HRS

STATE OF FLORIDA
DEPARTMENT OF HEALTH AND REHABILITATIVE SERVICES

# ONSITE SEWAGE DISPOSAL SYSTEM RESEARCH IN FLORIDA

## PERFORMANCE MONITORING AND GROUND WATER QUALITY IMPACTS OF OSDSs IN SUBDIVISION DEVELOPMENTS

PROGRESS REPORT
JULY 1989

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AYRES
ASSOCIATES

# ONSITE SEWAGE DISPOSAL SYSTEM RESEARCH IN FLORIDA

## Performance Monitoring and Ground Water Quality Impacts of OSDSs in Subdivision Developments

Progress Report

By

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For

Florida Department of Health and
Rehabilitative Services
Tallahassee, Florida

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## ACKNOWLEDGMENTS

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## SECTION 1
## EXECUTIVE SUMMARY

The work described herein is part of a multi-year research project sponsored by the Florida Department of Health and Rehabilitative Services (HRS) designed to evaluate the performance and ground water quality effects of Onsite Sewage Disposal Systems (OSDSs) in Florida. Previous research as part of this project focused on state-wide assessments of soil suitability for OSDSs and potential ground water quality impacts in eight hydrogeologic regimes of Florida. This phase of the research focused on monitoring the ground water beneath four specific subdivisions in four different hydrogeologic regimes and the performance of eight individual OSDSs in two of these. The ground water conditions varied between subdivisions with a high, well drained sand ridge setting in Polk County; a low, somewhat poorly drained flatwoods area in St. Johns site; a relict beach ridge environment in Brevard County and a shallow limestone aquifer (Biscayne) in Dade County. These subdivisions were chosen since they were thought to be representative of those developed largely under the requirements of the 1983 revisions to Chapter 10D-6, Florida Administrative Code, Standards for Onsite Sewage Disposal Systems.

### SUBDIVISION GROUND WATER MONITORING

The surficial ground water monitoring conducted to date has included the following activities:

- o Installation of soil borings and an evaluation of the shallow geology via soil borings.
- o Installation of temporary piezometer wells and the collection of water level and field water quality data.
- o Performance of electromagnetic (EM) terrain conductivity surveys at the four sites to aid in the placement of permanent monitoring wells.
- o Performance of ground penetrating radar (GPR) surveys at two of the sites to enhance the understanding of the shallow geology.
- o Evaluation of the preliminary data and selection of sites for more extensive ground water sampling and analysis.
- o Installation, development and sampling of monitoring wells.
- o Evaluation and interpretation of the ground water monitoring data.

At least 10 test borings were made at each site. Several of the test borings were completed as temporary piezometers (typically 7 to 11 locations). Based on the soil boring data, surface geophysical surveys and piezometer measurements, permanent ground water monitoring wells were sited and installed. Seven wells were normally placed with the exception of Polk County where only 5 were installed. Ground water monitoring activities described in this report took place between May 1987 and March 1988.

The water table aquifers studied were present in fine sands beneath the subdivisions in Polk, St. Johns and Brevard County, while in Dade County, the aquifer occurred in shallow limestone. The depth to ground water varied widely between the four subdivision sites: 1 to 4 ft. below ground surface in Brevard County, 3 to 5 ft. in Dade County, 2 to 7 ft. in St. Johns County and 9 to 18 ft. in Polk County. The observed horizontal gradients were normally quite low, typically less than 0.4%. Cursory estimates of ground water seepage velocities yielded rates typically well below 25 ft./yr. in the shallow ground water below the subdivisions in Polk, St. Johns and Brevard County. The rate .in the ground water below the subdivision in Dade County was considerably higher (670 ft./yr.) due to the cavernous and vugular limestone aquifer.

Ground water monitoring included the measurement of water table elevations and the collection of samples for water quality analyses. Analyses were made onsite for temperature, pH and specific conductance. Laboratory analyses were made for total dissolved solids (TDS), chlorides, 5-day biochemical oxygen demand ($BOD_5$), total Kjeldahl nitrogen (TKN), nitrate nitrogen ($NO_3$), total phosphorus (P), surfactants (MBAS), fecal coliform bacteria, volatile organic compounds (VOCs) and virus. Sampling and analyses for virus were conducted in Polk and St. Johns County, but this work has not been completed yet and will appear in the final report on this phase of the research.

