84	39.78	-5.11
19	5.56	26.15	26.61	-1.75
20	7.03	18.89	17.58	6.91

CURRENT: 18.20 AMPS EM-57 COIL AREA: 100.00 sq m.
FREQUENCY: 7.50 Hz GAIN: 7 RAMP TIME: 202.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
21	0.346	7201.6	7167.4	0.474
22	0.427	4280.4	4403.2	-2.86
23	0.550	2315.5	2383.3	-2.92
24	0.698	1289.0	1314.6	-1.98
25	0.869	750.5	770.5	-2.66

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	0.96				
P 2	0.03	0.98			
P 3	0.04	-0.05	0.67		
F 1	0.00	0.00	0.00	0.00	
T 2	0.00	0.00	0.00	0.00	1.00
	P 1	P 2	P 3	F 1	T 2

ST. JOHNS RIVER
WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SOUNDING DATA TABLE
SOUNDING 12 – SPRUCE CREEK
VOLUSIA COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.13–1

5.13.6 Summary of TDEM Sounding at Spruce Creek (Site 12)

- The depth to occurrence of salt water (5,000 mg/l isochlor) is interpreted to be 886 ft (-861 ft msl) and occur within the Lower Floridan aquifer.
- The ground water within the Floridan aquifer at this site is interpreted to contain an average chloride concentration above 250 mg/l. The 250 mg/l isochlor is not interpreted to be present within the Floridan aquifer.
- The results of the TDEM study are not in agreement with Rutledge (1985) who indicated that the chloride content in the Upper Floridan aquifer is less than 250 mg/l.

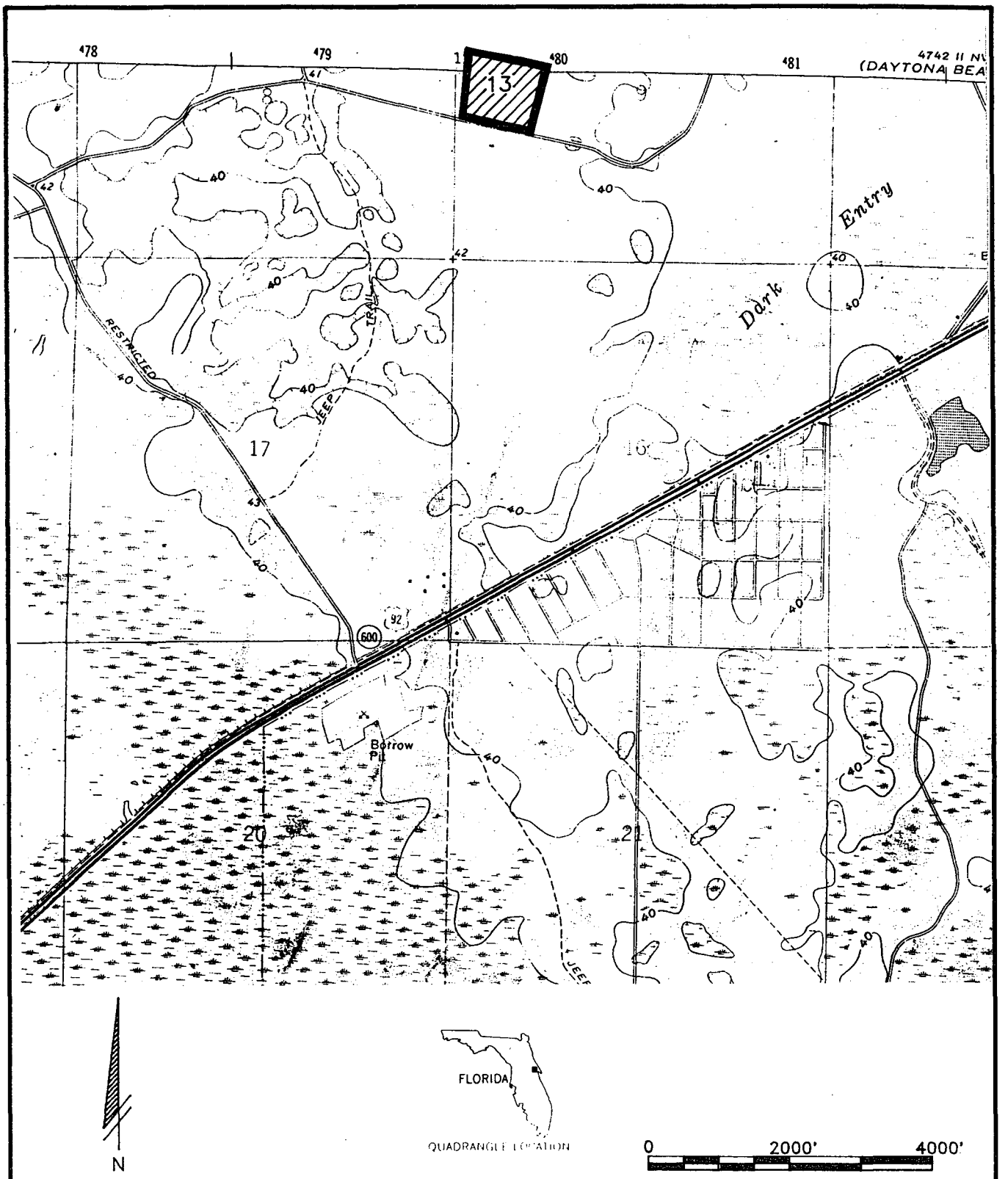
5.14 TDEM Site 13 - Little Tiger Bay

5.14.1 Location Description and Geoelectrical Section

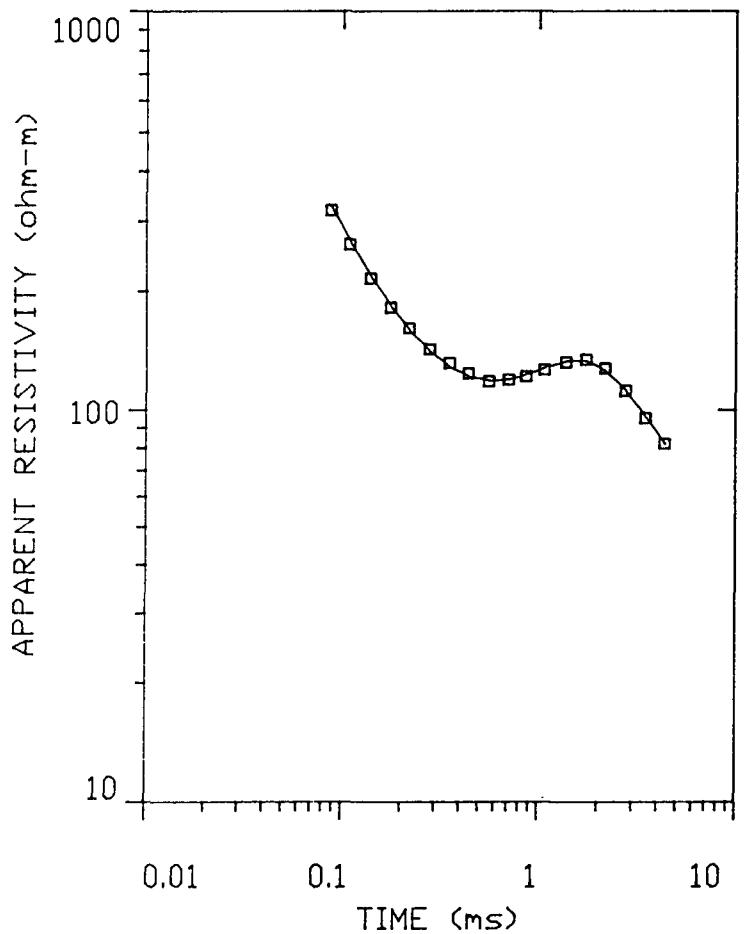
The site is located in the central portion of Volusia County, Florida (Figure 5.14-1). The site is located within a wooded area. No possible sources of interference were observed within the area of the site. QA soundings were performed 100 ft west and south of the initial Rx coil location. Results from the QA soundings indicate that the apparent resistivity values were unaffected by any interference sources.

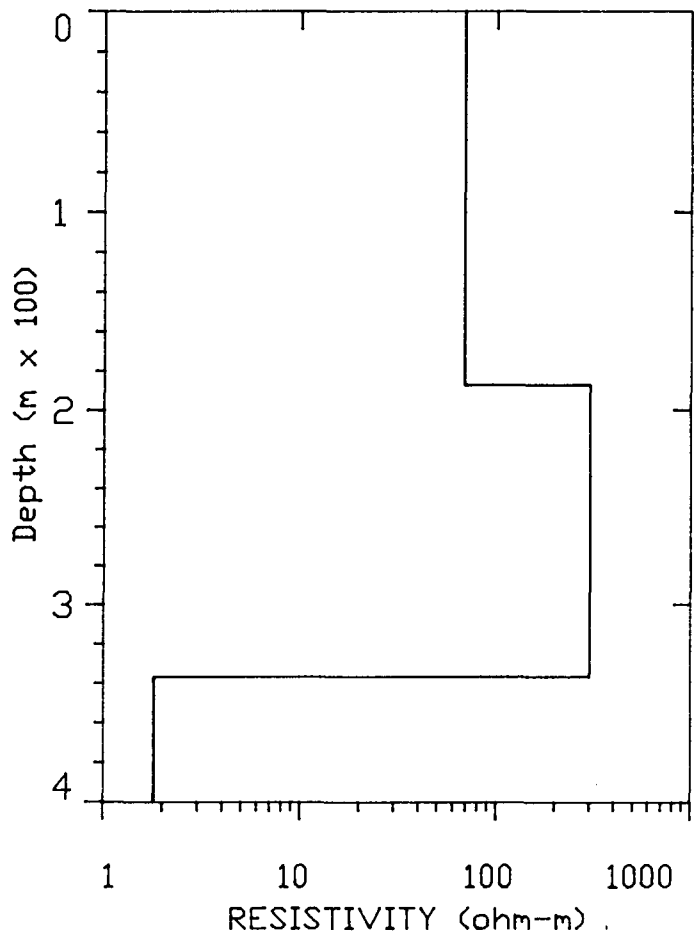
The Floridan aquifer occurs at an approximate depth of 31 ft bmsl or 70 ft bls (Rutledge, 1985) and is overlain by the Holocene to Miocene deposits. The base of the Floridan aquifer occurs at approximately 2,010 ft bmsl (Tibbals, 1990). The thickness of the Upper Floridan aquifer is approximately 720 ft and the depth to the top of the Lower Floridan aquifer is approximately 790 ft bls (Miller, 1986). A water quality study performed in the area of the site (Rutledge, 1985) indicates that the chloride concentration in the upper portion of the Floridan aquifer ranges from 0 to 50 mg/l.

The resistivity sounding data and best-fit model inversion are presented on Figure 5.14-2. The interpreted geoelectrical section consists of a three-layer subsurface.



ST. JOHNS RIVER WATER MANAGEMENT DISTRICT PALATKA, FLORIDA	SDII SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED	TDEM SURVEY LOCATION MAP SOUNDING 13 – LITTLE TIGER BAY VOLUSIA COUNTY, FLORIDA		
		DESIGNED BY: JEB CHECKED BY: MJW DRAWN BY: RBT	PROJECT NO.: 94767 DRAWING NO.: LOC-13 DATE: 07/05/94	FIGURE 5.14-1





—— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

MEASURED TDEM APPARENT RESISTIVITY AND 1-D INVERSION
SOUNDING 13 - LITTLE TIGER BAY
VOLUSIA COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	MDL-13	5.14-2
DRAWN BY:	RBT	DATE:	07/06/94	

5.14.2 Geological Interpretation of Geoelectrical Model

The three-layer geoelectrical section consists of a low resistivity (68 ohm-m), upper layer which correlates to a combined thickness of Holocene to Miocene deposits above the Floridan aquifer and a portion of the Floridan aquifer. The second layer has high resistivity (302 ohm-m) which means that because it is greater than 80 ohm-m the Floridan aquifer at this site contains fresh water. The thickness of the freshwater section is 150 m (492 ft) placing the depth to the low resistivity (saltwater) layer at 337 m (1,106 ft) below ground surface. The resistivity of the saltwater layer is 1.8 ohm-m. Layer 1 is considered to be the upper portion of the Floridan aquifer combined with the overlying Holocene to Miocene deposits, Layer 2 to be the Floridan aquifer containing fresh water, and Layer 3 to be the salt water within the Lower Floridan aquifer.

5.14.3 Depth to Occurrence of Salt Water

The bottom (third) layer of the geoelectrical model, with a resistivity of 1.8 ohm-m, is interpreted to represent salt water. It occurs at a depth of 1,106 ft (1,066 ft msl). Because the resistivity of Layer 2 (302 ohm-m) is greater than 80 ohm-m, the interpreted depth to the 5,000 mg/l isochlor is taken as 50 ft greater than the depth of the geoelectrical interface, or at a depth of 1,156 ft (-1,116 ft msl). The resistivity of Layer 3 (1.8 ohm-m) corresponds to a chloride content of 17,716 mg/l assuming a porosity of 25% and the validity and applicability of equation (4) of Section 4.2. It is presumed that because of the expected high chlorinity gradients, this value is sufficiently close to the 5,000 mg/l isochlor that they represent the same effective depth.

5.14.4 Depth of Occurrence of the 250 mg/l Isochlor

The resistivity of Layer 2, 302 ohm-m, corresponds to a chloride content of less than 250 mg/l, assuming a 25% porosity and the validity and applicability of equation (4) of Section 4.2. The 250 mg/l isochlor is placed in the Floridan aquifer at a depth 50 ft above the Layer 3 interface or at 1,056 ft (-1,016 ft msl). For comparison, Rutledge (1985)

estimated a maximum thickness of more than 1,200 ft for water with a chloride concentration less than 250 mg/l in the Floridan aquifer at this site. The top of the Floridan aquifer occurs at an approximate depth of 31 ft bmsl or 70 ft bls at this site (Rutledge, 1985).

5.14.5 Accuracy of Measurement and Interpretation

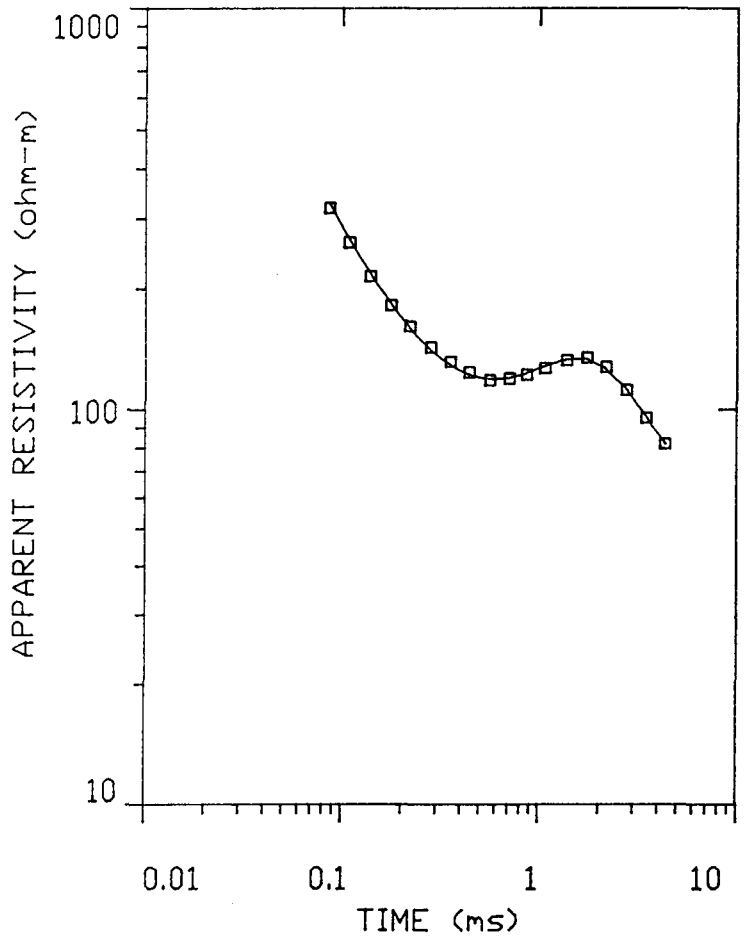
Figure 5.14-3 is the equivalence analysis at this site and the inversion table (Table 5.14-1) lists the upper and lower bounds of the inverted parameters of the geoelectrical model.

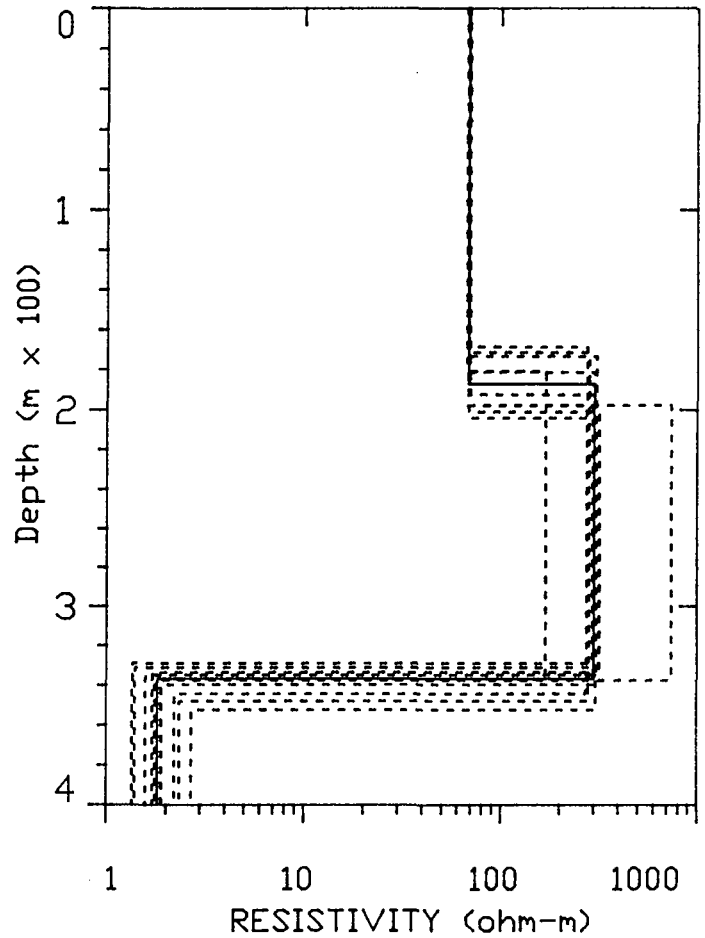
The range of equivalence in determining the depth to the low resistivity layer is about ±12 m (39 ft) which is 4% of the total depth. The resistivity of this layer has a range of from 1.3 to 2.7 ohm-m. This corresponds to a range in interpreted chloride content of from 24,588 mg/l to 11,759 mg/l, again subject to the same assumptions of porosity and validity of equation (4).

The equivalence range of the resistivity of Layer 2 is from 170 to 739 ohm-m which corresponds to a chloride content of less than 250 mg/l. The results of the TDEM study agree with the water quality results from Rutledge (1985). The chloride-to-sulfate ratio at the site is 5:1 (Table 5.1-4). Accordingly, equation (4) is valid.

5.14.6 Summary of TDEM Sounding at Little Tiger Bay (Site 13)

- The depth to occurrence of salt water (5,000 mg/l isochlor) is interpreted to be 1,156 ft (-1,116 ft msl) and occur within the Lower Floridan aquifer.
- The ground water within the Floridan aquifer at this site is interpreted to contain an average chloride concentration of less than 250 mg/l. The 250 mg/l isochlor is interpreted to be present in the Lower Floridan aquifer at a depth of 1,056 ft (-1,016 ft msl).





BEST-FIT MODELED CURVE

APPARENT RESISTIVITY VALUES USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

MEASURED TDEM APPARENT RESISTIVITY AND EQUIVALENCE FOR 1-D INVERSION
SOUNDING 13 - LITTLE TIGER BAY
VOLUSIA COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	EQU-13	5.14-3
DRAWN BY:	RBT	DATE:	07/06/94	

DATA SET: SITE 13

CLIENT: SJRWMD DATE: 07-MAY-94
LOCATION: LITTLE TIGER BAY SOUNDING: 1
COUNTY: VOLUSIA COUNTY, FLORIDA ELEVATION: 12.00 m
PROJECT: SALT WATER INTERFACE DETECTION EQUIPMENT: Geonics PROTEM
LOOP SIZE: 305.000 m by 335.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y)
SOUNDING COORDINATES: E: 0.0000 N: 0.0000

FITTING ERROR: 1.903 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			12.00	
1	68.39	187.0	-175.0	2.73
2	301.6	149.6	-324.7	0.496
3	1.80			

ALL PARAMETERS ARE FREE

PARAMETER BOUNDS FROM EQUIVALENCE ANALYSIS

LAYER		MINIMUM	BEST	MAXIMUM
RHO	1	67.195	68.395	69.478
	2	169.626	301.643	739.441
	3	1.347	1.810	2.711
THICK	1	168.563	-0.529	204.033
	2	127.046	1.000	179.205
DEPTH	1	168.563	187.077	204.033
	2	328.990	336.745	352.577

CURRENT: 19.90 AMPS EM-57 COIL AREA: 100.00 sq m.
FREQUENCY: 30.00 Hz GAIN: 2 RAMP TIME: 257.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.0867	80900.9	77996.9	3.58
2	0.108	62763.1	60893.1	2.97
3	0.138	45696.1	44708.2	2.16

ST. JOHNS RIVER
WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SOUNDING DATA TABLE
SOUNDING 13 – LITTLE TIGER BAY
VOLUSIA COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.14–1

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
4	0.175	32422.4	32035.5	1.19
5	0.218	22431.6	22784.4	-1.57
6	0.278	14686.7	14998.7	-2.12
7	0.351	9282.5	9593.1	-3.34
8	0.438	5838.6	5994.0	-2.66
9	0.558	3416.5	3404.1	0.362
10	0.702	1896.2	1897.0	-0.0393
11	0.858	1111.4	1099.5	1.06
12	1.06	610.8	600.5	1.68
13	1.37	305.1	302.1	0.983
14	1.74	163.9	165.2	-0.817
15	2.17	102.1	104.1	-1.97
16	2.77	67.54	67.48	0.0997
17	3.50	47.82	47.36	0.964
18	4.37	34.46	34.56	-0.280

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

	P 1	P 2	P 3	T 1	T 2
P 1	1.00				
P 2	0.00	0.01			
P 3	-0.01	-0.05	0.26		
T 1	-0.01	-0.06	0.14	0.93	
T 2	0.00	0.07	-0.33	0.11	0.79

ST. JOHNS RIVER
WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SOUNDING DATA TABLE
SOUNDING 13 – LITTLE TIGER BAY
VOLUSIA COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.14-1

- For comparison, Rutledge (1985) estimated a depth of greater than 1,270 ft to the 250 mg/l isochlor at this site. The results of the TDEM study agree with Rutledge (1985) who indicated that the chloride content in the Upper Floridan aquifer is less than 250 mg/l at this site.

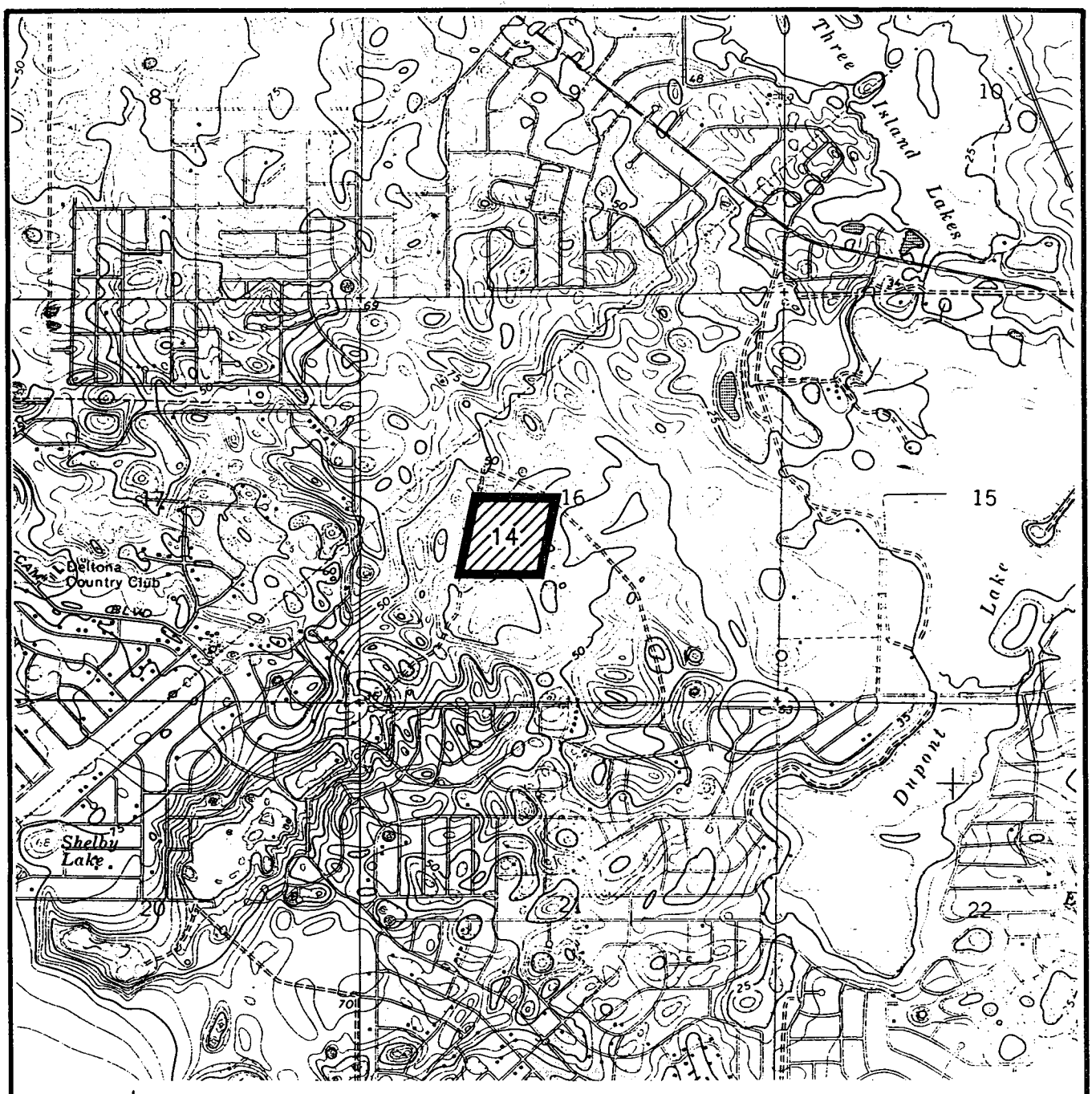
5.15 TDEM Site 14 - Deltona Environmental Restoration

5.15.1 Location Description and Geoelectrical Section

The site is located in western Volusia County, Florida (Figure 5.15-1). The site is located within a forested area. A possible interference source (a powerline) existed several hundred feet north of the Tx loop. QA soundings were performed 100 ft north and west of the initial Rx coil location. Results from the QA soundings indicate that the apparent resistivity values were unaffected by any interference sources.

The Floridan aquifer occurs at an approximate depth of 30 ft bmsl or 55 ft bls (Rutledge, 1985) and is overlain by the Holocene to Miocene deposits. The bottom of the Floridan aquifer occurs at a depth of 2160 ft bmsl (Tibbals, 1990). The thickness of the Upper Floridan aquifer is approximately 670 ft and the depth to the top of the Lower Floridan aquifer is approximately 725 ft bls (Miller, 1986). While drilling a monitor well (V-0773) within 1/4 mile from the TDEM site, SJRWMD has found chloride concentration in the Upper Floridan aquifer to be highly variable, reaching a high of approximately 1,600 mg/l at a depth of 194 ft and 6 mg/l at a depth of 620 ft. The bottom of the well was at 760 ft at the time of this review.

The resistivity sounding data and best-fit model inversion are presented on Figure 5.15-2. The interpreted geoelectrical section consists of a three-layer subsurface.

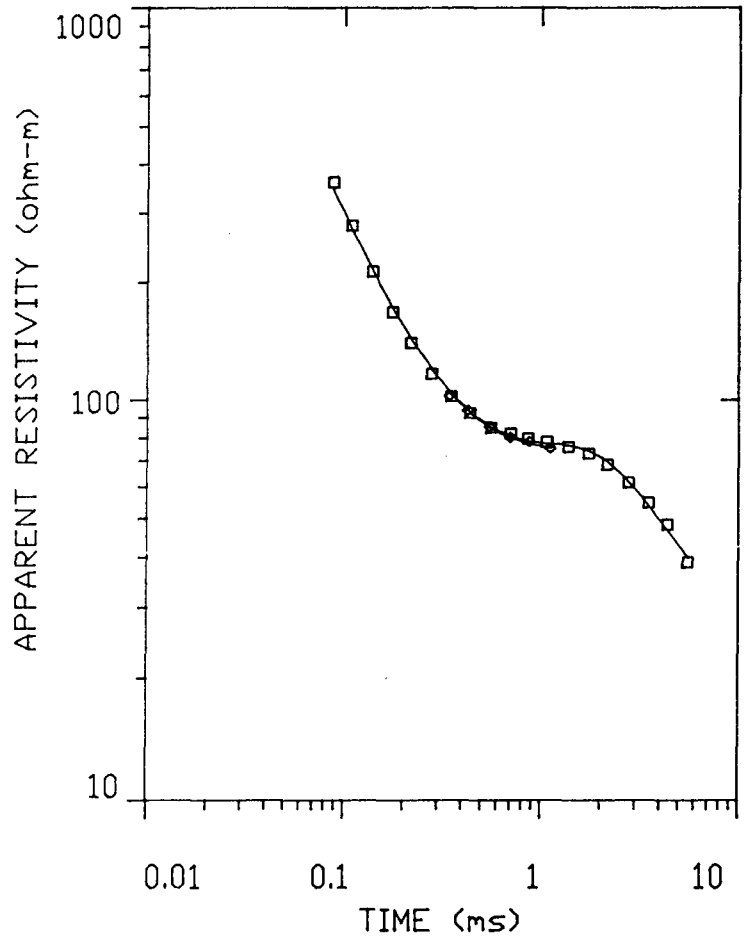


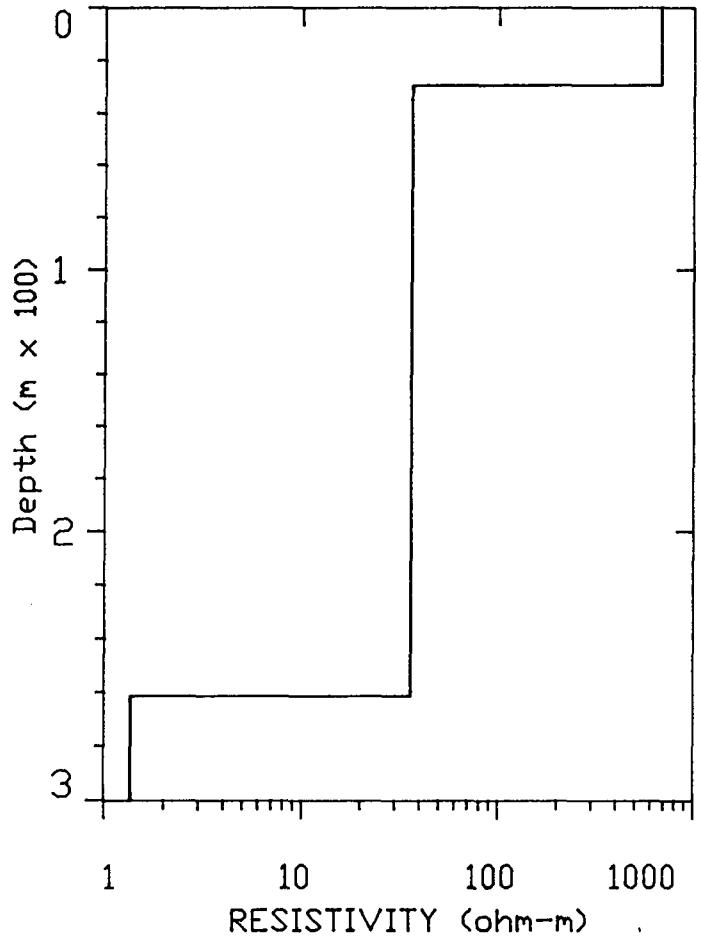
ST. JOHNS RIVER
WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SURVEY LOCATION MAP
SOUNDING 14 – DELTONA ENVIRONMENTAL RESTORATION
VOLUSIA COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	LOC-14	5.15-1
DRAWN BY:	RBT	DATE:	07/05/94	





BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

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SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

MEASURED TDEM APPARENT RESISTIVITY AND 1-D INVERSION
SOUNDING 14 - DELTONA ENVIRONMENTAL RESTORATION
VOLUSIA COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	MDL-14	5.15-2
DRAWN BY:	RBT	DATE:	07/06/94	

5.15.2 Geological Interpretation of Geoelectrical Model

The three-layered geoelectrical section consists of a high resistivity (675 ohm-m), upper layer which is 29 m (95 ft) thick and considered to be the sediments of Holocene to Miocene deposits and the upper portion of the Floridan aquifer. The second layer has only intermediate resistivity (36 ohm-m) which, because it is less than 80 ohm-m, suggests the Floridan aquifer at this depth contains brackish water. The thickness of the brackish section is 232 m (761 ft), placing the depth to the low resistivity (saltwater) layer at 261 m (856 ft) below ground surface. The resistivity of the saltwater saturated layer is 1.4 ohm-m. Layer 1 is considered to be the combined thickness of Holocene and Miocene deposits above the Floridan aquifer with the upper portion of the Florida aquifer, Layer 2 to be the Floridan aquifer (brackish) and Layer 3 to be the salt water within the Lower Floridan aquifer.

5.15.3 Depth to Occurrence of Salt Water

The bottom (third) layer of the geoelectrical model, with a resistivity of 1.4 ohm-m, is interpreted to represent salt water. It occurs at a depth of 856 ft (-831 ft msl). Because the resistivity of Layer 2 (36 ohm-m) is interpreted to represent brackish water within the Floridan aquifer (i.e., is less than 80 ohm-m), the interpreted depth to the 5,000 mg/l isochlor is equal to the depth of the geoelectrical interface, or at 856 ft depth (-831 ft msl). The resistivity of Layer 3 (1.4 ohm-m) corresponds to a chloride content of greater than 20,000 mg/l assuming a porosity of 25% and the validity and applicability of equation (4) of Section 4.2. It is presumed that because of the expected high chlorinity gradients, this value is sufficiently close to the 5,000 mg/l isochlor that they represent the same effective depth.

5.15.4 Depth of Occurrence of the 250 mg/l Isochlor

The resistivity of Layer 2, 36 ohm-m, corresponds to a chloride content above 250 mg/l, assuming a 25% porosity and the validity and applicability of equation (4) of Section 4.2. This layer extends from 96 to 761 ft bls.

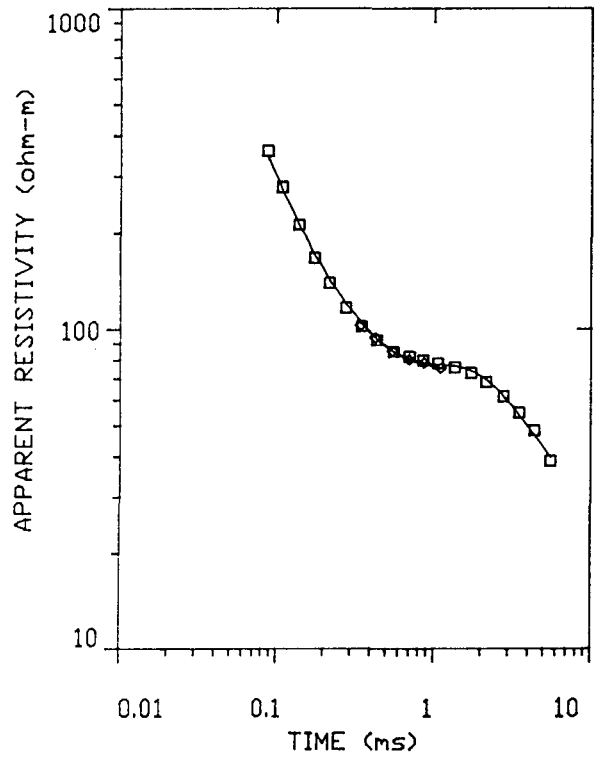
Because Layer 1 has a resistivity of greater than 80 ohm-m and Layer 2 has a resistivity of 36 ohm-m, the 250 mg/l isochlor is assumed to occur at 25 ft above the boundary between Layer 1 and Layer 2. That depth is 71 ft bls. For comparison, Rutledge (1985) estimated a maximum thickness of approximately 500 ft for water with a chloride concentration less than 250 mg/l in the Floridan aquifer at this site. The top of the Floridan aquifer occurs at an approximate depth of 30 ft bmsl or 55 ft bls at this site (Rutledge, 1985).

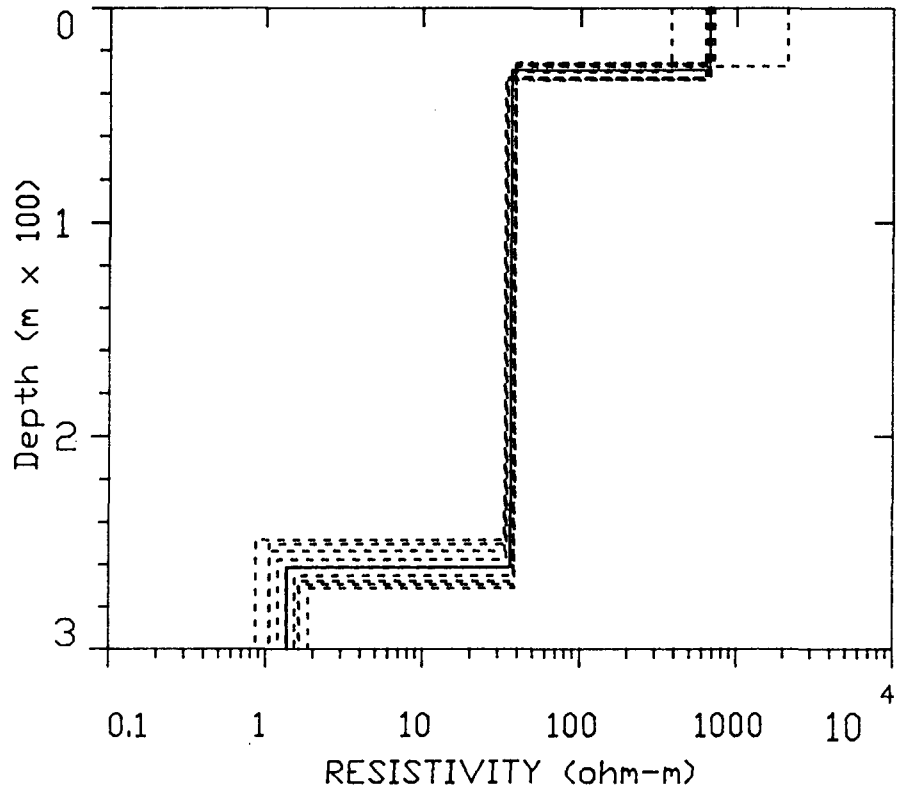
5.15.5 Accuracy of Measurement and Interpretation

Figure 5.15-3 is the equivalence analysis at this site and the inversion table (Table 5.15-1) lists the upper and lower bounds of the inverted parameters of the geoelectrical model.

The range of equivalence in determining the depth to the low resistivity layer is about ±11 m (36 ft) which is 4% of the total depth. The resistivity of this layer has a range from 0.9 to 1.9 ohm-m. This corresponds to a range in interpreted chloride content of from greater than 20,000 mg/l to 16,775 mg/l, again subject to the same assumptions of porosity and validity of equation (4).

The equivalence range of the resistivity of Layer 2 is from 33 to 39 ohm-m which corresponds to chloride content above 250 mg/l. The results of the TDEM study do not agree with the thickness estimates for freshwater (<250 mg/l chloride) from Rutledge (1985). The chloride-to-sulfate ratio at the site is 5:1 (Table 5.1-4). Accordingly, equation (4) is valid.





—— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

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MEASURED TDEM APPARENT RESISTIVITY AND EQUIVALENCE FOR 1-D INVERSION
SOUNDING 14 – DELTONA ENVIRONMENTAL RESTORATION
VOLUSIA COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	EQU-14	5.15-3
DRAWN BY:	RBT	DATE:	07/06/94	

DATA SET: SITE 14

CLIENT: SJRWMD DATE: 08-MAY-94
LOCATION: DELTONA ENVIRONMENTAL REST. SOUNDING: 1
COUNTY: VOLUSIA COUNTY, FLORIDA ELEVATION: 7.50 m
PROJECT: SALT WATER INTERFACE DETECTION EQUIPMENT: Geonics PROTEM
LOOP SIZE: 305.000 m by 305.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y)
SOUNDING COORDINATES: E: 0.0000 N: 0.0000

FITTING ERROR: 2.681 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			7.50	
1	674.6	29.28	-21.78	0.0434
2	36.40	232.0	-253.8	6.37
3	1.35			

ALL PARAMETERS ARE FREE

PARAMETER BOUNDS FROM EQUIVALENCE ANALYSIS

	LAYER	MINIMUM	BEST	MAXIMUM
RHO	1	379.404	674.687	2133.547
	2	33.273	36.409	38.754
	3	0.858	1.359	1.870
THICK	1	26.018	-1.756	33.923
	2	215.516	1.000	244.268
DEPTH	1	26.018	29.284	33.923
	2	248.471	261.347	271.251

CURRENT: 21.00 AMPS EM-57 COIL AREA: 100.00 sq m.
FREQUENCY: 30.00 Hz GAIN: 4 RAMP TIME: 260.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	emf (nV/m sqrd) SYNTHETIC	DIFFERENCE (percent)
1	0.0867	64857.6	68618.7	-5.79
2	0.108	54990.0	56700.4	-3.11
3	0.138	44686.4	44479.3	0.463

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TDEM SOUNDING DATA TABLE
SOUNDING 14 – DELTONA ENVIRONMENTAL RESTORATION
VOLUSIA COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.15–1

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
4	0.175	35214.3	34059.1	3.28
5	0.218	26703.8	25837.0	3.24
6	0.278	19080.1	18364.5	3.75
7	0.351	13019.2	12730.3	2.21
8	0.438	8672.6	8640.2	0.373
9	0.558	5382.9	5390.8	-0.146
10	0.702	3195.7	3289.3	-2.92
11	0.858	2017.3	2067.3	-2.47
12	1.06	1210.9	1223.5	-1.03
13	1.37	674.8	664.2	1.57
14	1.74	393.9	384.1	2.48
15	2.17	250.3	243.7	2.66
16	2.77	158.8	157.4	0.936
17	3.50	105.4	108.2	-2.66
18	4.37	73.23	77.19	-5.40
19	5.56	55.53	53.55	3.55

CURRENT: 21.00 AMPS EM-57 COIL AREA: 100.00 sq m.
FREQUENCY: 7.50 Hz GAIN: 6 RAMP TIME: 260.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
20	0.346	13396.8	13088.5	2.30
21	0.427	9053.3	9104.1	-0.561
22	0.550	5546.8	5603.3	-1.01
23	0.698	3354.2	3381.4	-0.809
24	0.869	2011.9	2054.0	-2.09
25	1.10	1159.4	1159.8	-0.0365

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	0.01				
P 2	0.00	0.98			
P 3	0.01	-0.07	0.62		
T 1	0.05	0.04	0.10	0.90	
T 2	-0.01	-0.02	-0.06	0.03	0.98
	P 1	P 2	P 3	T 1	T 2

ST. JOHNS RIVER
WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

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TDEM SOUNDING DATA TABLE
SOUNDING 14 – DELTONA ENVIRONMENTAL RESTORATION
VOLUSIA COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.15-1

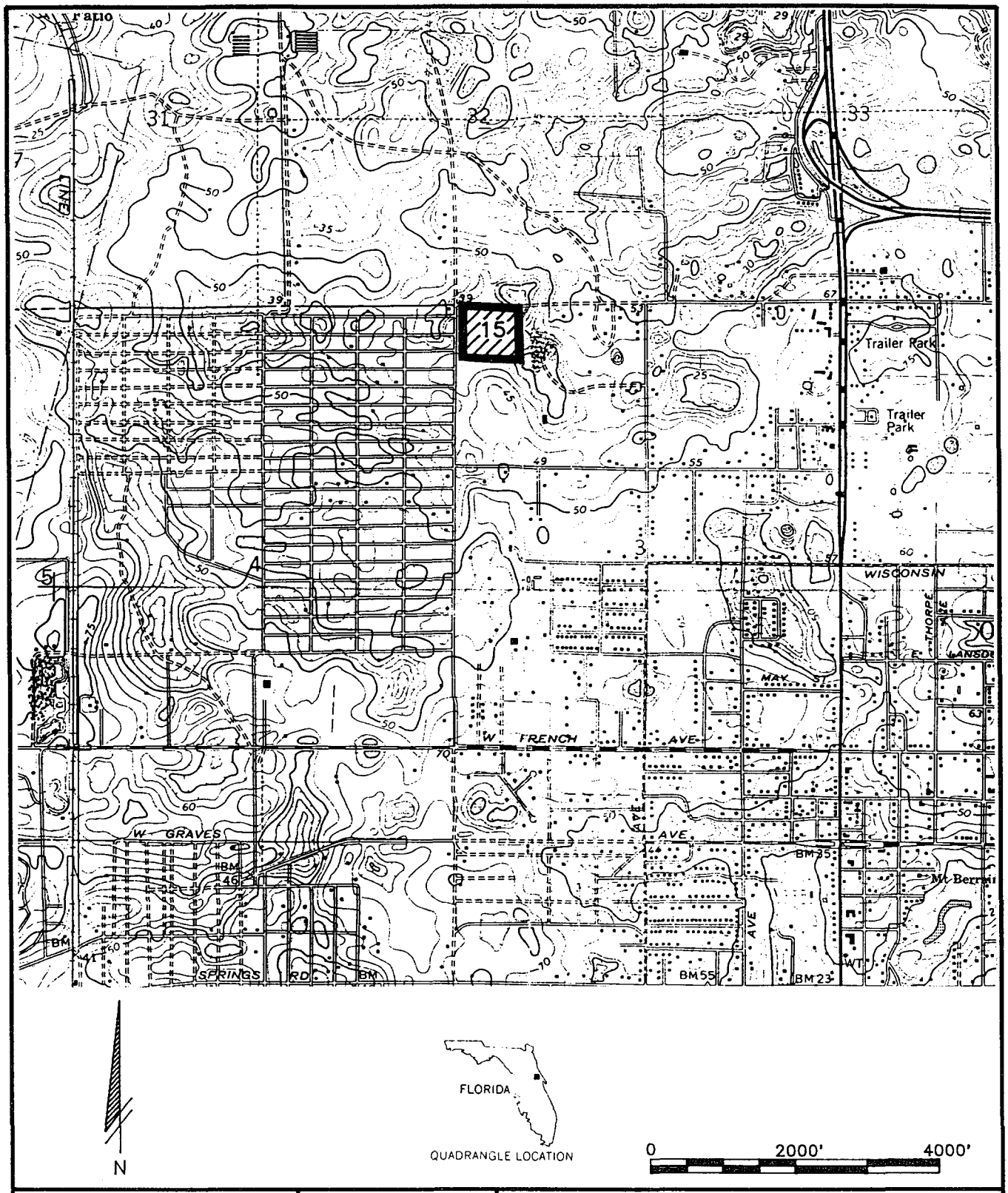
5.15.6 Summary of TDEM Sounding at Deltona Environmental Restoration (Site 14)

- The depth to occurrence of salt water (5,000 mg/l isochlor) is interpreted to be 856 ft (-831 ft msl) and occur within the Lower Floridan aquifer.
- The ground water within the Floridan aquifer at this site from 71 to 761 ft bls is interpreted to contain an average chloride concentration above 250 mg/l. The 250 mg/l isochlor is interpreted to occur at 71 ft bls. The thickness of freshwater (<250 mg/l chloride) in the Upper Floridan aquifer at this site is interpreted to be 16 ft.
- The results of the TDEM study are not in agreement with the maximum thickness estimates for freshwater (<250 mg/l chloride) from Rutledge (1985) which indicated that the maximum thickness of freshwater (<250 mg/l chloride) in the Upper Floridan aquifer at this site is approximately 500 ft. However, the results of the TDEM study do agree with water quality analyses obtained by SJRWMD while drilling a monitor well (V-0773). The analyses indicate that the average chloride concentration for the Upper Floridan aquifer is above 250 mg/l. The monitor well is located within 1/4 mile of the TDEM site.

5.16 TDEM Site 15 - Orange City

5.16.1 Location Description and Geoelectrical Section

The site is located in southwestern Volusia County near Orange City, Florida (Figure 5.16-1). The site is located within a forested area near a residential neighborhood. Possible interference sources (powerlines) existed 170 ft to the west and 100 ft to the east of the Tx loop. QA soundings were performed 75 ft north, east and west of the initial Rx coil location. Results from the QA soundings indicate that the apparent resistivity values were unaffected by any interference sources.

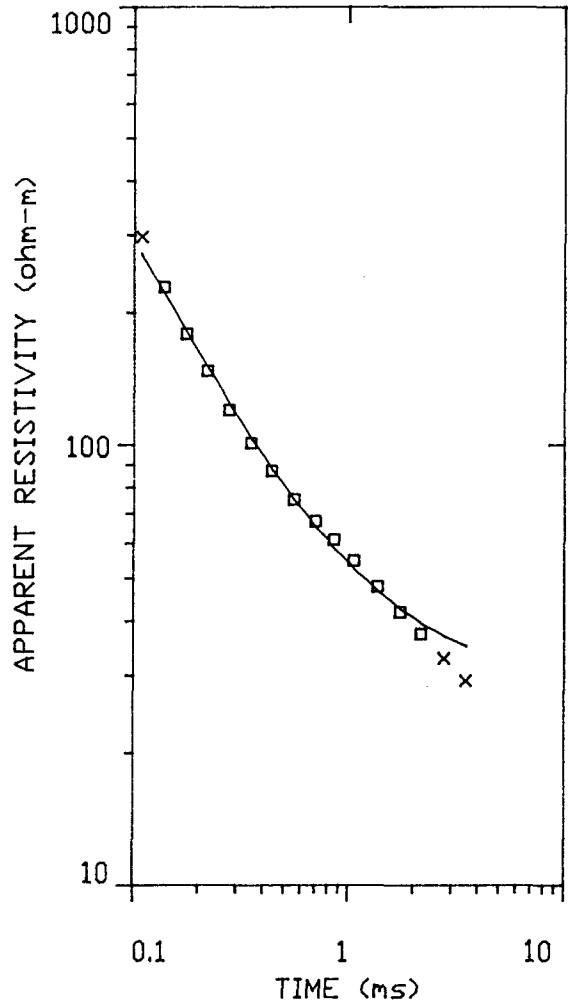


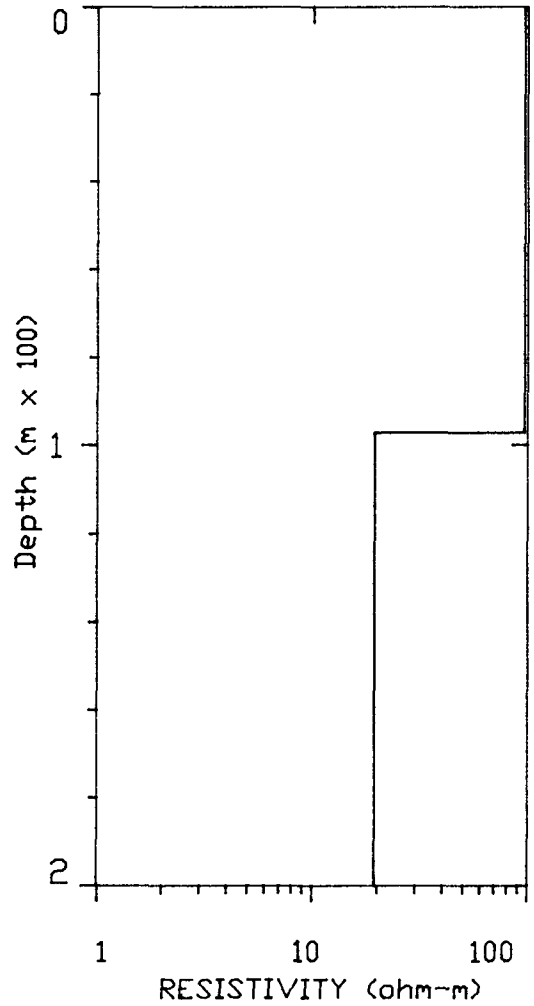
ST. JOHNS RIVER
WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SURVEY LOCATION MAP
SOUNDING 15 – ORANGE CITY
VOLUSIA COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	LOC-15	5.16-1
DRAWN BY:	RBT	DATE:	07/05/94	





——— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

X APPARENT RESISTIVITY VALUES NOT USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

MEASURED TDEM APPARENT RESISTIVITY AND 1-D INVERSION
SOUNDING 15 - ORANGE CITY
VOLUSIA COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	MDL-15	5.16-2
DRAWN BY:	RBT	DATE:	07/06/94	

The Floridan aquifer occurs at an approximate depth of 50 ft bmsl or 85 ft bls (Rutledge, 1985) and is overlain by Holocene to Miocene deposits. The bottom of the Floridan aquifer occurs at an approximate depth of 2100 ft bmsl (Tibbals, 1990). The thickness of the Upper Floridan aquifer is approximately 600 ft and the depth to the top of the Lower Floridan aquifer is approximately 685 ft bls (Miller, 1986). A water quality study performed in the area of the site (Rutledge, 1985) indicates that the chloride concentration in the upper portion of the Floridan aquifer ranges from 0 to 50 mg/l.

The resistivity sounding data and best-fit model inversion are presented on Figure 5.16-2. The interpreted geoelectrical section consists of a two-layer subsurface.

5.16.2 Geological Interpretation of Geoelectrical Model

The first layer occurs at 97 m (318 ft) bls and not at the hydrostratigraphic contact between the Holocene and Miocene deposits (85 ft bls) and the Floridan Aquifer System. Therefore, it can be interpreted that there exists a two-layer geoelectrical section with a 318 ft thick surface layer with a resistivity of 97 ohm-m overlying a low resistivity layer (19 ohm-m). It can be interpreted that the Holocene to Miocene deposits and the upper part of the Floridan aquifer system exist as a combined but indistinguishable (geoelectrical) layer, overlying a saltwater saturated Upper Floridan aquifer at a depth of 318 ft bls.

5.16.3 Depth to Occurrence of Salt Water

The bottom (second) layer of the geoelectrical model, with a resistivity of 19 ohm-m, is interpreted to represent salt water. It occurs at a depth of 318 ft (-283 ft msl). Because the resistivity of Layer 1 (97 ohm-m) is greater than 80 ohm-m, the interpreted depth to the 5,000 mg/l isochlor is taken as 50 ft greater than the depth of the geoelectrical interface, or at a depth of 368 ft (333 ft msl). The resistivity of Layer 2 (19.4 ohm-m)

corresponds to a chloride content of 1,540 mg/l assuming a porosity of 25% and the validity and applicability of equation (4) of Section 4.2. It is presumed that because of the expected high chlorinity gradients, this value is sufficiently close to the 5,000 mg/l isochlor that they represent the same effective depth.

5.16.4 Depth of Occurrence of the 250 mg/l Isochlor

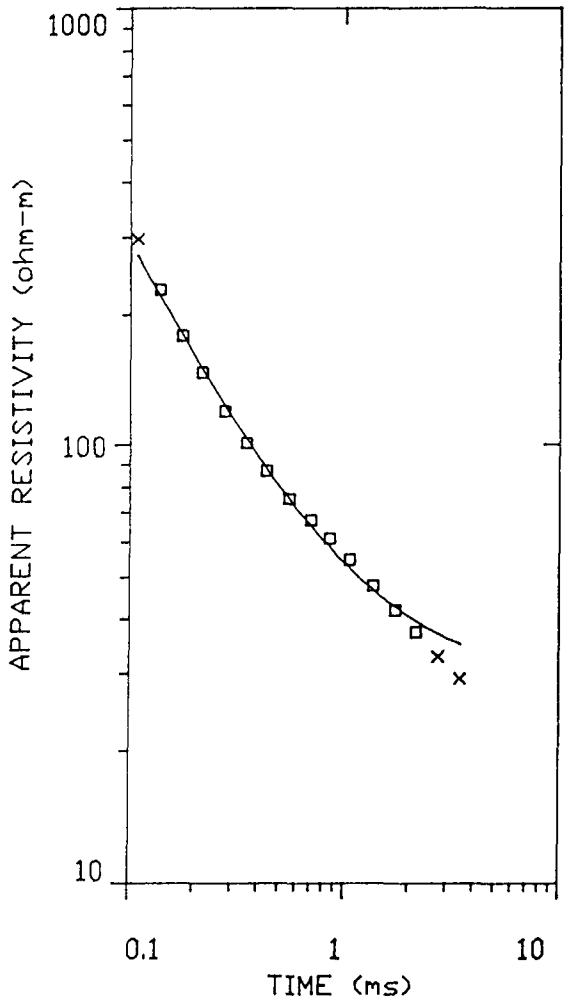
Since the resistivity (97 ohm-m) of Layer 1 is greater than 80 ohm-m, the chloride concentration in the Upper Floridan aquifer is less than 250 mg/l, even though Layer 1 contains Holocene to Miocene deposits. Since the resistivity of Layer 1 (97 ohm-m) is greater than 80 ohm-m, the 250 mg/l isochlor is interpreted to occur 50 ft above the boundary between Layer 1 and Layer 2. That depth is 268 ft. For comparison, Rutledge (1985) estimated a maximum thickness of approximately 200 ft for water with a chloride concentration less than 250 mg/l in the Floridan aquifer at this site. The top of the Floridan aquifer occurs at an approximate depth of 50 ft bmsl or 85 ft bls at this site (Rutledge, 1985).

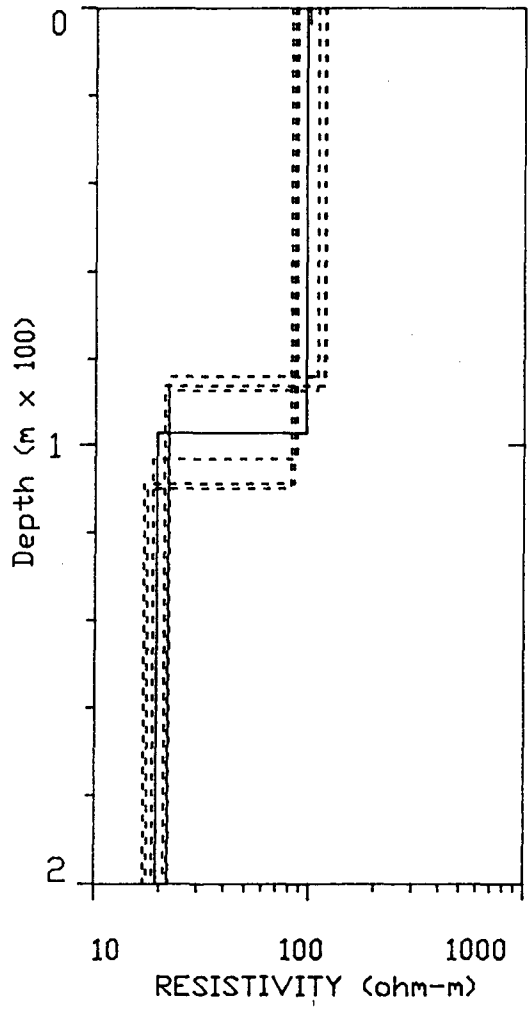
5.16.5 Accuracy of Measurement and Interpretation

Figure 5.16-3 is the equivalence analysis at this site and the inversion table (Table 5.16-1) lists the upper and lower bounds of the inverted parameters of the geoelectrical model. The range of equivalence in determining the depth to the low resistivity layer is about ±13 m (43 ft) which is 11% of the total depth.

The resistivity of this layer has a range of from 17 to 22 ohm-m. This corresponds to a range in interpreted chloride content of from 1,739 mg/l to 1,309 mg/l, again subject to the same assumptions of porosity and validity of equation (4).

The equivalence range of the resistivity of Layer 1 is from 82 to 119 ohm-m. Since the resistivity is greater than 80 ohm-m, the chloride concentration in the upper part of the Floridan aquifer is less than 250 mg/l even though Layer 1 is in part comprised of both the upper portion of the Floridan aquifer and the Holocene to Miocene deposits.





—— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

X APPARENT RESISTIVITY VALUES NOT USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

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SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

MEASURED TDEM APPARENT RESISTIVITY AND EQUIVALENCE FOR 1-D INVERSION
SOUNDING 15 - ORANGE CITY
VOLUSIA COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	EQU-15	5.16-3
DRAWN BY:	RBT	DATE:	07/06/94	

DATA SET: SITE 15

CLIENT: SJRWMD
DATE: 08-MAY-94
LOCATION: ORANGE CITY
SOUNDING: 1
COUNTY: VOLUSIA COUNTY, FLORIDA
ELEVATION: 11.00 m
PROJECT: SALT WATER INTERFACE DETECTION
EQUIPMENT: Geonics PROTEM
LOOP SIZE: 228.500 m by 237.000 m
AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y)
SOUNDING COORDINATES: E: 0.0000 N: 0.0000

FITTING ERROR: 4.673 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			11.00	
1	96.91	97.19	-86.19	1.00
2	19.36			

ALL PARAMETERS ARE FREE

PARAMETER BOUNDS FROM EQUIVALENCE ANALYSIS

	LAYER	MINIMUM	BEST	MAXIMUM
RHO	1	82.237	96.916	118.727
	2	16.900	19.369	22.038
THICK	1	84.039	1.000	109.973
DEPTH	1	84.039	97.199	109.973

CURRENT: 19.50 AMPS EM-57 COIL AREA: 100.00 sq m.
FREQUENCY: 30.00 Hz GAIN: 5 RAMP TIME: 212.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.108	26961.3	30685.5	-13.81 MASKED
2	0.138	21702.0	22760.9	-4.87
3	0.175	17230.0	17021.8	1.20
4	0.218	13356.7	12945.4	3.07
5	0.278	9918.9	9464.2	4.58
6	0.351	7160.3	6901.3	3.61
7	0.438	5122.3	5037.0	1.66

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TDEM SOUNDING DATA TABLE
SOUNDING 15 – ORANGE CITY
VOLUSIA COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.16-1

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)	
8	0.558	3492.4	3498.2	-0.164	
9	0.702	2325.2	2429.5	-4.48	
10	0.858	1627.2	1740.3	-6.94	
11	1.06	1112.9	1191.3	-7.03	
12	1.37	728.5	754.5	-3.57	
13	1.74	489.0	477.1	2.41	
14	2.17	334.4	307.6	8.01	
15	2.77	220.8	185.1	16.17	MASKED
16	3.50	146.5	111.6	23.81	MASKED

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

	P 1	P 2	T 1
P 1	0.96		
P 2	-0.02	0.98	
T 1	0.02	0.02	0.98

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WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

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SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SOUNDING DATA TABLE
SOUNDING 15 – ORANGE CITY
VOLUSIA COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.16–1

5.16.6 Summary of TDEM Sounding at Orange City (Site 15)

- The depth of occurrence of salt water (5,000 mg/l isochlor) is interpreted to be 368 ft (-333 ft msl) and occur within the Upper Floridan aquifer.
- The 250 mg/l isochlor is interpreted to occur at 268 ft bls. The thickness of freshwater (<250 mg/l chloride) in the Upper Floridan aquifer at this site is interpreted to be 183 ft.
- The results of the TDEM study are in agreement with the thickness estimates for freshwater (<250 mg/l chloride) from Rutledge (1985) who indicated that the maximum thickness of freshwater (<250 mg/l chloride) in the Upper Floridan aquifer at the site is approximately 200 ft.

5.17 TDEM Site 16 - Geneva/Jungle Road

5.17.1 Location Description and Geoelectrical Section

The site is located in northeast Seminole County near Geneva, Florida (Figure 5.17-1). The site is located within an open field. No possible sources of interference existed near the Tx loop. QA soundings were performed 30 ft north and east of the initial Rx coil location. Results from the QA soundings indicate that the apparent resistivity values were unaffected by any interference sources.

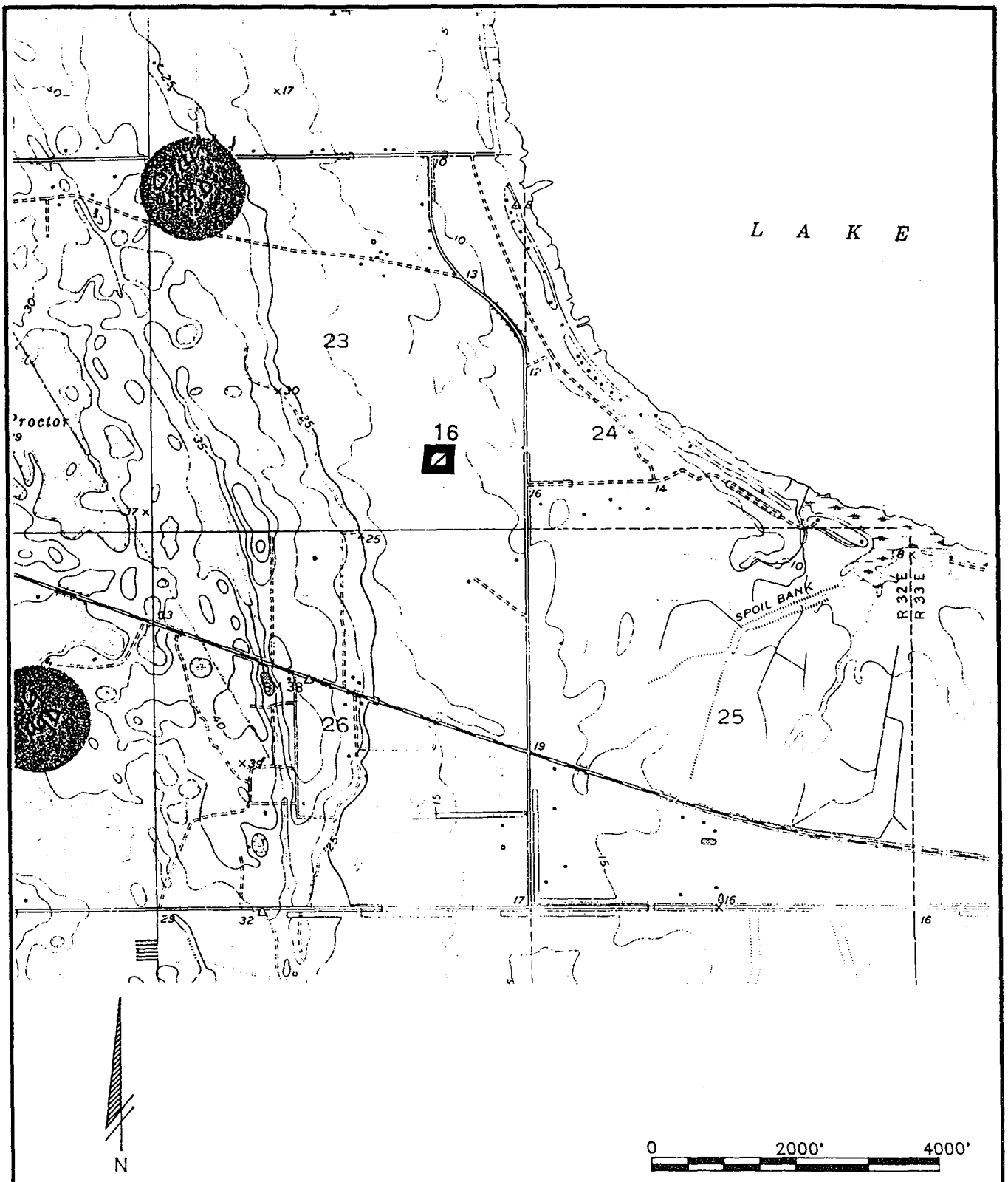
A hydrogeologic study was performed in the area of the site (Phelps and Rohrer, 1987). As part of the study, information from local wells was used to determine the thickness of Holocene to Miocene deposits overlying the Floridan aquifer and to estimate the depth to the "brackish" water interface. The brackish water interface in the area of the site occurs at an approximate depth of 215 ft (from Figure 15, Phelps and Rohrer, 1987).

The sediments associated with the Holocene to Miocene deposits are approximately 55 ft thick, based on the lithologic logs from well site 43, which was approximately 1 mile from the site. For comparison, the combined approximate thickness of sediments overlying the Floridan aquifer is 66 ft at the site (Tibbals, 1977). The bottom of the Floridan aquifer occurs at an approximate depth of 2,300 ft bmsl (Tibbals, 1990).

The resistivity sounding data and best-fit model inversion are presented on Figure 5.17-2. The interpreted geoelectrical section consists of a two-layer subsurface.

5.17.2 Geological Interpretation of Geoelectrical Model

The first layer occurs at 114 m (374 ft) bls and not at the hydrostratigraphic contact between the Holocene and Miocene deposits (66 ft bls) and the Floridan Aquifer System. Therefore, it can be interpreted that there exists a two-layer geoelectrical section with a 374 ft thick surface layer of intermediate resistivity (43 ohm-m) overlying a low resistivity layer (3.4 ohm-m). It can be interpreted that the Holocene to Miocene deposits and the upper part of the Floridan aquifer system exist as a combined but indistinguishable (geoelectrical) layer, overlying a saltwater saturated Floridan aquifer at a depth of 374 ft bls.



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PALATKA, FLORIDA

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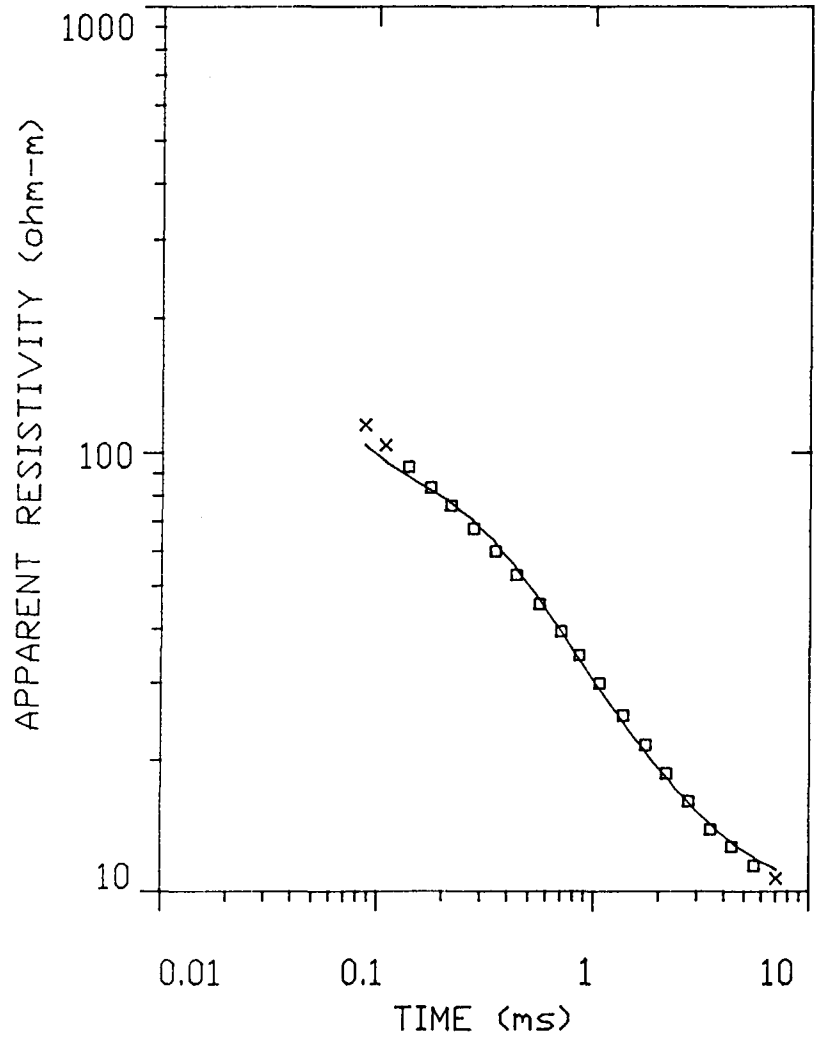
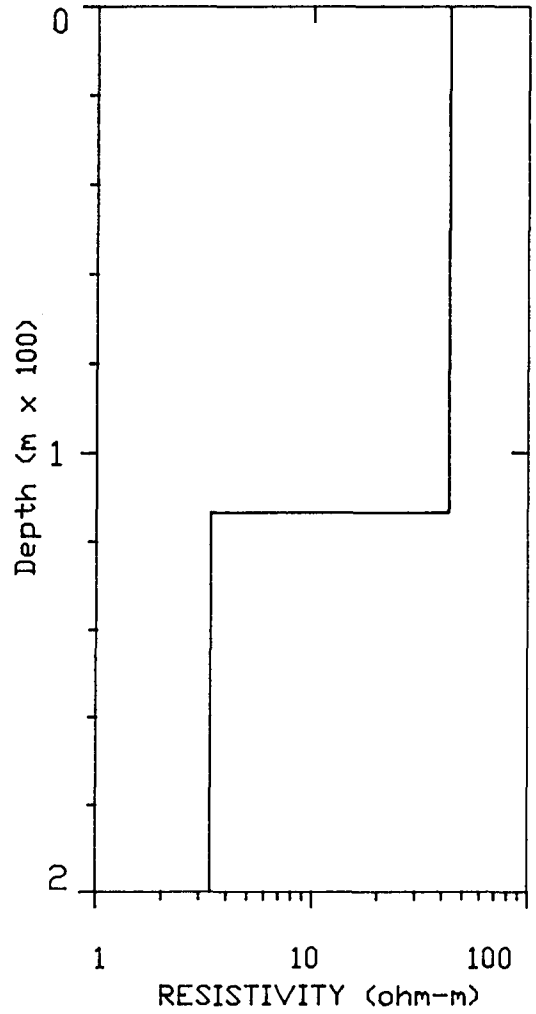
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SURVEY LOCATION MAP
SOUNDING 16 – GENEVA/JUNGLE ROAD
SEMINOLE COUNTY, FLORIDA

DESIGNED BY: JEB		PROJECT NO.:	94767	FIGURE
CHECKED BY: MJW		DRAWING NO.:	LOC-16	5.17-1
DRAWN BY: RBT		DATE:	07/05/94	





—— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

X APPARENT RESISTIVITY VALUES NOT USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

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MEASURED TDEM APPARENT RESISTIVITY AND 1-D INVERSION
SOUNDING 16 - GENEVA/JUNGLE ROAD
SEMINOLE COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	MDL-16	5.17-2
DRAWN BY:	RBT	DATE:	07/06/94	

5.17.3 Depth to Occurrence of Salt Water

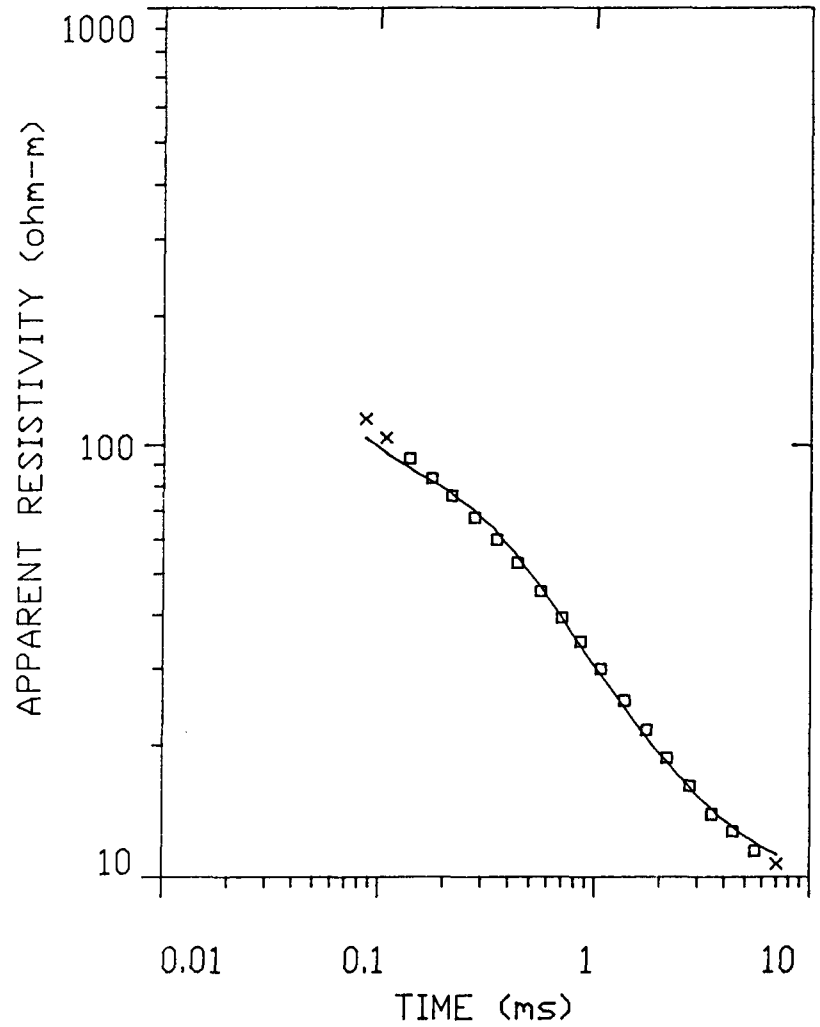
The bottom (second) layer of the geoelectrical model, with a resistivity of 3.4 ohm-m, is interpreted to represent salt water. It occurs at a depth of 374 ft (-357 ft msl). Because the resistivity of Layer 1 (43 ohm-m) is less than 80 ohm-m, the interpreted depth to the 5,000 mg/l isochlor is taken at the depth of the geoelectrical interface, or at 374 ft depth (-357 ft msl). The resistivity of Layer 2 (3.4 ohm-m) corresponds to a chloride content of 9,307 mg/l assuming a porosity of 25% and the validity and applicability of equation (4) of Section 4.2. It is presumed that because of the expected high chlorinity gradients, this value is sufficiently close to the 5,000 mg/l isochlor that they represent the same effective depth.

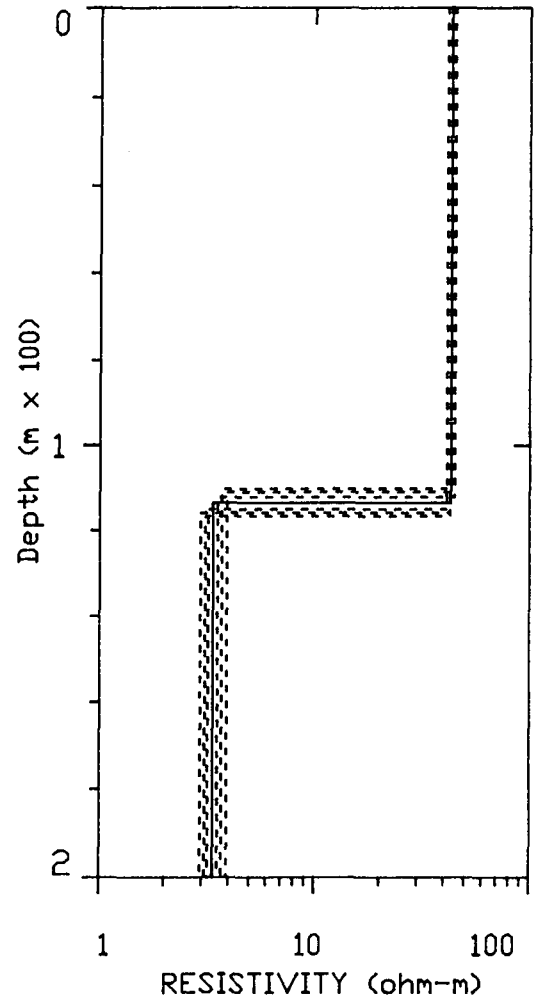
5.17.4 Depth of Occurrence of the 250 mg/l Isochlor

Because of the inability to segregate the Floridan aquifer from the overlying Holocene to Miocene deposits, the effective chloride concentration of Layer 1 cannot be calculated. Therefore, the depth of the 250 mg/l isochlor cannot be determined.

5.17.5 Accuracy of Measurement and Interpretation

Figure 5.17-3 is the equivalence analysis at this site and the inversion table (Table 5.17-1) lists the upper and lower bounds of the inverted parameters of the geoelectrical model. The range of equivalence in determining the depth to the low resistivity layer is about ±3 m (10 ft) which is 3% of the total depth. The estimated depth to the saltwater interface (374 ft) is not in agreement with Phelps and Rohrer (1987) who estimated an approximate depth of 215 ft in the area of the site. The discrepancy is probably due to different interfaces. Phelps and Rohrer (1987) estimated the depth to the 250 mg/l isochlor. The interface depth determined in this study corresponds to the 5,000 mg/l isochlor.





——— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

X APPARENT RESISTIVITY VALUES NOT USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

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MEASURED TDEM APPARENT RESISTIVITY AND EQUIVALENCE FOR 1-D INVERSION
SOUNDING 16 – GENEVA/JUNGLE ROAD
SEMINOLE COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	EQU-16	5.17-3
DRAWN BY:	RBT	DATE:	07/06/94	

DATA SET: SITE 16

CLIENT: SJRWMD DATE: 09-MAY-94
LOCATION: GENEVA/JUNGLE ROAD SOUNDING: 1
COUNTY: SEMINOLE COUNTY, FLORIDA ELEVATION: 5.00 m
PROJECT: SALT WATER INTERFACE DETECTION EQUIPMENT: Geonics PROTEM
LOOP SIZE: 91.400 m by 91.400 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y)
SOUNDING COORDINATES: E: 0.0000 N: 0.0000

FITTING ERROR: 4.758 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			5.00	
1	43.25	113.5	-108.5	2.62
2	3.36			

ALL PARAMETERS ARE FREE

PARAMETER BOUNDS FROM EQUIVALENCE ANALYSIS

	LAYER	MINIMUM	BEST	MAXIMUM
RHO	1	41.381	43.252	45.007
	2	2.933	3.366	3.908
THICK	1	110.186	1.000	116.711
DEPTH	1	110.186	113.533	116.711

CURRENT: 29.50 AMPS EM-57 COIL AREA: 100.00 sq m.
FREQUENCY: 30.00 Hz GAIN: 5 RAMP TIME: 133.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.0867	45042.4	52517.8	-16.59 MASKED
2	0.108	30462.0	34512.8	-13.29 MASKED
3	0.138	19465.4	21080.6	-8.29
4	0.175	12652.5	12927.8	-2.17
5	0.218	8416.3	8264.1	1.80
6	0.278	5485.2	5166.3	5.81
7	0.351	3646.5	3412.4	6.41

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TDEM SOUNDING DATA TABLE
SOUNDING 16 – GENEVA/JUNGLE ROAD
SEMINOLE COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.17-1

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)	
8	0.438	2524.5	2391.0	5.28	
9	0.558	1737.1	1672.2	3.73	
10	0.702	1210.2	1207.2	0.242	
11	0.858	886.8	914.4	-3.10	
12	1.06	643.1	673.5	-4.72	
13	1.37	442.4	467.2	-5.58	
14	1.74	307.1	325.5	-5.99	
15	2.17	221.2	228.6	-3.32	
16	2.77	149.7	152.1	-1.58	
17	3.50	104.3	100.3	3.78	
18	4.37	68.51	66.30	3.22	
19	5.56	43.76	41.11	6.04	
20	7.03	26.96	25.11	6.83	MASKED

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	1.00		
P 2	0.00	0.94	
T 1	0.00	0.01	1.00
	P 1	P 2	T 1

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TDEM SOUNDING DATA TABLE
SOUNDING 16 – GENEVA/JUNGLE ROAD
SEMINOLE COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.17–1

The resistivity of Layer 2 has a range of from 2.9 to 3.9 ohm-m. This corresponds to a range in interpreted chloride content of from 10,938 mg/l to 8,094 mg/l, again subject to the same assumptions of porosity and validity of equation (4).

The equivalence range of the resistivity of Layer 1 is from 41 to 45 ohm-m. A corresponding chloride concentration cannot be determined because Layer 1 is in part comprised of Holocene to Miocene deposits. Accordingly, equation (4) may not be valid.

5.17.6 Summary of TDEM Sounding at Geneva/Jungle Road (Site 16)

- The depth of occurrence of salt water (5,000 mg/l isochlor) is interpreted to be 374 ft (-357 ft msl) and occur within the Floridan aquifer. The estimated depth to the salt water interface is not in agreement with Phelps and Rohrer (1987). The discrepancy is probably due to different interfaces. Phelps and Rohrer (1987) estimated the depth (215 ft) to the 250 mg/l isochlor.
- The quality of ground water within the Floridan aquifer at this site cannot be interpreted because the analysis of the TDEM data does not allow the Holocene to Miocene deposits to be distinguished from the Floridan Aquifer System.

5.18 TDEM Site 17 - Geneva/Center

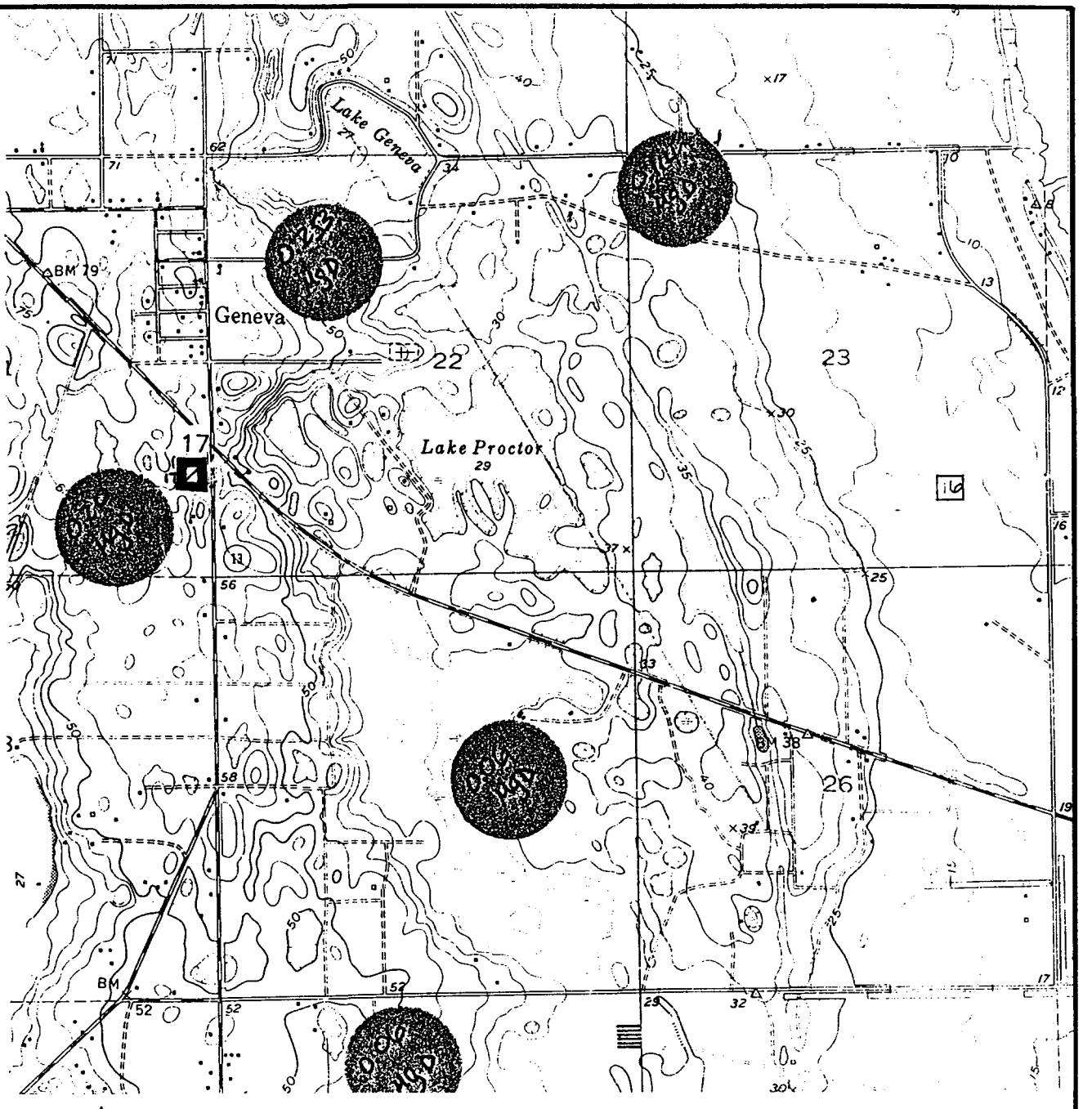
5.18.1 Location Description and Geoelectrical Section

The site is located in northeast Seminole County near Geneva, Florida (Figure 5.18-1). The site is located within an open field. Two possible sources of interference were present; a powerline 200-300 ft to the east and a house 200 ft to the south of the Tx loop. QA soundings were performed 36 ft to the east and west and 27 ft to the north and south of the initial Rx coil location. Results from the QA soundings indicate that the apparent resistivity values were unaffected by any interference sources.

A hydrogeologic study was performed in the area of the site (Phelps and Rohrer, 1987). As part of the study, information from local wells was used to determine the thickness of the Holocene to Miocene deposits overlying the Floridan aquifer and to estimate the depth to the "brackish" water interface. The brackish water interface occurs at an approximate depth of 345 ft at well site 36, approximately one mile from the site (from Figure 13, Phelps and Rohrer, 1987). The Holocene to Miocene sediments are approximately 121 ft thick at well site 36. For comparison, the combined approximate thickness of sediments overlying the Floridan aquifer is 99 ft at the site (Tibbals, 1977). The bottom of the Floridan aquifer occurs at an approximate depth of 2,300 ft bmsl (Tibbals, 1990). The resistivity sounding data and best-fit model inversion are presented on Figure 5.18-2. The interpreted geoelectrical section consists of a two-layer subsurface.

5.18.2 Geological Interpretation of Geoelectrical Model

The first layer occurs at 64 m (210 ft) bls and not at the hydrostratigraphic contact between the Holocene and Miocene deposits (99 ft bls) and the Floridan Aquifer System. Therefore, it can be interpreted that there exists a two-layer geoelectrical section with a 210 ft thick surface layer with a resistivity of 217 ohm-m overlying a low resistivity layer (4.2 ohm-m). It can be interpreted that the Holocene to Miocene deposits and the upper part of the Floridan Aquifer System exist as a combined but indistinguishable (geoelectrical) layer, overlying a saltwater saturated Floridan aquifer at a depth of 210 ft bls.



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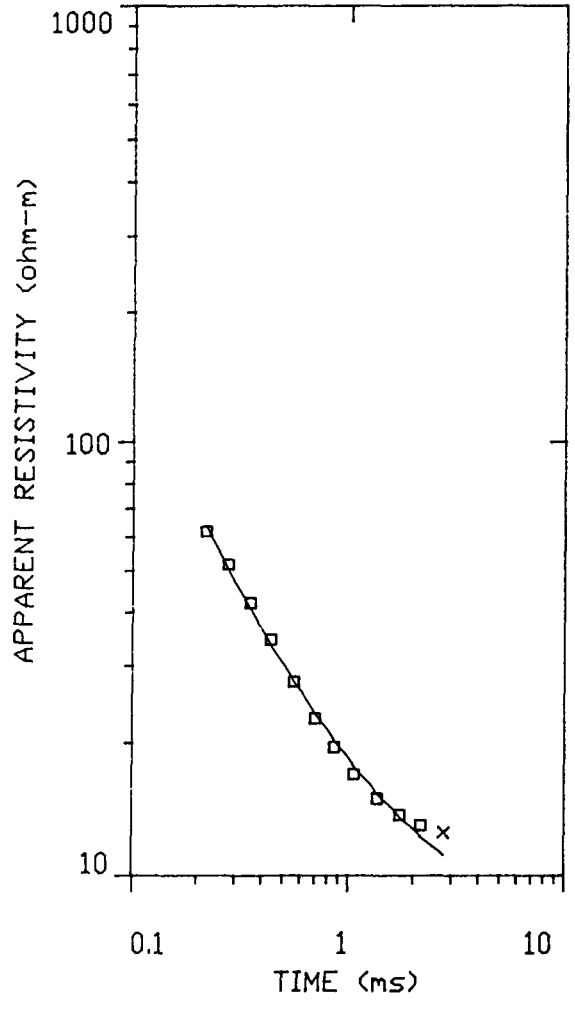
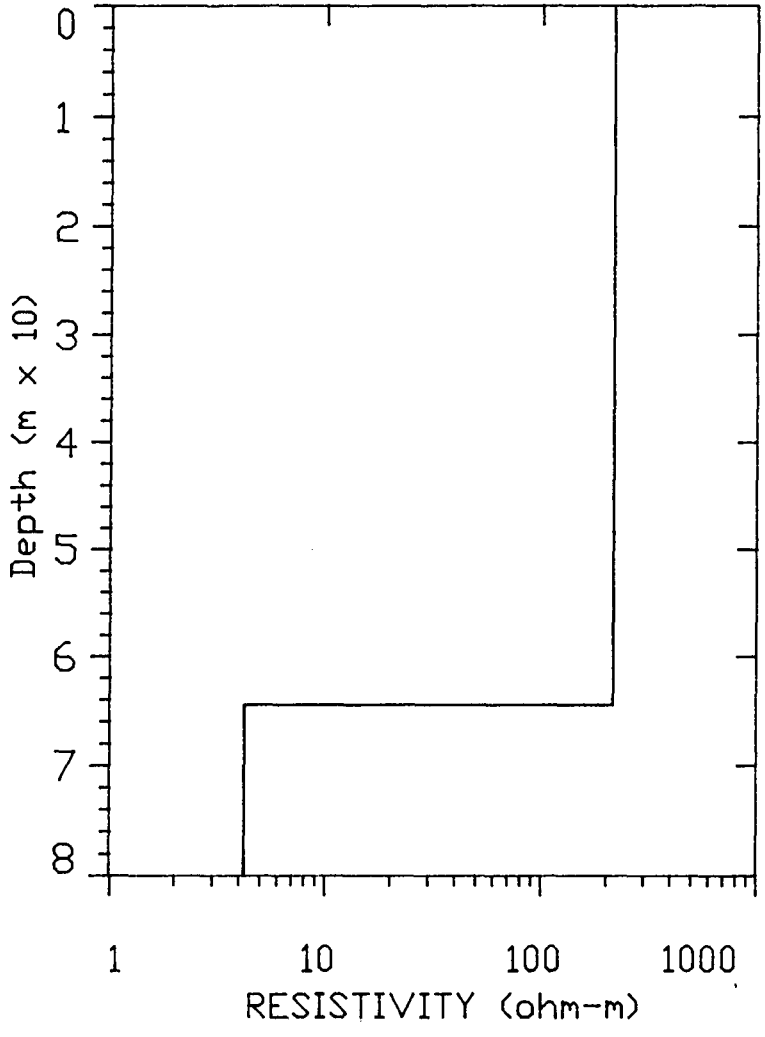
TDEM SURVEY LOCATION MAP
SOUNDING 17 -- GENEVA/CENTER
SEMINOLE COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	LOC-17	5.18-1
DRAWN BY:	RBT	DATE:	07/05/94	





—— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

X APPARENT RESISTIVITY VALUES NOT USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

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SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

MEASURED TDEM APPARENT RESISTIVITY AND 1-D INVERSION
SOUNDING 17 - GENEVA/CENTER
SEMINOLE COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	MDL-17	5.18-2
DRAWN BY:	RBT	DATE:	07/06/94	

5.18.3 Depth to Occurrence of Salt Water

The bottom (second) layer of the geoelectrical model, with a resistivity of 4.2 ohm-m, is interpreted to represent salt water. It occurs at a depth of 210 ft (-151 ft msl). Because the resistivity of Layer 1 (217 ohm-m) is greater than 80 ohm-m, the interpreted depth to the 5,000 mg/l isochlor is taken as 50 ft greater than the depth of the geoelectrical interface, or at a depth of 260 ft (-201 ft msl). The resistivity of Layer 2 (4.2 ohm-m) corresponds to a chloride content of 7,505 mg/l assuming a porosity of 25% and the validity and applicability of equation (4) of Section 4.2. It is presumed that because of the expected high chlorinity gradients, this value is sufficiently close to the 5,000 mg/l isochlor that they represent the same effective depth.