The ground water concentrations of many constituents varied widely between different wells on a given date and at a given well on different dates. Variations of an order of magnitude or more for pH, chlorides, nitrogen and phosphorus were not uncommon. The fluctuations were not consistent across all parameters ruling out simple dilution from precipitation events as a probable cause.

Paired wells located in close proximity to OSDSs revealed notable concentrations of constituents commonly associated with septic tank effluent (STE) (e.g. $BOD_5$, TKN, P). These constituents are not exclusively derived from STE, but have other anthropogenic and natural sources in the environment. Nevertheless, the concentrations were high enough in certain wells in all four subdivisions to suggest that STE might have been a contributor. For example, in the subdivisions in Brevard and Dade County, the concentrations of $BOD_5$ and TKN were routinely in the several part per million (ppm) range.

Fecal coliform bacteria were detected on one or more occasions in at least one well in each of the four subdivisions. In each of Polk and St. Johns County, a single sample from a single well revealed very low bacteria concentrations of 10 organisms/100 mL or less. In the subdivisions in Brevard and Dade County, 3 and 4 wells revealed fecal coliforms, respectively, with the concentrations in Dade County as high as 17,000 organisms/100 mL.

Volatile organic compounds (VOCs) were not detected in any of the ground water samples collected (method detection limits typically 5 micrograms/L or less), with the exception of one sample in St. Johns County (1.8 ug/L Chloroform).

The ground water monitoring data suggests that it is more appropriate to focus on individual OSDSs and/or small groups of OSDSs, rather than a subdivision as a whole, or "black box". Based on the low seepage velocities, the contaminant migration of even mobile contaminants (e.g. chlorides, nitrates) would be expected to be limited since the subdivisions monitored were relatively young in age (i.e. < 20 yr. old). In these settings, the downgradient, horizontal distances that contaminants theoretically could travel was correspondingly low. As a result, these younger subdivisions may not exhibit single plumes of ground water impact, but rather many individual plumes, possibly from each household.

## INDIVIDUAL OSDS MONITORING

The monitoring of individual OSDSs to date has occurred at each of four homes in the study subdivisions in Polk County and in St. Johns County. These two study sites were characterized by fine sandy soil profiles which were well drained and somewhat poorly drained, respectively.

At each home the work included:

- Household and OSDS characterization.
- Wastewater (STE) effluent characterization.
- Septage characterization.
- OSDS infiltration system operation monitoring.

In addition, at two of the homes in each subdivision, the following additional work has occurred:

- Soil sampling at the OSDS infiltrative surface and at 2 and 4 ft. beneath it at each of two locations.

Wastewater and septage characterization included analyses for a suite of constituents including: temperature, pH, specific conductance, chlorides, $BOD_5$, TDS, total suspended solids (TSS), fats, oils and greases (FOG), TKN, nitrite plus nitrate nitrogen ($NO_2$+$NO_3$), P, MBAS, fecal coliform bacteria, and virus. OSDS infiltration system monitoring included periodic measurement of the occurrence and depth of ponding. Soil sampling beneath OSDSs included analyses for soil grain size, moisture content, total organic carbon (TOC), TKN, $NO_3$, P, leachable ortho-phosphorus, VOCs and fecal coliform bacteria.

Based on the soils characterization and ground water monitoring in the two subdivisions it was found that soils of the same series name (Ona and Tavares) had distinctly different water table characteristics and drainage classifications between subdivisions. This was apparently due to significant water table changes in the Polk County subdivision over the last 20 years.

Septic tank effluent (STE) at eight homes in Florida contained appreciable concentrations of organics, solids, nutrients and bacteria. Additionally, trace levels of volatile organic compounds (VOCs) were measured. The average total VOCs at each home ranged from 9 to 75 micrograms per liter (ug/L). Toluene was found in almost every sample, while chloroform, and methylene chloride were often detected. At one home, 1,4-dichlorobenzene was detected. The STE concentrations were found to be within the range of those reported in the literature from other locations in the USA. Notable exceptions were STE temperature and TSS which were substantially higher.

Septage sampling at each of the eight homes revealed characteristics consistently lower than those in the literature. This may have been due in part to the relatively high septage temperatures observed (27 to 32°C). Concentrations of most constituents in the septage (e.g. $BOD_5$, TKN, P, VOCs) were about 5 to 10 times higher than those in the STE. Concentrations of TSS and FOG were approximately 20 times higher.

OSDS infiltration surfaces in the subdivision in St. Johns County were commonly closer than 2 ft. to ground water during portions of the year. One of the systems monitored appeared to have been in the saturated zone during part of this study based on monitoring well and OSDS data collected.

A suite of STE constituents were measured in soil samples collected at the infiltrative surface, 2 ft. below the infiltrative surface and 4 ft. below the infiltrative surface. Concentrations generally decreased considerably with depth below the infiltration area in unsaturated soils. Fecal coliform bacteria were found at the 2 ft. depth in only one of the sampled systems (St. Johns County). VOCs were not measured above detection limits in samples 2 ft. or more below the infiltrative surfaces of the OSDSs studied.

## PRELIMINARY CONCLUSIONS

This progress report presents the first results of field monitoring of ground water below unsewered subdivisions and monitoring of the performance of individual OSDSs. Several parts of the scope of work remain, including completion of the virus analyses. Interpretation of the current results as discussed herein may need further analysis and refinement in light of this. Therefore, the following conclusions are offered at this time based only on the results presented in this progress report.

The findings to date revealed that STE and septage generated in Florida contained substantial concentrations of pollutants and were generally similar in character to that which has been observed elsewhere in the USA. Notable exceptions were the lower concentrations of most constituents in septage and the higher suspended solids in STE. These may be attributed to the comparatively higher temperatures of both waste streams.

For STE disposed of in OSDS infiltration systems in Florida, the presence of at least 2 ft. of unsaturated fine sandy soil provides a relatively high degree of treatment for most constituents. Ground water quality in the vicinity of relatively new subdivisions (i.e. < 20 yr. old) served by individual OSDSs has not suffered substantial widespread contamination. However, localized areas of potential impact have been observed in all four subdivisions, particularly those in Brevard and Dade Counties.

It appears that in the hydrogeologic settings examined, the high OSDS densities in relatively new subdivisions have not resulted in higher degrees of ground water contamination than might be found adjacent to individual OSDSs in similar, but less densely populated areas. If subdivision wide impacts are to occur, they may simply take decades to manifest themselves due to the low ground water seepage velocities.

## RESEARCH STATUS

This progress report contains a synopsis of prior research as well as details of the methods and results of the recently conducted research as described above. This report combines and expands upon the information contained in two draft reports issued in July 1988: 1) Progress Report on the Monitoring of Individual OSDS in Two Florida Subdivisions, Ayres Associates and 2) Preliminary Results of OSDS Subdivision Ground Water Monitoring, Kirkner & Associates.

Further work remains to complete the research activities reported herein, notably the analysis and interpretation of the measurements made for virus. Additional monitoring of the four study subdivisions, including individual OSDSs and ground water quality is needed to further the understanding of the performance and ground water quality impacts of high density OSDSs.

## SECTION 2
## INTRODUCTION

### BACKGROUND

The State of Florida continues to experience a rapid rate of growth, with a significant portion occurring in new developments beyond the reach of municipal sewer services. Homes and business establishments in the unsewered areas must rely on onsite sewage disposal systems (OSDS) for wastewater treatment. OSDSs are subsurface infiltration systems that utilize the soil's capacity to treat the wastewater before ultimate recharge to the ground water. Currently, over 1.5 million households in Florida utilize OSDSs (Ayres Associates, 1987). Since 1983, permits for new OSDS installations in Florida have averaged over 60,000 annually, according to records of the Florida Department of Health and Rehabilitative Services (HRS). Many of the OSDSs in Florida occur in subdivisions of over 200 homes on 0.25 to 0.5 acre lots.

As a result of the number and densities of new OSDSs being permitted each year, concerns developed as to whether present OSDS regulations and practices were adversely influencing the public health and water resources of the State. To protect these vital resources, practices for treating and disposing of sewage in unsewered areas of Florida are being evaluated through a multi-year research project. Even though onsite sewage treatment and disposal have been studied by investigators in the U.S. and abroad for over 40 years, many important questions remain. This is particularly true in Florida where unique soil, hydrological and climatic conditions exist. A thorough knowledge of the capabilities of Florida's soils to treat sewage is needed to predict the impacts of present and projected development and to enable effective onsite system regulation and land use planning.