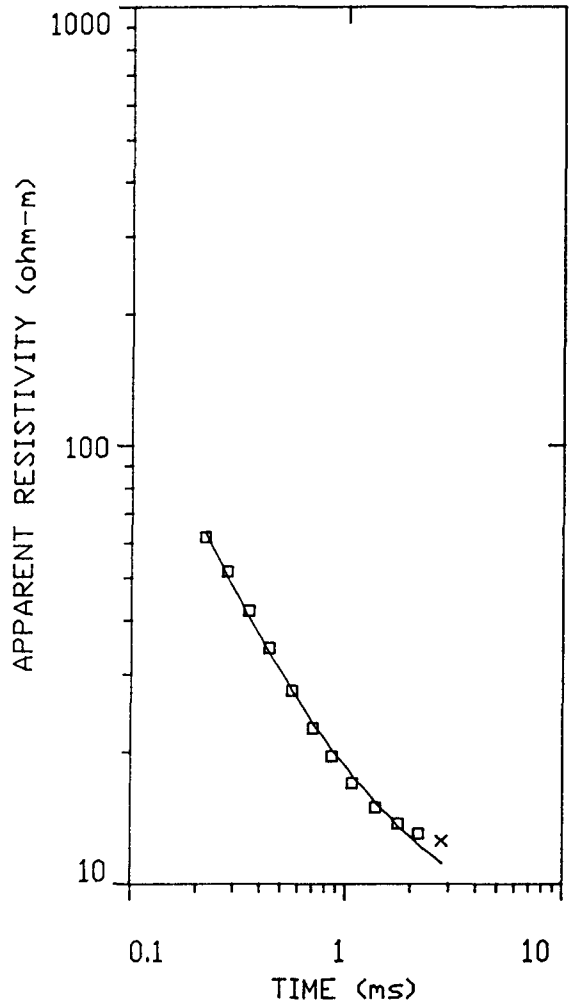
5.18.4 Depth of Occurrence of the 250 mg/l Isochlor

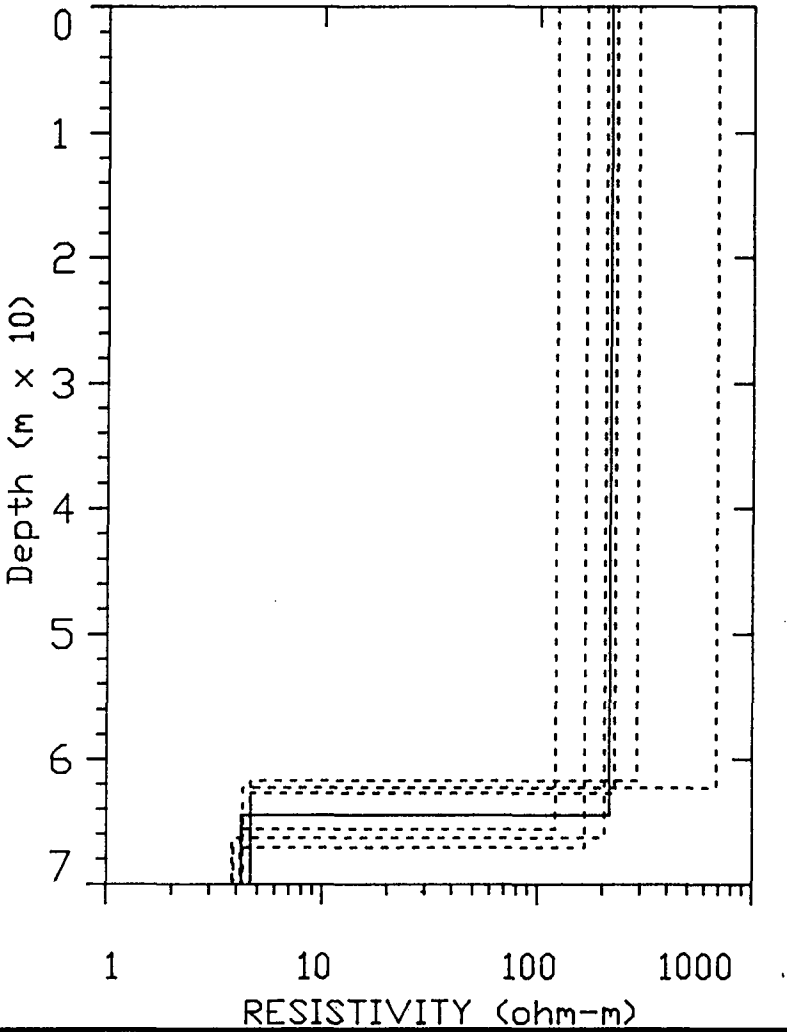
Since the resistivity of Layer 1 (217 ohm-m) is greater than 80 ohm-m, the chloride concentration in the Upper Floridan aquifer is less than 250 mg/l, even though Layer 1 contains Holocene to Miocene deposits. Since the resistivity of Layer 1 is greater than 80 ohm-m, the 250 mg/l isochlor is interpreted to occur 50 ft above the boundary between Layer 1 and Layer 2. That depth is 160 ft (-101 ft msl).

5.18.5 Accuracy of Measurement and Interpretation

Figure 5.18-3 is the equivalence analysis at this site and the inversion table (Table 5.18-1) lists the upper and lower bounds of the inverted parameters of the geoelectrical model.

The range of equivalence in determining the depth to the low resistivity layer is about ±3 m (10 ft) which is 5% of the total depth. The resistivity of this layer has a range of from 3.8 to 4.6 ohm-m. This corresponds to a range in interpreted chloride content of





BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

X APPARENT RESISTIVITY VALUES NOT USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

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SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

MEASURED TDEM APPARENT RESISTIVITY AND EQUIVALENCE FOR 1-D INVERSION
SOUNDING 17 - GENEVA/CENTER
SEMINOLE COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	EQU-17	5.18-3
DRAWN BY:	RBT	DATE:	07/06/94	

DATA SET: SITE 17

CLIENT: SJRWMD DATE: 09-MAY-94
LOCATION: GENEVA/CENTER SOUNDING: 1
COUNTY: SEMINOLE COUNTY, FLORIDA ELEVATION: 18.00 m
PROJECT: SALT WATER INTERFACE DETECTION EQUIPMENT: Geonics PROTEM
LOOP SIZE: 109.000 m by 82.300 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y)
SOUNDING COORDINATES: E: 0.0000 N: 0.0000

FITTING ERROR: 4.963 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			18.00	
1	217.3	64.45	-46.45	0.296
2	4.20			

ALL PARAMETERS ARE FREE

PARAMETER BOUNDS FROM EQUIVALENCE ANALYSIS

	LAYER	MINIMUM	BEST	MAXIMUM
RHO	1	122.230	217.358	687.348
	2	3.805	4.206	4.649
THICK	1	61.837	1.000	67.255
DEPTH	1	61.837	64.459	67.255

CURRENT: 29.00 AMPS EM-57 COIL AREA: 100.00 sq m.
FREQUENCY: 30.00 Hz GAIN: 4 RAMP TIME: 132.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.218	12214.4	11709.0	4.13
2	0.278	8714.7	9092.8	-4.33
3	0.351	6639.0	6992.1	-5.31
4	0.438	5125.9	5350.1	-4.37
5	0.558	3926.5	3907.3	0.488
6	0.702	2948.0	2842.6	3.57
7	0.858	2236.5	2116.9	5.34

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SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SOUNDING DATA TABLE
SOUNDING 17 – GENEVA/CENTER
SEMINOLE COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.18-1

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)	
8	1.06	1610.2	1512.8	6.04	
9	1.37	1041.6	1003.3	3.67	
10	1.74	652.3	663.6	-1.73	
11	2.17	406.6	444.0	-9.19	
12	2.77	234.0	278.6	-19.02	MASKED

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	0.00		
P 2	-0.02	0.96	
T 1	0.03	0.01	1.00
	P 1	P 2	T 1

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PALATKA, FLORIDA

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SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SOUNDING DATA TABLE
SOUNDING 17 – GENEVA/CENTER
SEMINOLE COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.18–1

from 8,311 mg/l to 6,839 mg/l, again subject to the same assumptions of porosity and validity of equation (4). The estimated depth to the 250 mg/l isochlor (160 ft) is not in agreement with Phelps and Rohrer (1987) who estimated an approximate depth of 345 ft to the 250 mg/l isochlor at site 36, approximately 1 mile away.

The equivalence range of the resistivity of Layer 1 is from 122 to 687 ohm-m. Since the resistivity of Layer 1 is greater than 80 ohm-m, the chloride concentration in the Upper Floridan aquifer is less than 250 mg/l.

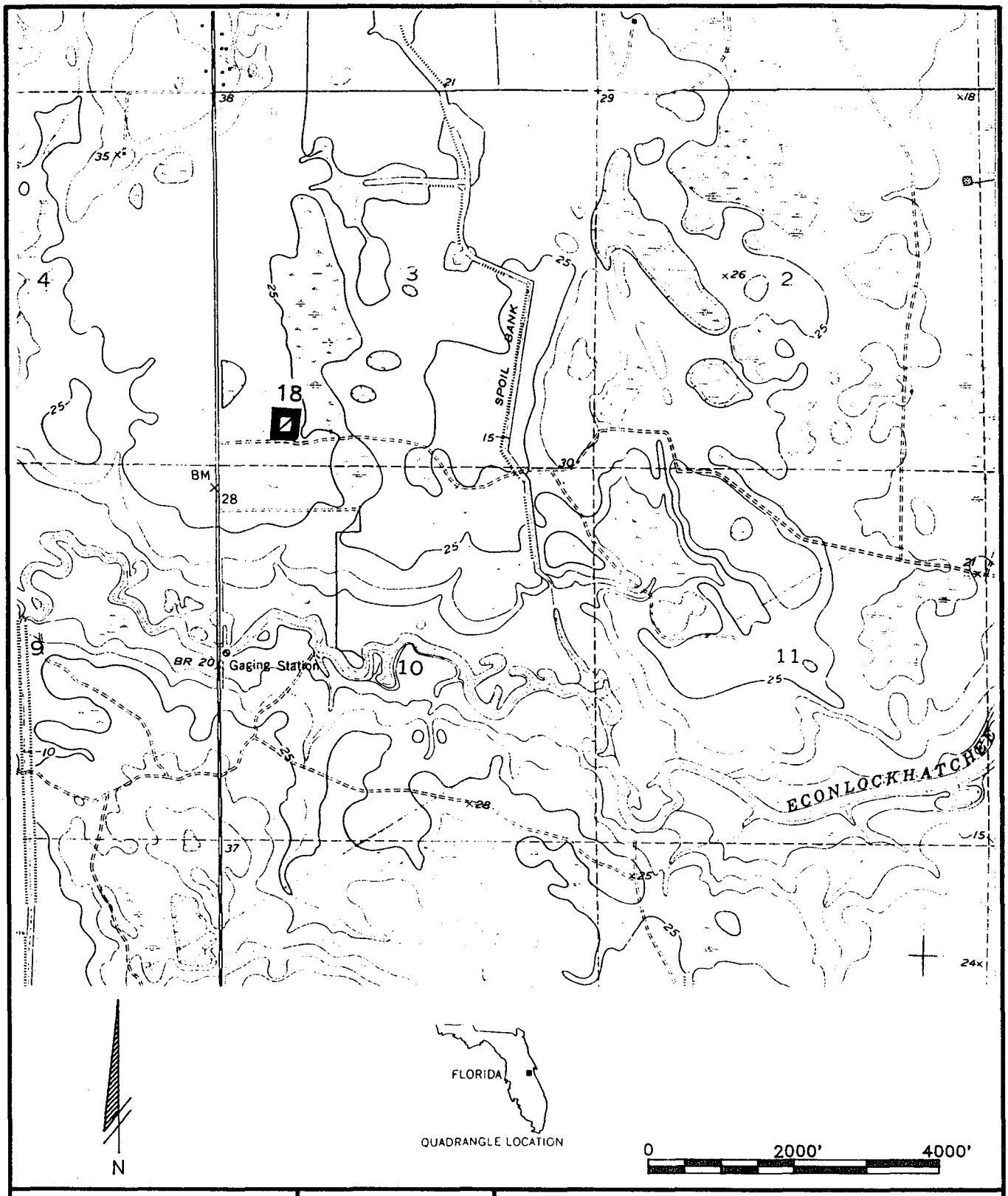
5.18.6 Summary of TDEM Sounding at Geneva/Center (Site 17)

- The depth of occurrence of salt water (5,000 mg/l isochlor) is interpreted to be 260 ft (-201 ft msl) and occur within the Floridan aquifer.
- The 250 mg/l isochlor is interpreted to occur at a depth of 160 ft (-101 ft msl). The results from the TDEM study do not compare with Phelps and Rohrer (1987) who estimated an approximate depth of 345 ft to the 250 mg/l isochlor at a site approximately one mile away.
- The ground water within the Upper Floridan aquifer at this site has a chloride concentration below 250 mg/l.

5.19 TDEM Site 18 - Geneva/Snow Hill

5.19.1 Location Description and Geoelectrical Section

The site is located in northeast Seminole County near Geneva, Florida (Figure 5.19-1). The site is located within a pasture. No sources of interference were present in the area of the Tx loop. QA soundings were performed 30 ft to the west and south of the initial Rx coil location. Results from the QA soundings indicate that the apparent resistivity values were unaffected by any interference sources.



ST. JOHNS RIVER
WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

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TDEM SURVEY LOCATION MAP
SOUNDING 18 – GENEVA/SNOW HILL
SEMINOLE COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	LOC-18	5.19-1
DRAWN BY:	RBT	DATE:	07/05/94	

A hydrogeologic study was performed in the area of the site (Phelps and Rohrer, 1987). As part of the study, information from local wells was used to determine the thickness of the Holocene to Miocene deposits overlying the Floridan aquifer and to estimate the depth to the "brackish" water interface. The chloride concentration in the upper portion of the Floridan aquifer in the area of the site is approximately 20 mg/l. The brackish water interface occurs at an approximate depth of 260 ft at well site 17 (from Figure 14, Phelps and Rohrer, 1987) which is approximately 2 miles north of the site. The depth to brackish water is assumed to thin to the south. The sediments associated with the Holocene to Miocene deposits are approximately 85 ft thick at well site 17. For comparison, the combined approximate thickness of sediments overlying the Floridan aquifer is 65 ft at the site (Tibbals, 1977). The bottom of the Floridan aquifer occurs at an approximate depth of 2,350 ft bmsl (Tibbals, 1990).

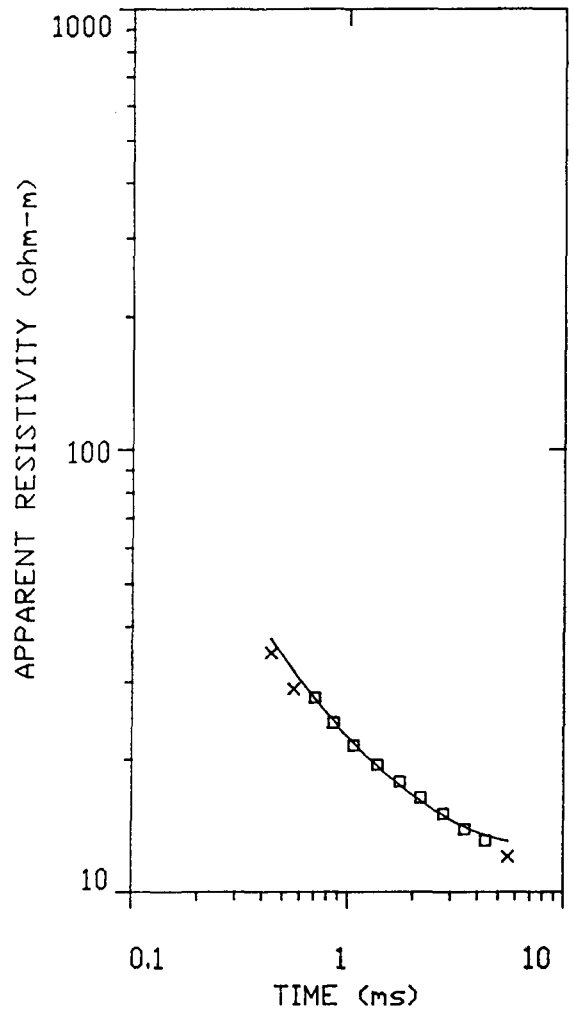
The resistivity sounding data and best-fit model inversion are presented on Figure 5.19-2. The interpreted geoelectrical section consists of a two-layer subsurface.

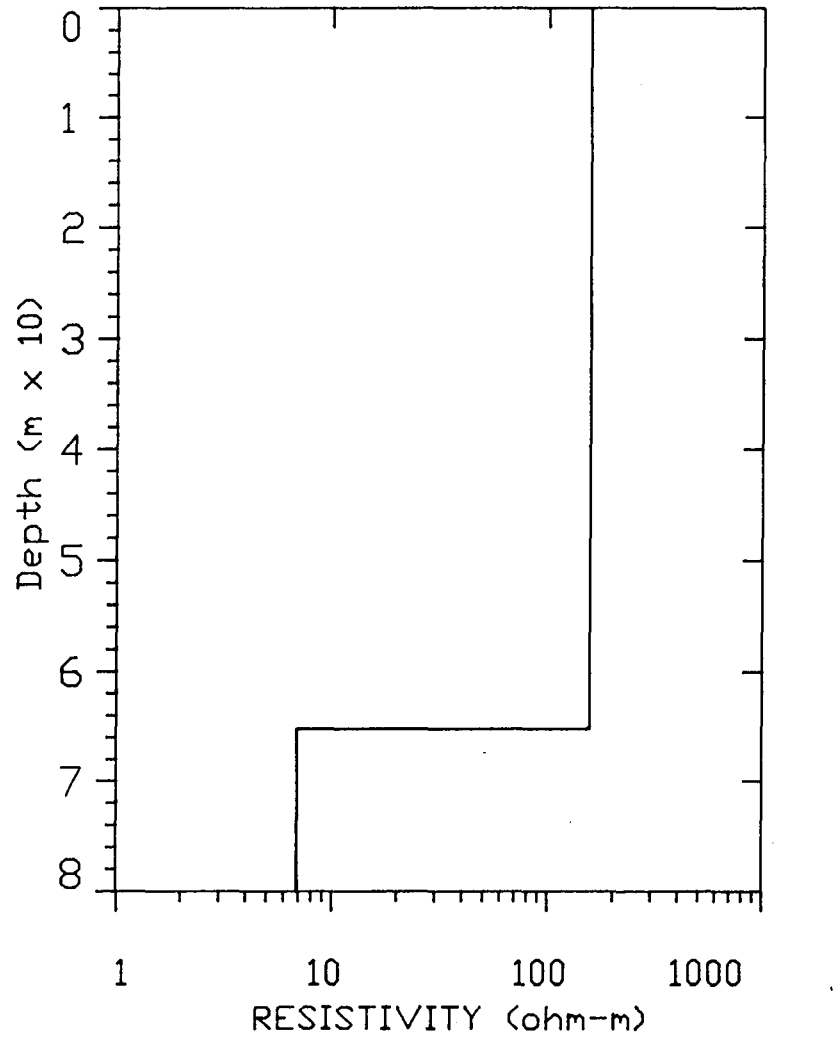
5.19.2 Geological Interpretation of Geoelectrical Model

The first layer occurs at 65 m (213 ft) bls and not at the hydrostratigraphic contact between the Holocene and Miocene deposits (65 ft bls) and the Floridan Aquifer System. Therefore, it can be interpreted that there exists a two-layer geoelectrical section with a 213 ft thick surface layer of high resistivity (158 ohm-m) overlying a low resistivity layer (6.9 ohm-m). It can be interpreted that the Holocene to Miocene deposits and the upper part of the Floridan aquifer system exist as a combined but indistinguishable (geoelectrical) layer, overlying a saltwater saturated Floridan aquifer at a depth of 213 ft bls.

5.19.3 Depth to Occurrence of Salt Water

The bottom (third) layer of the geoelectrical model, with a resistivity of 6.9 ohm-m, is interpreted to represent salt water. It occurs at a depth of 213 ft (-188 ft msl). Because the resistivity of Layer 2 (158 ohm-m) is greater than 80 ohm-m, the interpreted depth to





—— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

X APPARENT RESISTIVITY VALUES NOT USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

MEASURED TDEM APPARENT RESISTIVITY AND 1-D INVERSION
SOUNDING 18 – GENEVA/SNOW HILL
SEMINOLE COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	MDL-18	5.19-2
DRAWN BY:	RBT	DATE:	07/06/94	

the 5,000 mg/l isochlor is taken as 50 ft greater than the depth of the geoelectrical interface, or at a depth of 263 ft (-238 ft msl). The resistivity of Layer 2 (6.9 ohm-m) corresponds to a chloride content of 4,508 mg/l assuming a porosity of 25% and the validity and applicability of equation (4) of Section 4.2. It is presumed that because of the expected high chlorinity gradients, this value is sufficiently close to the 5,000 mg/l isochlor that they represent the same effective depth.

5.19.4 Depth of Occurrence of the 250 mg/l Isochlor

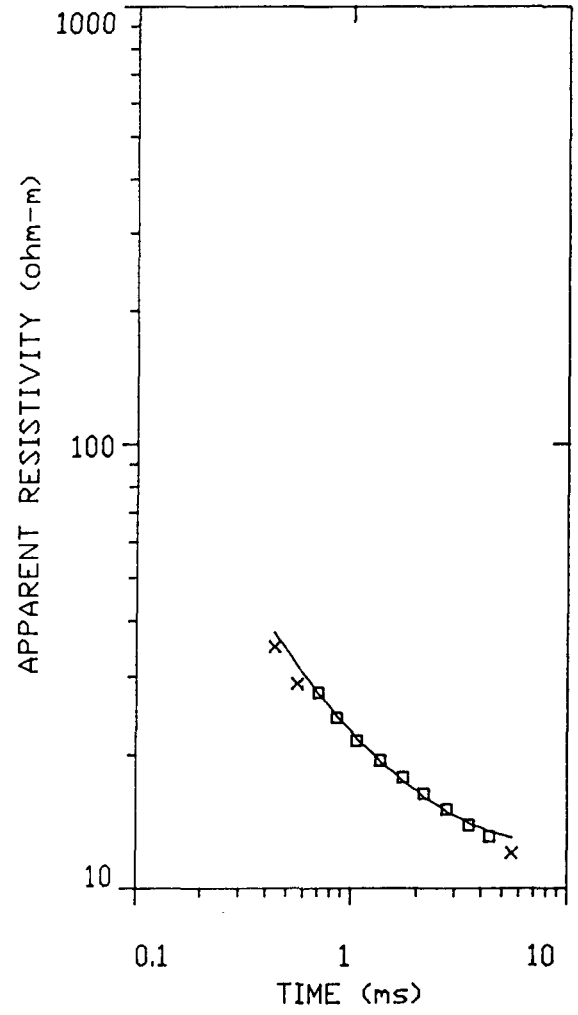
Since the resistivity of Layer 1 (158 ohm-m) is greater than 80 ohm-m, the chloride concentration in the Upper Floridan aquifer is less than 250 mg/l, even though Layer 1 contains Holocene to Miocene deposits. Since the resistivity of Layer 1 is greater than 80 ohm-m, the 250 mg/l isochlor is interpretated to occur 50 ft above the boundary between Layer 1 and Layer 2. That depth is 163 ft (-138 ft msl).

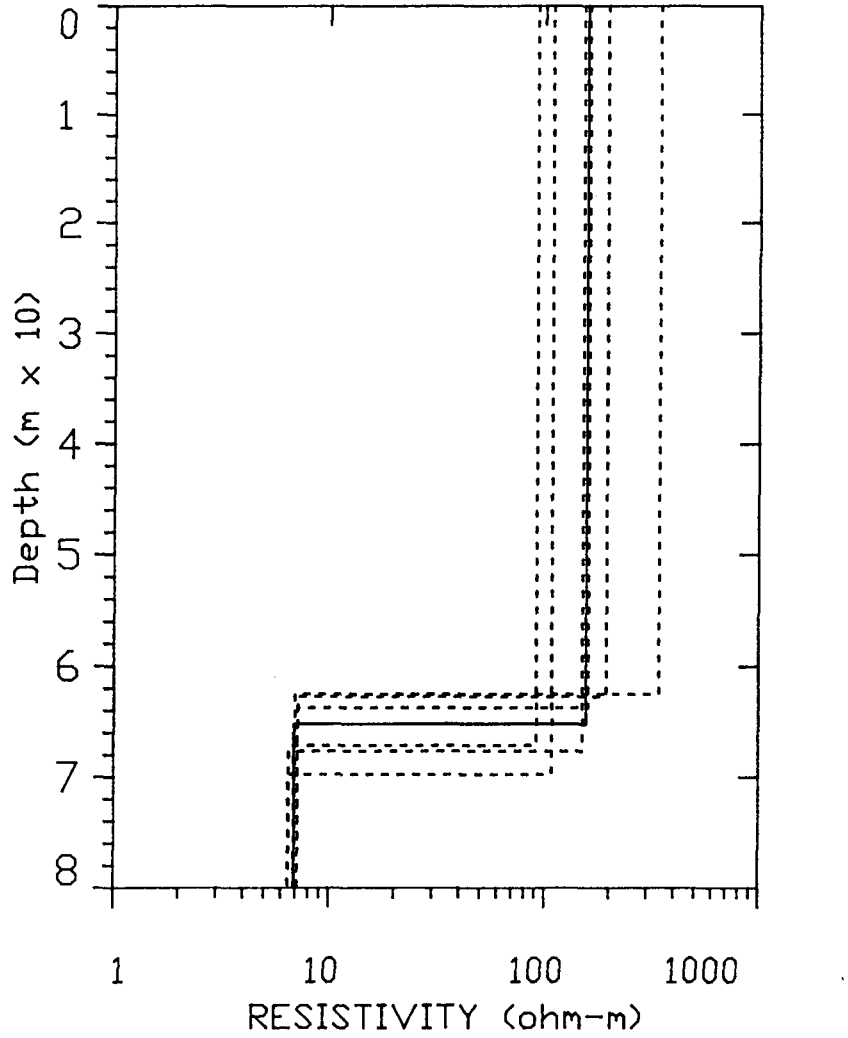
5.19.5 Accuracy of Measurement and Interpretation

Figure 5.19-3 is the equivalence analysis at this site and the inversion table (Table 5.19-1) lists the upper and lower bounds of the inverted parameters of the geoelectrical model.

The range of equivalence in determining the depth to the low resistivity layer is about ±4 m (13 ft) which is 6% of the total depth. The resistivity of this layer has a range of from 6.5 to 7.2 ohm-m. This corresponds to a range in interpreted chloride content of from 4,795 mg/l to 4,314 mg/l, again subject to the same assumptions of porosity and validity of equation (4).

The equivalence range of the resistivity of Layer 1 is from 92 to 344 ohm-m which corresponds to a chloride content of less than 250 mg/l. This corresponds well to the results from Phelps and Rohrer (1987) which also showed the concentration of chloride to





—— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

X APPARENT RESISTIVITY VALUES NOT USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

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MEASURED TDEM APPARENT RESISTIVITY AND EQUIVALENCE FOR 1-D INVERSION
SOUNDING 18 - GENEVA/SNOW HILL
SEMINOLE COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	EQU-18	5.19-3
DRAWN BY:	RBT	DATE:	07/06/94	

DATA SET: SITE 18

CLIENT: SJRWMD DATE: 09-MAY-94
LOCATION: GENEVA/SNOW HILL SOUNDING: 1
COUNTY: SEMINOLE COUNTY, FLORIDA ELEVATION: 7.50 m
PROJECT: SALT WATER INTERFACE DETECTION EQUIPMENT: Geonics PROTEM
LOOP SIZE: 91.500 m by 91.500 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y)
SOUNDING COORDINATES: E: 0.0000 N: 0.0000

FITTING ERROR: 2.185 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			7.50	
1	157.7	65.20	-57.70	0.413
2	6.89			

ALL PARAMETERS ARE FREE

PARAMETER BOUNDS FROM EQUIVALENCE ANALYSIS

	LAYER	MINIMUM	BEST	MAXIMUM
RHO	1	92.119	157.730	343.902
	2	6.457	6.898	7.165
THICK	1	62.493	1.000	69.752
DEPTH	1	62.493	65.200	69.752

CURRENT: 21.90 AMPS EM-57 COIL AREA: 100.00 sq m.
FREQUENCY: 30.00 Hz GAIN: 4 RAMP TIME: 122.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.438	3509.7	3139.9	10.53 MASKED
2	0.558	2548.4	2208.0	13.35 MASKED
3	0.702	1537.4	1548.3	-0.710
4	0.858	1131.6	1118.1	1.19
5	1.06	785.1	773.6	1.47
6	1.37	489.2	495.0	-1.17
7	1.74	307.6	316.9	-3.03

* S.D.I.I. *

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TDEM SOUNDING DATA TABLE
SOUNDING 18 – GENEVA/SNOW HILL
SEMINOLE COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.19-1

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)	
8	2.17	200.9	206.3	-2.67	
9	2.77	123.7	125.7	-1.64	
10	3.50	77.78	76.65	1.45	
11	4.37	48.91	47.00	3.90	
12	5.56	30.44	27.02	11.23	MASKED

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	0.01		
P 2	-0.01	0.98	
T 1	0.05	0.01	0.99
	P 1	P 2	T 1

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TDEM SOUNDING DATA TABLE
SOUNDING 18 – GENEVA/SNOW HILL
SEMINOLE COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.19-1

be less than 250 mg/l in this area. The chloride-to-sulfate ratio at the site is 5:1 (Table 5.1-4). Accordingly, Equation (4) is valid.

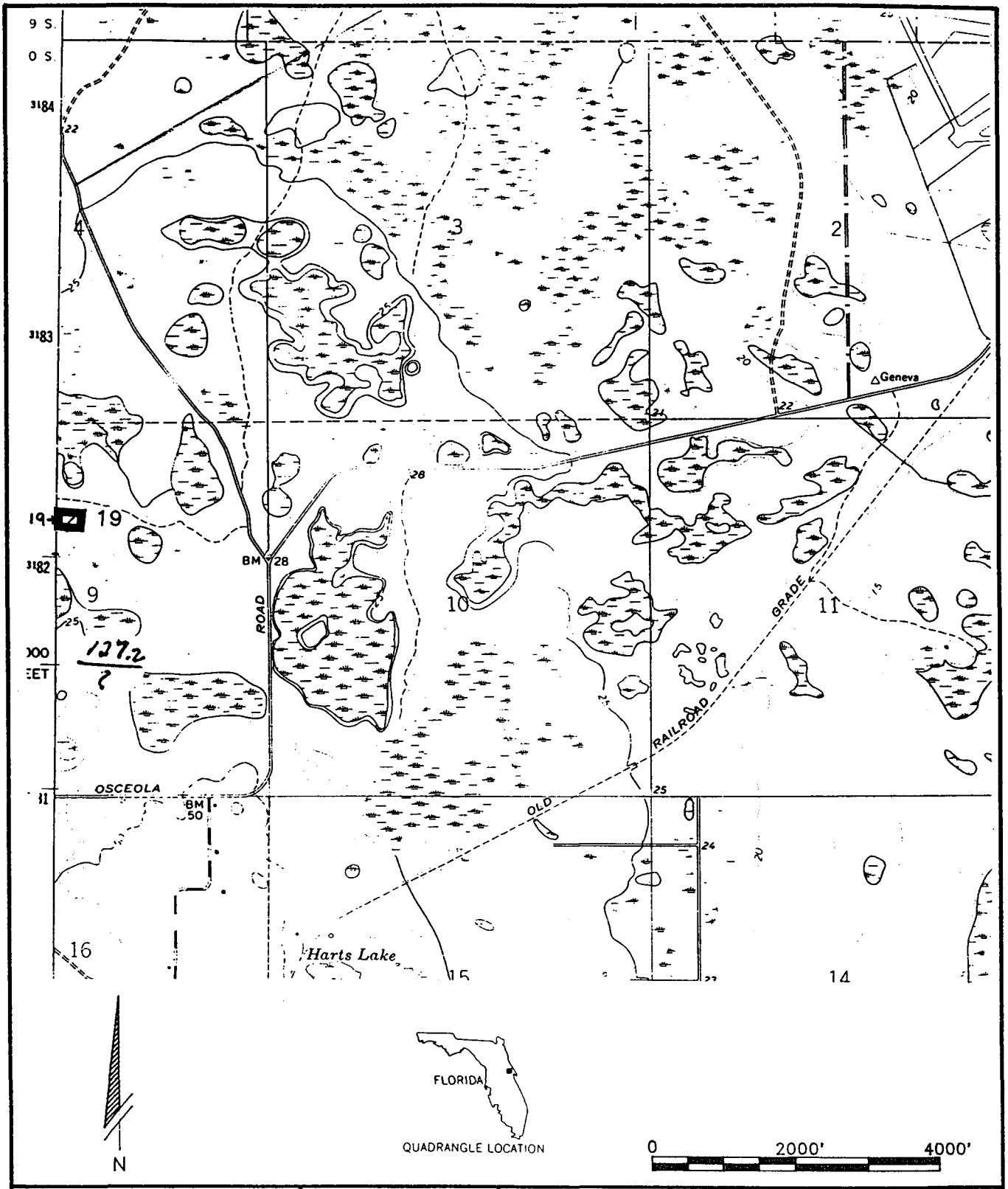
5.19.6 Summary of TDEM Sounding at Geneva/Snow Hill

- The depth of occurrence of salt water (5,000 mg/l isochlor) is interpreted to be 263 ft (-238 ft msl) and occur within the Floridan aquifer.
- The 250 mg/l isochlor is interpretated to occur at a depth of 163 ft (-138 ft msl). The results of the TDEM study do not compare with Phelps and Rohrer (1987) who estimated an approximate depth of 260 ft to the 250 mg/l isochlor at a site approximately 2 miles north. However, the depth to the 250 mg/l isochlor is assumed to thin to the south.
- The chloride concentration in the Upper Floridan aquifer is less than 250 mg/l at this site. This agrees with water quality results from Phelps and Rohrer (1987).

5.20 TDEM Site 19 - Geneva/Shawnee

5.20.1 Location Description and Geoelectrical Section

The site is located in northeast Seminole County near Geneva, Florida (Figure 5.20-1). The site is located within a pasture. A pond was present at the center of the loop, as a result, the Rx coil was placed 39 ft to the north and 50 ft to the east of the center of the Tx loop. No sources of interference were present in the area of the Tx loop. QA soundings were performed 30 ft to the west and 20 ft to the south of the initial Rx coil location. Results from the QA soundings indicate that the apparent resistivity values were unaffected by any interference sources.



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SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SURVEY LOCATION MAP
SOUNDING 19 – GENEVA/SHAWNEE
SEMINOLE COUNTY, FLORIDA

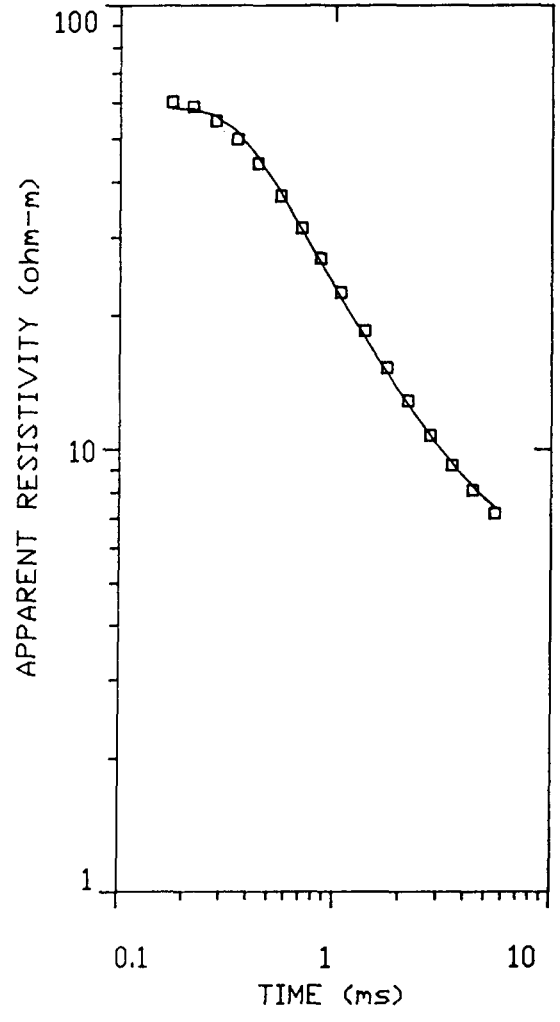
DESIGNED BY: JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY: MJW	DRAWING NO.:	LOC-19	5.20-1
DRAWN BY: RBT	DATE:	07/05/94	

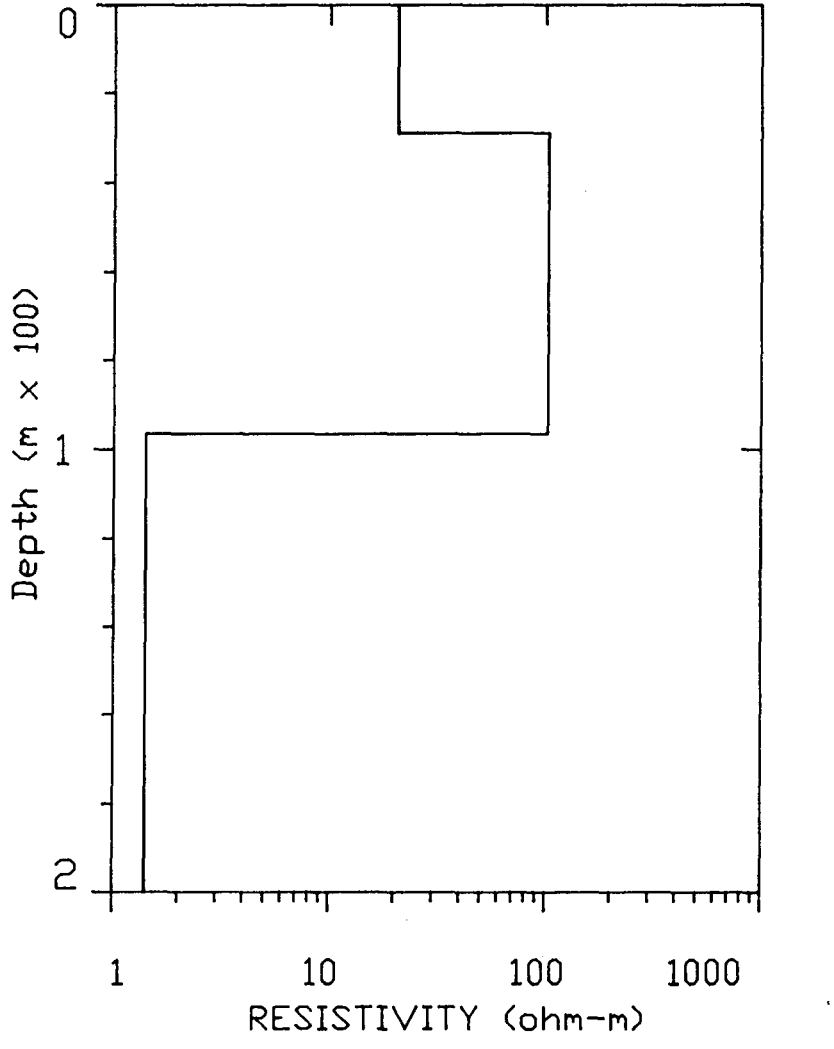
A hydrogeologic study was performed in the area of the site (Phelps and Rohrer, 1987). As part of the study, information from local wells was used to determine the thickness of the Holocene to Miocene deposits overlying the Floridan aquifer and to estimate the depth to the "brackish" water interface. The inferred depth to brackish water from the Phelps and Rohrer (1987) study was approximately 250 ft bls at well site 55, approximately 2.5 miles east of the site. The chloride concentration in the upper portion of the Floridan aquifer in the area of the site is approximately 25 mg/l. The sediments associated with the Holocene to Miocene deposits are approximately 95 ft thick (SJRWMD, personal communication). The bottom of the Floridan aquifer occurs at an approximate depth of 2,300 ft bmsl (Tibbals, 1990).

The resistivity sounding data and best-fit model inversion are presented on Figure 5.20-2. The interpreted geoelectrical section consists of a three-layer subsurface.

5.20.2 Geological Interpretation of Geoelectrical Model

The three-layer geoelectrical section consists of an upper layer with a resistivity of 21 ohm-m which correlates with the Holocene to Miocene deposits above the Floridan aquifer. The thickness of Layer 1 was fixed at 29 m (95 ft) based on the information from SJRWMD, personal communication. The second layer has high resistivity (103 ohm-m) which means that because it is greater than 80 ohm-m the Floridan aquifer at this site contains fresh water. The thickness of the freshwater section is 68 m (223 ft) placing the depth to the low resistivity (saltwater) layer at 97 m (318 ft) below ground surface. The resistivity of the saltwater layer is 1.4 ohm-m. Layer 1 is considered to be the Holocene to Miocene deposits, Layer 2 to be the Floridan aquifer containing fresh water and Layer 3 to be the salt water within the Floridan aquifer.





—— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

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SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

MEASURED TDEM APPARENT RESISTIVITY AND 1-D INVERSION
SOUNDING 19 - GENEVA/SHAWNEE
SEMINOLE COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	MDL-19	5.20-2
DRAWN BY:	RBT	DATE:	07/06/94	

5.20.3 Depth to Occurrence of Salt Water

The bottom (third) layer of the geoelectrical model, with a resistivity of 1.4 ohm-m, is interpreted to represent salt water. It occurs at a depth of 318 ft (-298 ft msl). Because the resistivity of Layer 2 (103 ohm-m) is greater than 80 ohm-m, the interpreted depth to the 5,000 mg/l isochlor is taken as 50 ft greater than the depth of the geoelectrical interface, or at a depth of 368 ft (-348 ft msl). The resistivity of Layer 3 (1.4 ohm-m) corresponds to a chloride content of greater than 20,000 mg/l assuming a porosity of 25% and the validity and applicability of equation (4) of Section 4.2. It is presumed that because of the expected high chlorinity gradients, this value is sufficiently close to the 5,000 mg/l isochlor that they represent the same effective depth.

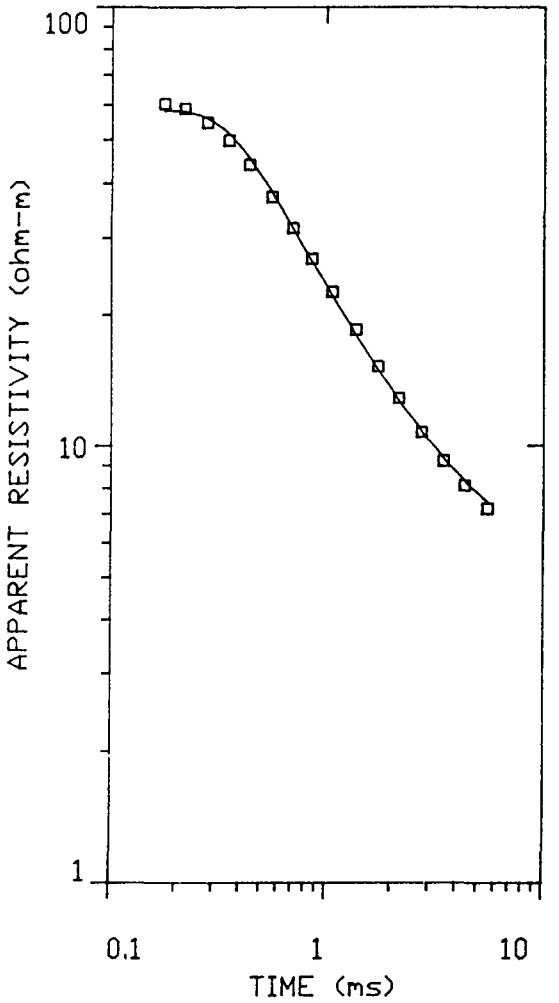
5.20.4 Depth of Occurrence of the 250 mg/l Isochlor

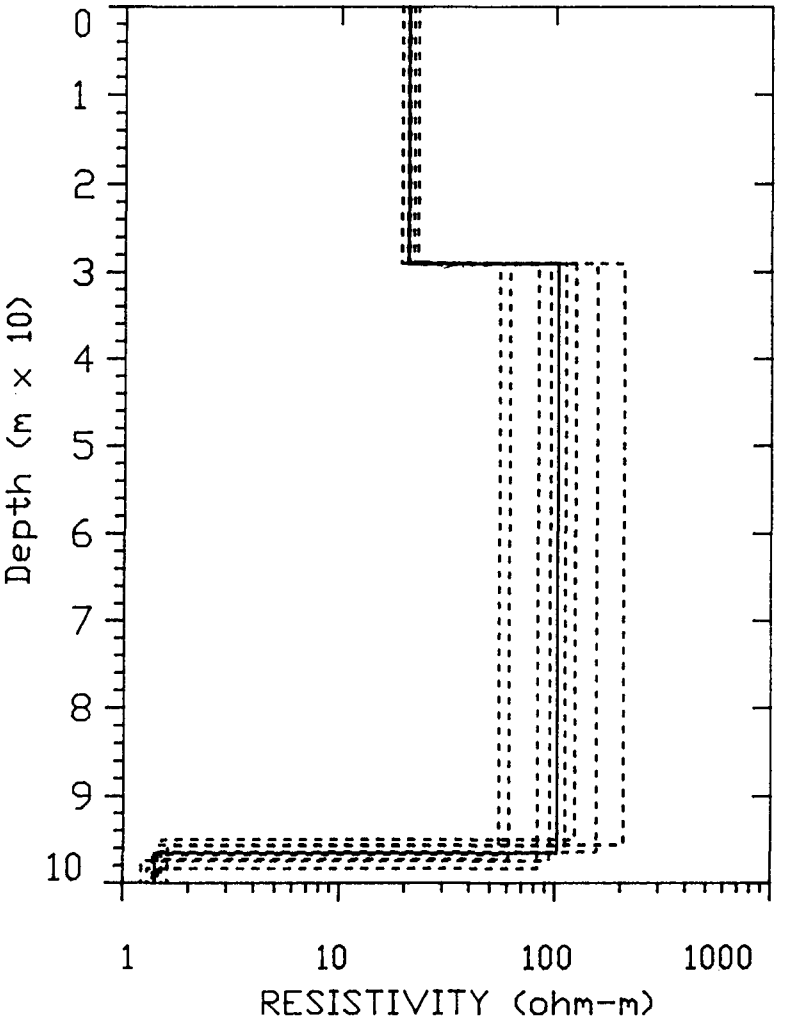
The resistivity of Layer 2, 103 ohm-m, corresponds to a chloride content of less than 250 mg/l, assuming a 25% porosity and the validity and applicability of equation (4) of Section 4.2. The 250 mg/l isochlor is placed in the Floridan aquifer at a depth 50 ft above the Layer 3 interface or at 268 ft (-248 ft msl). This depth is similar to the estimated 250 ft depth to brackish water by Phelps and Rohrer (1987) at well site 55, which is located approximately 2.5 miles east of the site.