This research project was authorized under the Florida Water Quality Assurance Act of 1983, which provided for a three dollar surcharge on each OSDS construction permit issued in the State during fiscal years 1983 to 1988. The project is being directed by Ayres Associates of Tampa Florida with the project tasks conducted by a team of scientists and engineers. The work reported herein was conducted by personnel from Ayres Associates, Kirkner and Associates of Lake Wales, Florida, and private and public laboratories within the State. The project is supervised through the HRS Environmental Health Office in Tallahassee.

The fundamental goal of this project is to ensure that OSDS practice in Florida protects the public health and water resources of the State through the application of technically sound State guidelines for management of onsite sewage disposal systems. These guidelines include site evaluation procedures, design criteria, installation techniques and management requirements. To achieve this goal, the research project has been divided into three major areas of study. These are: 1) to assess the impacts of OSDS use on ground waters, particularly in locations of high OSDS densities; 2) to evaluate the capabilities of Florida soils to accept and treat wastewater; and 3) to evaluate current OSDS practice in Florida and, based on the results of the other two areas of study, recommend appropriate revisions to Chapter 10D-6, Florida Administrative Code (FAC).

The phase of the research reported herein included two major areas of activity. Shallow ground water below unsewered subdivisions was monitored to determine if high-density use of OSDSs. in subdivisions had a significant impact on ground water quality near the subdivisions. Individual household OSDSs within the subdivisions were also studied to assess the wastewater treatment capabilities of the soils in which these systems were installed. Standard contaminants such as biochemical oxygen demand ($BOD_5$), suspended solids (TSS) and nitrates ($NO_3$) are being studied along with less studied environmental contaminants such as volatile organic compounds (VOCs) and virus.

## OBJECTIVES AND SCOPE

### Subdivision Ground Water Monitoring

To determine whether OSDS use in subdivisions is seriously detrimental to ground water quality, the shallow ground water Below high density unsewered subdivisions was monitored. One subdivision located in each of four different hydrologic settings of Florida have been under study. These subdivisions are located in Polk, St. Johns, Brevard, and Dade Counties. Site hydrogeologic conditions and ground water quality impacts were assessed by surface geophysical methods and the installation and sampling of ground water piezometers and monitoring wells.

### Individual OSDS Monitoring

The objectives of the individual OSDS monitoring were twofold. First, it was desired to characterize the quality of septic tank effluent (STE) from homes typical of those in the subdivisions studied. This characterization was mainly to confirm that STE quality was similar to literature values and to allow comparison of any contaminants found in soil and ground water monitoring with those discharged by household septic tanks in the subdivisions. The second objective was to evaluate the retardation and/or degradation of typical pollutants in STE as it percolated through unsaturated soil below the drainfield, or infiltration system of the homes studied. This so-called "treatment capability" could then be used to assess the likelihood of ground water contamination from an individiual OSDS source.

Individual OSDSs at four homes in each of two subdivisions have been under study. The individual systems studied were in the subdivisions in Polk and St. Johns County. At each home, the household and OSDS characteristics were determined, the STE and septage were characterized, and the operation of the OSDS was assessed. At two of the individual OSDSs in each of these subdivisions, soil sampling was conducted at and beneath the STE infiltrative surfaces.

## SECTION 3
## SYNOPSIS OF PRIOR OSDS PROJECT RESULTS

Several components of the first two study areas of the HRS Onsite Sewage Disposal System Research Project have been completed since the study began in 1986. Florida soil types have been evaluated as to how they were distributed geographically and which soils supported most of the current and projected future OSDS installations in the State (Ayres Associates, 1987; Sherman et al., 1988). The characteristics of these soils which affect their ability to accept and treat septic tank effluent (STE) were outlined. Also, information was gathered and presented on the OSDS design types most often used in Florida.

Results of this initial task helped identify which soils were most important to study in later parts of the research. It was found that soils with severe limitations for conventional OSDSs, as defined by the Soil Conservation Service (SCS), are increasingly the sites for developments using OSDSs. Also, it was estimated that 75% of current and projected future OSDS installations would be located in counties near Florida's metropolitan areas. Highest uses of OSDSs were predicted to continue in urban fringes of the State and more and more on soils poorly suited for OSDSs. The key soil limitations for concern and future study appeared to be related to high water table conditions in rapidly permeable sandy soils. OSDS use in these conditions has the greatest potential to result in ground water contamination.