5.20.5 Accuracy of Measurement and Interpretation

Figure 5.20-3 is the equivalence analysis at this site and the inversion table (Table 5.20-1) lists the upper and lower bounds of the inverted parameters of the geoelectrical model.

The range of equivalence in determining the depth to the low resistivity layer is about ±2 m (6 ft) which is 2% of the total depth. The resistivity of this layer has a range of from 1.2 to 1.6 ohm-m. This corresponds to a range in interpreted chloride content of from 26,650 mg/l to 19,949 mg/l, again subject to the same assumptions of porosity and validity of equation (4).





BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
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MEASURED TDEM APPARENT RESISTIVITY AND EQUIVALENCE FOR 1-D INVERSION
SOUNDING 19 - GENEVA/SHAWNEE
SEMINOLE COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	EQU-19	5.20-3
DRAWN BY:	RBT	DATE:	07/06/94	

DATA SET: SITE 19

CLIENT: SJRWMD DATE: 09-MAY-94
LOCATION: GENEVA/SHAWNEE SOUNDING: 1
COUNTY: SEMINOLE COUNTY, FLORIDA ELEVATION: 6.00 m
PROJECT: SALT WATER INTERFACE DETECTION EQUIPMENT: Geonics PROTEM
LOOP SIZE: 67.000 m by 96.000 m AZIMUTH:
COIL LOC: 15.400 m (X), 12.000 m (Y)
SOUNDING COORDINATES: E: 0.0000 N: 0.0000

FITTING ERROR: 3.725 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)		ELEVATION (meters)	CONDUCTANCE (Siemens)
				6.00	
1	20.58	29.00	*	-23.00	1.40
2	102.9	67.56		-90.56	0.656
3	1.40				

"*" INDICATES FIXED PARAMETER

PARAMETER BOUNDS FROM EQUIVALENCE ANALYSIS

LAYER		MINIMUM	BEST	MAXIMUM
RHO	1	19.121	20.582	22.826
	2	54.965	102.938	207.070
	3	1.218	1.407	1.608
THICK	1	29.000	0.000	29.000
	2	66.002	1.000	69.362
DEPTH	1	29.000	29.000	29.000
	2	95.002	96.561	98.362

CURRENT: 26.90 AMPS EM-57 COIL AREA: 100.00 sq m.
FREQUENCY: 30.00 Hz GAIN: 4 RAMP TIME: 112.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.175	14723.2	15527.6	-5.46
2	0.218	8825.9	8999.7	-1.96
3	0.278	5355.1	5161.0	3.62

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TDEM SOUNDING DATA TABLE
SOUNDING 19 – GENEVA/SHAWNEE
SEMINOLE COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.20–1

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
4	0.351	3436.5	3249.8	5.43
5	0.438	2383.1	2264.3	4.98
6	0.558	1670.0	1612.7	3.43
7	0.702	1202.4	1212.7	-0.860
8	0.858	925.5	951.5	-2.81
9	1.06	700.2	728.9	-4.09
10	1.37	506.6	531.7	-4.96
11	1.74	372.4	386.5	-3.80
12	2.17	276.4	283.8	-2.67
13	2.77	196.5	196.8	-0.175
14	3.50	137.6	135.8	1.27
15	4.37	95.88	93.11	2.89
16	5.56	62.95	60.23	4.32

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

	P 1	P 2	P 3	F 1	T 2
P 1	0.98				
P 2	0.10	0.04			
P 3	-0.01	-0.04	0.92		
F 1	0.00	0.00	0.00	0.00	
T 2	0.00	0.02	0.01	0.00	1.00

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PALATKA, FLORIDA

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TDEM SOUNDING DATA TABLE
SOUNDING 19 – GENEVA/SHAWNEE
SEMINOLE COUNTY, FLORIDA

PROJECT NO.: 94767

TABLE: 5.20–1

The equivalence range of the resistivity of Layer 2 is from 55 to 207 ohm-m which, over the majority of this range, corresponds to a chloride content of less than 250 mg/l. This corresponds well to the results from Phelps and Rohrer (1987) which also showed the concentration of chloride to be less than 250 mg/l in this area. The chloride-to-sulfate ratio at the site is approximately 7:1 (Table 5.1-4), rather than 5:1. Accordingly, Equation (4) may not be valid.

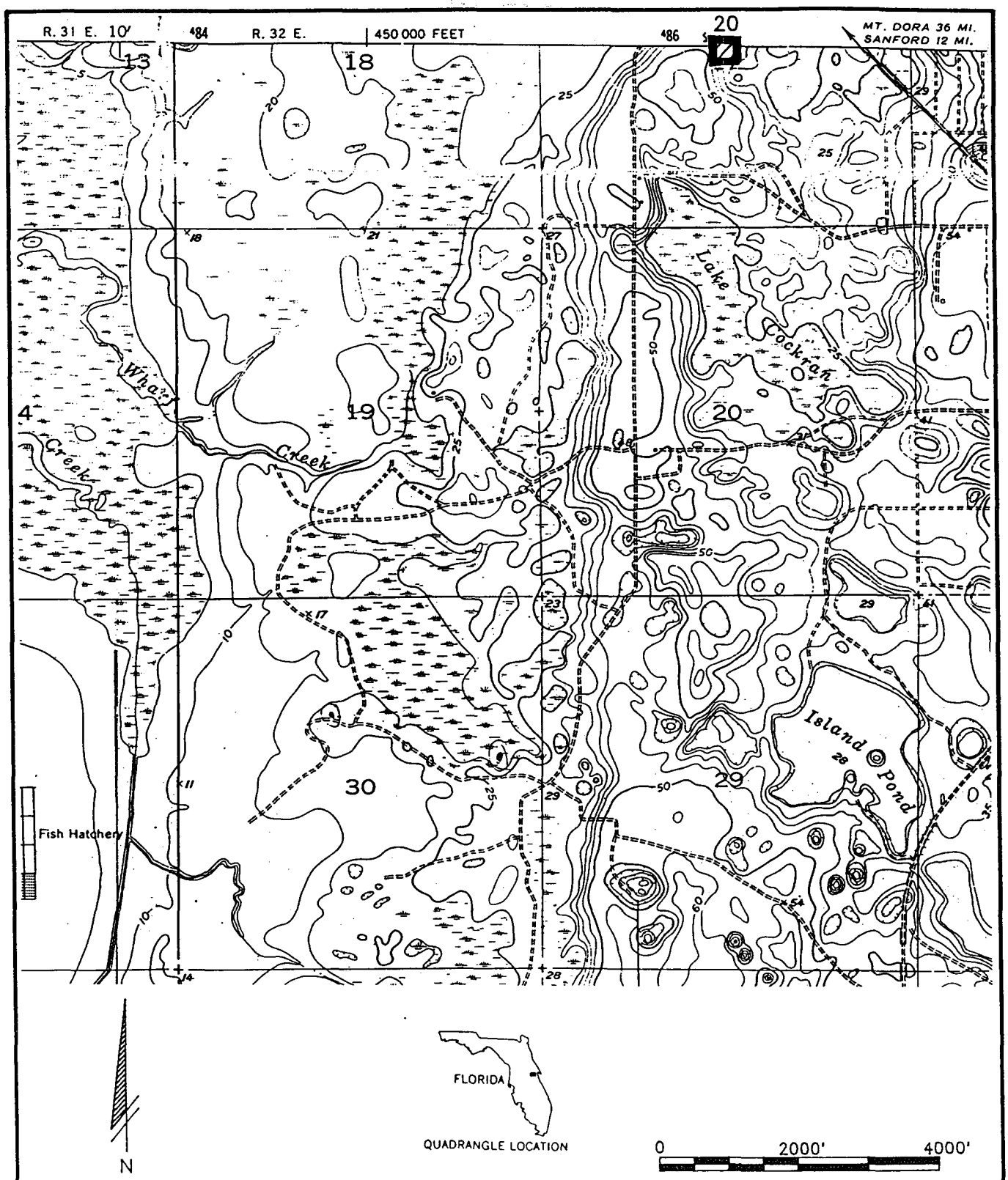
5.20.6 Summary of TDEM Sounding at Geneva/Shawnee (Site 19)

- The depth to occurrence of salt water (5,000 mg/l isochlor) is interpreted to be 368 ft (-348 ft msl) and occur within the Floridan aquifer.
- The ground water within the Floridan aquifer at this site is interpreted to contain an average chloride concentration of less than 250 mg/l. The 250 mg/l isochlor is interpreted to be present in the Floridan aquifer at a depth of 268 ft (-248 ft msl). For comparison, Phelps and Rohrer (1987) estimated a similar depth (250 ft) to the 250 mg/l isochlor at well site 55, which is located approximately 2.5 miles east of the site.
- Results from the TDEM survey agree with Phelps and Rohrer (1987) who mapped the chloride concentration in the Floridan aquifer to be below 250 mg/l at this site.

5.21 TDEM Site 20 - Geneva/Irrigation

5.21.1 Location Description and Geoelectrical Section

The site is located in northeast Seminole County near Geneva, Florida (Figure 5.21-1). The site is located in a citrus grove in the City of Sanford's reclaimed water facility. No sources of interference were present in the area of the Tx loop. QA soundings were performed 30 ft to the north, west and east of the initial Rx coil location. Results from the QA soundings indicate that the apparent resistivity values were unaffected by any interference sources.



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TDEM SURVEY LOCATION MAP
SOUNDING 20 – GENEVA/IRRIGATION
SEMINOLE COUNTY, FLORIDA

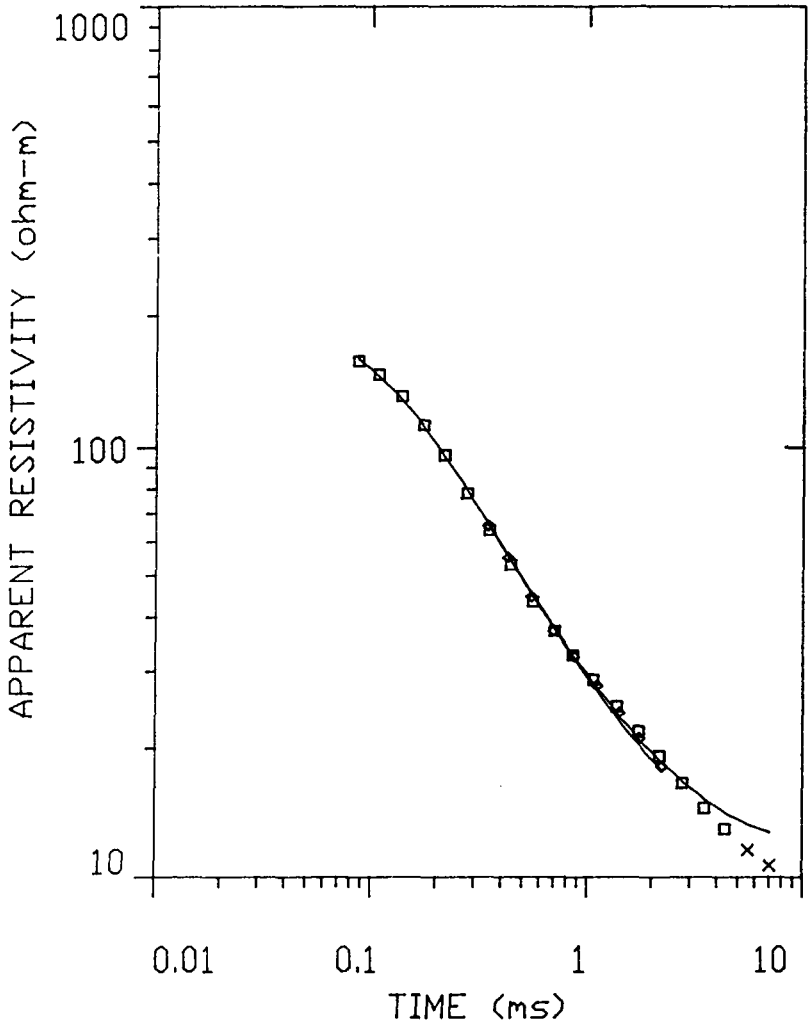
DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	LOC–20	5.21–1
DRAWN BY:	RBT	DATE:	07/05/94	

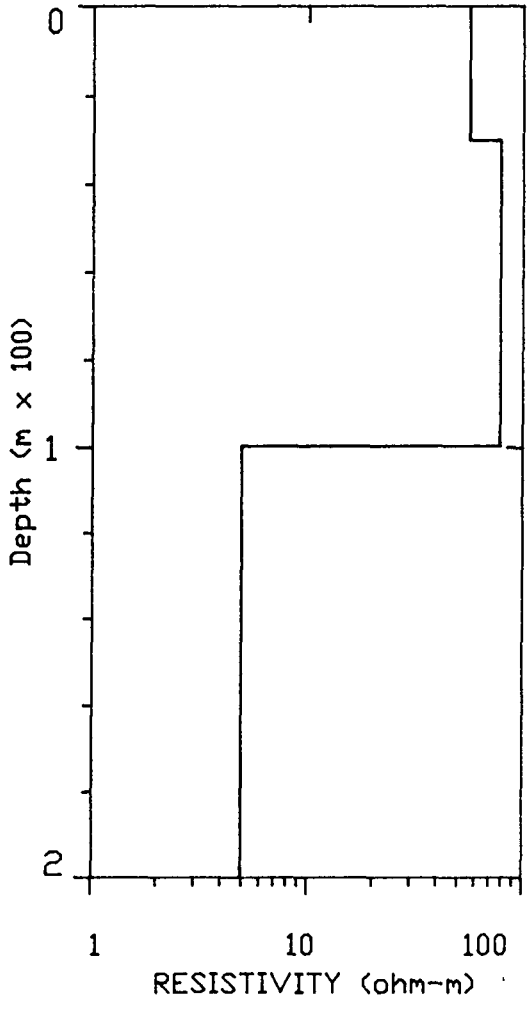
A hydrogeologic study was performed in the area of the site (Phelps and Rohrer, 1987). As part of the study, information from local wells was used to determine the thickness of the Holocene to Miocene deposits overlying the Floridan aquifer and to estimate the depth to the "brackish" water interface. The inferred depth to brackish water from the Phelps and Rohrer (1987) study was approximately 225 ft bls at site 23, approximately 2 miles south of the site. The chloride concentration in the upper portion of the Floridan aquifer in the area of the site is below 250 mg/l. The sediments associated with the Holocene to Miocene deposits are approximately 100 ft thick (SJRWMD, personal communication). The bottom of the Floridan aquifer occurs at an approximate depth of 2,270 ft bmsl (Tibbals, 1990).

The resistivity sounding data and best-fit model inversion are presented on Figure 5.21-2. The interpreted geoelectrical section consists of a three-layer subsurface.

5.21.2 Geological Interpretation of Geoelectrical Model

The three-layered geoelectrical section consists of an upper layer with a resistivity of 56 ohm-m, which is considered to be the Holocene to Miocene deposits above the Floridan aquifer. The thickness of Layer 1 was fixed at a 30 m (100 ft) value based on information from SJRWMD, personal communication. The second layer has only intermediate resistivity (79 ohm-m) which, because it is less than 80 ohm-m, suggests the Floridan aquifer at this site contains brackish water. The thickness of the brackish section is 70 m (230 ft), placing the depth to the low resistivity (saltwater) layer at 100 m (328 ft) below ground surface. The resistivity of the saltwater saturated layer is 4.9 ohm-m. Layer 1 is considered to be the Holocene to Miocene deposits, Layer 2 to be the Floridan aquifer (brackish) and Layer 3 to be the saltwater within the Floridan aquifer.





—— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

X APPARENT RESISTIVITY VALUES NOT USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

MEASURED TDEM APPARENT RESISTIVITY AND 1-D INVERSION
SOUNDING 20 - GENEVA/IRRIGATION
SEMINOLE COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	MDL-20	5.21-2
DRAWN BY:	RBT	DATE:	07/06/94	

5.21.3 Depth to Occurrence of Salt Water

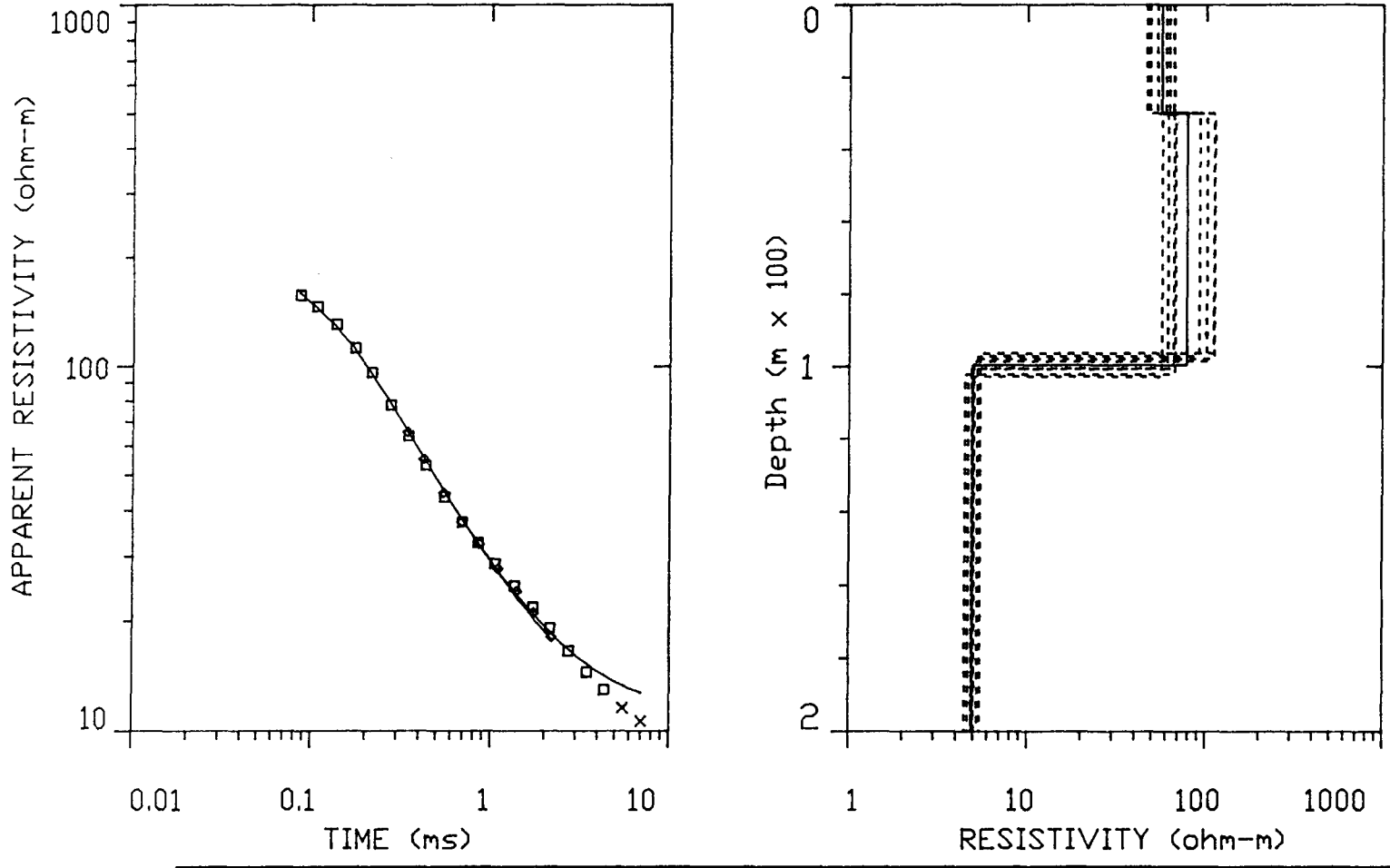
The bottom (third) layer of the geoelectrical model, with a resistivity of 4.9 ohm-m, is interpreted to represent salt water. It occurs at a depth of 328 ft (-288 ft msl). Because the resistivity of Layer 2 (79 ohm-m) is interpreted to represent brackish water within the Floridan aquifer (i.e., is less than 80 ohm-m), the interpreted depth to the 5,000 mg/l isochlor is equal to the depth of the geoelectric interface, or at 328 ft depth (-288 ft msl). The resistivity of Layer 3 (4.9 ohm-m) corresponds to a chloride content of 6,411 mg/l assuming a porosity of 25% and the validity and applicability of equation (4) of Section 4.2. It is presumed that because of the expected high chlorinity gradients, this value is sufficiently close to the 5,000 mg/l isochlor that they represent the same effective depth.

5.21.4 Depth of Occurrence of the 250 mg/l Isochlor

The resistivity of Layer 2, 79 ohm-m, corresponds to a chloride content above 250 mg/l, assuming a 25% porosity and the validity and applicability of equation (4) of Section 4.2. As the interpreted chloride content exceeds 250 mg/l, the 250 mg/l isochlor does not occur within the Floridan aquifer at this site. For comparison, Phelps and Rohrer (1987) estimated the depth to the 250 mg/l isochlor at approximately 225 ft bls at site 23, approximately 2 miles south of the site.

5.21.5 Accuracy of Measurement and Interpretation

Figure 5.21-3 is the equivalence analysis at this site and the inversion table (Table 5.21-1) lists the upper and lower bounds of the inverted parameters of the geoelectrical model.



—— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

X APPARENT RESISTIVITY VALUES NOT USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

MEASURED TDEM APPARENT RESISTIVITY AND EQUIVALENCE FOR 1-D INVERSION
SOUNDING 20 - GENEVA/IRRIGATION
SEMINOLE COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	EQU-20	5.21-3
DRAWN BY:	RBT	DATE:	07/06/94	

DATA SET: SITE 20

CLIENT: SJRWMD DATE: 10-MAY-94
LOCATION: GENEVA/IRRIGATION SOUNDING: 1
COUNTY: SEMINOLE COUNTY, FLORIDA ELEVATION: 12.00 m
PROJECT: SALT WATER INTERFACE DETECTION EQUIPMENT: Geonics PROTEM
LOOP SIZE: 91.500 m by 91.500 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y)
SOUNDING COORDINATES: E: 0.0000 N: 0.0000

FITTING ERROR: 4.442 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)		ELEVATION (meters)	CONDUCTANCE (Siemens)
				12.00	
1	56.22	30.00	*	-18.00	0.533
2	78.54	69.64		-87.64	0.886
3	4.94				

"*" INDICATES FIXED PARAMETER

PARAMETER BOUNDS FROM EQUIVALENCE ANALYSIS

	LAYER	MINIMUM	BEST	MAXIMUM
RHO	1	46.192	56.229	65.767
	2	56.503	78.541	111.866
	3	4.489	4.945	5.447
THICK	1	30.000	0.000	30.000
	2	66.341	1.000	72.908
DEPTH	1	30.000	30.000	30.000
	2	96.341	99.644	102.908

CURRENT: 29.00 AMPS EM-37 COIL AREA: 100.00 sq m.
FREQUENCY: 30.00 Hz GAIN: 5 RAMP TIME: 127.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.0867	27836.6	27244.2	2.12
2	0.108	17890.0	18091.8	-1.12
3	0.138	11482.3	11763.3	-2.44

* S.D.I.I. *

ST. JOHNS RIVER
WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

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SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SOUNDING DATA TABLE
SOUNDING 20 – GENEVA/IRRIGATION
SEMINOLE COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.21-1

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
4	0.175	7978.0	8067.6	-1.12
5	0.218	5831.3	5878.1	-0.803
6	0.278	4341.4	4249.5	2.11
7	0.351	3264.3	3152.7	3.41
8	0.438	2480.4	2376.9	4.17
9	0.558	1821.9	1730.8	5.00
10	0.702	1299.7	1268.9	2.36
11	0.858	954.2	954.9	-0.0737
12	1.06	674.2	693.7	-2.89
13	1.37	444.9	470.1	-5.67
14	1.74	298.9	318.4	-6.53
15	2.17	209.3	217.8	-4.04
16	2.77	141.3	140.2	0.768
17	3.50	96.61	89.79	7.05
18	4.37	65.58	57.58	12.19
19	5.56	42.59	34.64	18.67 MASKED
20	7.03	26.80	20.55	23.32 MASKED

CURRENT: 29.00 AMPS EM-37 COIL AREA: 100.00 sq m.
FREQUENCY: 7.50 Hz GAIN: 8 RAMP TIME: 127.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
21	0.346	3259.1	3229.8	0.899
22	0.427	2495.1	2475.0	0.804
23	0.550	1819.2	1782.5	2.01
24	0.698	1317.5	1296.8	1.57
25	0.869	934.9	954.6	-2.10
26	1.10	642.4	670.7	-4.39
27	1.40	440.8	467.7	-6.09
28	1.75	310.0	329.5	-6.27
29	2.22	215.6	222.0	-2.96

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	0.78				
P 2	0.36	0.35			
P 3	0.01	-0.03	0.98		
F 1	0.00	0.00	0.00	0.00	
T 2	-0.02	0.05	0.01	0.00	0.99

* S.D.I.I. *

ST. JOHNS RIVER
WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SOUNDING DATA TABLE
SOUNDING 20 – GENEVA/IRRIGATION
SEMINOLE COUNTY, FLORIDA

PROJECT NO.: 94767

TABLE: 5.21-1

The range of equivalence in determining the depth to the low resistivity layer is about ±3 m (10 ft) which is 3% of the total depth. The resistivity of this layer has a range from 4.5 to 5.4 ohm-m. This corresponds to a range in interpreted chloride content of from 6,995 mg/l to 5,803 mg/l, again subject to the same assumptions of porosity and validity of equation (4). The equivalence range of the resistivity of Layer 2 is from 57 to 112 ohm-m, with a best fit at 79 ohm-m. This resistivity (79 ohm-m) corresponds to a chloride content above 250 mg/l and does not agree with the results from Phelps and Rohrer (1987) who showed the concentration of chloride to be less than 250 mg/l in this area. The chloride-to-sulfate ratio at the site is 7:1 (Table 5.1-4), rather than 5:1. Accordingly, equation (4) may not be valid.

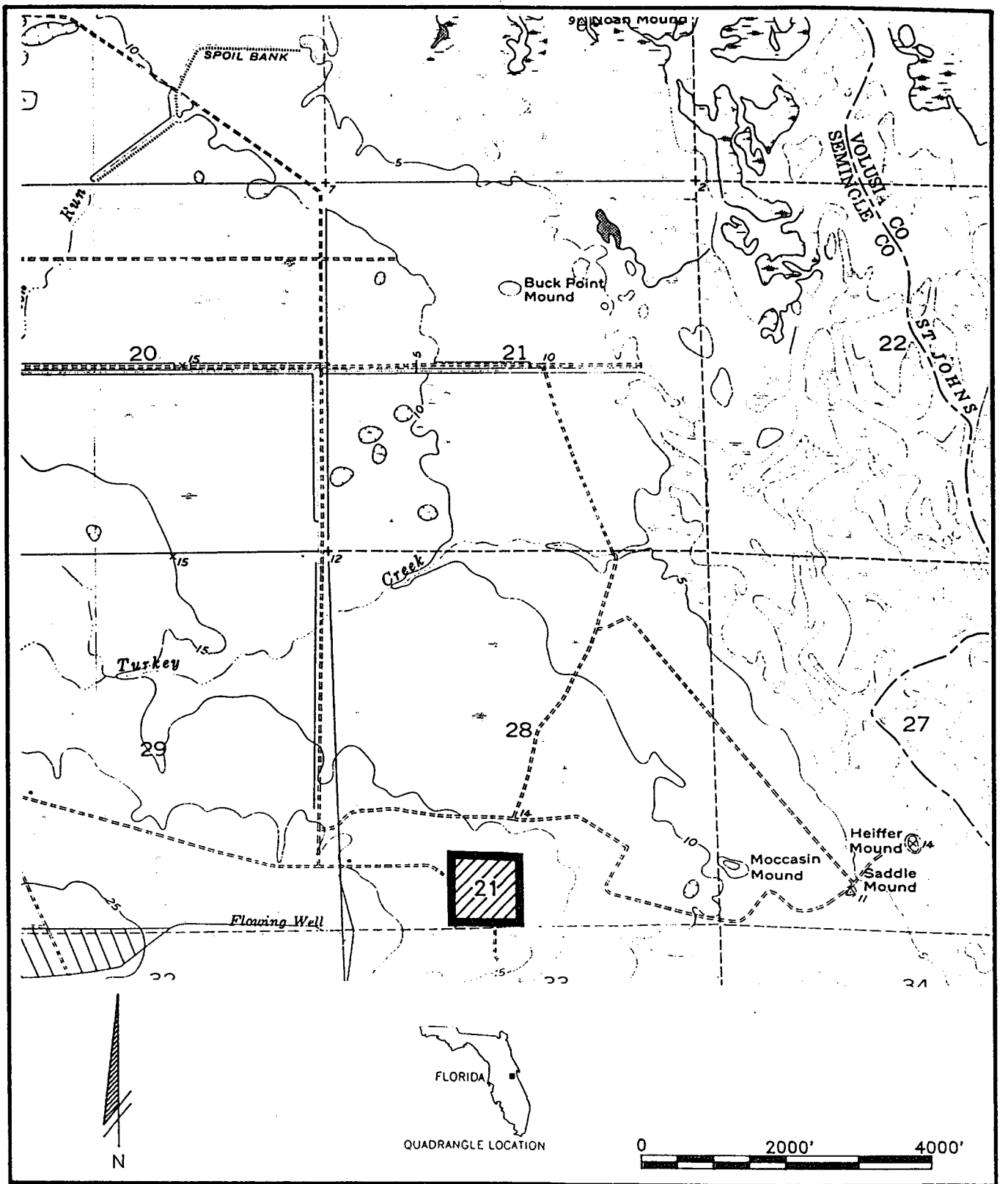
5.21.6 Summary of TDEM Sounding at Geneva/Irrigation (Site 20)

- The depth of occurrence of salt water (5,000 mg/l isochlor) is interpreted to be 328 ft (-288 ft msl) and occur within the Floridan aquifer.
- The ground water within the Floridan aquifer at this site is interpreted to contain an average chloride concentration above 250 mg/l. The 250 mg/l isochlor is not interpreted to be present within the Floridan aquifer. The results of the TDEM survey, in terms of water quality, do not agree with the results from Phelps and Rohrer (1987) in the area of this site.

5.22 TDEM Site 21 - Lee Ranch #1

5.22.1 Location Description and Geoelectrical Section

The site is located in southeastern Seminole County, Florida (Figure 5.22-1). The site is located within a pasture. A possible interference source (a chain link fence) existed 100 ft northwest of the Tx loop. QA soundings were performed 100 ft north, south, and west of the initial Rx coil location. Results from the QA soundings indicate that the apparent resistivity values were unaffected by any interference sources.



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TDEM SURVEY LOCATION MAP
SOUNDING 21 – LEE RANCH #1
SEMINOLE COUNTY, FLORIDA

DESIGNED BY: JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY: MJW	DRAWING NO.:	LOC-21	5.22-1
DRAWN BY: RBT	DATE:	07/05/94	

The Floridan aquifer occurs at an approximate depth of 105 ft bls (Tibbals, 1977) and is overlain by the surficial aquifer system and the Hawthorn Group. The base of the Floridan aquifer occurs at a depth of approximately 2,400 bmsl (Tibbals, 1990). The thickness of the Upper Floridan aquifer is approximately 900 ft and the depth to the top of the Lower Floridan aquifer is approximately 1,000 ft bls (Miller, 1986). The chloride concentration in the Floridan aquifer ranges between 1,000 to 4,000 mg/l at the site (Tibbals, 1977).

The resistivity sounding data and best-fit model inversion are presented on Figure 5.22-2. The interpreted geoelectrical section consists of a one-layer subsurface.

5.22.2 Geological Interpretation of Geoelectrical Model

The one-layered geoelectrical section consists of a low resistivity (9.1 ohm-m) layer which is considered to be a combined Hawthorn Group, surficial sediments, and Floridan aquifer. The resistivity of this layer (9.1 ohm-m) suggests the Floridan aquifer at this site contains brackish to salt water.

5.22.3 Depth to Occurrence of Salt Water

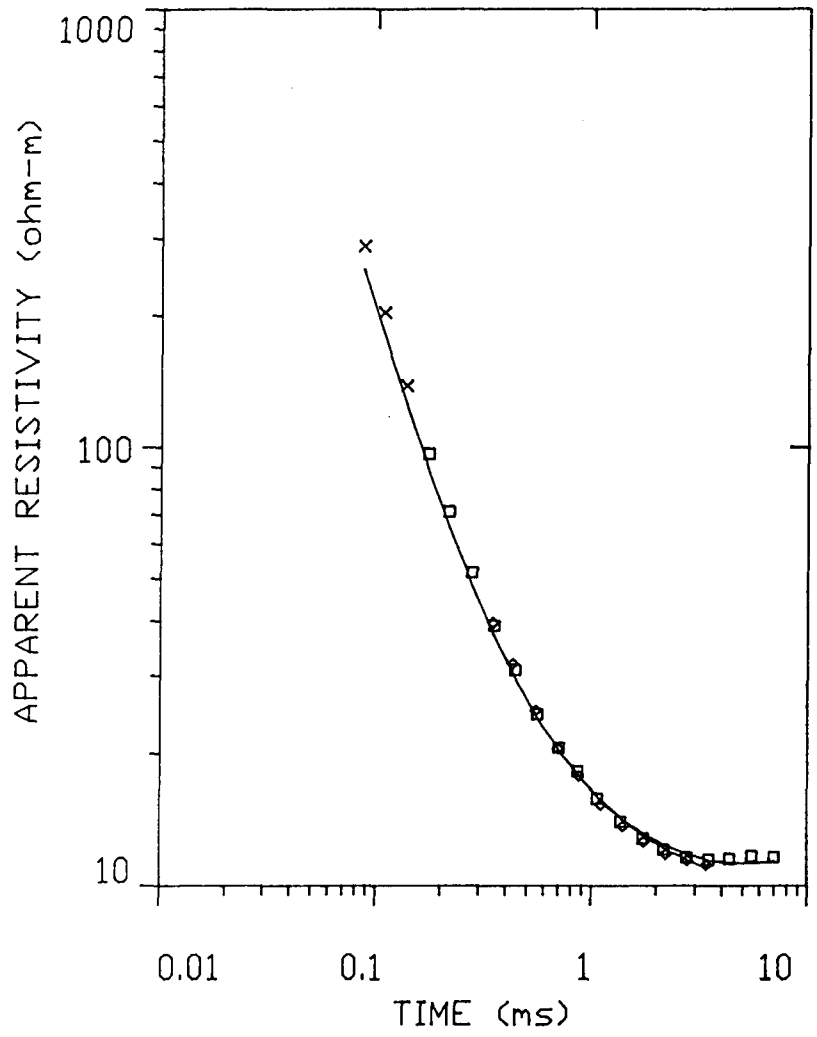
Based upon the TDEM results, all the sediments within the geoelectric section appeared to be saturated with brackish to salt water. Accordingly, it was not possible to determine the depth to the 5,000 mg/l isochlor.

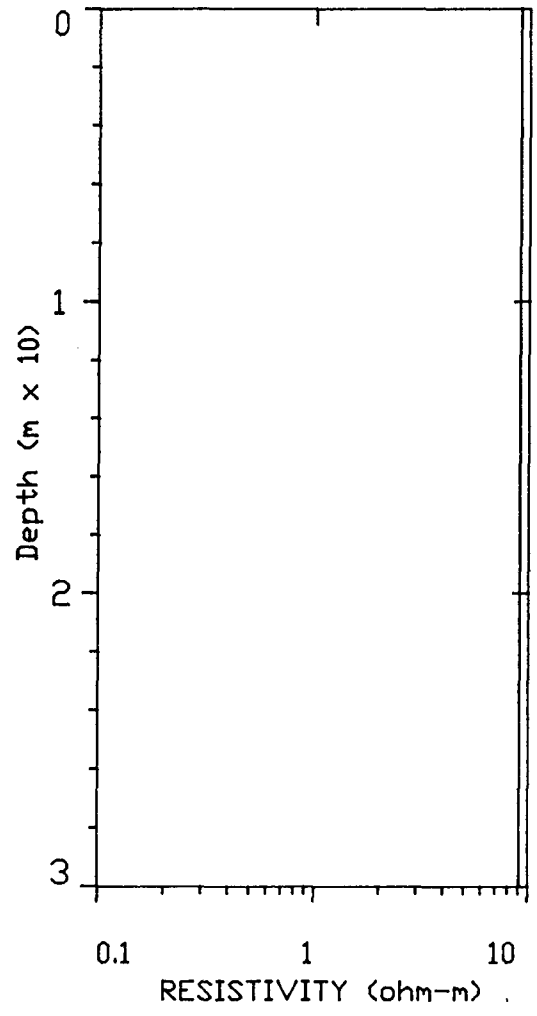
5.22.4 Depth of Occurrence of the 250 mg/l Isochlor

Based upon the TDEM results, all the sediments within the geoelectric section appeared to be saturated with brackish to salt water. Accordingly, the 250 mg/l isochlor is not present in the Floridan aquifer at this site.

5.22.5 Accuracy of Measurement and Interpretation

Figure 5.22-3 is the equivalence analysis at this site and the inversion table (Table 5.22-1) lists the upper and lower bounds of the inverted parameters of the geoelectrical model.





BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

X APPARENT RESISTIVITY VALUES NOT USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

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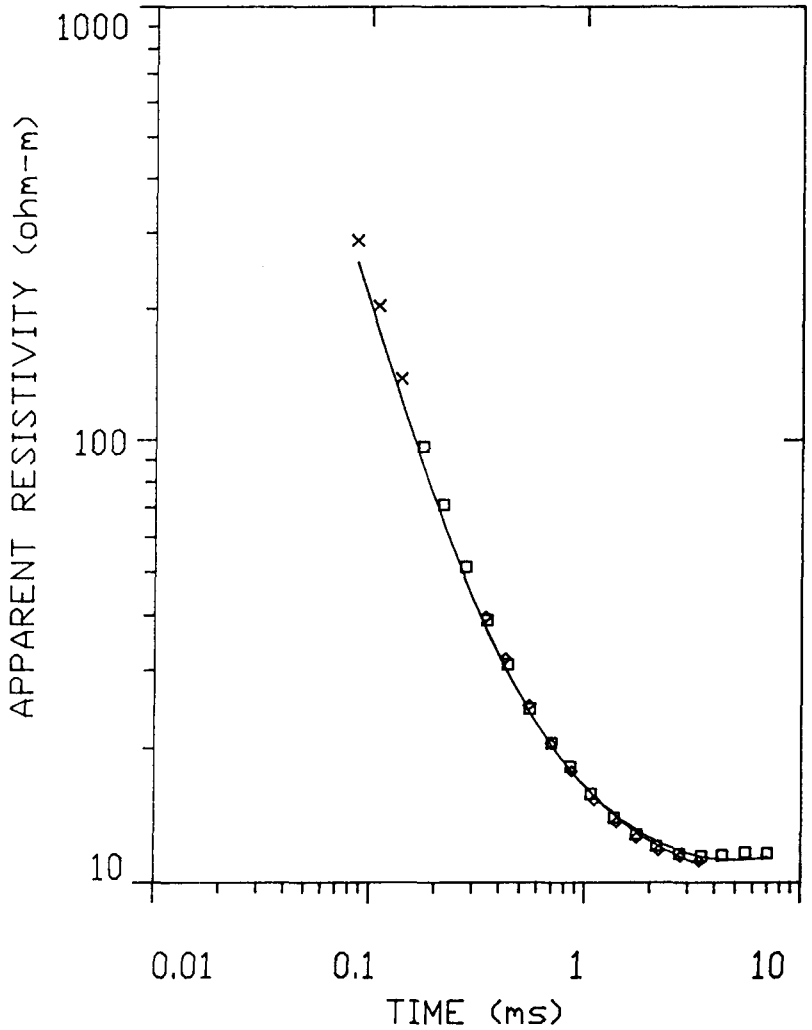
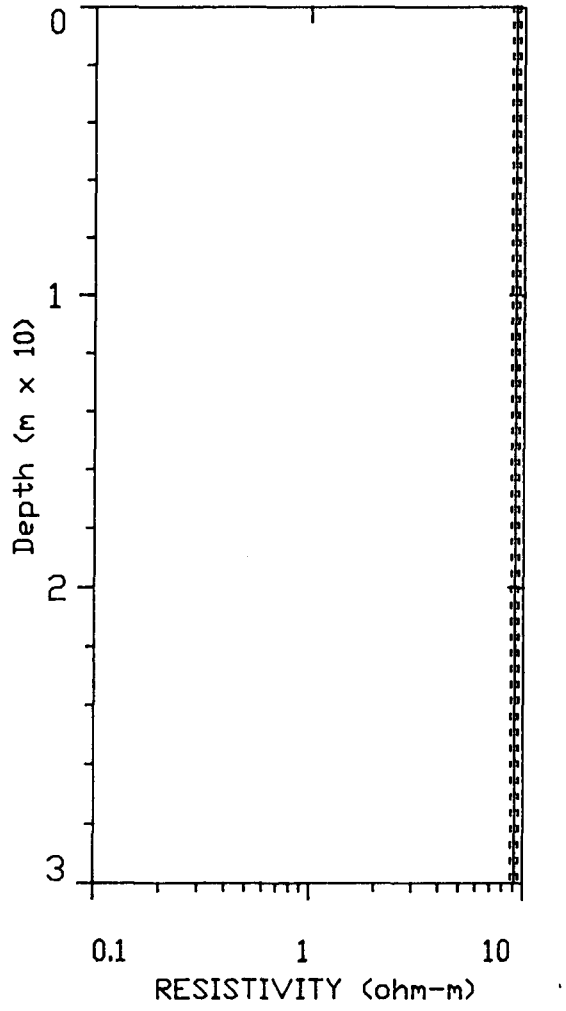
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

MEASURED TDEM APPARENT RESISTIVITY AND 1-D INVERSION
SOUNDING 21 - LEE RANCH #1
SEMINOLE COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	MDL-21	5.22-2
DRAWN BY:	RBT	DATE:	07/06/94	





——— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

X APPARENT RESISTIVITY VALUES NOT USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

MEASURED TDEM APPARENT RESISTIVITY AND EQUIVALENCE FOR 1-D INVERSION
SOUNDING 21 - LEE RNACH #1
SEMINOLE COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	EQU-21	5.22-3
DRAWN BY:	RBT	DATE:	07/06/94	

DATA SET: SITE 21

CLIENT: SJRWMD DATE: 10-MAY-94
LOCATION: LEE RANCH #1 SOUNDING: 1
COUNTY: SEMINOLE COUNTY, FLORIDA ELEVATION: 6.00 m
PROJECT: SALT WATER INTERFACE DETECTION EQUIPMENT: Geonics PROTEM
LOOP SIZE: 305.000 m by 305.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y)
SOUNDING COORDINATES: E: 0.0000 N: 0.0000

FITTING ERROR: 5.863 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			6.00	
1	9.08			

ALL PARAMETERS ARE FREE

PARAMETER BOUNDS FROM EQUIVALENCE ANALYSIS

	LAYER	MINIMUM	BEST	MAXIMUM
RHO	1	8.732	9.086	9.445

CURRENT: 19.50 AMPS EM-37 COIL AREA: 100.00 sq m.
FREQUENCY: 30.00 Hz GAIN: 3 RAMP TIME: 232.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.0867	84213.0	100736.4	-19.62 MASKED
2	0.108	82000.9	97625.0	-19.05 MASKED
3	0.138	79205.8	92680.9	-17.01 MASKED
4	0.175	74918.4	85969.2	-14.75
5	0.218	68466.8	77877.6	-13.74
6	0.278	60399.1	67039.1	-10.99
7	0.351	51094.0	55500.5	-8.62
8	0.438	41645.8	44429.3	-6.68
9	0.558	32190.4	33206.8	-3.15
10	0.702	23609.0	24111.4	-2.12
11	0.858	17194.3	17643.3	-2.61

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
12	1.06	12358.5	12198.3	1.29
13	1.37	7916.7	7678.1	3.01
14	1.74	4958.6	4782.8	3.54
15	2.17	3125.1	3012.4	3.60
16	2.77	1804.4	1761.2	2.39
17	3.50	1024.0	1028.6	-0.449
18	4.37	583.7	604.8	-3.59
19	5.56	313.0	332.2	-6.14
20	7.03	175.3	181.0	-3.22

CURRENT: 19.50 AMPS EM-37 COIL AREA: 100.00 sq m.
FREQUENCY: 7.50 Hz GAIN: 3 RAMP TIME: 232.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
21	0.346	51719.6	56373.4	-8.99
22	0.427	42357.2	45822.9	-8.18
23	0.550	32473.6	33975.5	-4.62
24	0.698	24167.4	24451.9	-1.17
25	0.869	17308.0	17409.7	-0.587
26	1.10	11785.9	11508.0	2.35
27	1.40	7741.1	7447.4	3.79
28	1.75	5032.3	4830.7	4.00
29	2.22	3061.8	2960.9	3.29
30	2.79	1814.4	1814.4	-0.00412
31	3.42	1130.5	1157.2	-2.35

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER
P 1 1.00
P 1

ST. JOHNS RIVER
WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SOUNDING DATA TABLE
SOUNDING 21 - LEE RANCH #1
SEMINOLE COUNTY, FLORIDA

PROJECT NO.: 94767

TABLE: 5.22-1

The range of equivalence in determining the resistivity of Layer 1 is 8.7 to 9.4 ohm-m. This corresponds to an interpreted chloride content from 3,544 mg/l to 3,269 mg/l, again subject to the same assumptions of porosity and validity of equation (4). The chloride-to-sulfate ratio at the site is 7:1 (Table 5.1-4), rather than 5:1. Accordingly, equation (4) may not be valid.