A second component of the OSDS project was a ground water contamination risk assessment using computer simulation techniques (Kirkner and Associates, 1987; Voorhees and Rice, 1987; Anderson et al., 1988). The objective of this phase of the research was to assess the relative potential of various surficial aquifer conditions in Florida for contamination from high density OSDS use (i.e., subdivisions on OSDS). This work was to facilitate the selection of subdivisions for field monitoring.

As part of this phase of study, a computer contaminant transport model was developed which utilized uncertainty analysis in the evaluation of input parameters (Voorhees and Rice, 1987). This allowed the input of mean parameter values as well as a measure of the degree of spread (uncertainty) of the parameter based on its distribution in the field. No single value of porosity, for example, was appropriate to a given region because a whole range of porosity values may exist in nature. By using statistical measures of this range as input to the contamination model, a distribution of contaminant concentrations could be predicted rather than a single value. This distribution was indicative of the range of contamination which might occur from an OSDS subdivision in the region modeled. The results of the modeling study provided useful insight into the direction of the remaining research effort.

As expected, seepage velocity (the speed of water flow within an aquifer) had the greatest effect on contaminant transport. However, both high and low seepage velocity conditions showed reasons for potential concern. In surficial aquifer settings with high seepage velocities, contaminants moved much further down gradient from the source, but were reduced in concentration. In contrast, low seepage velocities resulted in less transport but higher concentrations of contaminants. Dispersivity was also an important parameter in the analysis, since it combined with the seepage velocity to describe contaminant spread.

Although the trends which resulted from the modeling effort were as expected, the relative values of the results were more interesting. For example, the model showed that a 50 acre subdivision of 200 homes may cause nitrate contamination of concern in several hydrogeologic settings. Another result of interest was the length of time for contamination to reach maximum concentrations from such subdivisions under typical Florida surficial aquifer gradients. The computer simulations suggested that twenty to thirty years may be necessary to reach ultimate contaminant concentrations downgradient from OSDS subdivisions under certain conditions (Anderson, et.al., 1988).

The research reports and papers describing the work to date include:

- Ayres Associates. 1987. Onsite Sewage Disposal System Research in Florida: Impact of Florida's growth on the Use of Onsite Sewage Disposal Systems.

- Kirkner & Associates. 1987. Risk Assessment of Onsite Sewage Disposal Systems for Selected Florida Hydrologic Regions.

- Voorhees, M. L. and J. M. Rice. 1987. Application of Sensitivity and Second Order Uncertainty Analysis in Formulating Regional Groundwater Contamination Risks and Data Sensitivities.

- Anderson, D. L., J. M. Rice, M. L. Voorhees, R. A. Kirkner and K. M. Sherman. 1988. Groundwater Modeling with Uncertainty Analysis to Assess the Contamination Potential from Onsite Sewage Disposal Systems in Florida.

- Sherman, K. M., D. L. Anderson, D. L. Hargett, R. J. Otis and J. C. Heber. 1988. Florida's Onsite Sewage Disposal System (OSDS) Research Project.

- Ayres Associates. 1989. Performance monitoring and ground water quality impacts of OSDSs in subdivision developments. (This report).

Complete citations for the above may be found in the References section of this report.

# SECTION 4
# SITE SELECTION AND CHARACTERIZATION

This section contains a description of the process used to select specific sites for monitoring including subdivisions and individual OSDSs therein. Four subdivisions were selected for ground water monitoring; one in each of the following counties:

- o Polk County,
- o St. Johns County
- o Brevard County, and
- o Dade County.

Eight individual OSDSs were monitored, four in each of the subdivisions in Polk and St. Johns County.

## SUBDIVISION GROUND WATER MONITORING

### Site Selection

The selection of OSDS monitoring sites was a cooperative effort on the part of the investigative team and personnel from various city, county, and Florida state governmental agencies. Subdivisions throughout the State were screened for suitability for inclusion in the study according to a comprehensive list of parameters including location, density of systems, age of systems, conformance to current HRS construction codes, and other criteria. Several of the more heavily weighted criteria used in the selection process are discussed below.