5.22.6 Summary of TDEM Sounding at Lee Ranch #1 (Site 21)

- It is not possible to determine the depth to salt water (5,000 mg/l isochlor) or the 250 mg/l isochlor because based on the TDEM results the entire Floridan aquifer appears to be saturated with brackish to salt water. The TDEM results agree with Tibbals (1977) who indicated that the Floridan aquifer at this site contains brackish water.

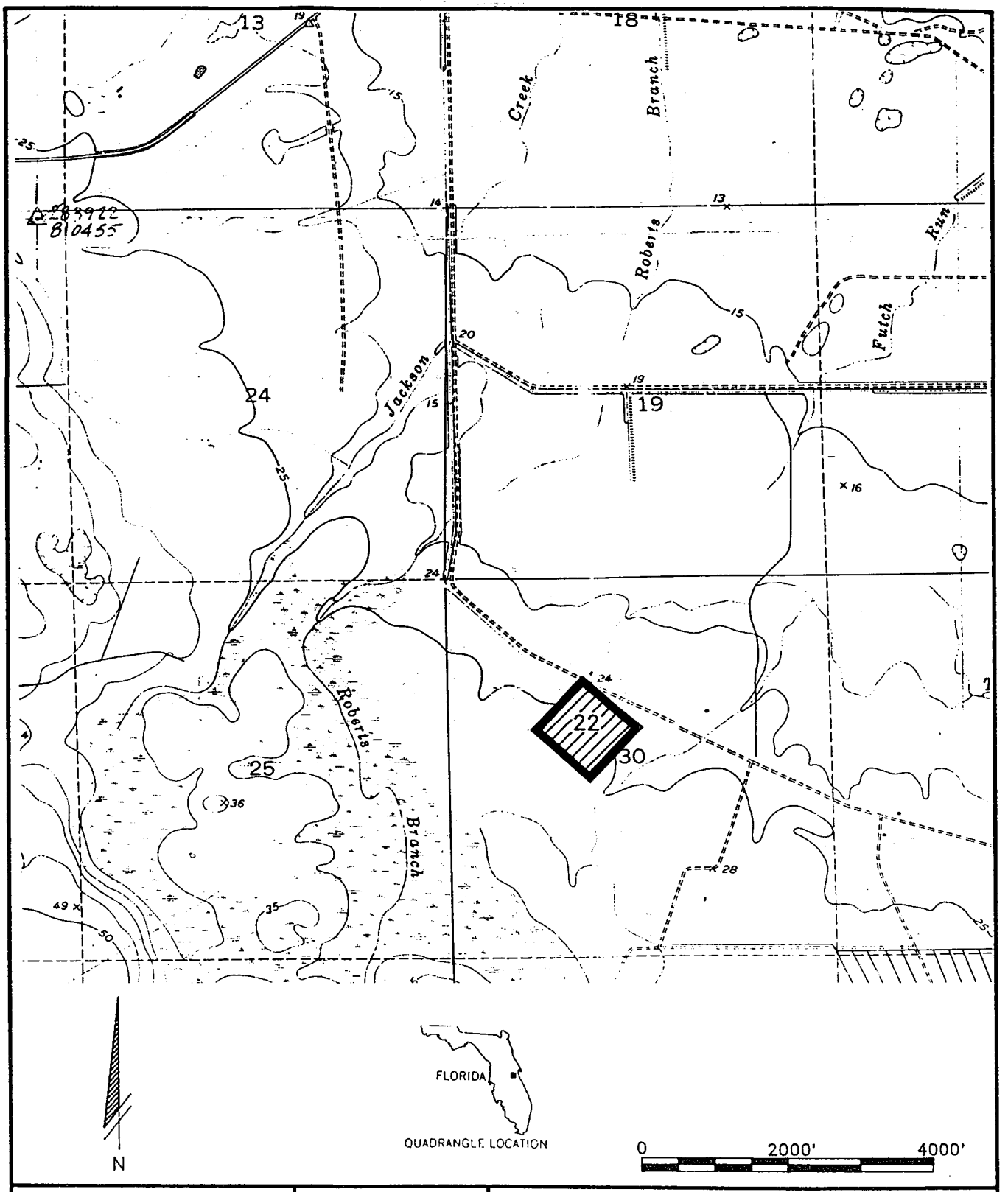
5.23 TDEM Site 22 - Lee Ranch #2

5.23.1 Location Description and Geoelectrical Section

The site is located in southeastern Seminole County, Florida (Figure 5.23-1). The site is located within a pasture. A possible interference source (a barbed wire link fence) existed 100 ft south of the Tx loop. QA soundings were performed 100 ft north and south of the initial Rx coil location. Results from the QA soundings indicate that the apparent resistivity values were unaffected by any interference sources.

The Floridan aquifer occurs at an approximate depth of 105 ft bls (Tibbals, 1977) and is overlain by the surficial aquifer system and the Hawthorn Group. The base of the Floridan aquifer occurs at a depth of approximately 2,400 ft bmsl (Tibbals, 1990). The thickness of the Upper Floridan aquifer is approximately 875 ft and the depth to the top of the Lower Floridan aquifer is approximately 980 ft bls (Miller, 1986). The chloride concentration in the Floridan aquifer is above 250 mg/l at this site (Tibbals, 1977).

The resistivity sounding data and best-fit model inversion are presented on Figure 5.23-2. The interpreted geoelectrical section consists of a one-layer subsurface.

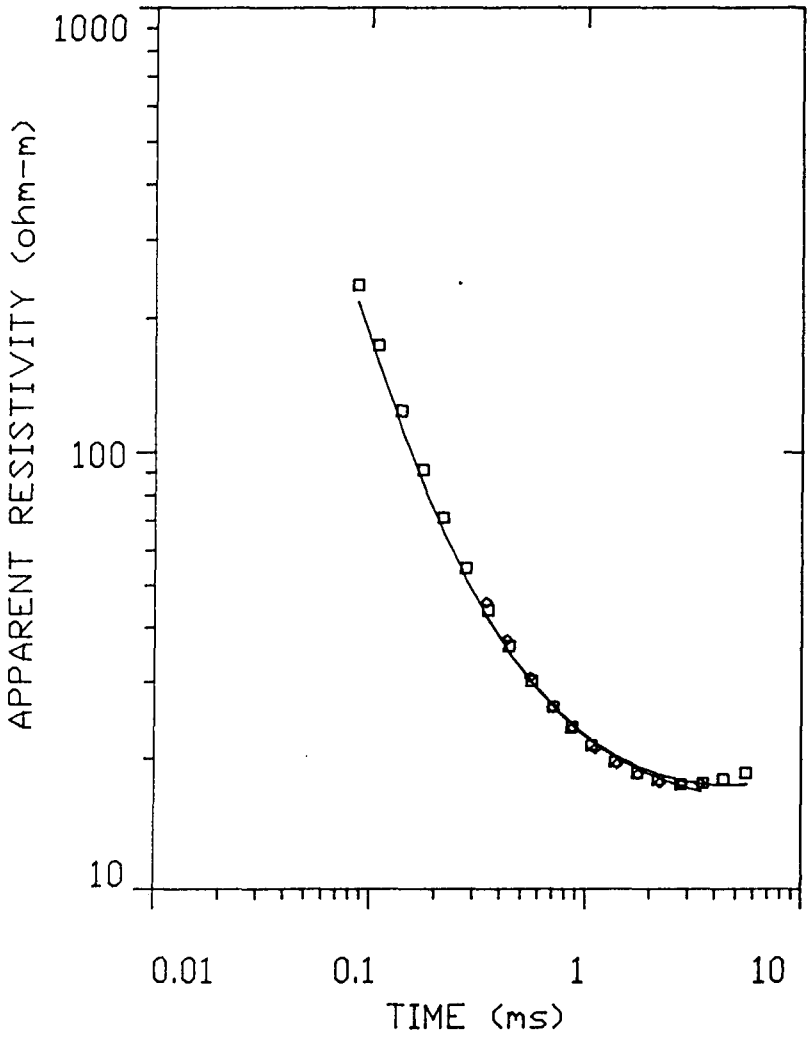


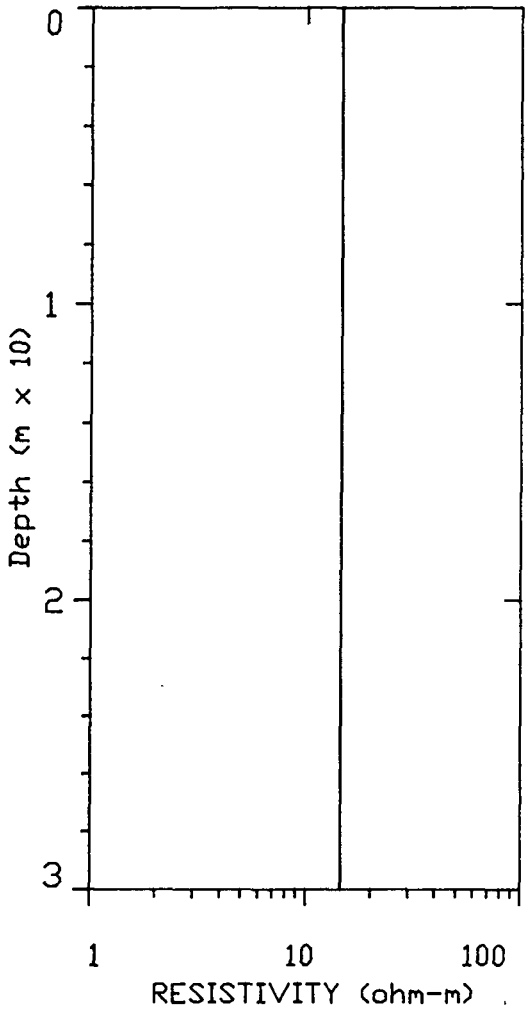
ST. JOHNS RIVER
WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SURVEY LOCATION MAP
SOUNDING 22 – LEE RANCH #2
SEMINOLE COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	LOC–22	5.23–1
DRAWN BY:	RBT	DATE:	07/05/94	





—— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

MEASURED TDEM APPARENT RESISTIVITY AND 1-D INVERSION
SOUNDING 22 - LEE RANCH #2
SEMINOLE COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	MDL-22	5.23-2
DRAWN BY:	RBT	DATE:	07/06/94	

5.23.2 Geological Interpretation of Geoelectrical Model

The one-layered geoelectrical section consists of a low resistivity (15 ohm-m) layer which is considered to be a combined Hawthorn Group, surficial sediments, and Floridan Aquifer. The resistivity of this layer (15 ohm-m) suggests the Floridan aquifer at this site contains brackish to salt water.

5.23.3 Depth to Occurrence of Salt Water

Based upon the TDEM results, all the sediments within the geoelectric section appeared to be saturated with brackish to salt water. Accordingly, it was not possible to determine the depth to the 5,000 mg/l isochlor.

5.23.4 Depth of Occurrence of the 250 mg/l Isochlor

Based upon the TDEM results, all the sediments within the geoelectric section appeared to be saturated with brackish to salt water. Accordingly, the 250 mg/l isochlor is not present in the Floridan aquifer at this site.

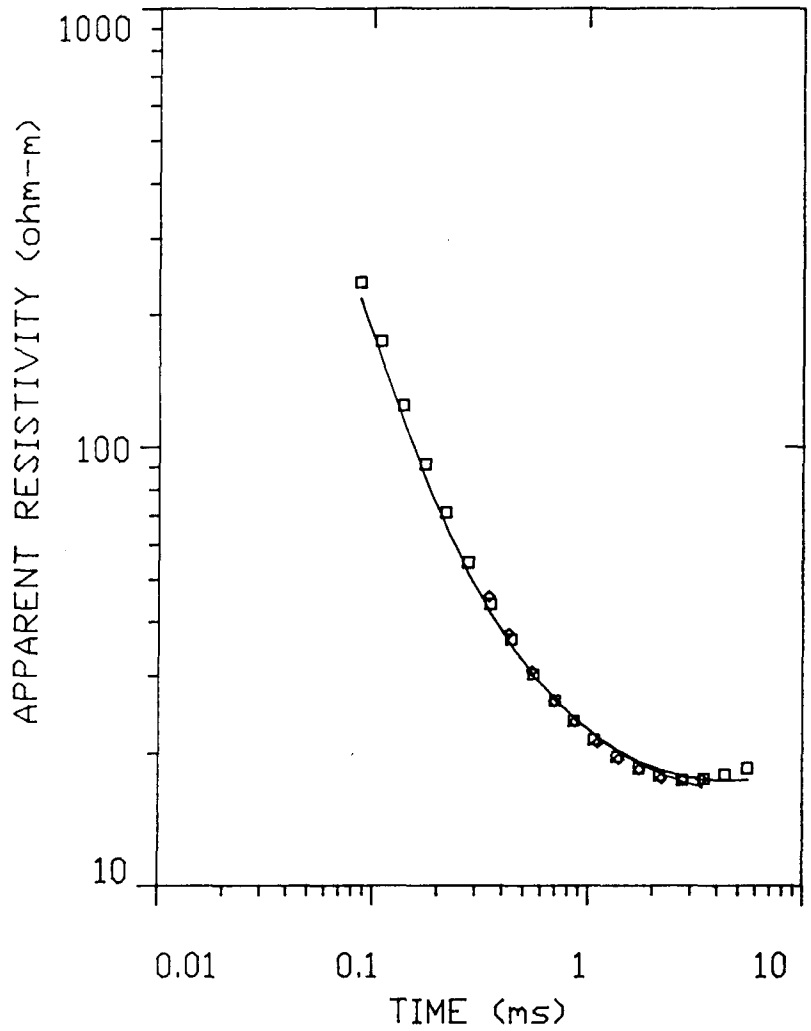
5.23.5 Accuracy of Measurement and Interpretation

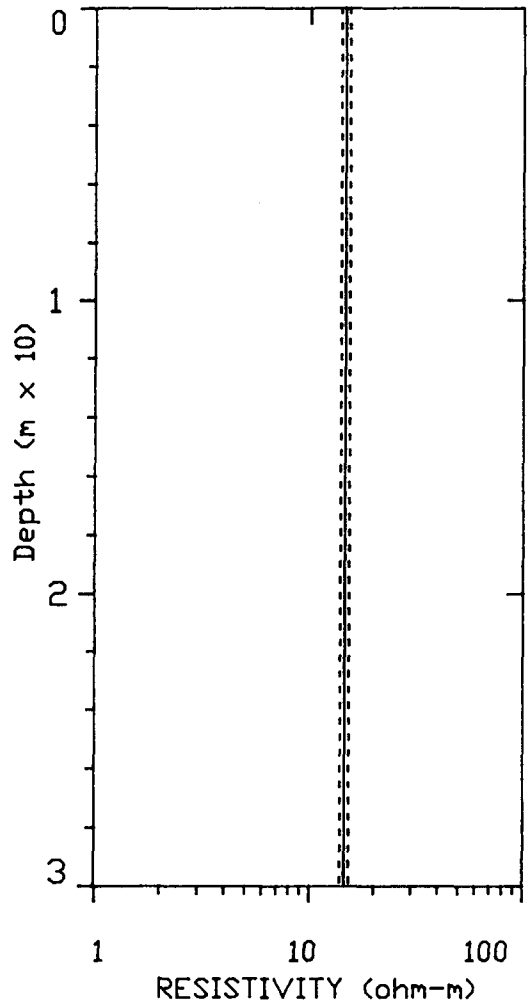
Figure 5.23-3 is the equivalence analysis at this site and the inversion table (Table 5.23-1) lists the upper and lower bounds of the inverted parameters of the geoelectrical model.

The range of equivalence in determining the resistivity of Layer 1 is 14 to 15 ohm-m. This corresponds to a range in interpreted chloride content of from 1,563 mg/l to 1,991 mg/l, again subject to the same assumptions of porosity and validity of equation (4). The chloride-to-sulfate ratio at the site is 7:1 (Table 5.1-4), rather than 5:1. Accordingly, equation (4) may not be valid.

5.23.6 Summary of TDEM Sounding at Lee Ranch #2 (Site 22)

- It is not possible to determine the depth to salt water (5,000 mg/l isochlor) or the 250 mg/l isochlor because based on the TDEM results the entire Floridan aquifer appears to be saturated with brackish to salt water.





—— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

MEASURED TDEM APPARENT RESISTIVITY AND EQUIVALENCE FOR 1-D INVERSION
SOUNDING 22 – LEE RANCH #2
SEMINOLE COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	EQU-22	5.23-3
DRAWN BY:	RBT	DATE:	07/06/94	

DATA SET: SITE 22

CLIENT: SJRWMD DATE: 11-MAY-94
LOCATION: LEE RANCH #2 SOUNDING: 1
COUNTY: SEMINOLE COUNTY, FLORIDA ELEVATION: 7.50 m
PROJECT: SALT WATER INTERFACE DETECTION EQUIPMENT: Geonics PROTEM
LOOP SIZE: 305.000 m by 305.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y)
SOUNDING COORDINATES: E: 0.0000 N: 0.0000

FITTING ERROR: 7.252 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			7.50	
1	14.55			

ALL PARAMETERS ARE FREE

PARAMETER BOUNDS FROM EQUIVALENCE ANALYSIS

	LAYER	MINIMUM	BEST	MAXIMUM
RHO	1	13.884	14.552	15.229

CURRENT: 20.20 AMPS EM-57 COIL AREA: 100.00 sq m.
FREQUENCY: 30.00 Hz GAIN: 1 RAMP TIME: 232.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	emf (nV/m sqrd) SYNTHETIC	DIFFERENCE (percent)
1	0.0867	116390.3	132704.2	-14.01
2	0.108	107466.4	123174.7	-14.61
3	0.138	96569.0	109909.9	-13.81
4	0.175	84482.9	94764.5	-12.17
5	0.218	70957.2	79574.9	-12.14
6	0.278	57274.4	62730.1	-9.52
7	0.351	44544.7	47779.7	-7.26
8	0.438	33913.1	35496.2	-4.66
9	0.558	24441.8	24632.9	-0.782
10	0.702	16936.4	16810.9	0.740
11	0.858	12019.1	11732.7	2.38

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
12	1.06	8090.5	7760.6	4.07
13	1.37	4936.4	4679.8	5.19
14	1.74	2977.0	2819.0	5.30
15	2.17	1811.5	1730.8	4.45
16	2.77	1020.1	988.9	3.06
17	3.50	562.3	567.4	-0.897
18	4.37	312.8	329.0	-5.17
19	5.56	162.7	178.6	-9.78

CURRENT: 20.20 AMPS EM-57 COIL AREA: 100.00 sq m.
FREQUENCY: 7.50 Hz GAIN: 5 RAMP TIME: 232.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
20	0.346	43375.4	48725.0	-12.33
21	0.427	34428.9	36873.2	-7.09
22	0.550	24638.3	25277.9	-2.59
23	0.698	17272.3	17049.6	1.28
24	0.869	11703.1	11527.3	1.50
25	1.10	7549.4	7256.3	3.88
26	1.40	4735.1	4513.5	4.68
27	1.75	2960.9	2838.5	4.13
28	2.22	1752.3	1692.6	3.40
29	2.79	1001.6	1015.1	-1.35
30	3.42	598.5	637.2	-6.47

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER
P 1 1.00
P 1

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TDEM SOUNDING DATA TABLE
SOUNDING 22 – LEE RANCH #2
SEMINOLE COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.23–1

5.24 TDEM Site 23 - Seminole Ranch/Orange County

5.24.1 Location Description and Geoelectrical Section

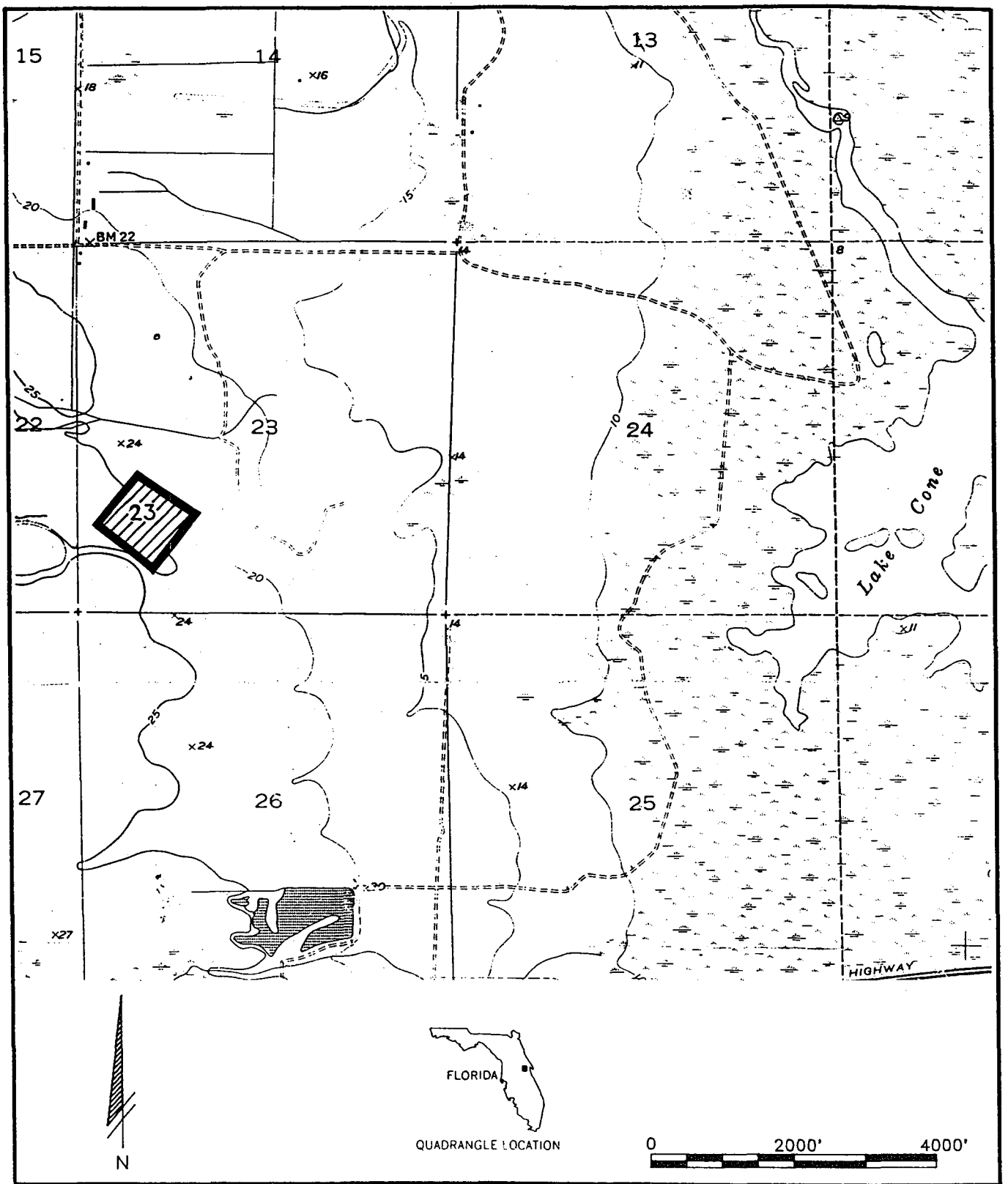
The site is located in northeast Orange County, Florida (Figure 5.24-1). The site is located within a pasture. No possible sources of interference were visible near the project site. QA soundings were performed 100 ft south and east of the initial Rx coil location. Results from the QA soundings indicate that the apparent resistivity values were unaffected by any interference sources.

The Floridan aquifer occurs at an approximate depth of 170 ft bls (Tibbals, 1990) and is overlain by the surficial aquifer system and the Hawthorn Group. The base of the Floridan aquifer occurs at an approximate depth of 2500 ft bmsl (Tibbals, 1990). The thickness of the Upper Floridan aquifer is approximately 880 ft and the depth to the top of the Lower Floridan aquifer is approximately 1,050 ft bls (Miller, 1986). The chloride concentration in the Floridan aquifer is above 250 mg/l at this site (Tibbals, 1990).

The resistivity sounding data and best-fit model inversion are presented on Figure 5.24-2. The interpreted geoelectrical section consists of a three-layer subsurface.

5.24.2 Geological Interpretation of Geoelectrical Model

The three-layered geoelectrical section consists of a low resistivity (18 ohm-m), upper layer which is considered to be the Hawthorn Group and surficial sediments above the Floridan aquifer. The thickness of Layer 1 was fixed at a 52 m (170 ft) value based on published information (Tibbals, 1990). The second layer has only intermediate resistivity (31 ohm-m) which, because it is less than 80 ohm-m, suggests the Floridan aquifer at this site contains brackish water. The thickness of the brackish section is 257 m (843 ft), placing the depth to the low resistivity (saltwater) layer at 309 m (1014 ft)



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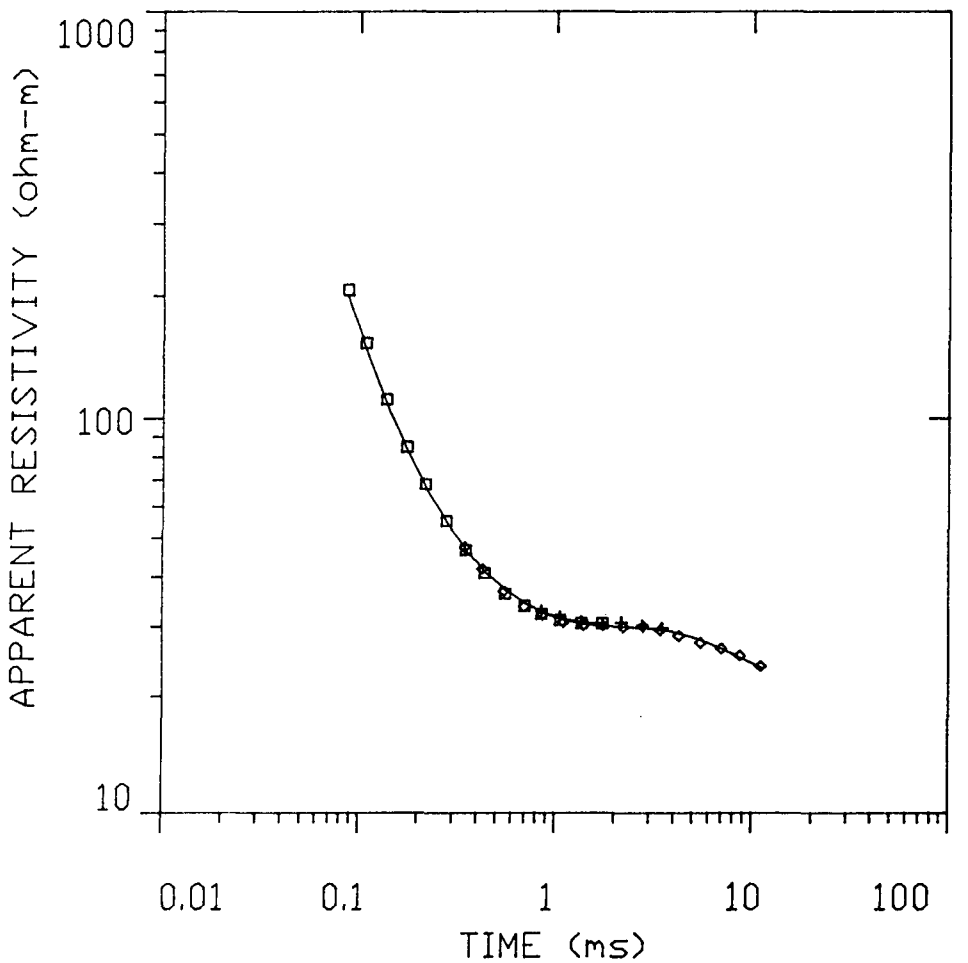
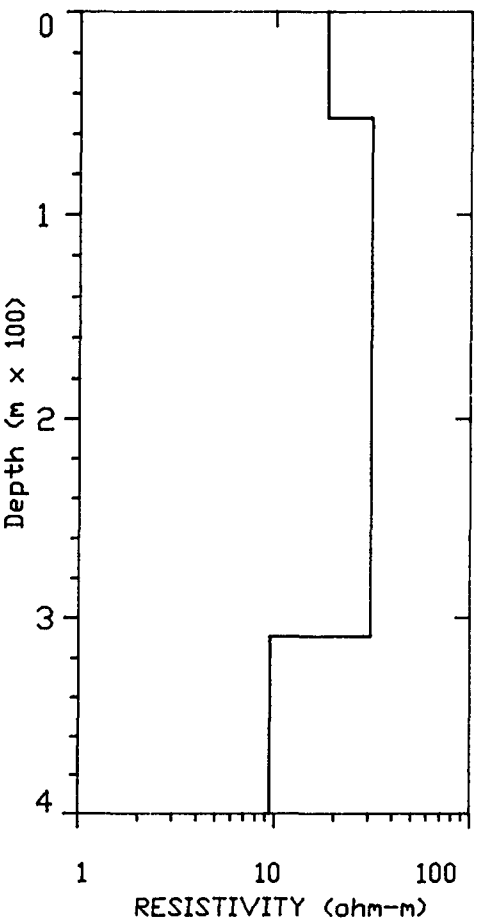
TDEM SURVEY LOCATION MAP
SOUNDING 23 – SEMINOLE RANCH/ORANGE COUNTY
ORANGE COUNTY, FLORIDA

DESIGNED BY: JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY: MJW	DRAWING NO.:	LOC-23	5.24-1
DRAWN BY: RBT	DATE:	07/05/94	





—— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

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MEASURED TDEM APPARENT RESISTIVITY AND 1-D INVERSION
SOUNDING 23 - SEMINOLE RANCH/ORANGE COUNTY
ORANGE COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	MDL-23	5.24-2
DRAWN BY:	RBT	DATE:	07/06/94	

below ground surface. The resistivity of the saltwater saturated layer is 9.5 ohm-m. Layer 1 is considered to be the Hawthorn Group and surficial sediments, Layer 2 to be the Floridan aquifer (brackish) and Layer 3 to be the salt water within the Lower Floridan aquifer.

5.24.3 Depth to Occurrence of Salt Water

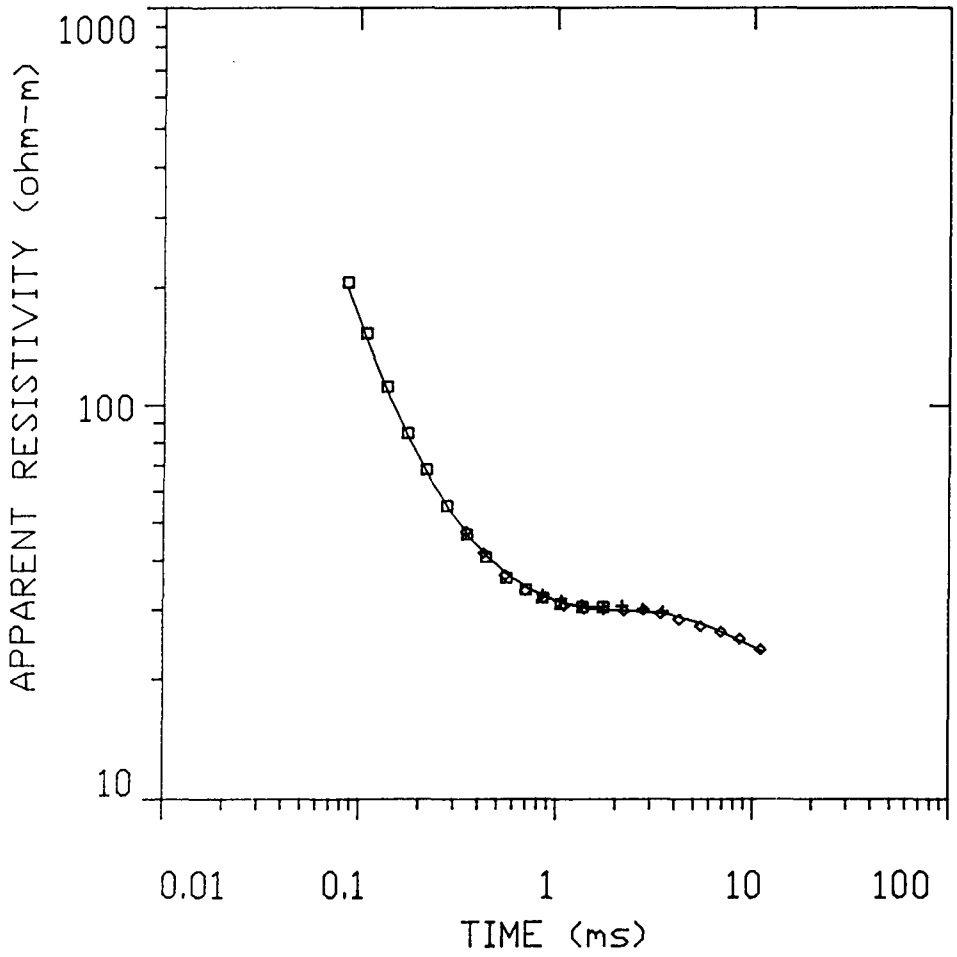
The bottom (third) layer of the geoelectrical model, with a resistivity of 9.5 ohm-m, is interpreted to represent salt water. It occurs at a depth of 1014 ft (-994 ft msl). Because the resistivity of Layer 2 (31 ohm-m) is interpreted to represent brackish water within the Floridan aquifer (i.e., is less than 80 ohm-m), the interpreted depth to the 5,000 mg/l isochlor is equal to the depth of the geoelectrical interface, or at 1014 ft depth (-994 ft msl). The resistivity of Layer 3 (9.5 ohm-m) corresponds to a chloride content of 3,233 mg/l assuming a porosity of 25% and the validity and applicability of equation (4) of Section 4.2. It is presumed that because of the expected high chlorinity gradients, this value is sufficiently close to the 5,000 mg/l isochlor that they represent the same effective depth.

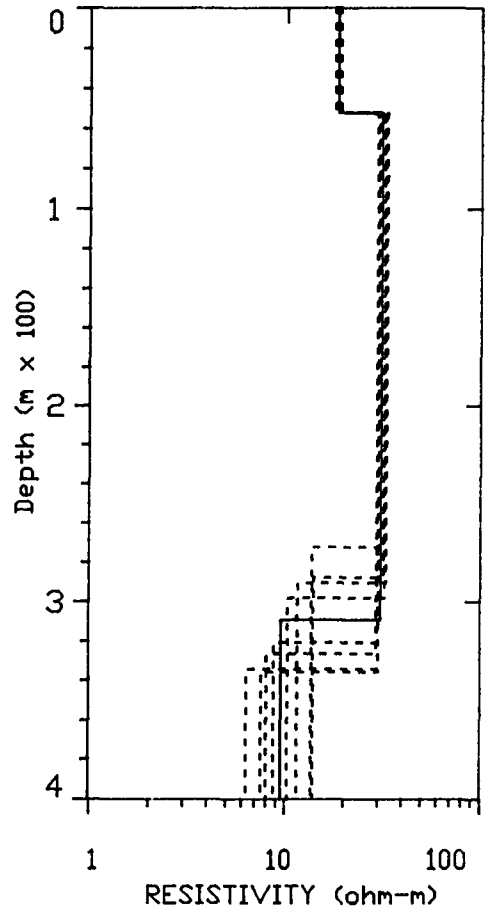
5.24.4 Depth of Occurrence of the 250 mg/l Isochlor

The resistivity of Layer 2, 31 ohm-m, corresponds to a chloride content above 250 mg/l, assuming a 25% porosity and the validity and applicability of equation (4) of Section 4.2. As the interpreted chloride content exceeds 250 mg/l, the 250 mg/l isochlor does not occur within the Floridan aquifer at this site.

5.24.5 Accuracy of Measurement and Interpretation

Figure 5.24-3 is the equivalence analysis at this site and the inversion table (Table 5.24-1) lists the upper and lower bounds of the inverted parameters of the geoelectrical model.





—— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

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MEASURED TDEM APPARENT RESISTIVITY AND EQUIVALENCE FOR 1-D INVERSION
SOUNDING 23 – SEMINOLE RANCH/ORANGE COUNTY
ORANGE COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	EQU-23	5.24-3
DRAWN BY:	RBT	DATE:	07/06/94	

DATA SET: SITE 23

CLIENT: SJRWMD DATE: 11-MAY-94
LOCATION: SEMINOLE RANCH/ORANGE COUNTY SOUNDING: 1
COUNTY: ORANGE COUNTY, FLORIDA ELEVATION: 6.00 m
PROJECT: SALT WATER INTERFACE DETECTION EQUIPMENT: Geonics PROTEM
LOOP SIZE: 305.000 m by 305.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y)
SOUNDING COORDINATES: E: 0.0000 N: 0.0000

FITTING ERROR: 2.297 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)		ELEVATION (meters)	CONDUCTANCE (Siemens)
				6.00	
1	18.21	52.00	*	-46.00	2.85
2	31.04	257.0		-303.0	8.28
3	9.49				

"*" INDICATES FIXED PARAMETER

PARAMETER BOUNDS FROM EQUIVALENCE ANALYSIS

	LAYER	MINIMUM	BEST	MAXIMUM
RHO	1	17.615	18.217	18.838
	2	29.407	31.048	33.078
	3	6.336	9.491	13.864
THICK	1	52.000	0.000	52.000
	2	220.050	1.000	283.695
DEPTH	1	52.000	52.000	52.000
	2	272.050	309.097	335.695

CURRENT: 20.00 AMPS EM-57 COIL AREA: 100.00 sq m.
FREQUENCY: 30.00 Hz GAIN: 3 RAMP TIME: 232.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.0867	141869.0	149653.5	-5.48
2	0.108	128435.6	135581.4	-5.56
3	0.138	111773.0	116565.5	-4.28

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TDEM SOUNDING DATA TABLE
SOUNDING 23 – SEMINOLE RANCH/ORANGE COUNTY
ORANGE COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.24–1

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
4	0.175	93348.1	95898.4	-2.73
5	0.218	74424.1	76433.4	-2.69
6	0.278	55982.7	56385.3	-0.719
7	0.351	40107.6	40044.4	0.157
8	0.438	28080.6	27744.2	1.19
9	0.558	18389.8	17784.7	3.29
10	0.702	11504.9	11251.6	2.20
11	0.858	7480.4	7349.9	1.74
12	1.06	4580.6	4512.4	1.48
13	1.37	2517.0	2500.0	0.674
14	1.74	1386.1	1389.0	-0.207

CURRENT: 20.00 AMPS EM-57 COIL AREA: 100.00 sq m.
FREQUENCY: 7.50 Hz GAIN: 5 RAMP TIME: 232.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
15	0.346	40466.9	40990.0	-1.29
16	0.427	28881.3	29033.6	-0.527
17	0.550	18664.8	18320.7	1.84
18	0.698	11785.6	11420.2	3.09
19	0.869	7294.8	7181.6	1.55
20	1.10	4237.4	4158.4	1.86
21	1.40	2407.7	2390.9	0.697
22	1.75	1395.1	1397.0	-0.136
23	2.22	778.1	775.6	0.316
24	2.79	436.5	442.2	-1.29
25	3.42	271.4	269.1	0.816
26	4.26	164.6	161.0	2.19
27	5.49	92.67	90.32	2.52
28	6.96	53.80	53.80	0.00383
29	8.66	33.10	33.60	-1.49
30	11.06	19.71	19.94	-1.20

CURRENT: 20.00 AMPS EM-57 COIL AREA: 100.00 sq m.
FREQUENCY: 3.00 Hz GAIN: 6 RAMP TIME: 232.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)

31	0.857	7313.0	7404.5	-1.25
32	1.06	4480.1	4546.7	-1.48
33	1.37	2482.4	2532.2	-2.00
34	1.74	1384.9	1418.8	-2.44
35	2.17	790.9	822.4	-3.97
36	2.77	441.4	451.9	-2.37
37	3.50	251.6	256.3	-1.89

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	1.00				
P 2	0.01	0.99			
P 3	0.01	-0.04	0.49		
F 1	0.00	0.00	0.00	0.00	
T 2	-0.01	0.02	0.12	0.00	0.95
	P 1	P 2	P 3	F 1	T 2

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TDEM SOUNDING DATA TABLE
SOUNDING 23 – SEMINOLE RANCH/ORANGE COUNTY
ORANGE COUNTY, FLORIDA

PROJECT NO.: 94767

TABLE: 5.24–1

The range of equivalence in determining the depth to the low resistivity layer is about ±32 m (105 ft) which is 10% of the total depth. The resistivity of this layer has a range from 6.3 to 13.9 ohm-m. This corresponds to a range in interpreted chloride content of from 4,952 mg/l to 2,161 mg/l, again subject to the same assumptions of porosity and validity of equation (4).

The equivalence range of the resistivity of Layer 2 is from 29 to 33 ohm-m which corresponds to a chloride content above 250 mg/l. The chloride-to-sulfate ratio at the site is 2:1 (Table 5.1-4), rather than 5:1. Accordingly, equation (4) may not be valid.

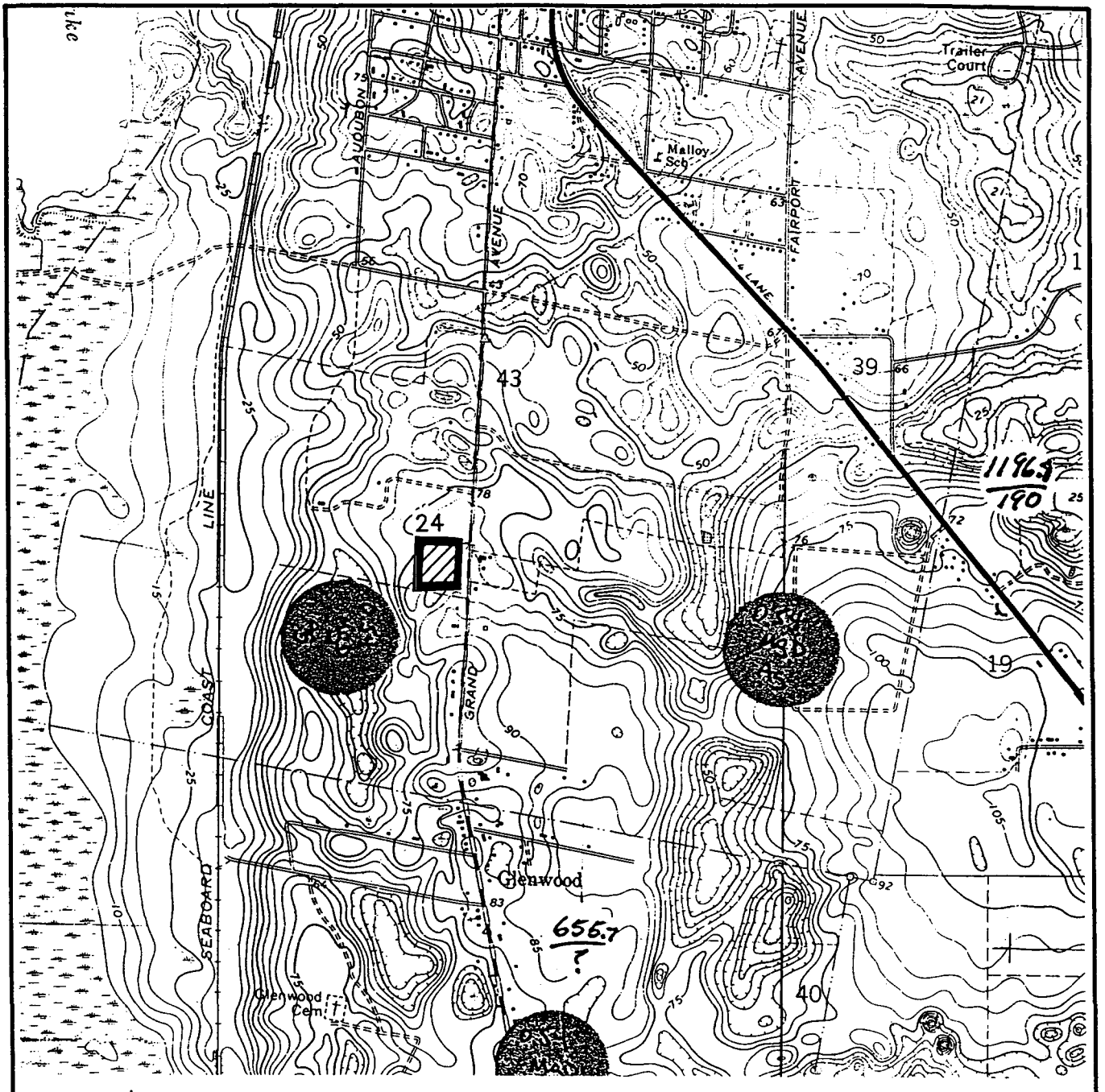
5.24.6 Summary of TDEM Sounding at Seminole Ranch/Orange County (Site 23)

- The depth to occurrence of salt water (5,000 mg/l isochlor) is interpreted to be 1014 ft (-994 ft msl) and occurs near the transition between the Upper and Lower Floridan aquifer.
- The ground water within the Floridan aquifer at this site is interpreted to contain an average chloride concentration above 250 mg/l. The 250 mg/l isochlor is not interpreted to be present within the Floridan aquifer. This conclusion is consistent with Tibbals (1990) who indicated that the chloride concentration in the Floridan aquifer is above 250 mg/l at the site.

5.25 TDEM Site 24 - Glenwood/North

5.25.1 Location Description and Geoelectrical Section

The site is located in western Volusia County near Glenwood, Florida (Figure 5.25-1). The site is located within an abandoned orange grove near a residential housing development. Two possible interference sources (powerlines) existed 200-300 ft north and east of the Tx loop. QA soundings were performed 60 ft north and east of the initial Rx coil location. Results from the QA soundings indicate that the apparent resistivity values were unaffected by any interference sources.



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TDEM SURVEY LOCATION MAP
SOUNDING 24 – GLENWOOD/NORTH
VOLUSIA COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	LOC-24	5.25-1
DRAWN BY:	RBT	DATE:	07/05/94	

The Floridan aquifer occurs at an approximate depth of 20 ft bmsl or 100 ft bls (Rutledge, 1982) and is overlain by Holocene to Miocene deposits. The base of the Floridan aquifer occurs at an approximate depth of 2050 ft bmsl (Tibbals, 1990). The thickness of the Upper Floridan aquifer is approximately 700 ft and the depth to the top of the Lower Floridan aquifer is approximately 800 ft bls (Miller, 1986). A water quality study performed in the area of the site (Rutledge, 1982) indicates that the chloride concentration in the upper portion of the Floridan aquifer varies between 26 and 250 mg/l.

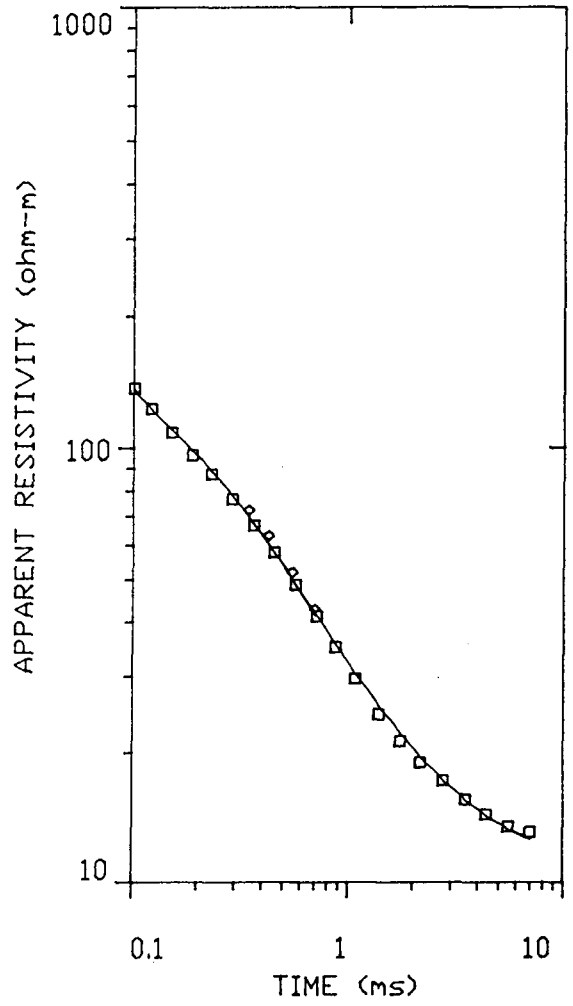
The resistivity sounding data and best-fit model inversion are presented on Figure 5.25-2. The interpreted geoelectrical section consists of a two-layer subsurface.