The preliminary research effort focused on locations that represented the diverse hydrogeology of the State (Kirkner and Associates, 1987). Areas were selected from this group which included ridge and coastal environments. Areas of the State experiencing very rapid population growth were also identified as vulnerable to impacts because of the proliferation of septic systems. The components of the hydrogeologic regime of the subdivision such as soil type, thickness of the unsaturated zone, and subsurface lithology influence the importance of its location. The proximity of potential interferences such as adjacent agriculture, industry and other subdivisions also limited the location criteria.

The number of homes and consequent number of OSDSs situated within a limited area was considered an important factor in determining the extent of potential impacts to ground water by the OSDSs. The subdivisions required a sufficient number of operating OSDSs installed on 0.25 to 0.5 acre lots to supply the potential impacts. The initial screening keyed on subdivisions containing sixty (60) or more homes with year round occupancy. This criteria removed seasonal residential developments from consideration.

The age of the OSDSs was important in two respects. In the first place, the longer the OSDSs were in operation, the greater the potential for impacts to the underlying ground water. Secondly, the OSDSs must have been installed in accordance with the new revisions to Chapter 10D-6 which went into effect in 1983. Unless the OSDSs within a subdivision were proven to be in accordance with the new code, this criteria limited the selection to systems installed following adoption of the code. This fact limited the age of OSDSs selected.

## Site Characteristics

Subdivision sites in four counties were ultimately selected for inclusion in this study, including one each in Polk, St. Johns, Brevard and Dade County. The location of each site in Florida is shown in Figure 4.1 and the general subdivision characteristics are summarized in Table 4.1. Details regarding the natural resource characteristics of each site are given below.

### Polk County Subdivision --

A subdivision site located in northwestern Polk County was selected to evaluate OSDS ground water impacts in an upland environment within the Central Florida Ridge land resource unit.

The climate of Polk County is subtropical and is characterized by warm humid summers and moderately cool winters. Annual average rainfall is approximately 52 in. Rainfall is seasonal with about 65 percent occurring during the months of June through September. During these months, the rain usually falls from localized convective thunderstorms.

Polk County is located in the Central Highlands physiographic division as defined by Cook (1939). These highlands parallel the longitudinal axis of the Florida peninsula. The major topographic features in the county are three long, irregular, and generally parallel, north-south trending ridges which are separated and bounded by relatively flat lowlands.

The ridges are flanked by solution features commonly referred to as sinkholes. The sinkholes are formed by the lowering of surficial sand and clay units into voids in the underlying limestone units. Many of these sinkholes have filled with water, creating the numerous lakes common to this part of Florida.

The subdivision site is situated on the eastern flank of the Lakeland Ridge in northwestern Polk County. The general location of the study area is depicted on Figure 4.2. The Lakeland Ridge is the westernmost of the three ridges described above and begins approximately ten miles northwest of Lakeland, extending south-southeastward towards Ft. Meade (White, 1958). Altitudes along the crest of the Ridge range from 150 to 270 ft. above mean sea level (MSL) (Figure 4.3). Land surface at the site ranges in elevation from 120 to 140 ft. above MSL.