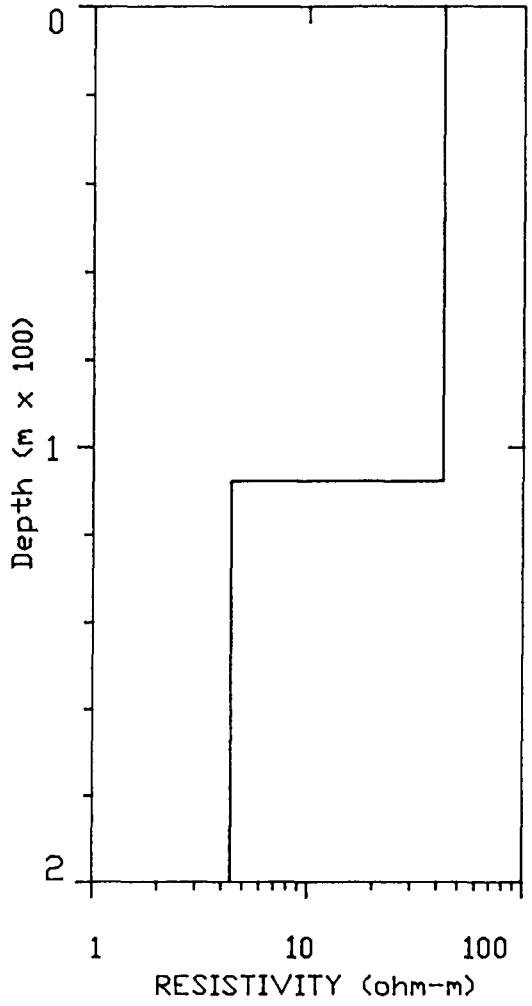
5.25.2 Geological Interpretation of Geoelectrical Model

The first layer occurs at 108 m (354 ft) bls and not at the hydrostratigraphic contact between the Holocene and Miocene deposits (100 ft bls) and the Floridan Aquifer System. Therefore, it can be interpreted that there exists a two-layer geoelectrical section with a 354 ft surface layer of intermediate resistivity (42 ohm-m) overlying a low resistivity layer (4.4 ohm-m). It can be interpreted that the Holocene to Miocene deposits and the upper part of the Floridan aquifer system exist as a combined but indistinguishable (geoelectrical) layer, overlying a saltwater saturated Floridan aquifer at a depth of 354 ft bls.

5.25.3 Depth to Occurrence of Salt Water

The bottom (second) layer of the geoelectrical model, with a resistivity of 4.4 ohm-m, is interpreted to represent salt water. It occurs at a depth of 354 ft (-274 ft msl). Because the resistivity of Layer 1 (42 ohm-m) is less than 80 ohm-m, the interpreted depth to the 5,000 mg/l isochlor is taken at the depth of the geoelectrical interface, or at 354 ft depth (-274 ft msl). For comparison, Rutledge (1982) calculated an approximate depth of 600 ft bmsl for the freshwater-saltwater interface at this site. The interface calculated by Rutledge (1982) is based on a modified Ghyben-Herzberg principle.





——— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

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MEASURED TDEM APPARENT RESISTIVITY AND 1-D INVERSION
SOUNDING 24 - GLENWOOD/NORTH
VOLUSIA COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	MDL-24	5.25-2
DRAWN BY:	RBT	DATE:	07/06/94	

The resistivity of Layer 2 (4.4 ohm-m) corresponds to a chloride content of 7,157 mg/l assuming a porosity of 25% and the validity and applicability of equation (4) of Section 4.2. It is presumed that because of the expected high chlorinity gradients, this value is sufficiently close to the 5,000 mg/l isochlor that they represent the same effective depth.

5.25.4 Depth of Occurrence of the 250 mg/l Isochlor

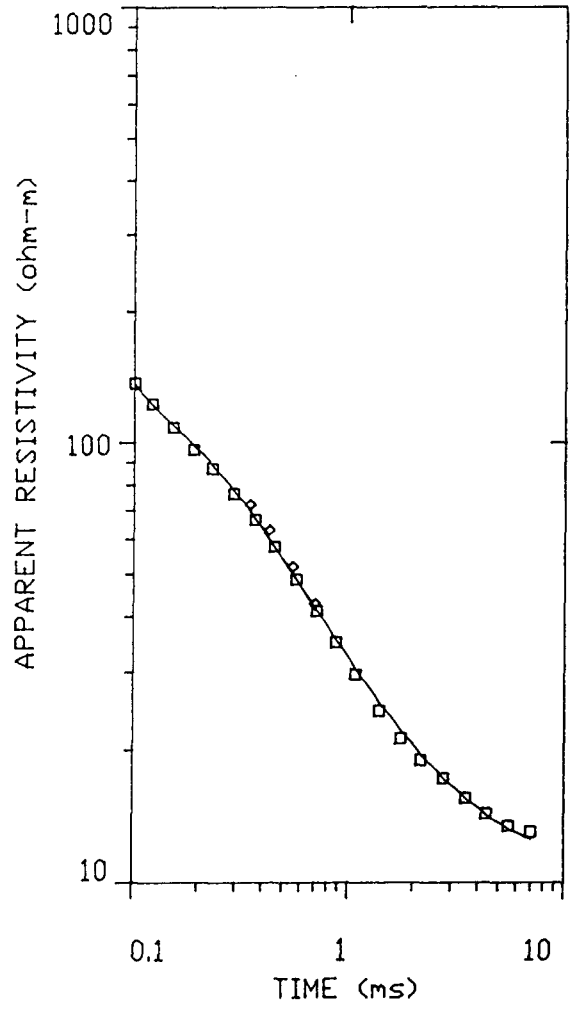
Because of the inability to segregate the Floridan aquifer from the overlying Holocene to Miocene deposits, the effective chloride concentration of Layer 1 cannot be calculated. For comparison, Rutledge (1982) mapped a chloride concentration of between 26 to 250 mg/l in the upper part of the Floridan aquifer at this site. Rutledge (1985) estimated a maximum thickness of less than 300 ft for water with a chloride concentration less than 250 mg/l in the Floridan aquifer at this site. The top of the Floridan aquifer occurs at an approximate depth of 20 ft bmsl or 100 ft bls at this site (Rutledge, 1982).

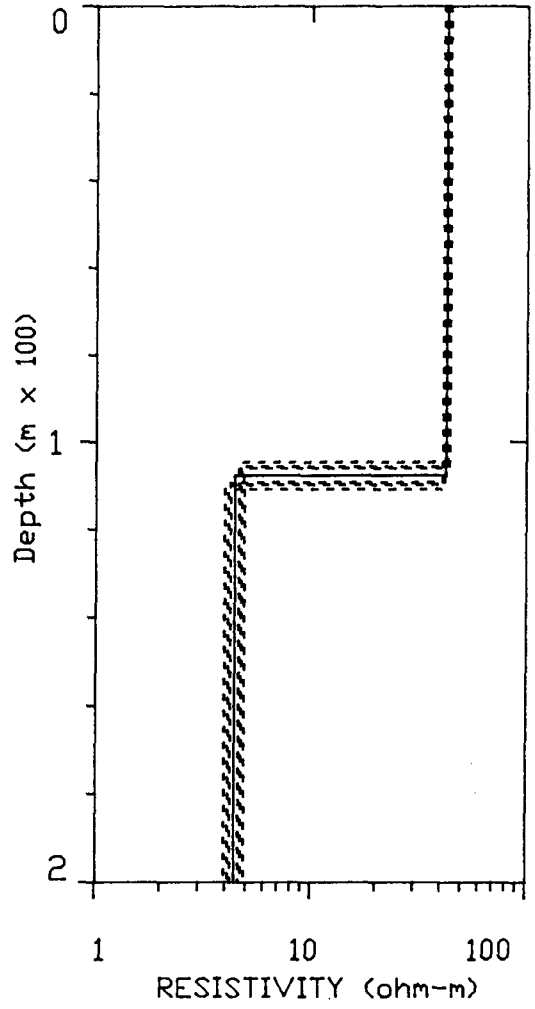
5.25.5 Accuracy of Measurement and Interpretation

Figure 5.25-3 is the equivalence analysis at this site and the inversion table (Table 5.25-1) lists the upper and lower bounds of the inverted parameters of the geoelectrical model.

The range of equivalence in determining the depth to the low resistivity layer is about ±3 m (10 ft) which is 3% of the total depth. The resistivity of this layer has a range from 3.9 to 4.9 ohm-m. This corresponds to a range in interpreted chloride content from 8,094 mg/l to 6,411 mg/l, again subject to the same assumptions of porosity and validity of equation (4).

The equivalence range of the resistivity of Layer 1 is from 41 to 44 ohm-m. A corresponding chloride concentration cannot be determined because Layer 1 is in part comprised of Holocene to Miocene deposits. Accordingly, equation (4) may not be valid.





—— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

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SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

MEASURED TDEM APPARENT RESISTIVITY AND EQUIVALENCE FOR 1-D INVERSION
SOUNDING 24 - GLENWOOD/NORTH
VOLUSIA COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	EQU-24	5.25-3
DRAWN BY:	RBT	DATE:	07/06/94	

5-193

DATA SET: SITE 24

CLIENT: SJRWMD DATE: 11-MAY-94
LOCATION: GLENWOOD/NORTH SOUNDING: 1
COUNTY: VOLUSIA COUNTY, FLORIDA ELEVATION: 24.50 m
PROJECT: SALT WATER INTERFACE DETECTION EQUIPMENT: Geonics PROTEM
LOOP SIZE: 182.000 m by 169.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y)
SOUNDING COORDINATES: E: 0.0000 N: 0.0000

FITTING ERROR: 3.929 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			24.50	
1	42.49	107.6	-83.14	2.53
2	4.39			

ALL PARAMETERS ARE FREE

PARAMETER BOUNDS FROM EQUIVALENCE ANALYSIS

	LAYER	MINIMUM	BEST	MAXIMUM
RHO	1	40.972	42.492	44.130
	2	3.948	4.395	4.864
THICK	1	104.681	1.000	110.778
DEPTH	1	104.681	107.648	110.778

CURRENT: 25.10 AMPS EM-47 COIL AREA: 100.00 sq m.
FREQUENCY: 30.00 Hz GAIN: 4 RAMP TIME: 187.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.100	76603.4	77473.6	-1.13
2	0.121	55910.5	56292.2	-0.682
3	0.151	38771.5	38233.8	1.38
4	0.188	26822.6	25941.1	3.28
5	0.231	18594.8	18146.1	2.41
6	0.291	12700.2	12385.7	2.47
7	0.365	8866.7	8733.4	1.50

* S.D.I.I. *

ST. JOHNS RIVER
WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SOUNDING DATA TABLE
SOUNDING 24 – GLENWOOD/NORTH
VOLUSIA COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.25–1

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
8	0.452	6437.8	6412.0	0.400
9	0.570	4650.7	4637.3	0.287
10	0.712	3428.4	3422.1	0.181
11	0.871	2644.5	2590.3	2.05
12	1.08	1981.7	1904.8	3.88
13	1.39	1403.5	1313.1	6.44
14	1.75	977.2	916.8	6.18
15	2.18	669.3	640.2	4.34
16	2.78	421.2	421.2	-0.00572
17	3.52	272.2	273.4	-0.445
18	4.39	177.0	178.8	-1.04
19	5.56	108.0	110.3	-2.17
20	7.04	62.70	66.31	-5.75

CURRENT: 25.10 AMPS EM-47 COIL AREA: 100.00 sq m.
FREQUENCY: 7.50 Hz GAIN: 6 RAMP TIME: 187.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
21	0.346	8973.5	9525.7	-6.15
22	0.427	6505.8	7016.1	-7.84
23	0.550	4602.7	4933.6	-7.18
24	0.698	3405.2	3575.5	-5.00

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	1.00		
P 2	-0.01	0.96	
T 1	0.00	0.01	1.00
	P 1	P 2	T 1

ST. JOHNS RIVER
WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

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SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SOUNDING DATA TABLE
SOUNDING 24 – GLENWOOD/NORTH
VOLUSIA COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.25-1

5.25.6 Summary of TDEM Sounding at Glenwood/North (Site 24)

- The depth of occurrence of salt water (5,000 mg/l isochlor) is interpreted to be 354 ft (-274 ft msl) and occur within the Upper Floridan aquifer.
- The quality of ground water within the Floridan aquifer at this site cannot be interpreted because the analysis of the TDEM data does not allow the Holocene to Miocene deposits to be distinguished from the Floridan Aquifer System.

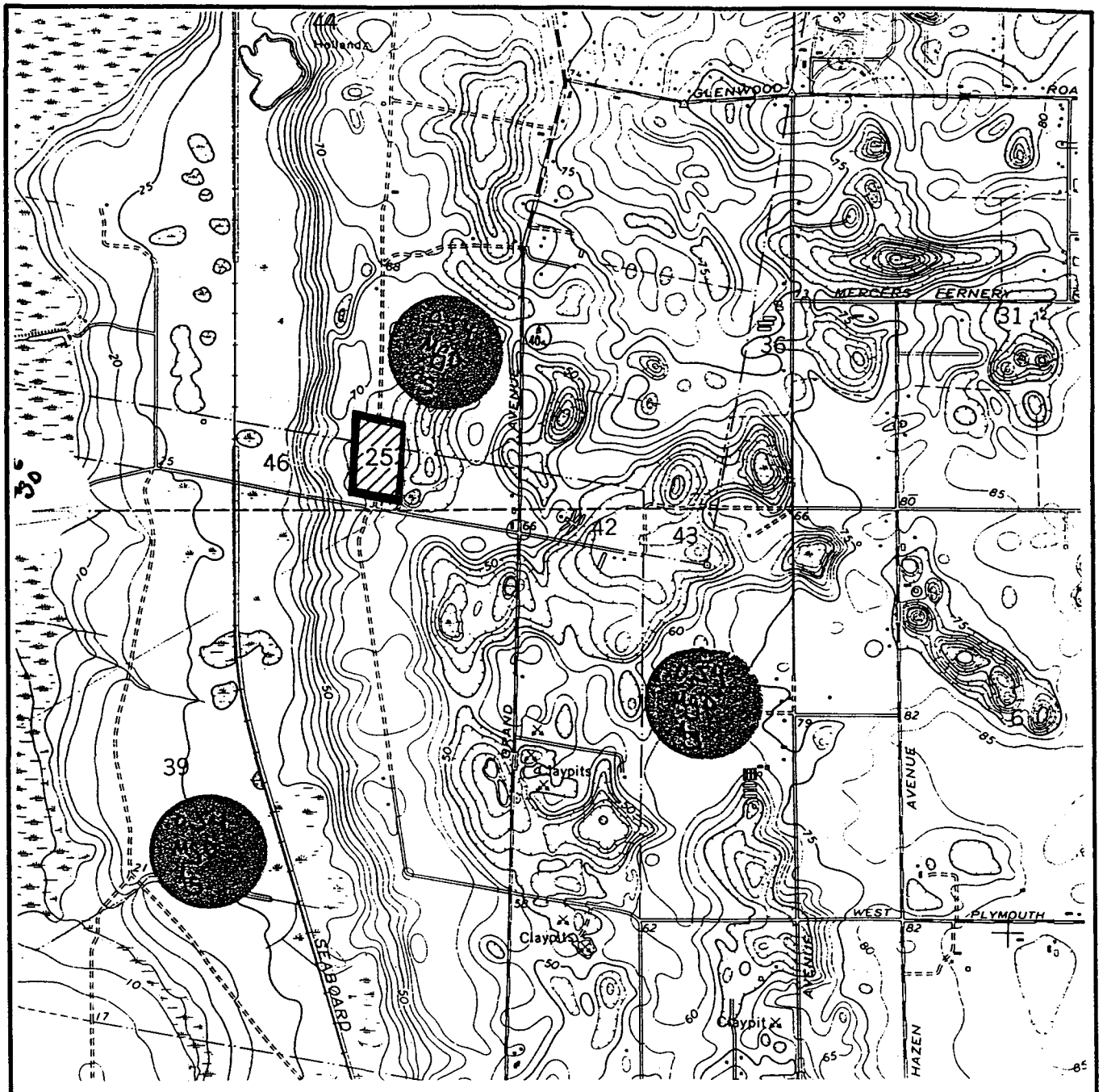
5.26 TDEM Site 25 - Glenwood/South

5.26.1 Location Description and Geoelectrical Section

The site is located in western Volusia County near Glenwood, Florida (Figure 5.26-1). The site is located within a wooded area. Scattered pieces of trash, creating possible sources of interference, were present near the eastern portion of the Tx loop. QA soundings were performed 100 ft south and 60 ft east of the initial Rx coil location. Results from the QA soundings indicate that the apparent resistivity values were unaffected by any interference sources.

The Floridan aquifer occurs at an approximate depth of 25 ft bmsl or 100 ft bls (SJRWMD, personal communication) and is overlain by the Holocene to Miocene deposits. The base of the Floridan aquifer occurs at an approximate depth of 2030 ft bmsl (Tibbals, 1990). The thickness of the Upper Floridan aquifer is approximately 650 ft and the depth to the top of the Lower Floridan aquifer is approximately 775 ft bls (Miller, 1986). A water quality study performed in the area of the site (Rutledge, 1985) indicates that the chloride concentration in the upper portion of the Floridan aquifer varies between 51 and 250 mg/l.

The resistivity sounding data and best-fit model inversion are presented on Figure 5.26-2. The interpreted geoelectrical section consists of a three-layer subsurface.



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PALATKA, FLORIDA

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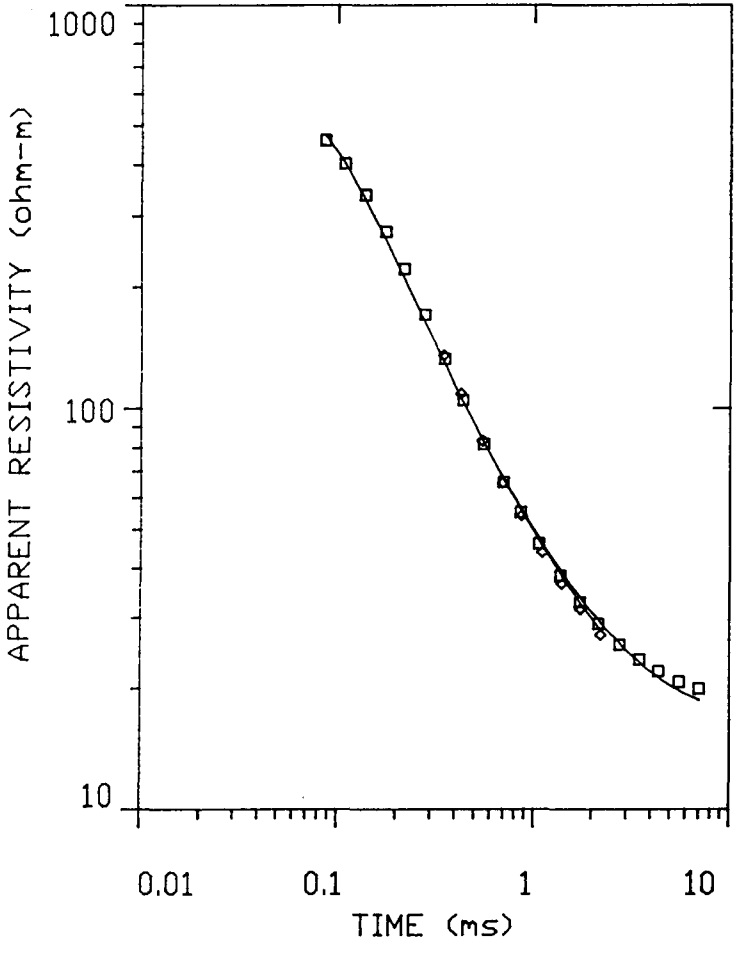
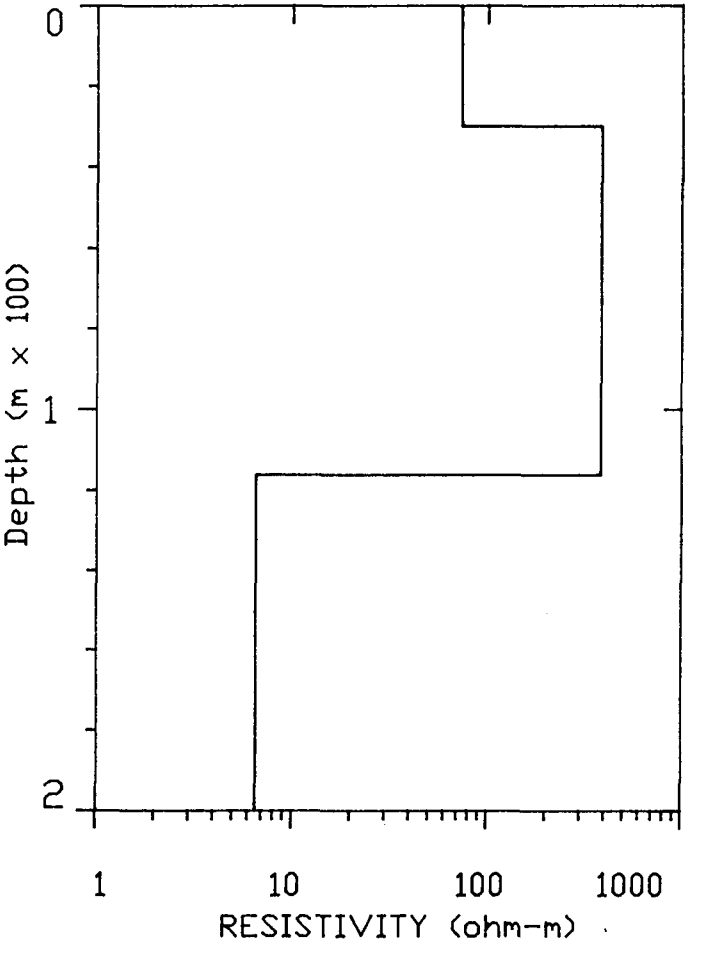
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SURVEY LOCATION MAP
SOUNDING 25 – GLENWOOD/SOUTH
VOLUSIA COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	LOC-25	5.26-1
DRAWN BY:	RBT	DATE:	07/05/94	





5-198

BEST-FIT MODELED CURVE

APPARENT RESISTIVITY VALUES USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

MEASURED TDEM APPARENT RESISTIVITY AND 1-D INVERSION
SOUNDING 25 - GLENWOOD/SOUTH
VOLUSIA COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	MDL-25	5.26-2
DRAWN BY:	RBT	DATE:	07/06/94	

5.26.2 Geological Interpretation of Geoelectrical Model

The three-layer geoelectrical section consists of an upper layer with a resistivity of 73 ohm-m, which correlates with the Holocene to Miocene deposits above the Floridan aquifer. The thickness of Layer 1 was fixed at 30 m (100 ft) based on information from SJRWMD, personal communication. The second layer has high resistivity (383 ohm-m) which means that because it is greater than 80 ohm-m the Floridan aquifer at this site contains fresh water. The thickness of the freshwater section is 86 m (282 ft) placing the depth to the low resistivity (saltwater) layer at 116 m (381 ft) below ground surface. The resistivity of the saltwater layer is 6.5 ohm-m. Layer 1 is considered to be the Holocene to Miocene deposits, Layer 2 to be the Floridan aquifer containing fresh water, and Layer 3 to be the salt water within the Upper Floridan aquifer.

5.26.3 Depth to Occurrence of Salt Water

The bottom (third) layer of the geoelectrical model, with a resistivity of 6.5 ohm-m, is interpreted to represent salt water. It occurs at a depth of 381 ft (-306 ft msl). Because the resistivity of Layer 2 (383 ohm-m) is greater than 80 ohm-m, the interpreted depth to the 5,000 mg/l isochlor is taken as 50 ft greater than the depth of the geoelectrical interface, or at a depth of 431 ft (-356 ft msl). The resistivity of Layer 3 (6.5 ohm-m) corresponds to a chloride content of 4,795 mg/l assuming a porosity of 25% and the validity and applicability of equation (4) of Section 4.2. It is presumed that because of the expected high chlorinity gradients, this value is sufficiently close to the 5,000 mg/l isochlor that they represent the same effective depth.

5.26.4 Depth of Occurrence of the 250 mg/l Isochlor

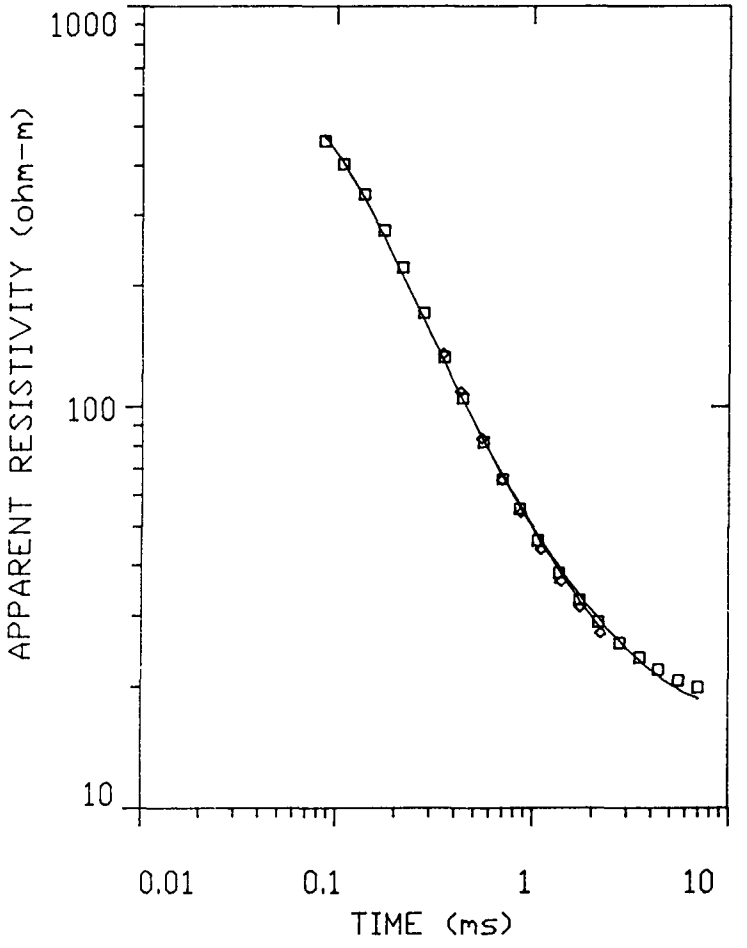
The resistivity of Layer 2, 329 ohm-m, corresponds to a chloride content of less than 250 mg/l, assuming a 25% porosity and the validity and applicability of equation (4) of Section 4.2. The 250 mg/l isochlor is placed in the Floridan aquifer at a depth 50 ft above the Layer 3 interface or at 331 ft (-256 ft msl). For comparison, Rutledge (1985) estimated a maximum thickness of approximately 300 ft for water with a chloride concentration less than 250 mg/l in the Floridan aquifer at this site. The top of the Floridan aquifer occurs at an approximate depth of 25 ft bmsl or 100 ft bls at this site (SJRWMD, personal communication).

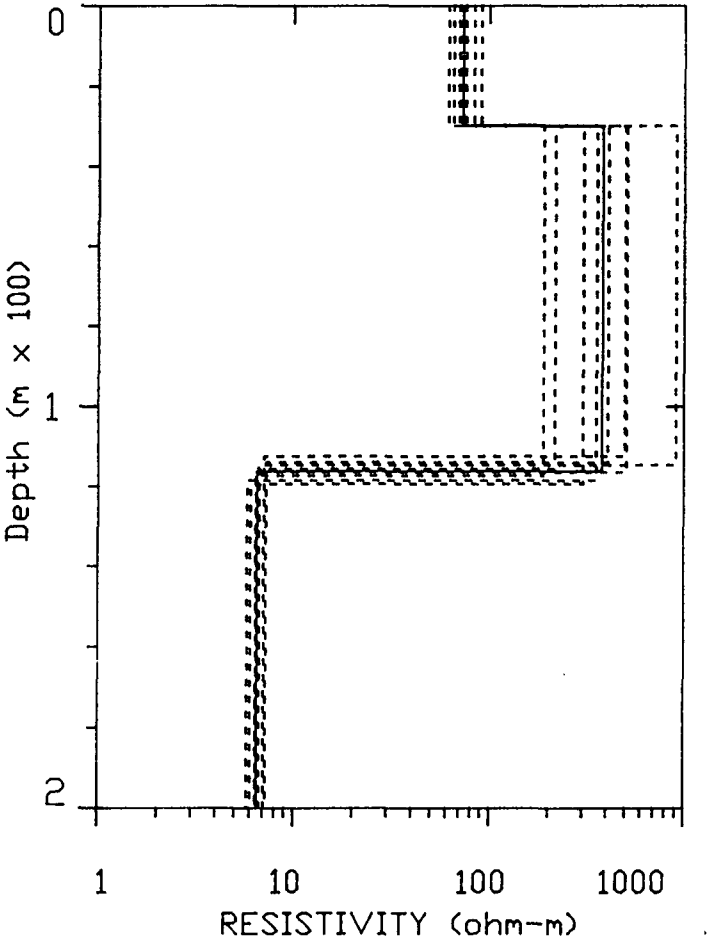
5.26.5 Accuracy of Measurement and Interpretation

Figure 5.26-3 is the equivalence analysis at this site and the inversion table (Table 5.26-1) lists the upper and lower bounds of the inverted parameters of the geoelectrical model.

The range of equivalence in determining the depth to the low resistivity layer is about ±4 m (13 ft) which is 3% of the total depth. The resistivity of this layer has a range of from 5.8 to 7.2 ohm-m. This corresponds to a range in interpreted chloride content of from 5,392 mg/l to 4,314 mg/l, again subject to the same assumptions of porosity and validity of equation (4).

The equivalence range of the resistivity of Layer 2 is from 190 to 912 ohm-m which corresponds to a chloride content of less than 250 mg/l. The results of the TDEM study are in agreement with the water quality results from Rutledge (1985). The chloride-to-sulfate ratio at the site is 5:1 (Table 5.1-4). Accordingly, Equation (4) is valid.





5-201

——— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

MEASURED TDEM APPARENT RESISTIVITY AND EQUIVALENCE FOR 1-D INVERSION
SOUNDING 25 – GLENWOOD/SOUTH VOLUSIA COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	EQU-25	5.26-3
DRAWN BY:	RBT	DATE:	07/06/94	

DATA SET: SITE 25

CLIENT: SJRWMD DATE: 11-MAY-94
LOCATION: GLENWOOD/SOUTH SOUNDING: 1
COUNTY: VOLUSIA COUNTY, FLORIDA ELEVATION: 23.00 m
PROJECT: SALT WATER INTERFACE DETECTION EQUIPMENT: Geonics PROTEM
LOOP SIZE: 183.000 m by 305.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y)
SOUNDING COORDINATES: E: 0.0000 N: 0.0000

FITTING ERROR: 4.782 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)		ELEVATION (meters)	CONDUCTANCE (Siemens)
				23.00	
1	72.91	30.00	*	-7.00	0.411
2	382.6	86.09		-93.09	0.224
3	6.52				

"*" INDICATES FIXED PARAMETER

PARAMETER BOUNDS FROM EQUIVALENCE ANALYSIS

	LAYER	MINIMUM	BEST	MAXIMUM
RHO	1	61.533	72.918	90.804
	2	189.749	382.666	911.769
	3	5.838	6.526	7.246
THICK	1	30.000	0.000	30.000
	2	82.370	1.000	89.430
DEPTH	1	30.000	30.000	30.000
	2	112.370	116.094	119.430

CURRENT: 19.10 AMPS EM-57 COIL AREA: 100.00 sq m.
FREQUENCY: 30.00 Hz GAIN: 5 RAMP TIME: 197.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.0867	25243.3	24181.1	4.20
2	0.108	17770.3	17562.5	1.16
3	0.138	12541.1	12908.6	-2.92

* S.D.I.I. *

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT PALATKA, FLORIDA	SDII SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED	TDEM SOUNDING DATA TABLE SOUNDING 25 – GLENWOOD/SOUTH VOLUSIA COUNTY, FLORIDA PROJECT NO.: 94767 TABLE: 5.26–1

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
4	0.175	9471.7	10023.8	-5.82
5	0.218	7520.3	8088.4	-7.55
6	0.278	6079.6	6420.9	-5.61
7	0.351	4950.2	5121.5	-3.46
8	0.438	4056.4	4089.8	-0.824
9	0.558	3224.7	3151.3	2.27
10	0.702	2510.0	2417.9	3.67
11	0.858	1971.8	1892.6	4.01
12	1.06	1501.0	1426.5	4.96
13	1.37	1061.1	1007.1	5.08
14	1.74	737.1	705.3	4.31
15	2.17	510.8	497.2	2.67
16	2.77	332.5	329.0	1.02
17	3.50	210.3	216.1	-2.75
18	4.37	133.6	141.4	-5.83
19	5.56	80.27	86.80	-8.13
20	7.03	47.33	52.37	-10.64

CURRENT: 19.10 AMPS EM-57 COIL AREA: 100.00 sq m.
FREQUENCY: 7.50 Hz GAIN: 7 RAMP TIME: 197.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
21	0.346	4979.9	5245.7	-5.33
22	0.427	4087.3	4248.9	-3.95
23	0.550	3245.5	3251.2	-0.176
24	0.698	2563.5	2481.2	3.20
25	0.869	1972.5	1907.6	3.29
26	1.10	1470.9	1396.9	5.02
27	1.40	1073.0	1013.5	5.54
28	1.75	771.7	736.6	4.54
29	2.22	531.6	513.1	3.47

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	0.93				
P 2	0.19	0.05			
P 3	-0.01	-0.02	0.98		
F 1	0.00	0.00	0.00	0.00	
T 2	0.00	0.02	0.01	0.00	1.00

ST. JOHNS RIVER
WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SOUNDING DATA TABLE
SOUNDING 25 – GLENWOOD/SOUTH
VOLUSIA COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.26–1

5.26.6 Summary of TDEM Sounding at Glenwood/South (Site 25)

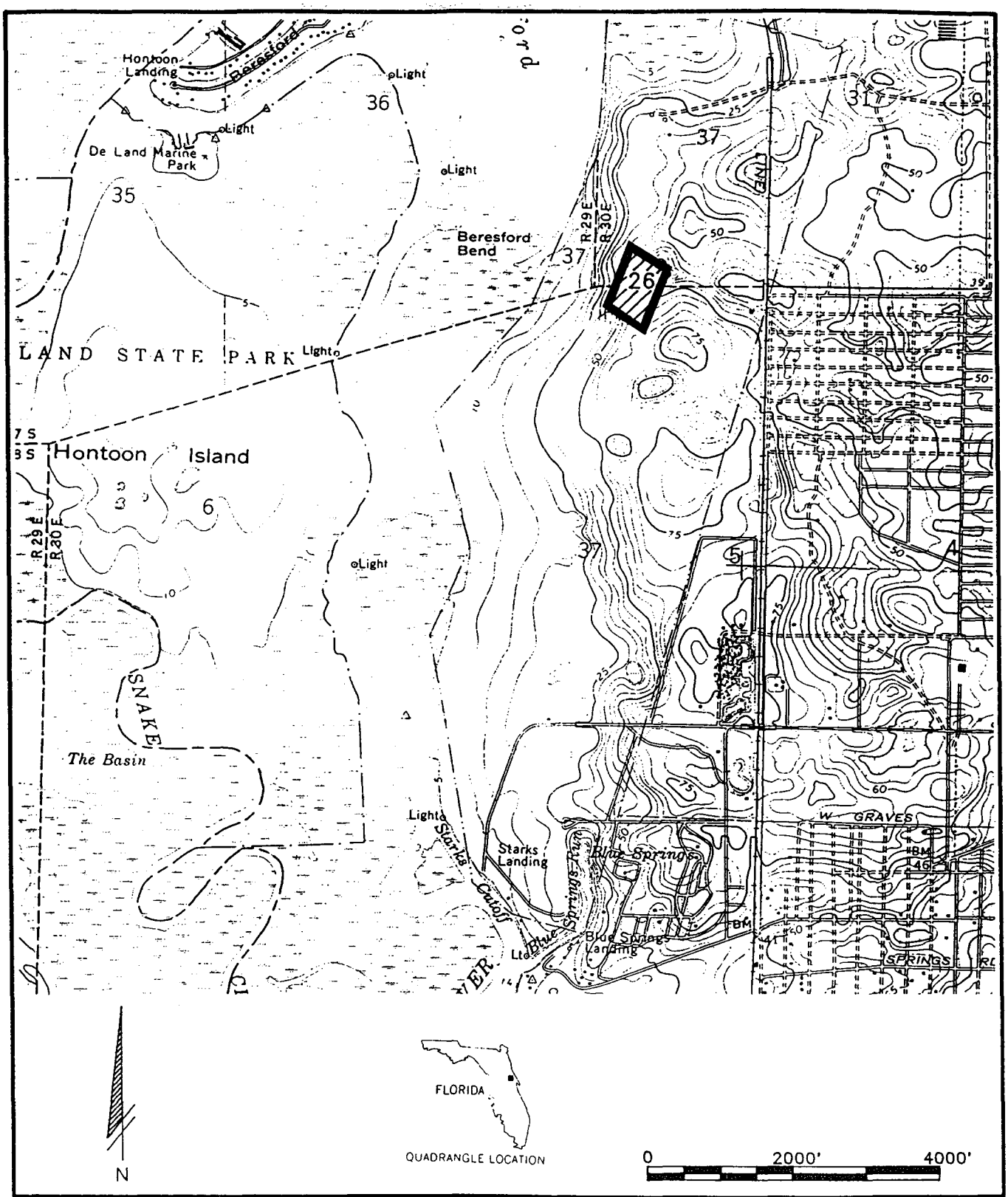
- The depth to occurrence of salt water (5,000 mg/l isochlor) is interpreted to be 431 ft (-356 ft msl) and occur within the Upper Floridan aquifer.
- The ground water within the Floridan aquifer at this site is interpreted to contain an average chloride concentration of less than 250 mg/l. The 250 mg/l isochlor is interpreted to be present in the Floridan aquifer at a depth of 331 ft (-256 ft msl). For comparison, Rutledge (1985) estimated a depth of approximately 400 ft for the 250 mg/l isochlor at this site.
- The results from the TDEM survey agree with Rutledge (1985) who indicates that chloride concentrations in the Floridan aquifer are below 250 mg/l at this site.

5.27 TDEM Site 26 - Blue Springs State Park/Orchard

5.27.1 Location Description and Geoelectrical Section

The site is located in southwestern Volusia County within Blue Springs State Park, Florida (Figure 5.27-1). The site is located in an abandoned orange grove. No possible sources of interference were visible near the Tx loop. QA soundings were performed 100 ft south and 56 ft west of the initial Rx coil location. Results from the QA soundings indicate that the apparent resistivity values were unaffected by any interference sources.

The Floridan aquifer occurs at an approximate depth of 45 ft bmsl or 94 ft bls (Rutledge, 1985) and is overlain by Holocene to Miocene deposits. The base of the Floridan aquifer occurs at an approximate depth of 2,100 ft bmsl (Tibbals, 1990). The thickness of the Upper Floridan aquifer is approximately 600 ft and the depth to the top of the Lower Floridan aquifer is approximately 650 ft bls (Miller, 1986). A water quality study performed in the area of the site (Rutledge, 1985) indicates that the chloride concentration in the upper portion of the Floridan aquifer exceeds 250 mg/l.



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WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SURVEY LOCATION MAP

SOUNDING 26 – BLUE SPRING STATE PARK/ORCHARD
VOLUSIA COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	LOC-26	5.27-1
DRAWN BY:	RBT	DATE:	07/05/94	

The resistivity sounding data and best-fit model inversion are presented on Figure 5.27-2. The interpreted geoelectrical section consists of a two-layer subsurface.

5.27.2 Geological Interpretation of Geoelectrical Model

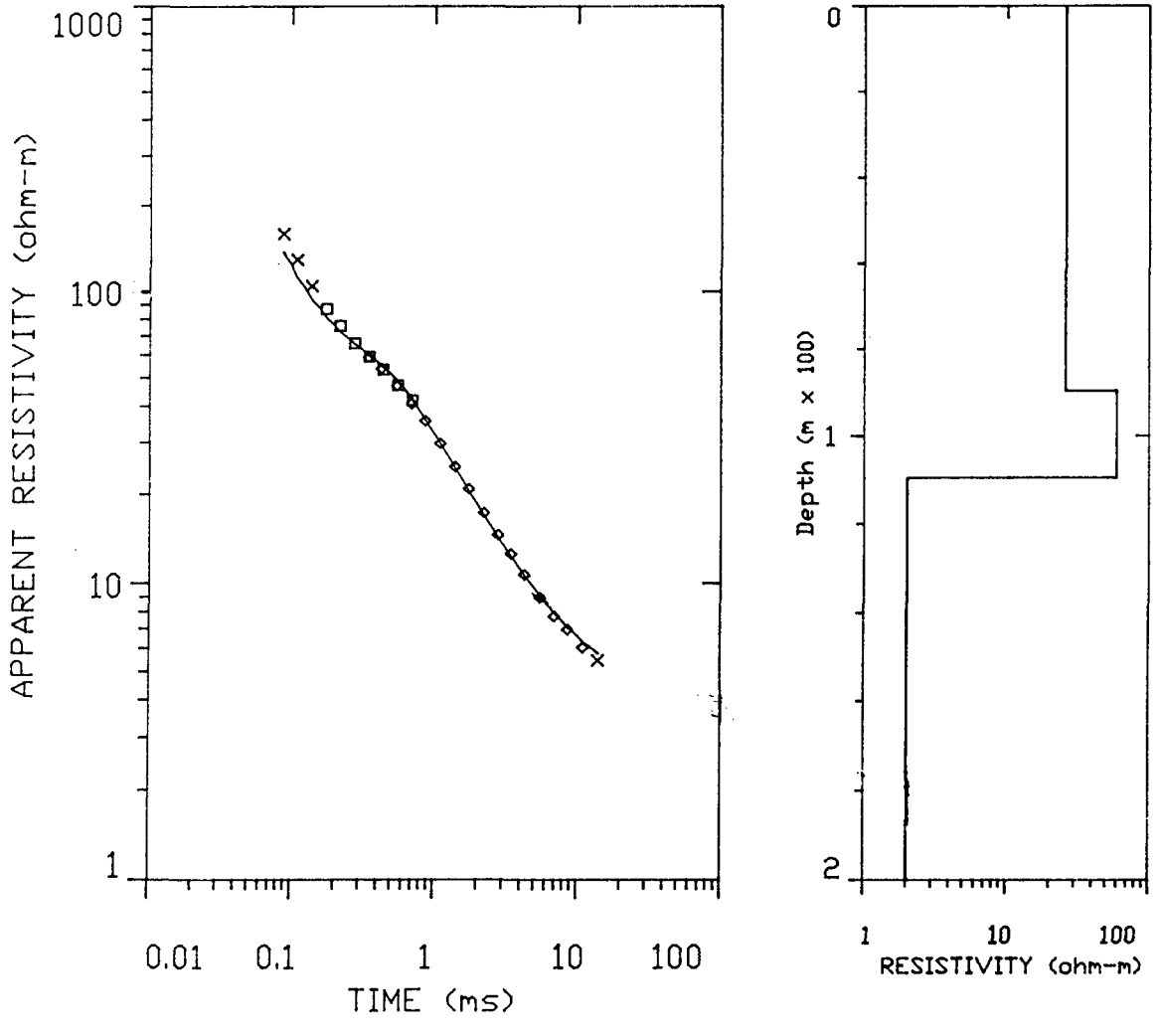
The first layer occurs at 111 m (364 ft) bls and not at the stratigraphic contact between the Holocene and Miocene deposits (94 ft bls) and the Floridan Aquifer System. Therefore, it can be interpreted that there exists a two-layer geoelectrical section with a 364 ft thick surface layer of intermediate resistivity (26 ohm-m) overlying a low resistivity layer (2.0 ohm-m). It can be interpreted that the Holocene to Miocene deposits and the upper part of the Floridan aquifer system exist as a combined but indistinguishable (geoelectrical) layer, overlying a saltwater saturated Upper Floridan aquifer at a depth of 364 ft bls.

5.27.3 Depth to Occurrence of Salt Water

The bottom (second) layer of the geoelectrical model, with a resistivity of 2.0 ohm-m, is interpreted to represent salt water. It occurs at a depth of 364 ft (-315 ft msl). Because the resistivity of Layer 1 (26 ohm-m) is less than 80 ohm-m, the interpreted depth to the 5,000 mg/l isochlor is taken at the depth of the geoelectrical interface, or at 364 ft depth (-315 ft msl). The resistivity of Layer 2 (2.0 ohm-m) corresponds to a chloride content of 15,929 mg/l assuming a porosity of 25% and the validity and applicability of equation (4) of Section 4.2. It is presumed that because of the expected high chlorinity gradients, this value is sufficiently close to the 5,000 mg/l isochlor that they represent the same effective depth.

5.27.4 Depth of Occurrence of the 250 mg/l Isochlor

Because of the inability to segregate the Floridan aquifer from the overlying Holocene to Miocene deposits, the effective chloride concentration of Layer 1 cannot be calculated.



——— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

X APPARENT RESISTIVITY VALUES NOT USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

MEASURED TDEM APPARENT RESISTIVITY AND 1-D INVERSION
SOUNDING 26 - BLUE SPRING STATE PARK/ORCHARD
VOLUSIA COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	MDL-26	5.27-2
DRAWN BY:	RBT	DATE:	07/06/94	

5.27.5 Accuracy of Measurement and Interpretation

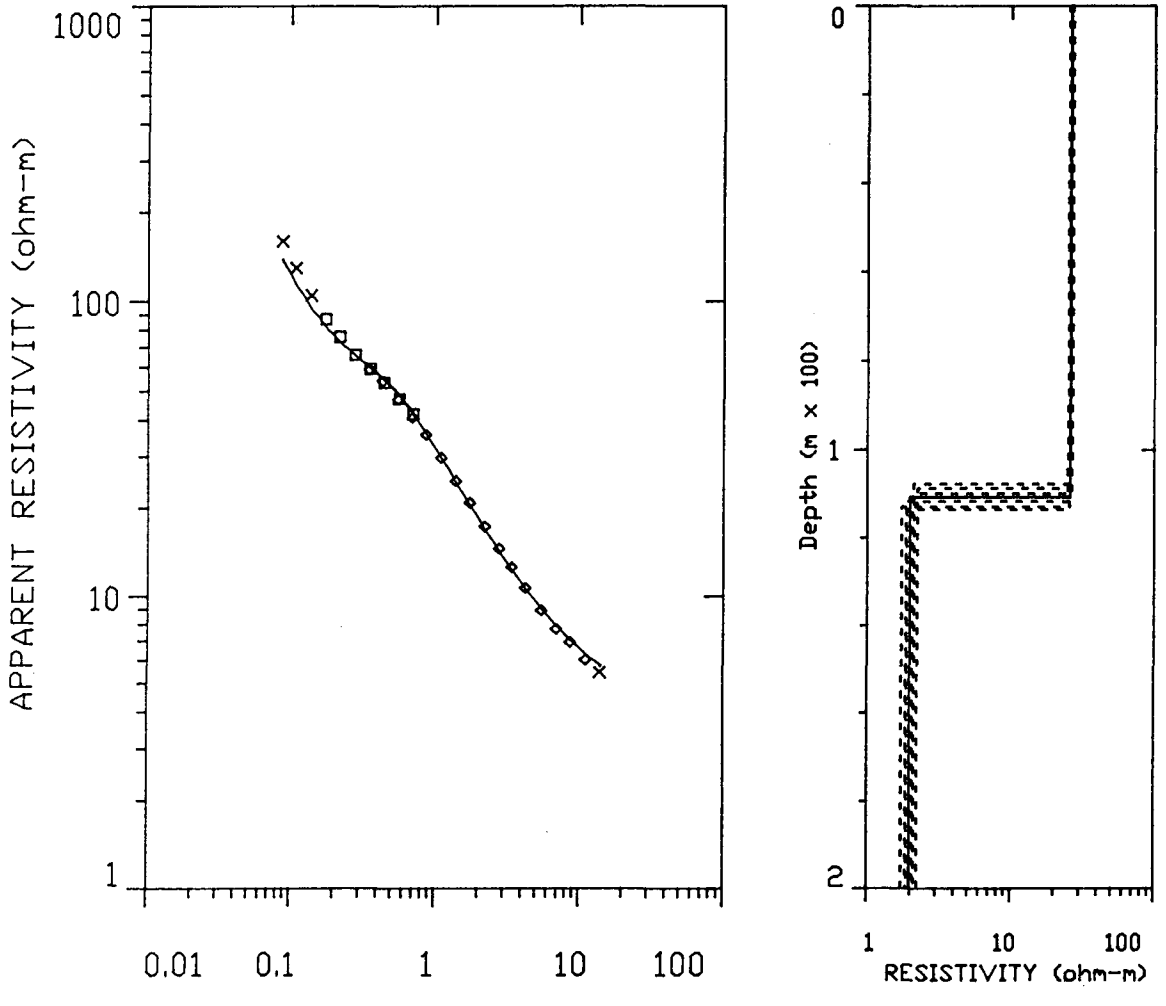
Figure 5.27-3 is the equivalence analysis at this site and the inversion table (Table 5.27-1) lists the upper and lower bounds of the inverted parameters of the geoelectrical model.

The range of equivalence in determining the depth to the low resistivity layer is about ±3 m (10 ft) which is 3% of the total depth. The resistivity of this layer has a range from 1.7 to 2.2 ohm-m. This corresponds to a range in interpreted chloride content from 18,767 mg/l to 14,467 mg/l, again subject to the same assumptions of porosity and validity of equation (4).

The equivalence range of the resistivity of Layer 1 is from 25 to 27 ohm-m. A corresponding chloride concentration cannot be determined because Layer 1 is in part comprised of the Holocene to Miocene deposits. Accordingly, equation (4) may not be valid.

5.27.6 Summary of TDEM Sounding at Blue Springs State Park/Orchard (Site 26)

- The depth of occurrence of salt water (5,000 mg/l isochlor) is interpreted to be 364 ft (-315 ft msl) and occur within the Upper Floridan aquifer.
- The quality of ground water within the Floridan aquifer at this site cannot be interpreted because the analysis of the TDEM data does not allow the Holocene to Miocene deposits to be distinguished from the Floridan Aquifer System.



—— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

X APPARENT RESISTIVITY VALUES NOT USED IN MODEL

TIME (ms)

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

MEASURED TDEM APPARENT RESISTIVITY AND EQUIVALENCE FOR 1-D INVERSION
SOUNDING 26 – BLUE SPRING STATE PARK/ORCHARD
VOLUSIA COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	EQU-26	5.27-3
DRAWN BY:	RBT	DATE:	07/06/94	

DATA SET: SITE 26

CLIENT: SJRWMD DATE: 12-MAY-94
LOCATION: BLUE SPRINGS STATE PARK/ORCH. SOUNDING: 1
COUNTY: VOLUSIA COUNTY, FLORIDA ELEVATION: 15.00 m
PROJECT: SALT WATER INTERFACE DETECTION EQUIPMENT: Geonics PROTEM
LOOP SIZE: 171.000 m by 304.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y)
SOUNDING COORDINATES: E: 0.0000 N: 0.0000

FITTING ERROR: 4.071 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			15.00	
1	26.00	110.7	-95.70	4.25
2	1.97			

ALL PARAMETERS ARE FREE

PARAMETER BOUNDS FROM EQUIVALENCE ANALYSIS

	LAYER	MINIMUM	BEST	MAXIMUM
RHO	1	25.070	26.000	26.861
	2	1.727	1.970	2.227
THICK	1	107.649	1.000	113.520
DEPTH	1	107.649	110.700	113.520

CURRENT: 18.10 AMPS EM-57 COIL AREA: 100.00 sq m.
FREQUENCY: 30.00 Hz GAIN: 3 RAMP TIME: 196.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.0867	110399.4	136549.6	-23.68 MASKED
2	0.108	87134.1	105545.5	-21.13 MASKED
3	0.138	65071.9	75700.3	-16.33 MASKED
4	0.175	47330.8	52375.6	-10.65
5	0.218	33512.4	35858.4	-7.00
6	0.278	22528.7	22809.4	-1.24
7	0.351	14806.2	14564.4	1.63

ST. JOHNS RIVER
WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

SDII
SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SOUNDING DATA TABLE
SOUNDING 26 – BLUE SPRING STATE PARK/ORCHARD
VOLUSIA COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.27-1

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
8	0.438	9931.3	9567.9	3.65
9	0.558	6535.5	6213.5	4.92
10	0.702	4393.5	4303.3	2.05

CURRENT: 18.10 AMPS EM-57 COIL AREA: 100.00 sq m.
FREQUENCY: 7.50 Hz GAIN: 5 RAMP TIME: 196.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
11	0.346	15469.3	15108.6	2.33
12	0.427	10450.1	10166.8	2.71
13	0.550	6815.9	6499.1	4.64
14	0.698	4655.4	4468.1	4.02
15	0.869	3290.5	3269.0	0.654
16	1.10	2348.9	2366.2	-0.733
17	1.40	1712.3	1755.6	-2.53
18	1.75	1272.6	1319.8	-3.70
19	2.22	930.9	967.2	-3.89
20	2.79	681.7	708.8	-3.97
21	3.42	510.5	530.3	-3.88
22	4.26	376.7	383.6	-1.83
23	5.49	260.9	258.0	1.12
24	6.96	179.8	174.7	2.79
25	8.66	121.9	119.7	1.78
26	11.06	81.52	76.74	5.87
27	14.00	52.70	48.77	7.44 MASKED

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	1.00		
P 2	0.00	0.96	
T 1	0.00	0.01	1.00
	P 1	P 2	T 1

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TDEM SOUNDING DATA TABLE
SOUNDING 26 – BLUE SPRING STATE PARK/ORCHARD
VOLUSIA COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.27-1

5.28 TDEM Site 27 - Titusville

5.28.1 Location Description and Geoelectrical Section

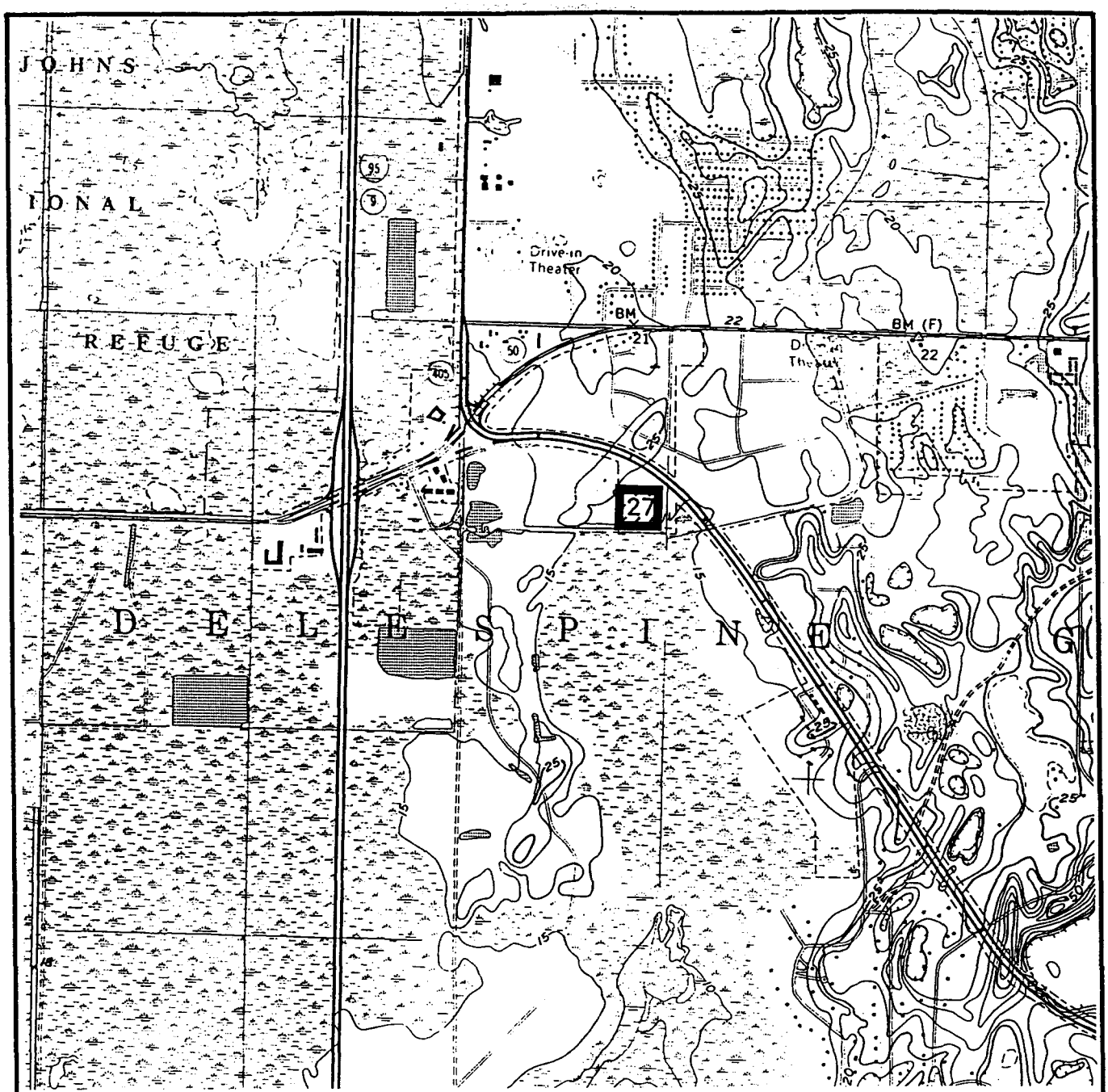
The site is located in northern Brevard County near Titusville, Florida (Figure 5.28-1). The site is located within a wooded area. Potential sources of interference, scattered pieces of garbage, were present throughout the site. QA soundings were performed 50 ft north and west of the initial Rx coil location. Results from the QA soundings indicate that the apparent resistivity values were unaffected by any interference sources.

The Floridan aquifer occurs at an approximate depth of 115 ft bls and is overlain by the Holocene to Miocene deposits. The base of the Floridan aquifer occurs at approximately 2,600 ft bmsl (Tibbals, 1990). The thickness of the Upper Floridan aquifer is approximately 1,025 ft and the depth to the top of the Lower Floridan aquifer is approximately 1,140 ft bls (Miller, 1986).

The resistivity sounding data and best-fit model inversion are presented on Figure 5.28-2. The interpreted geoelectrical section consists of a two-layer subsurface.

5.28.2 Geological Interpretation of Geoelectrical Model

The bottom of the first layer occurs at 20 m (66 ft) bls and not at the hydrostratigraphic contact between the Holocene and Miocene deposits (115 ft bls) and the Floridan Aquifer System. Therefore, it can be interpreted that there exists a two-layer geoelectrical section with a 66 ft surface layer of low resistivity (12 ohm-m) overlying a lower resistivity layer (2.6 ohm-m). It can be interpreted that Layer 1 consists of the upper portion of the Holocene to Miocene deposits. Layer 2 constitutes the lower portion of the Holocene to Miocene deposits and underlying Floridan aquifer.



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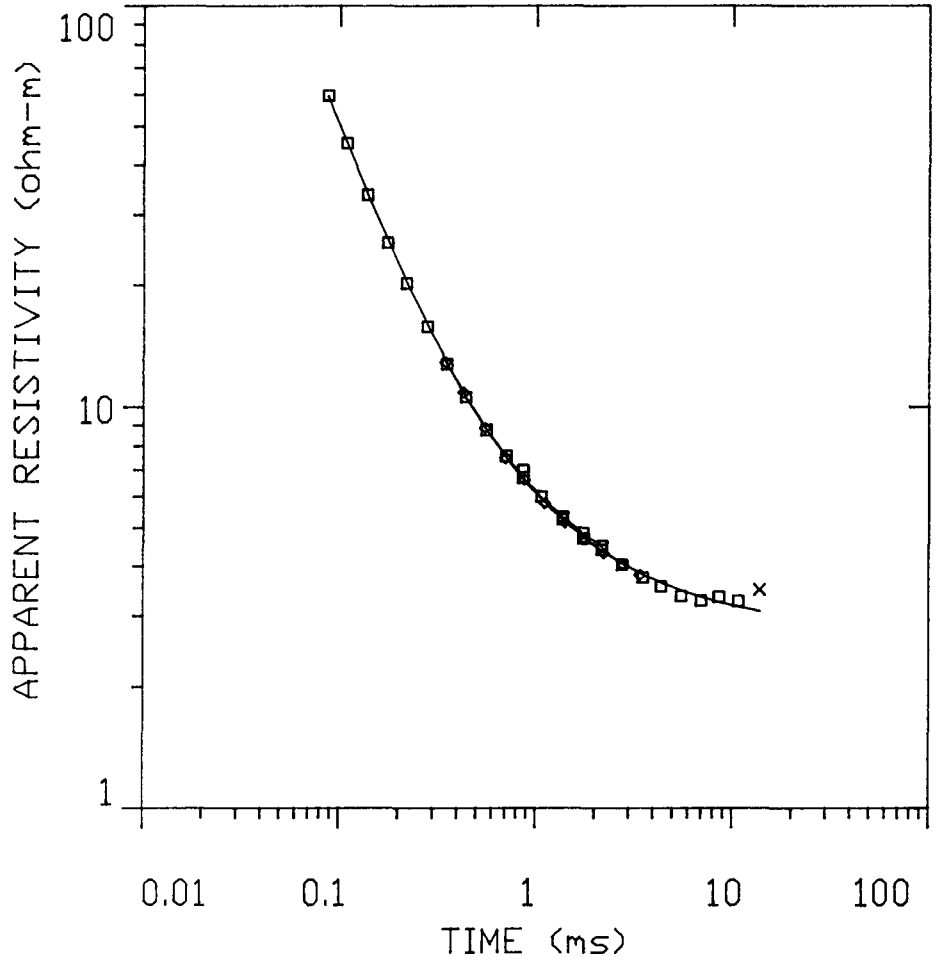
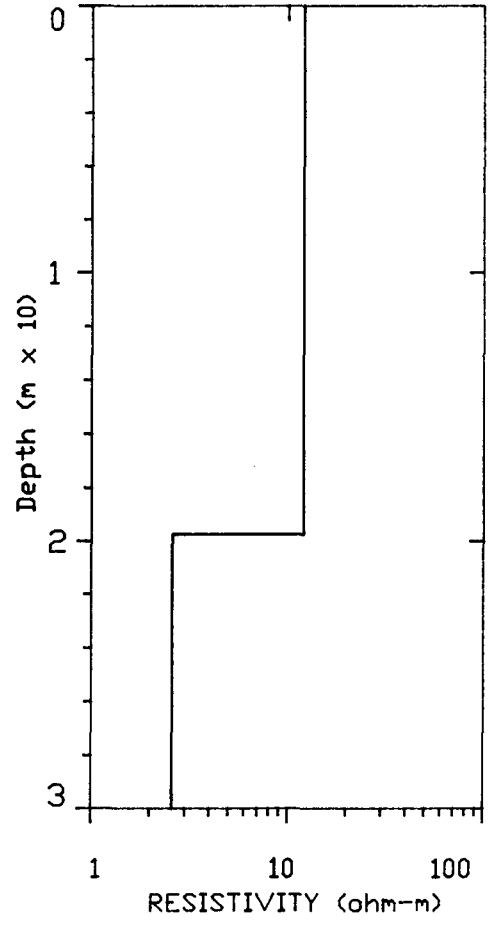
TDEM SURVEY LOCATION MAP
SOUNDING 27 – TITUSVILLE
BREVARD COUNTY, FLORIDA

DESIGNED BY: JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY: MJW	DRAWING NO.:	LOC-27	5.28-1
DRAWN BY: RBT	DATE:	07/05/94	





—— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

X APPARENT RESISTIVITY VALUES NOT USED IN MODEL

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MEASURED TDEM APPARENT RESISTIVITY AND 1-D INVERSION
SOUNDING 27 - TITUSVILLE
BREVARD COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	MDL-27	5.28-2
DRAWN BY:	RBT	DATE:	07/06/94	

5.28.3 Depth to Occurrence of Salt Water

Based upon the TDEM results, the lowermost layer within the geoelectric section includes sediments from the Holocene to Miocene deposits. It also appears to be saturated with brackish to salt water. Accordingly, it was not possible to determine the depth to the 5,000 mg/l isochlor, because the assumptions of equation (4) are invalid.

5.28.4 Depth of Occurrence of the 250 mg/l Isochlor

Based upon the TDEM results, the lowermost layer within the geoelectric section include sediments from the Holocene to Miocene deposits. It also appears to be saturated with brackish to salt water. Accordingly, the 250 mg/l isochlor is not present in the Floridan aquifer at this site.

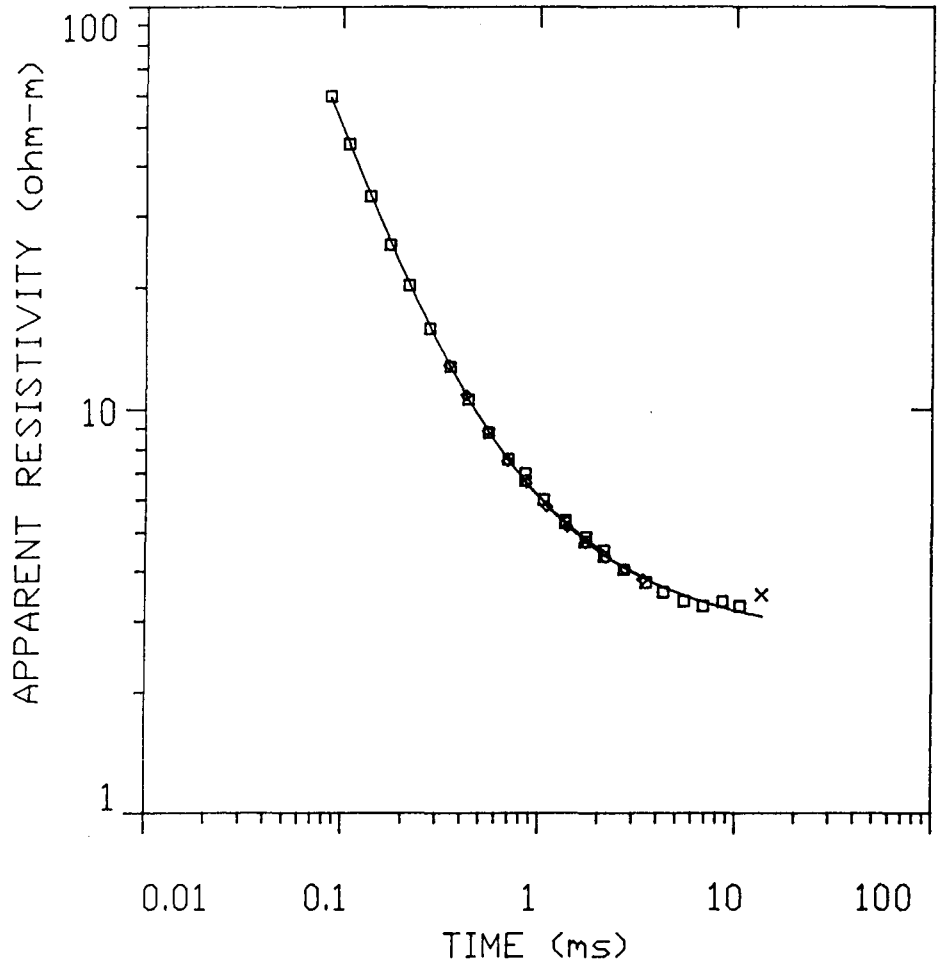
5.28.5 Accuracy of Measurement and Interpretation

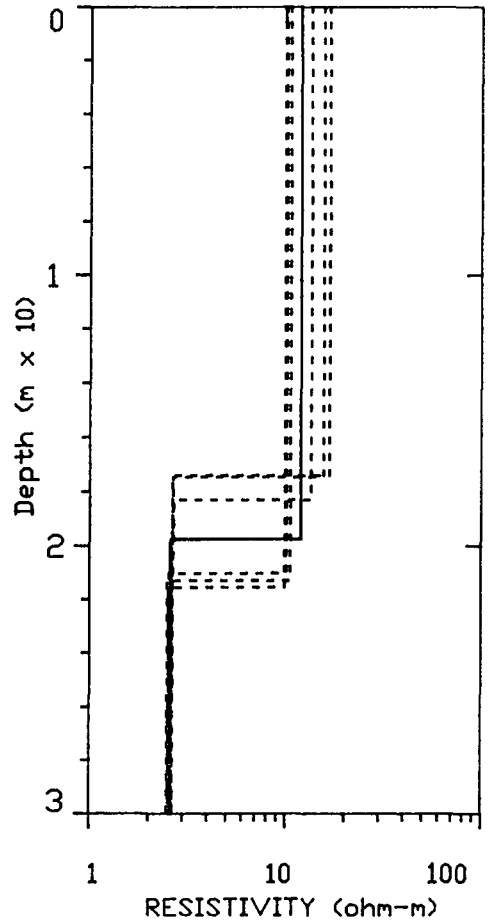
Figure 5.28-3 is the equivalence analysis at this site and the inversion table (Table 5.28-1) lists the upper and lower bounds of the inverted parameters of the geoelectrical model.

The range of equivalence in determining the resistivity of Layer 2 is 2.5 to 2.7 ohm-m. Because the assumptions of equation (4) are not valid for the geoelectric solution developed for the site, it is not possible to determine a range in chloride concentrations.

5.28.6 Summary of TDEM Sounding at Titusville (Site 27)

- It is not possible to determine the depth to salt water (5,000 mg/l isochlor) because each of the geoelectric layers developed from the TDEM results contain sediments from above the Floridan aquifer. Accordingly, the assumptions of equation (4) are not valid.
- Based upon the TDEM results, the lowermost layer appears to be saturated with brackish to salt water. Accordingly, the 250 mg/l isochlor is not present in the Floridan aquifer at this site.





5-216

—— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

X APPARENT RESISTIVITY VALUES NOT USED IN MODEL

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MEASURED TDEM APPARENT RESISTIVITY AND EQUIVALENCE FOR 1-D INVERSION
SOUNDING 27 - TITUSVILLE
BREVARD COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	EQU-27	5.28-3
DRAWN BY:	RBT	DATE:	07/06/94	

DATA SET: SITE 27

CLIENT: SJRWMD
DATE: 12-MAY-94
LOCATION: TITUSVILLE
SOUNDING: 1
COUNTY: BREVARD COUNTY, FLORIDA
ELEVATION: 4.50 m
PROJECT: SALT WATER INTERFACE DETEC
EQUIPMENT: Geonics PROTEM
LOOP SIZE: 152.300 m by 147.000 m
AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y)
SOUNDING COORDINATES: E: 0.0000 N: 0.0000

FITTING ERROR: 2.124 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			4.50	
1	12.05	19.74	-15.24	1.63
2	2.59			

ALL PARAMETERS ARE FREE

PARAMETER BOUNDS FROM EQUIVALENCE ANALYSIS

	LAYER	MINIMUM	BEST	MAXIMUM
RHO	1	9.960	12.057	16.870
	2	2.511	2.591	2.674
THICK	1	17.412	1.000	21.554
DEPTH	1	17.412	19.742	21.554

CURRENT: 21.10 AMPS EM-37 COIL AREA: 100.00 sq m.
FREQUENCY: 30.00 Hz GAIN: 3 RAMP TIME: 142.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.0867	231773.0	233815.0	-0.881
2	0.108	202130.5	202852.0	-0.356
3	0.138	171410.7	170485.8	0.539
4	0.175	143433.3	141365.9	1.44
5	0.218	117127.3	116541.7	0.499
6	0.278	92693.4	91710.7	1.06
7	0.351	71262.7	70907.4	0.498

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TDEM SOUNDING DATA TABLE
SOUNDING 27 – TITUSVILLE
BREVARD COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.28-1

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
8	0.438	54135.7	54030.6	0.194
9	0.558	39207.8	38974.3	0.595
10	0.702	27572.7	27746.3	-0.629
11	0.858	18885.0	20161.7	-6.76
12	1.06	13754.0	13953.2	-1.44
13	1.37	8753.5	8864.0	-1.26
14	1.74	5536.3	5604.6	-1.23
15	2.17	3570.2	3592.1	-0.613

CURRENT: 21.10 AMPS EM-37 COIL AREA: 100.00 sq m.
FREQUENCY: 7.50 Hz GAIN: 4 RAMP TIME: 142.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
16	0.346	72799.9	72301.7	0.684
17	0.427	55715.5	56014.0	-0.535
18	0.550	40061.1	39968.2	0.231
19	0.698	28477.6	28175.6	1.06
20	0.869	19827.2	19920.5	-0.470
21	1.10	13247.6	13201.1	0.351
22	1.40	8696.7	8634.0	0.720
23	1.75	5733.1	5683.7	0.860
24	2.22	3602.2	3554.9	1.31
25	2.79	2242.9	2225.1	0.796
26	3.42	1473.8	1447.9	1.76

CURRENT: 21.10 AMPS EM-37 COIL AREA: 100.00 sq m.
FREQUENCY: 3.00 Hz GAIN: 4 RAMP TIME: 142.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
27	0.857	20109.1	20384.1	-1.36
28	1.06	13871.7	14127.9	-1.84
29	1.37	8952.7	9026.5	-0.824
30	1.74	5767.7	5753.8	0.241
31	2.17	3716.4	3727.7	-0.304
32	2.77	2301.3	2265.0	1.57
33	3.50	1418.8	1383.6	2.47

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TDEM SOUNDING DATA TABLE
SOUNDING 27 – TITUSVILLE
BREVARD COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.28-1

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)	
34	4.37	882.4	856.1	2.98	
35	5.56	526.7	502.7	4.57	
36	6.98	309.3	301.0	2.67	
37	8.56	179.2	188.7	-5.33	
38	10.64	108.4	113.9	-5.07	
39	13.70	52.30	62.93	-20.33	MASKED

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	0.74		
P 2	-0.02	1.00	
T 1	0.10	0.01	0.95
	P 1	P 2	T 1

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TDEM SOUNDING DATA TABLE
SOUNDING 27 – TITUSVILLE
BREVARD COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.28–1

5.29 TDEM Site 28 - Christmas

5.29.1 Location Description and Geoelectrical Section

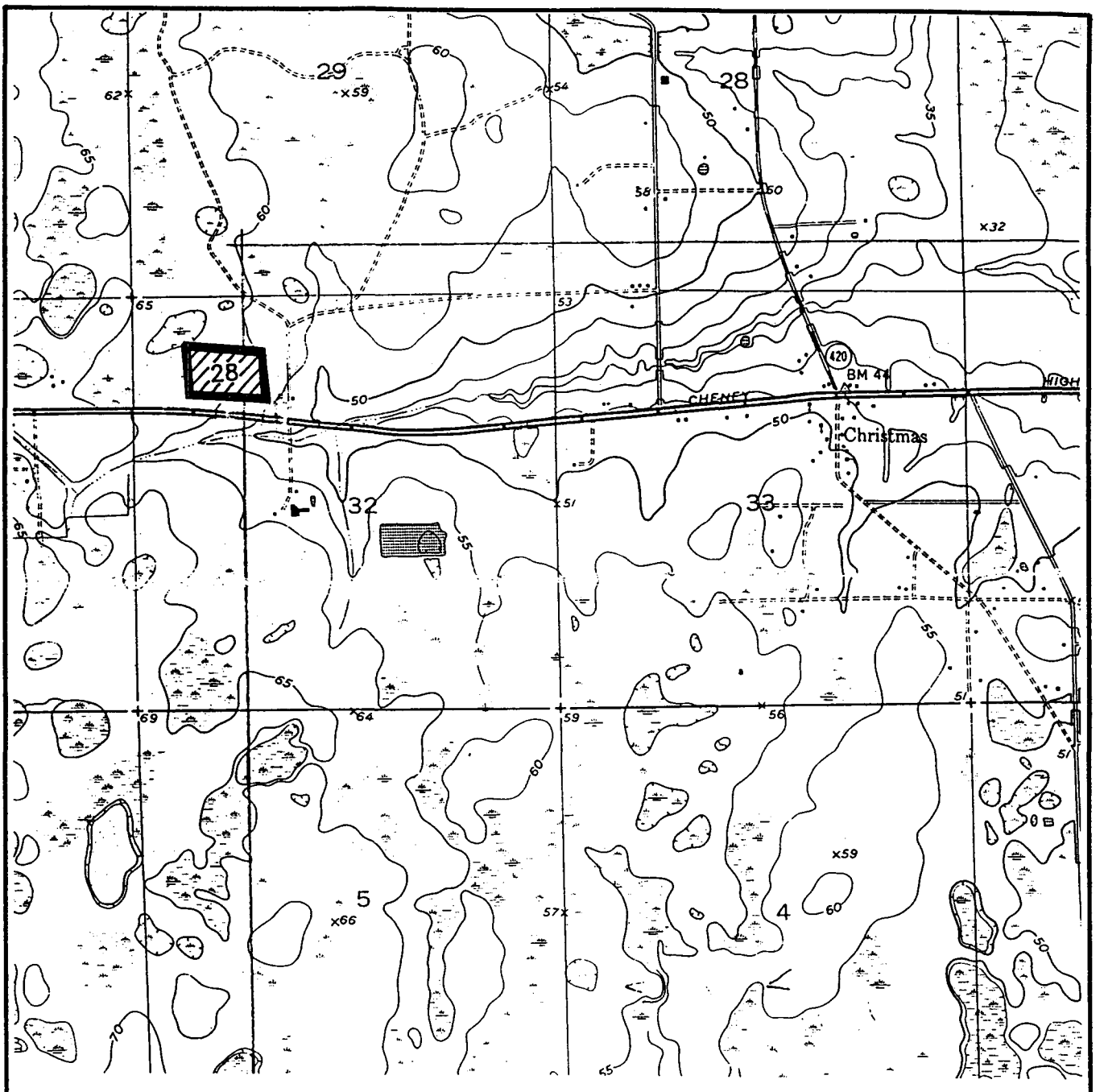
The site is located in eastern Orange County near Christmas, Florida (Figure 5.29-1). The site is located within a pasture. A possible source of interference (a powerline) existed 300 ft south of the Tx loop. QA soundings were performed 100 ft east and 60 ft south of the initial Rx coil location. Results from the QA soundings indicate that the apparent resistivity values were unaffected by any interference sources.

The Floridan aquifer occurs at an approximate depth of 130 ft bmsl or 190 ft bls (SJRWMD, personal communication) and is overlain by the surficial aquifer system and the Hawthorn Group. The base of the Floridan aquifer occurs at an approximate depth of 2,500 ft bmsl (Tibbals, 1990). The thickness of the Upper Floridan aquifer is approximately 910 ft and the depth to the top of the Lower Floridan aquifer is approximately 1,100 ft bls (Miller, 1986). The chloride concentration in the Floridan aquifer at this site is above 250 mg/l (Tibbals, 1990).

The resistivity sounding data and best-fit model inversion are presented on Figure 5.29-2. The interpreted geoelectrical section consists of a three-layer subsurface.

5.29.2 Geological Interpretation of Geoelectrical Model

There is a sufficient electrical resistivity contrast to distinguish two geological layers above the third saltwater saturated layer. The first layer occurs at a depth of 126 m (413 ft) and not at the hydrostratigraphic contact (190 ft bls) between the Hawthorn Group and the Floridan Aquifer System. The first layer has an intermediate-resistivity value (41 ohm-m) and is considered to represent the Hawthorn Group and surficial sediments combined with the upper portion of the Floridan aquifer. The second layer also has an intermediate resistivity value (62 ohm-m) which, because it is less than 80 ohm-m, suggests the Floridan aquifer at this site contains brackish water. The third layer occurs at a depth of 250 m (820 ft) and with a resistivity of 23 ohm-m is considered to be saturated with salt water.



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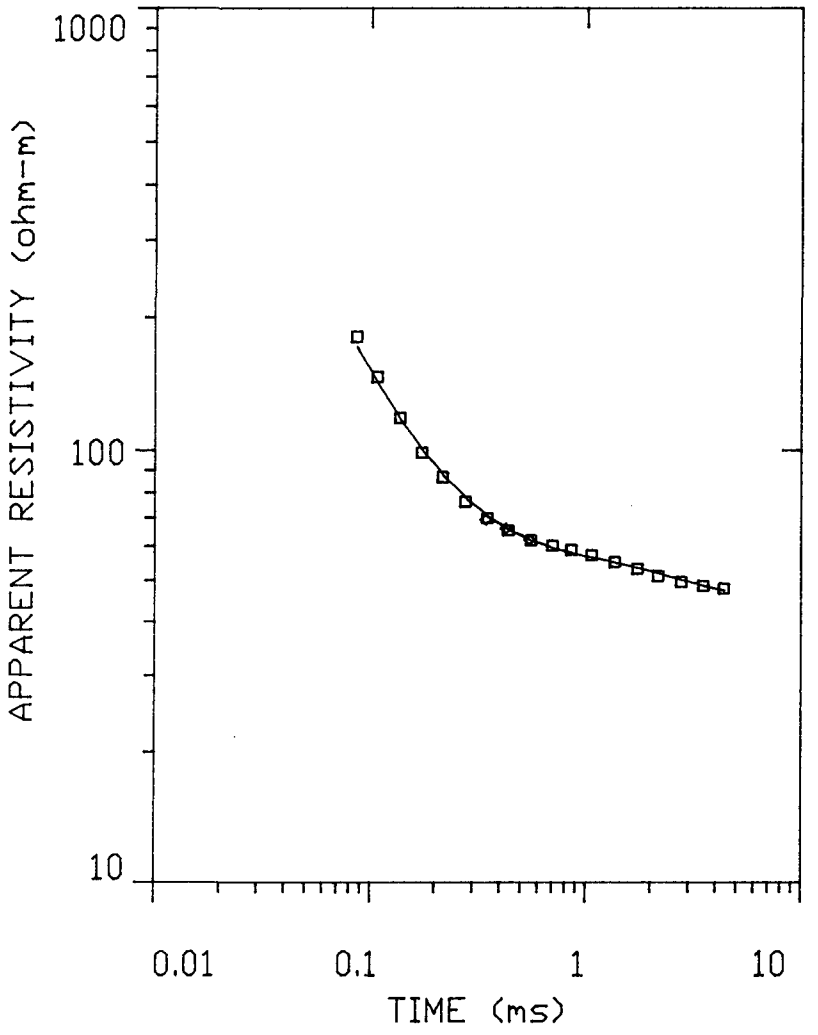
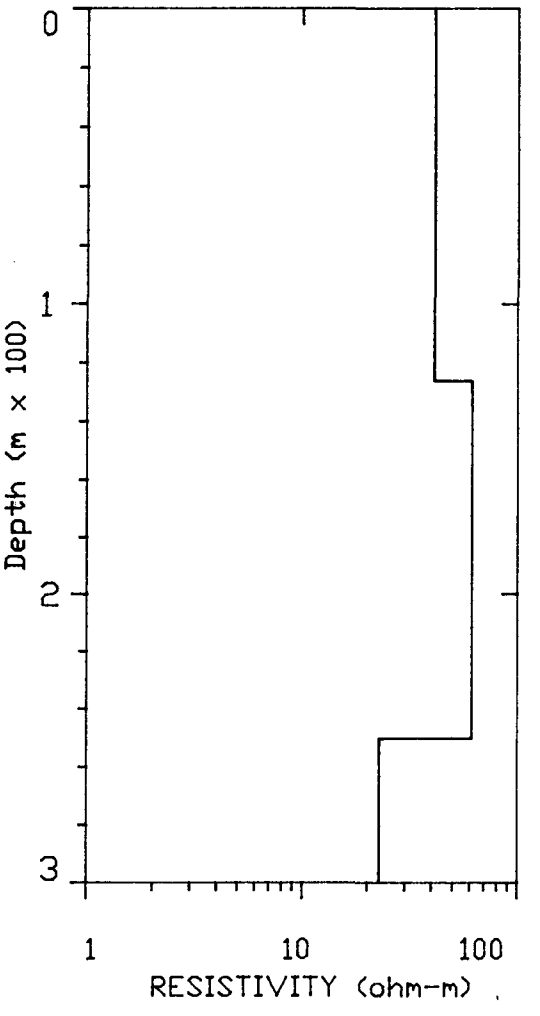
TDEM SURVEY LOCATION MAP
SOUNDING 28 – CHRISTMAS
ORANGE COUNTY, FLORIDA

DESIGNED BY: JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY: MJW	DRAWING NO.:	LOC-28	5.29-1
DRAWN BY: RBT	DATE:	07/05/94	





——— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

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MEASURED TDEM APPARENT RESISTIVITY AND 1-D INVERSION
SOUNDING 28 – CHRISTMAS
ORANGE COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	MDL-28	5.29-2
DRAWN BY:	RBT	DATE:	07/06/94	

5.29.3 Depth to Occurrence of Salt Water

The bottom (third) layer of the geoelectrical model, with a resistivity of 23 ohm-m, is interpreted to represent salt water. It occurs at a depth of 820 ft (-760 ft msl). Because the resistivity of Layer 2 (62 ohm-m) is interpreted to represent brackish water within the Floridan aquifer (i.e., is less than 80 ohm-m), the interpreted depth to the 5,000 mg/l isochlor is equal to the depth of the geoelectrical interface, or at 820 ft depth (-760 ft msl). The site was also modeled using a two-layer model which resulted in a deeper depth (1,027 ft bls) to brackish water. A two-layer model results in a 43 ohm-m layer overlying a 33 ohm-m layer at a depth of 1,027 ft. Because the fitting error was much better for the three-layer model (2.7%) compared to the two-layer model (6.2%), a three-layer model was used.

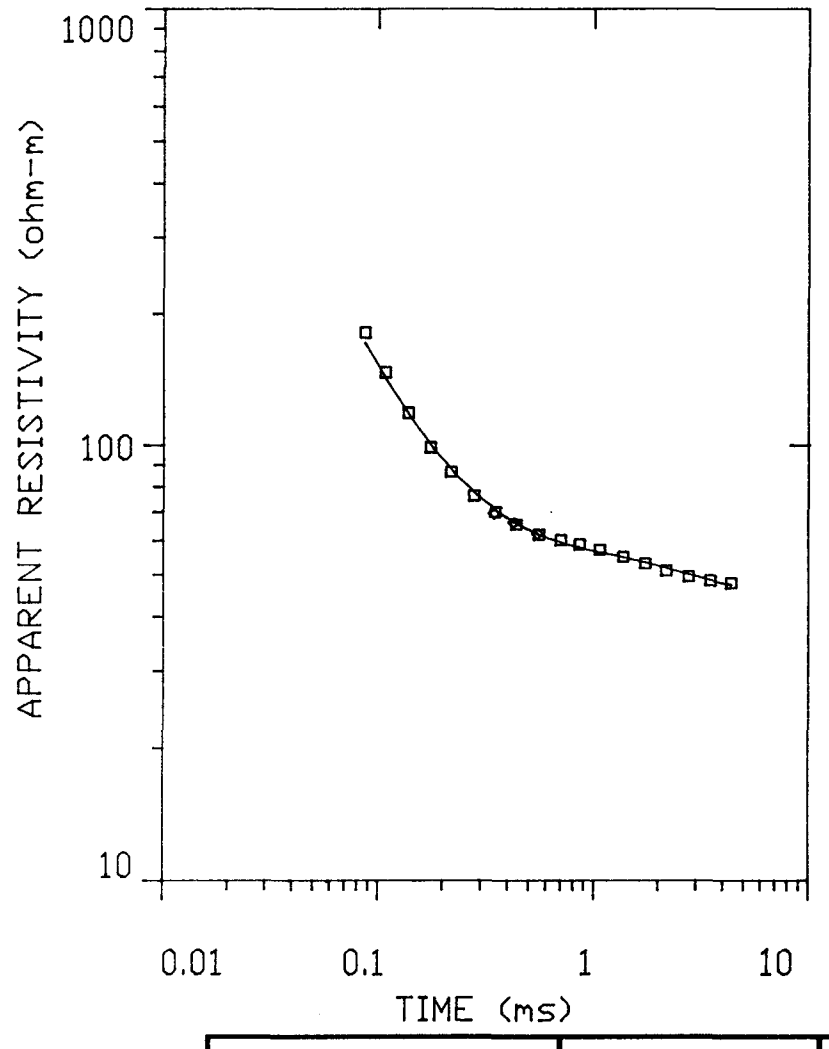
The resistivity of Layer 3 (23 ohm-m) corresponds to a chloride content of 1,786 mg/l assuming a porosity of 25% and the validity and applicability of equation (4) of Section 4.2. It is presumed that because of the expected high chlorinity gradients, this value is sufficiently close to the 5,000 mg/l isochlor that they represent the same effective depth.

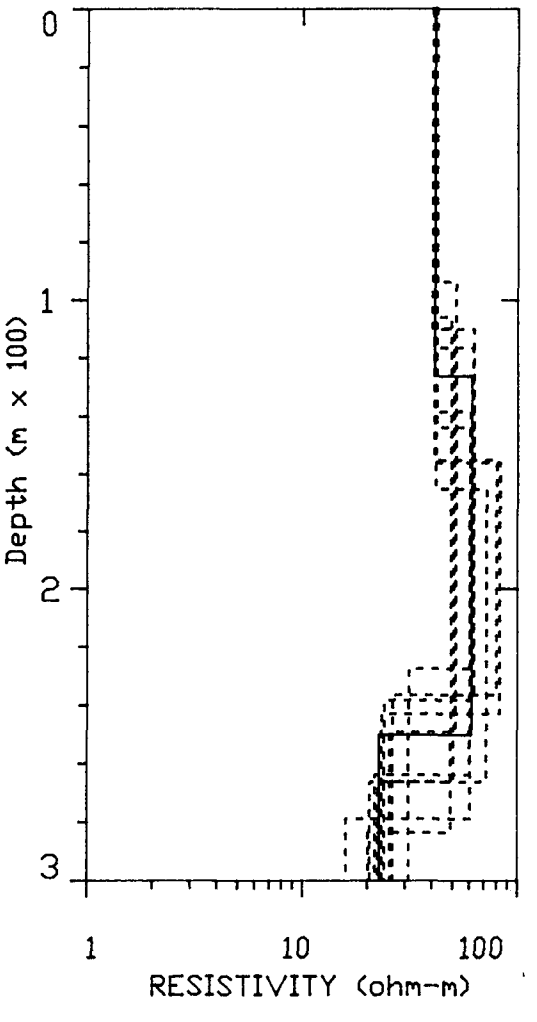
5.29.4 Depth of Occurrence of the 250 mg/l Isochlor

The resistivity of Layer 2, 62 ohm-m, corresponds to a chloride content above 250 mg/l, assuming a 25% porosity and the validity and applicability of equation (4) of Section 4.2. As the interpreted chloride content exceeds 250 mg/l, the 250 mg/l isochlor does not occur within the Floridan aquifer at this site.

5.29.5 Accuracy of Measurement and Interpretation

Figure 5.29.3 is the equivalence analysis at this site and the inversion table (Table 5.29-1) lists the upper and lower bounds of the inverted parameters of the geoelectrical model.





—— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
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MEASURED TDEM APPARENT RESISTIVITY AND EQUIVALENCE FOR 1-D INVERSION
SOUNDING 28 - CHRISTMAS
ORANGE COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	EQU-28	5.29-3
DRAWN BY:	RBT	DATE:	07/06/94	

DATA SET: SITE 28

CLIENT: SJRWMD DATE: 13-MAY-94
LOCATION: CHRISTMAS SOUNDING: 1
COUNTY: ORANGE COUNTY, FLORIDA ELEVATION: 18.00 m
PROJECT: SALT WATER INTERFACE DETECTION EQUIPMENT: Geonics PROTEM
LOOP SIZE: 305.000 m by 183.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y)
SOUNDING COORDINATES: E: 0.0000 N: 0.0000

FITTING ERROR: 2.718 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			18.00	
1	41.13	126.2	-108.2	3.06
2	61.64	123.9	-232.1	2.01
3	22.81			

ALL PARAMETERS ARE FREE

PARAMETER BOUNDS FROM EQUIVALENCE ANALYSIS

	LAYER	MINIMUM	BEST	MAXIMUM
RHO	1	40.173	41.133	42.070
	2	49.219	61.641	82.993
	3	15.917	22.816	31.259
THICK	1	93.579	-0.489	165.184
	2	81.496	1.000	177.811
DEPTH	1	93.579	126.205	165.184
	2	227.553	250.187	283.596

CURRENT: 18.60 AMPS EM-37 COIL AREA: 100.00 sq m.
FREQUENCY: 30.00 Hz GAIN: 3 RAMP TIME: 194.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.0867	99685.6	108169.5	-8.51
2	0.108	78915.5	82719.7	-4.82
3	0.138	58928.7	59437.8	-0.863

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TDEM SOUNDING DATA TABLE
SOUNDING 28 – CHRISTMAS
ORANGE COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.29–1

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
4	0.175	42756.7	41815.7	2.20
5	0.218	29978.4	29368.8	2.03
6	0.278	19823.9	19233.8	2.97
7	0.351	12615.4	12409.8	1.63
8	0.438	8014.9	7956.5	0.728
9	0.558	4748.0	4751.3	-0.0679
10	0.702	2793.3	2847.8	-1.95
11	0.858	1752.3	1798.1	-2.61
12	1.06	1062.9	1083.7	-1.95
13	1.37	600.4	602.8	-0.402
14	1.74	348.3	346.1	0.635
15	2.17	212.8	207.8	2.31
16	2.77	120.9	119.1	1.50
17	3.50	69.63	69.56	0.0994
18	4.37	40.84	41.58	-1.79

CURRENT: 18.60 AMPS EM-37 COIL AREA: 100.00 sq m.
FREQUENCY: 7.50 Hz GAIN: 5 RAMP TIME: 194.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
19	0.346	13260.2	12772.0	3.68
20	0.427	8422.2	8396.3	0.307
21	0.550	4903.4	4914.7	-0.230

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	1.00				
P 2	0.00	0.72			
P 3	0.01	-0.02	0.47		
T 1	-0.01	-0.20	0.14	0.65	
T 2	0.00	0.34	0.18	0.26	0.46
	P 1	P 2	P 3	T 1	T 2

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PALATKA, FLORIDA

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TDEM SOUNDING DATA TABLE
SOUNDING 28 – CHRISTMAS
ORANGE COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.29-1

The range of equivalence in determining the depth to the low resistivity layer is about ±28 m (92 ft) which is 11% of the total depth. The resistivity of this layer has a range from 16 to 31 ohm-m. This corresponds to a range in interpreted chloride content of from 1,857 mg/l to 885 mg/l, again subject to the same assumptions of porosity and validity of equation (4).

The equivalence range of the resistivity of Layer 2 is from 49 to 83 ohm-m which, for the majority of the range, corresponds to a chloride content above 250 mg/l. The chloride-to-sulfate ratio at the site is 3:1 (Table 5.1-4). Accordingly, Equation (4) may not be valid.

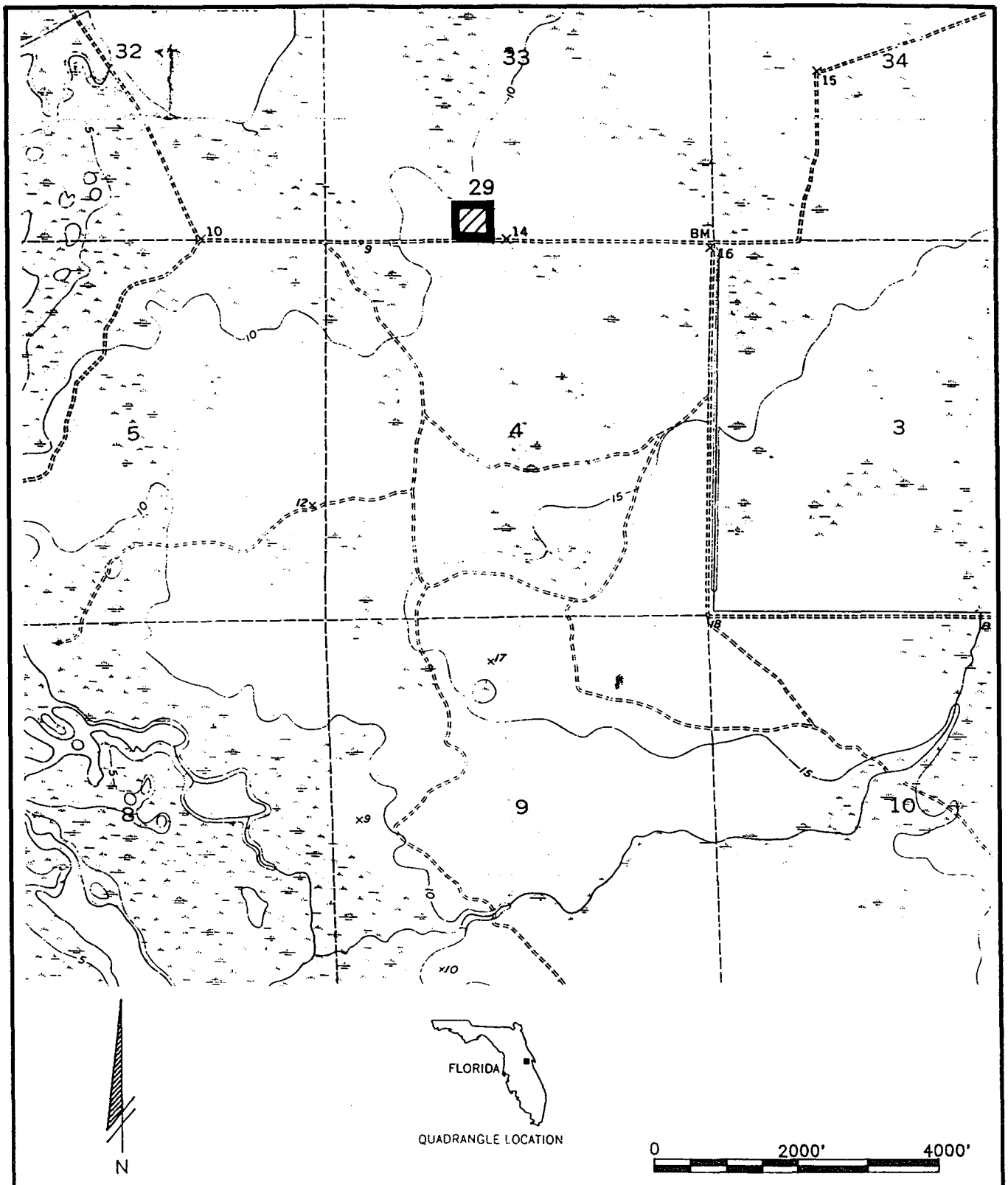
5.29.6 Summary of TDEM Sounding at Christmas (Site 28)

- The depth to occurrence of salt water (5,000 mg/l isochlor) is interpreted to be 820 ft (-760 ft msl) and occur within the Upper Floridan aquifer.
- The ground water within the Floridan aquifer at this site is interpreted to contain an average chloride concentration above 250 mg/l. The 250 mg/l isochlor is not interpreted to be present within the Floridan aquifer.

5.30 TDEM Site 29 - Seminole Ranch/Brevard County

5.30.1 Location Description and Geoelectrical Section

The site is located in northern Brevard County, Florida (Figure 5.30-1). The site is located within a wooded area. No possible sources of interference were observed in the vicinity of the Tx loop. QA soundings were performed 50 ft east, south, and west of the initial Rx coil location. Results from the QA soundings indicate that the apparent resistivity values were unaffected by any interference sources.



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TDEM SURVEY LOCATION MAP
SOUNDING 29 – SEMINOLE RANCH/BREVARD COUNTY
BREVARD COUNTY, FLORIDA

DESIGNED BY: JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY: MJW	DRAWING NO.:	LOC-29	5.30-1
DRAWN BY: RBT	DATE:	07/05/94	

The Floridan aquifer occurs at an approximate depth of 80 ft bmsl or 90 ft bls (Tibbals, 1990) and is overlain by Holocene to Miocene deposits. The base of the Floridan aquifer occurs at a depth of approximately 2,500 bmsl (Tibbals, 1990). The thickness of the Upper Floridan aquifer is approximately 960 ft and the depth to the top of the Lower Floridan aquifer is approximately 1,050 ft bls (Miller, 1986). The chloride concentration in the Upper Floridan aquifer at this site is above 1,000 mg/l (Tibbals, 1990).

The resistivity sounding data and best-fit model inversion are presented on Figure 5.30-2. The interpreted geoelectrical section consists of a one-layer subsurface.

5.30.2 Geological Interpretation of Geoelectrical Model

The one-layered geoelectrical section consists of a low resistivity (5.1 ohm-m), upper layer which is considered to be a combined Holocene to Miocene deposits and Floridan aquifer. The resistivity of this layer (5.1 ohm-m) suggests the Floridan aquifer at this site contains salt water.

5.30.3 Depth to Occurrence of Salt Water

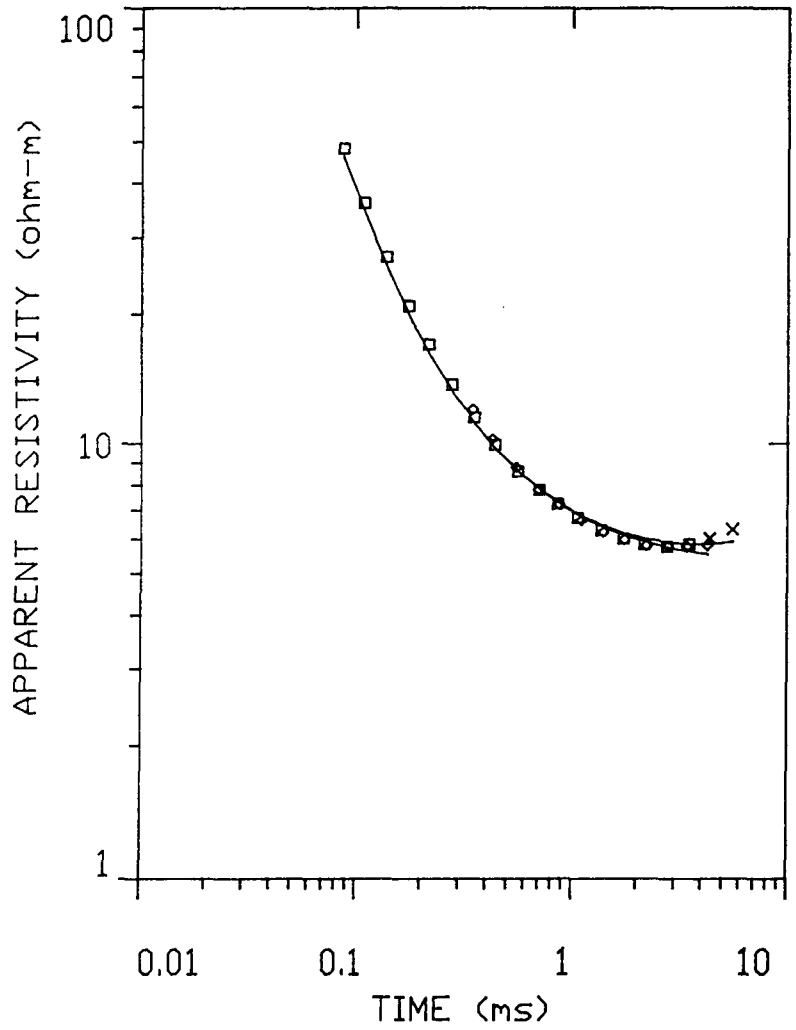
Based upon the TDEM results, all the sediments within the geoelectric section appeared to be saturated with brackish to salt water. Accordingly, it was not possible to determine the depth to the 5,000 mg/l isochlor.

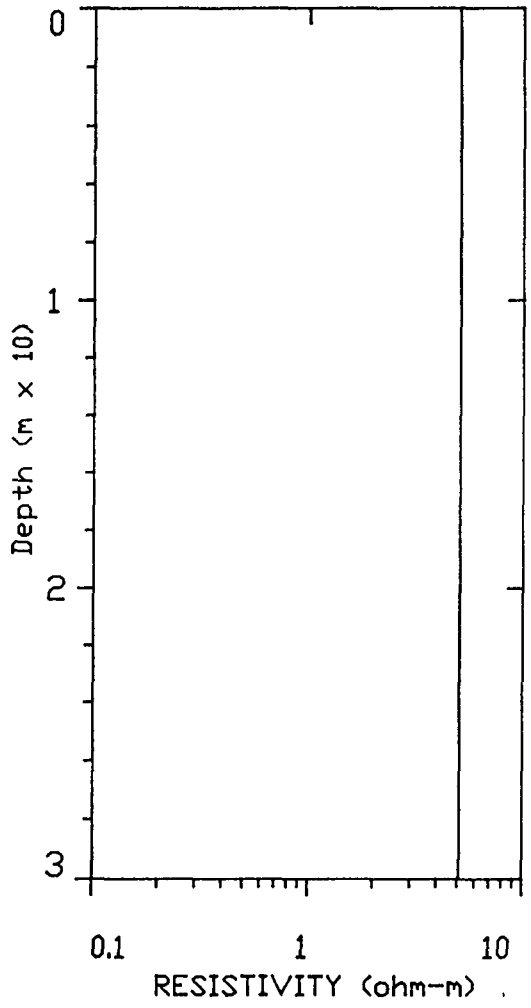
5.30.4 Depth of Occurrence of the 250 mg/l Isochlor

Based upon the TDEM results, all the sediments within the geoelectric section appeared to be saturated with brackish to salt water. Accordingly, the 250 mg/l isochlor is not present in the Floridan aquifer at this site.

5.30.5 Accuracy of Measurement and Interpretation

Figure 5.30-3 is the equivalence analysis at this site and the inversion table (Table 5.30-1) lists the upper and lower bounds of the inverted parameters of the geoelectrical model.





——— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

X APPARENT RESISTIVITY VALUES NOT USED IN MODEL

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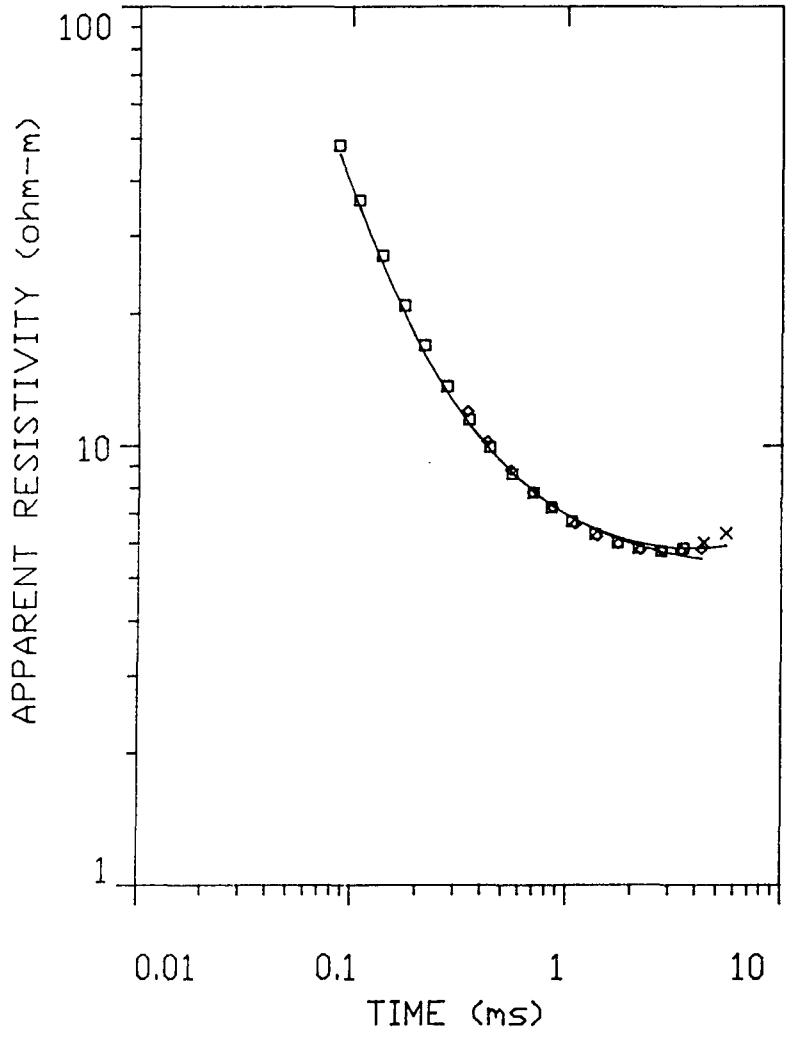
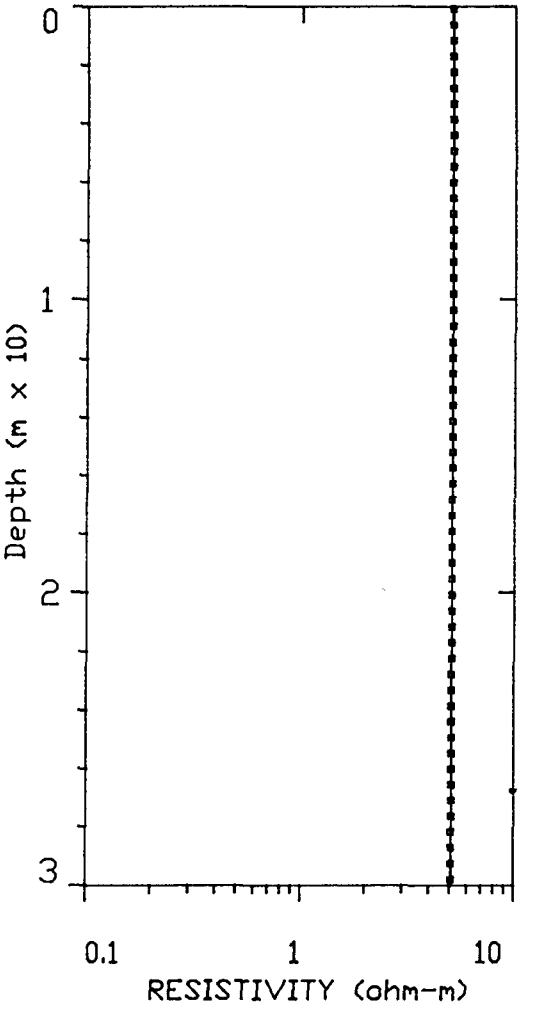
MEASURED TDEM APPARENT RESISTIVITY AND 1-D INVERSION
SOUNDING 29 – SEMINOLE RANCH/BREVARD COUNTY
BREVARD COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	MDL-29	5.30-2
DRAWN BY:	RBT	DATE:	07/06/94	





——— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

X APPARENT RESISTIVITY VALUES NOT USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
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MEASURED TDEM APPARENT RESISTIVITY AND EQUIVALENCE FOR 1-D INVERSION
SOUNDING 29 – SEMINOLE RANCH/BREVARD COUNTY
BREVARD COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	EQU-29	5.30-3
DRAWN BY:	RBT	DATE:	07/06/94	

DATA SET: SITE 29

CLIENT: SJRWMD DATE: 13-MAY-94
LOCATION: SEMINOLE RANCH/BREVARD COUNTY SOUNDING: 1
COUNTY: BREVARD COUNTY ELEVATION: 3.00 m
PROJECT: SALT WATER INTERFACE DETECTION EQUIPMENT: Geonics PROTEM
LOOP SIZE: 152.000 m by 152.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y)
SOUNDING COORDINATES: E: 0.0000 N: 0.0000

FITTING ERROR: 4.725 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			3.00	
1	5.08			

ALL PARAMETERS ARE FREE

PARAMETER BOUNDS FROM EQUIVALENCE ANALYSIS

	LAYER	MINIMUM	BEST	MAXIMUM
RHO	1	4.943	5.087	5.226

CURRENT: 22.00 AMPS EM-57 COIL AREA: 100.00 sq m.
FREQUENCY: 30.00 Hz GAIN: 1 RAMP TIME: 154.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.0867	344808.0	369337.1	-7.11
2	0.108	307329.6	328515.6	-6.89
3	0.138	256809.0	276782.0	-7.77
4	0.175	208949.1	224165.3	-7.28
5	0.218	164143.4	177135.5	-7.91
6	0.278	123672.5	130562.3	-5.57
7	0.351	89720.9	93475.5	-4.18
8	0.438	64118.2	65734.1	-2.52
9	0.558	43414.7	43189.4	0.518
10	0.702	28366.7	28145.0	0.781
11	0.858	19248.5	18952.9	1.53

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TDEM SOUNDING DATA TABLE
SOUNDING 29 – SEMINOLE RANCH/BREVARD COUNTY
BREVARD COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.30-1

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
12	1.06	12481.5	12118.2	2.91
13	1.37	7365.4	7068.9	4.02
14	1.74	4341.1	4147.5	4.46
15	2.17	2608.4	2495.4	4.33
16	2.77	1448.1	1399.6	3.34
17	3.50	790.6	791.6	-0.121
18	4.37	432.7	454.1	-4.95 MASKED
19	5.56	220.6	244.1	-10.67 MASKED

CURRENT: 22.00 AMPS EM-57 COIL AREA: 100.00 sq m.
FREQUENCY: 7.50 Hz GAIN: 4 RAMP TIME: 154.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
20	0.346	87234.2	95629.2	-9.62
21	0.427	65256.7	68660.7	-5.21
22	0.550	43627.6	44425.8	-1.82
23	0.698	28791.3	28550.6	0.836
24	0.869	18688.8	18562.6	0.675
25	1.10	11582.4	11255.3	2.82
26	1.40	7052.8	6788.0	3.75
27	1.75	4311.7	4166.0	3.37
28	2.22	2495.6	2430.1	2.62
29	2.79	1417.4	1432.1	-1.03
30	3.42	854.4	887.5	-3.86
31	4.26	487.4	525.9	-7.90

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER
P 1 1.00
P 1

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TDEM SOUNDING DATA TABLE
SOUNDING 29 – SEMINOLE RANCH/BREVARD COUNTY
BREVARD COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.30–1

The range of equivalence in determining the resistivity of Layer 1 is 4.9 to 5.2 ohm-m. A corresponding chloride concentration cannot be determined because Layer 1 is in part comprised of the Holocene to Miocene deposits. The chloride-to-sulfate ratio at the site is 5:1 (Table 5.1-4). Accordingly, equation (4) is valid.

5.30.6 Summary of TDEM Sounding at Seminole Ranch/Brevard County (Site 29)

- It is not possible to determine the depth to salt water (5,000 mg/l isochlor) because based on the TDEM results the entire Floridan aquifer appears to be saturated with brackish to salt water. The 250 mg/l isochlor is not present in the Floridan aquifer at this site.

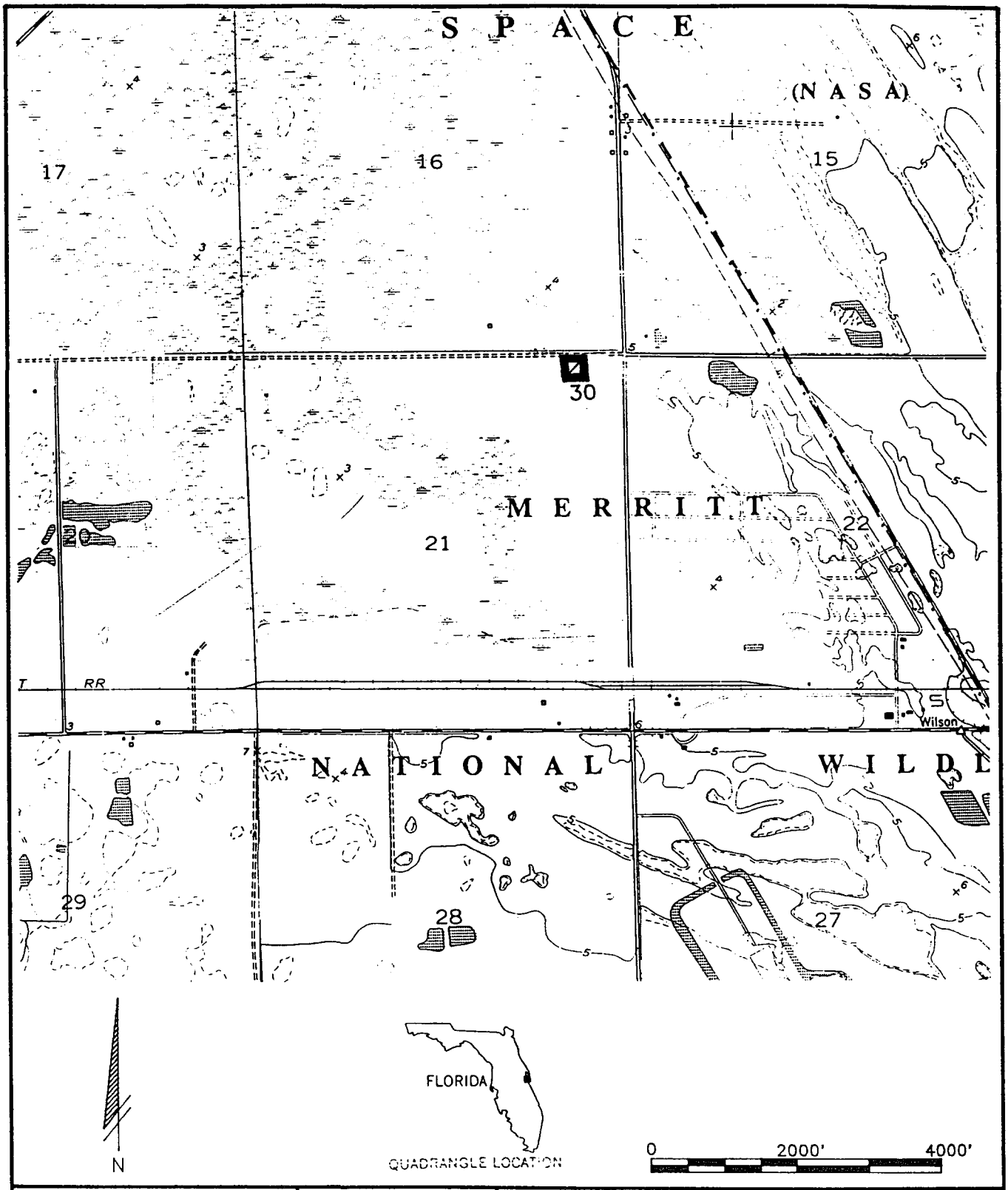
5.31 TDEM Site 30 - Merritt Island/NWR

5.31.1 Location Description and Geoelectrical Section

The site is located in northern Brevard County within the Merritt Island National Wildlife Refuge (Figure 5.31-1). The site is located within an area of dense vegetation. No possible sources of interference were observed in the vicinity of the Tx loop. QA soundings were performed 30 ft east and north of the initial Rx coil location. Results from the QA soundings indicate that the apparent resistivity values were unaffected by any interference sources.

The Floridan aquifer occurs at an approximate depth of 150 ft bmsl or 155 ft bls (SJRWMD, personal communication) and is overlain by Holocene to Miocene deposits. The base of the Floridan aquifer occurs at an approximate depth of 2400 ft bmsl (Tibbals, 1990). The thickness of the Upper Floridan aquifer is approximately 870 ft and the depth to the top of the Lower Floridan aquifer is approximately 1,025 ft bls (Miller, 1986). The chloride concentration in the Upper Floridan aquifer at the site is above 1,000 mg/l (Tibbals, 1990).

The resistivity sounding data and best-fit model inversion are presented on Figure 5.31-2. The interpreted geoelectrical section consists of a two-layer subsurface.



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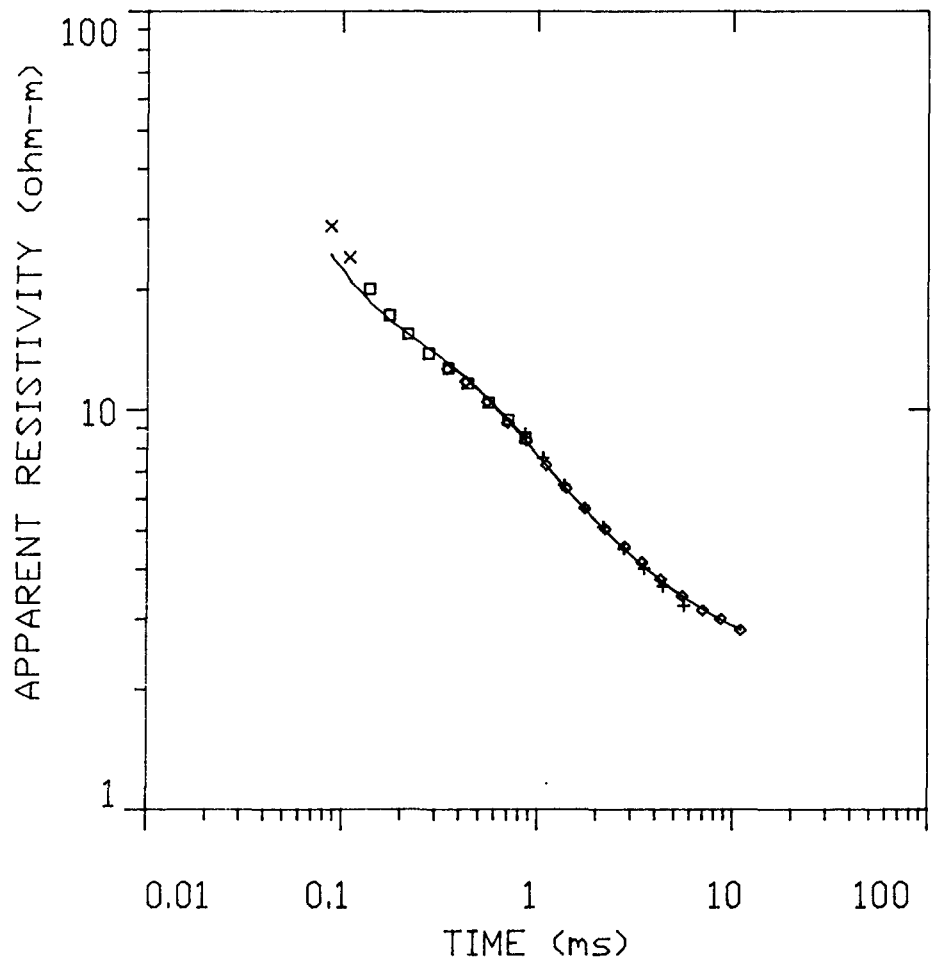
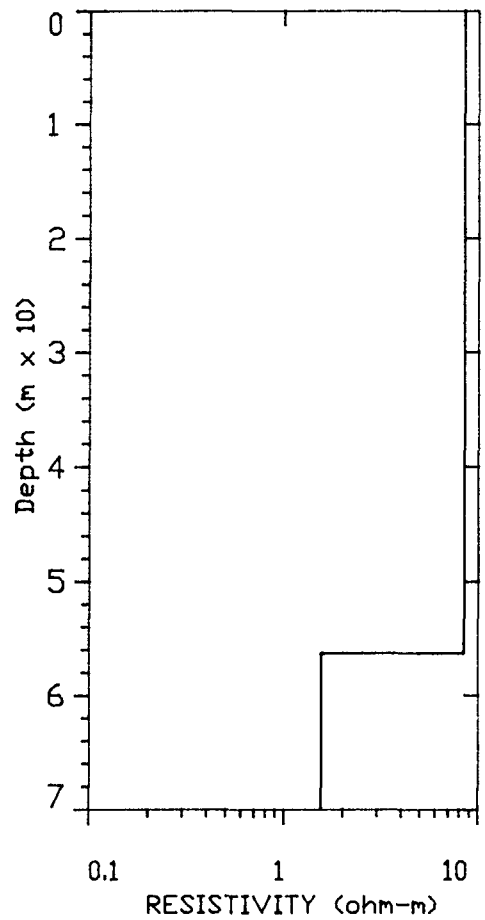
TDEM SURVEY LOCATION MAP
SOUNDING 30 – MERRITT ISLAND/NWR
BREVARD COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	LOC-30	5.31-1
DRAWN BY:	RBT	DATE:	07/05/94	





—— BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

X APPARENT RESISTIVITY VALUES NOT USED IN MODEL

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
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MEASURED TDEM APPARENT RESISTIVITY AND 1-D INVERSION
SOUNDING 30 - MERRITT ISLAND/NWR
BREVARD COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	MDL-30	5.31-2
DRAWN BY:	RBT	DATE:	07/06/94	

5.31.2 Geological Interpretation of Geoelectrical Model

The first layer occurs at 56 m (184 ft) bls which is near the hydrostratigraphic contact between the Holocene to Miocene sediments and the Floridan Aquifer System (155 ft bls). Therefore, it can be interpreted that there exists a two-layer geoelectrical section with a surface layer 184 ft thick with a low resistivity (8.4 ohm-m) overlying a layer with a lower resistivity (1.5 ohm-m). It can be interpreted that Layer 1 consists of the Holocene to Miocene deposits overlying a saltwater saturated Floridan aquifer at a depth of 184 ft bls.

5.31.3 Depth to Occurrence of Salt Water

The bottom (second) layer of the geoelectrical model, with a resistivity of 1.5 ohm-m, is interpreted to represent salt water. It occurs at a depth of 184 ft (-179 ft msl). Because the resistivity of Layer 1 (8.4 ohm-m) is less than 80 ohm-m, the interpreted depth to the 5,000 mg/l isochlor is taken at the depth of the geoelectrical interface, or at 184 ft depth (-179 ft msl). The resistivity of Layer 2 (1.5 ohm-m) corresponds to a chloride content of greater than 20,000 mg/l assuming a porosity of 25% and the validity and applicability of equation (4) of Section 4.2. It is presumed that because of the expected high chlorinity gradients, this value is sufficiently close to the 5,000 mg/l isochlor that they represent the same effective depth.

5.31.4 Depth of Occurrence of the 250 mg/l Isochlor

Since the resistivity of Layer 2 (1.5 ohm-m) is less than 80 ohm-m, the 250 mg/l isochlor is not present in the Floridan aquifer at this site. For comparison, Tibbals (1990) estimated the chloride concentration in the Upper Floridan aquifer to exceed 1,000 mg/l at the site.

5.31.5 Accuracy of Measurement and Interpretation

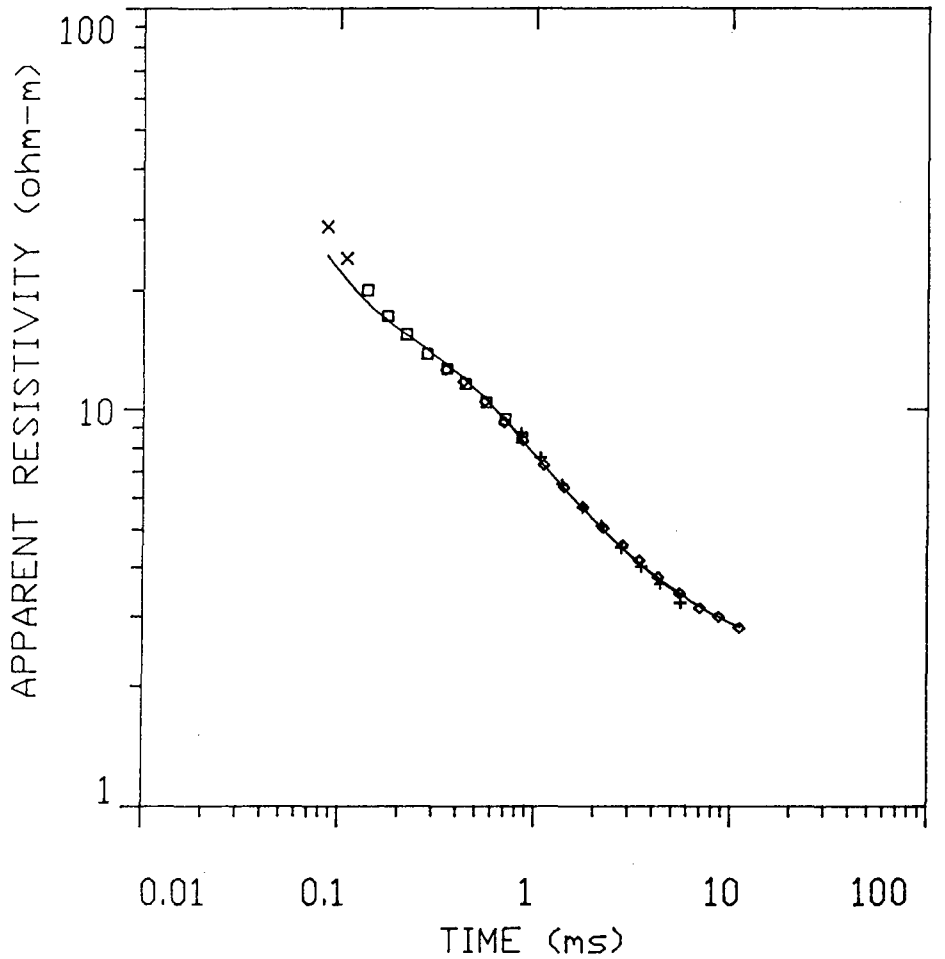
Figure 5.31-3 is the equivalence analysis at this site and the inversion table (Table 5.31-1) lists the upper and lower bounds of the inverted parameters of the geoelectrical model. The range of equivalence in determining the depth to the low resistivity layer is about ±2 m (6 ft) which is 3% of the total depth.

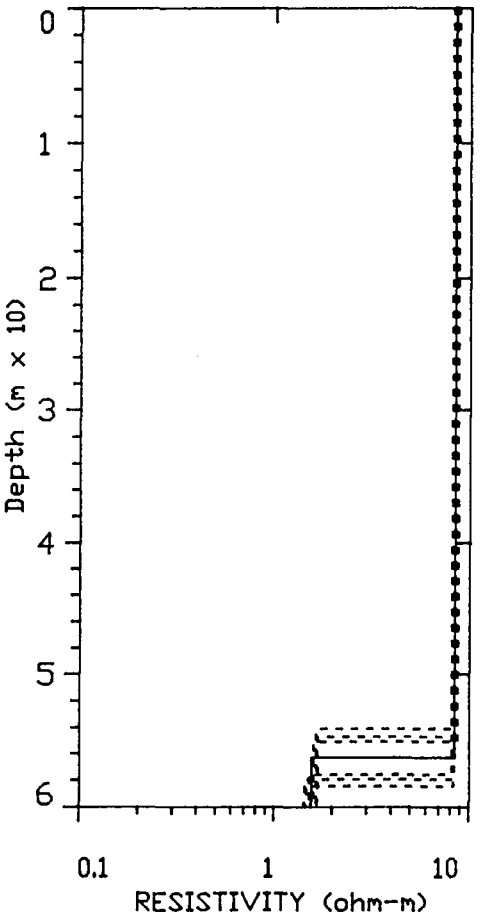
The resistivity of this layer has a range of from 1.4 to 1.7 ohm-m. This corresponds to a range in interpreted chloride content of from 22,821 mg/l to 18,767 mg/l, again subject to the same assumptions of porosity and validity of equation (4).

The equivalence range of the resistivity of Layer 1 is from 8.1 to 8.7 ohm-m. A corresponding chloride concentration cannot be determined because Layer 1 is comprised of the Holocene to Miocene deposits. Accordingly, equation (4) may not be valid.

5.31.6 Summary of TDEM Sounding at Merritt Island/NWR (Site 30)

- The depth of occurrence of salt water (5,000 mg/l isochlor) is interpreted to be 184 ft (-179 ft msl) and occur within the Floridan aquifer.
- The 250 mg/l isochlor is not present in the Floridan aquifer at this site. The TDEM results agree with Tibbals (1990) who estimated the chloride concentration in the Upper Floridan aquifer to exceed 1,000 mg/l at this site.





BEST-FIT MODELED CURVE

□ APPARENT RESISTIVITY VALUES USED IN MODEL

X APPARENT RESISTIVITY VALUES NOT USED IN MODEL

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MEASURED TDEM APPARENT RESISTIVITY AND EQUIVALENCE FOR 1-D INVERSION
SOUNDING 30 - MERRITT ISLAND/NWR
BREVARD COUNTY, FLORIDA

DESIGNED BY:	JEB	PROJECT NO.:	94767	FIGURE
CHECKED BY:	MJW	DRAWING NO.:	EQU-30	5.31-3
DRAWN BY:	RBT	DATE:	07/06/94	

DATA SET: SITE 30

CLIENT: SJRWMD DATE: 13-MAY-94
LOCATION: MERRITT ISLAND/NWR SOUNDING: 1
COUNTY: BREVARD COUNTY, FLORIDA ELEVATION: 1.50 m
PROJECT: SALT WATER INTERFACE DETECTION EQUIPMENT: Geonics PROTEM
LOOP SIZE: 91.400 m by 91.400 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y)
SOUNDING COORDINATES: E: 0.0000 N: 0.0000

FITTING ERROR: 3.286 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			1.50	
1	8.44	56.29	-54.79	6.66
2	1.54			

ALL PARAMETERS ARE FREE

PARAMETER BOUNDS FROM EQUIVALENCE ANALYSIS

	LAYER	MINIMUM	BEST	MAXIMUM
RHO	1	8.142	8.444	8.745
	2	1.431	1.546	1.670
THICK	1	54.104	1.000	58.472
DEPTH	1	54.104	56.298	58.472

CURRENT: 21.50 AMPS EM-57 COIL AREA: 100.00 sq m.
FREQUENCY: 30.00 Hz GAIN: 1 RAMP TIME: 112.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.0867	263740.4	337430.9	-27.94 MASKED
2	0.108	199527.3	240678.2	-20.62 MASKED
3	0.138	141869.0	158764.2	-11.90
4	0.175	98366.1	102559.6	-4.26
5	0.218	66650.6	67002.6	-0.528
6	0.278	43070.4	41450.1	3.76
7	0.351	27373.4	26287.7	3.96

* S.D.I.I. *

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TDEM SOUNDING DATA TABLE
SOUNDING 30 – MERRITT ISLAND/NWR
BREVARD COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.31-1

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
8	0.438	17907.8	17283.5	3.48
9	0.558	11518.1	11182.4	2.91
10	0.702	7528.7	7535.6	-0.0914
11	0.858	5334.2	5366.8	-0.611

CURRENT: 21.50 AMPS EM-57 COIL AREA: 100.00 sq m.
FREQUENCY: 7.50 Hz GAIN: 5 RAMP TIME: 112.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
12	0.346	28571.5	27114.4	5.09
13	0.427	18788.9	18206.3	3.10
14	0.550	11876.7	11553.3	2.72
15	0.698	7851.7	7691.2	2.04
16	0.869	5305.9	5332.1	-0.493
17	1.10	3567.9	3578.5	-0.297
18	1.40	2406.8	2415.3	-0.351
19	1.75	1643.5	1660.5	-1.03
20	2.22	1085.6	1099.1	-1.24
21	2.79	712.2	728.6	-2.30
22	3.42	490.3	501.6	-2.30
23	4.26	328.0	330.3	-0.697
24	5.49	201.5	201.2	0.104
25	6.96	125.9	124.6	1.08
26	8.66	78.72	79.10	-0.479
27	11.06	47.02	46.77	0.526

CURRENT: 21.50 AMPS EM-57 COIL AREA: 100.00 sq m.
FREQUENCY: 3.00 Hz GAIN: 7 RAMP TIME: 112.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
28	0.857	5171.0	5460.4	-5.59
29	1.06	3690.7	3815.9	-3.39
30	1.37	2485.3	2518.2	-1.32
31	1.74	1672.1	1680.7	-0.514
32	2.17	1128.9	1148.0	-1.69
33	2.77	741.1	741.9	-0.101

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TDEM SOUNDING DATA TABLE
SOUNDING 30 – MERRITT ISLAND/NWR
BREVARD COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.31-1

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
34	3.50	488.9	483.8	1.05
35	4.37	327.0	317.7	2.84
36	5.56	212.0	199.3	6.01

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	1.00		
P 2	0.00	0.98	
T 1	0.00	0.01	0.99
	P 1	P 2	T 1

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PALATKA, FLORIDA

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SUBSURFACE DETECTION INVESTIGATIONS INCORPORATED

TDEM SOUNDING DATA TABLE
SOUNDING 30 – MERRITT ISLAND/NWR
BREVARD COUNTY, FLORIDA

PROJECT NO.: 94767
TABLE: 5.31-1

6.0 SUMMARY AND CONCLUSIONS

A TDEM survey was performed at 30 sites in the St. Johns River Water Management District during the months of April through May, 1994. The principal findings of this survey can be summarized as follows:

TDEM is a geoelectrical method which can be used to estimate the vertical variation of resistivity of subsurface formations and/or hydrostratigraphic units. Translating the geophysical measurement of electrical resistivity into a model of geology and water quality depends upon comparison to other available subsurface data, consistency of data sets from nearby soundings from this and prior years, and application of empirical relationships to produce interpreted water-quality results. As outlined in Section 4, the conversions to water quality values (chloride concentrations) are based upon the relationships established using Kwader's (1982) data for Seminole County, as used for SJRWMD in previous studies (Blackhawk, 1990; CEES, 1992; SDII, 1993). The formulae employed use assumptions of a 25% porosity, similar water chemistry (specifically, a 5:1 chloride-to-sulfate ratio) as Kwader's data, and that the saltwater interface occurs within the Floridan Aquifer System. With regards the latter point, chloride concentration values are generally presented only for those portions of the geoelectrical section which correspond to the Floridan aquifer.

Under circumstances where there is little contrast in resistivity between the Holocene to Miocene deposits, surficial sediments, or Hawthorn Group and the Floridan aquifer, the chloride concentration of the ground water above the freshwater/saltwater interface cannot generally be determined. This is because of the assumptions implicit in equation (4) are not valid. However, if the resistivity of such a layer is either greater than 80 ohm-m or less than 20 ohm-m, it can be concluded that the chloride concentration in the Upper Floridan aquifer is either below or above 250 mg/l, respectively.

Finally, because the freshwater/saltwater boundary is not an abrupt interface but a transition zone, criteria relating to the relative resistivities above and below the geoelectrical interface were used to establish an empirical definition of depths to the 250 and 5,000 mg/l isochlors. Again, these were the same criteria as used in past years' TDEM surveys (Blackhawk, 1990; CEES, 1992; SDII, 1993) in order to maintain consistency from year to year.

6.1 Determining the Depth of the Interface Between Fresh Water and Ground Water of High Chloride Concentration (Greater Than 1,450 mg/l)

As stated in previous years' reports (Blackhawk, 1990; CEES, 1992; SDII, 1993), "ground water with a chloride content greater than 1,450 mg/l is characterized in the Floridan aquifer by resistivities less than 20 ohm-m when the aquifer has a porosity of about 25%." In accordance with this statement, a deep layer with a resistivity of less than 20 ohm-m was detected at 29 of the 30 sites surveyed. At the Christmas sounding, Site 29, the basal resistivity layer had a resistivity of 23 ohm-m. The resistivity value was sufficiently close to 20.0 ohm-m that the results of this sounding were considered similar to the other sites. At Site 4 (Georgetown Cove), Site 21 (Lee Ranch #1), Site 22 (Lee Ranch #2) and Site 29 (Seminole Ranch/Brevard County), there was not sufficient contrast in the resistivity between the geoelectric layers to state that either the geoelectric layer exists or that the geoelectric contact represented the contact between fresh and salt water. At Site 27 (Titusville), it was not possible to determine the depth to salt water because the lowermost geoelectric layer included sediments from the Holocene to Miocene deposits. Accordingly, the assumptions used in the empirical model to estimate the chloride concentration from an apparent resistivity value are not valid. The remaining 25 sites show variation in depth to this interface to range from approximately 184 to 1,156 ft. All the interpreted depths place the saltwater interface within the Floridan Aquifer System.

6.2 Water Quality in the Floridan aquifer and Depth of Occurrence of the 250 mg/l Isochlor

Based on the assumptions that: (a) The Floridan aquifer has a porosity of 25%, (b) ground water within the study area have a chemistry similar to those analyzed by Kwader (1982), and (c) equation (4) in Section 4.2 is valid, ground water having chloride concentrations of less than 250 mg/l correspond to geoelectrical layers having resistivities in excess of 80 ohm-m. The distribution of resistivities of the Floridan aquifer show, for the most part, high resistivities and, therefore, fresh waters of less than 250 mg/l are present in the Floridan aquifer in several of the survey areas. At twelve of the sites, the resistivity of the Floridan aquifer was less than 80 ohm-m and brackish water is interpreted to be present. When a layer with a chloride concentration of less than 250 mg/l is interpreted, the position of the 250 mg/l isochlor is fixed by the relative resistivities of the deep, conductive layer and the fresh (resistive) layer above - generally placing it 50 ft above the geoelectrical interface. When the resistivity of the Floridan aquifer is such that the interpreted chloride concentration exceeds 250 mg/l, a depth to the 250 mg/l isochlor was not determined as the entire system is considered to be brackish.

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