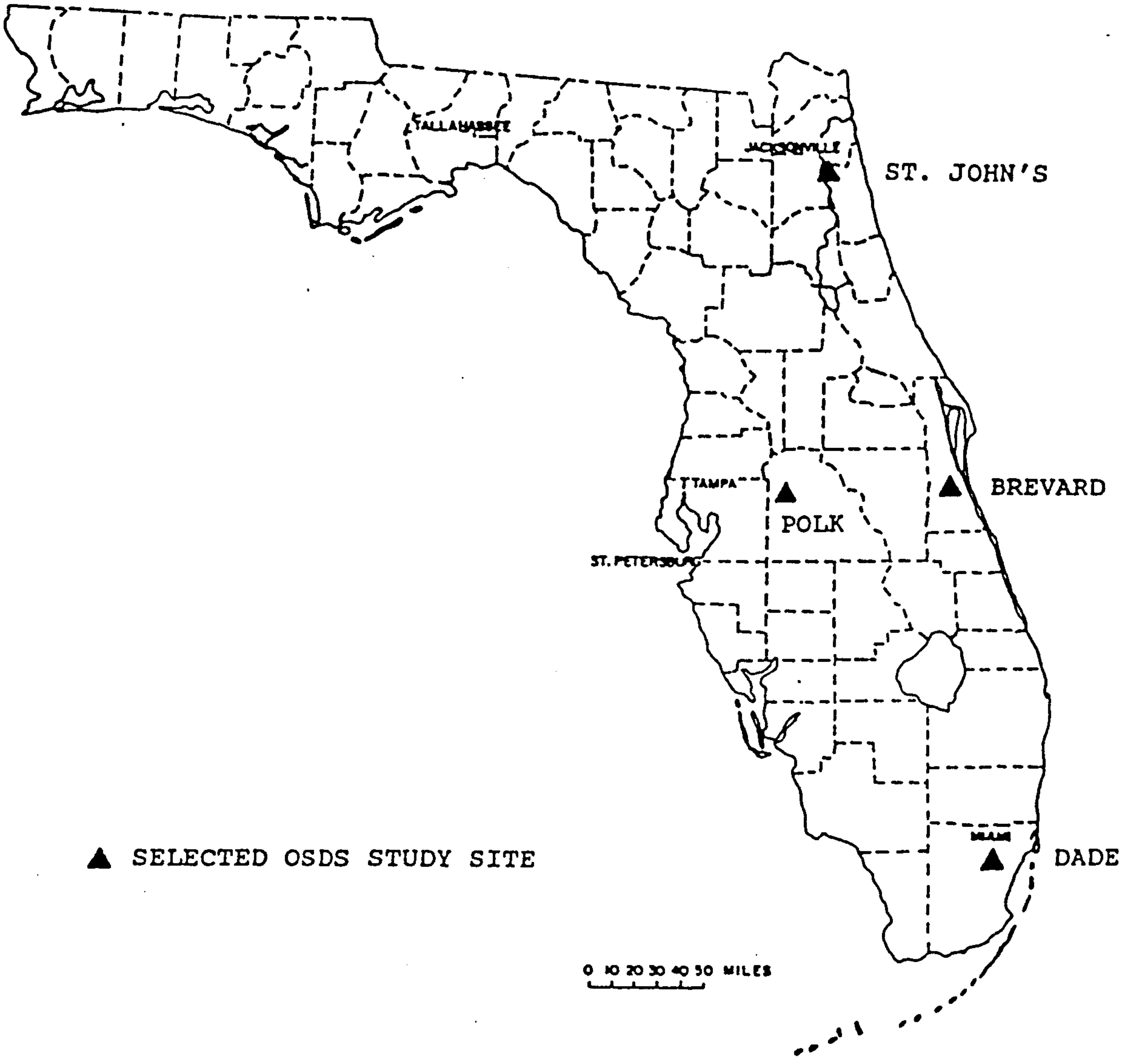

Figure 4.1. Locations of subdivisions selected for study.

Table 4.1. General characteristics of four subdivisions studied.[1]

| County | Land Resource Unit | Total Lots (no.) | Existing Homes Number (no.) | Lot Size (acres) | Age Range (yr.) |
|---|---|---|---|---|---|
| Polk | Central Florida Ridge | 118 | 67 | 0.26 | 0 - 14 |
| St. Johns | North Florida Flatwoods | 300 | 185 | 0.34 | 0 - 22[2] |
| Brevard | Central/South Florida Flatwoods | 155[3] | 72 | 0.23 | 0 - 5 |
| Dade | Everglades | 90 | 63 | 0.31 | 0 - 3 |

[1] Characteristics shown were present at the start of the subdivision monitoring work which began in 1987. The lot size shown is typical.

[2] Only one home was 22 years old. The next oldest home was 13 years old.

[3] Part of a 75,000 lot subdivision development.

Surface drainage in the area is poorly defined due to the thickness and generally high permeability of the surficial sand units. The runoff that does occur is mainly confined to the numerous closed basins within the ridges. The regional surface water drainage features that are best developed occur between the ridges and generally flow toward the south.

The surface water drainage within the site vicinity is restricted by its location on a topographically high sand ridge. The extremely permeable and relatively thick surficial sand units encourages very rapid rainfall infiltration. Stormwater surface drainage is conveyed via storm drains into a lake which is located at the north end of the site in a topographically low area.

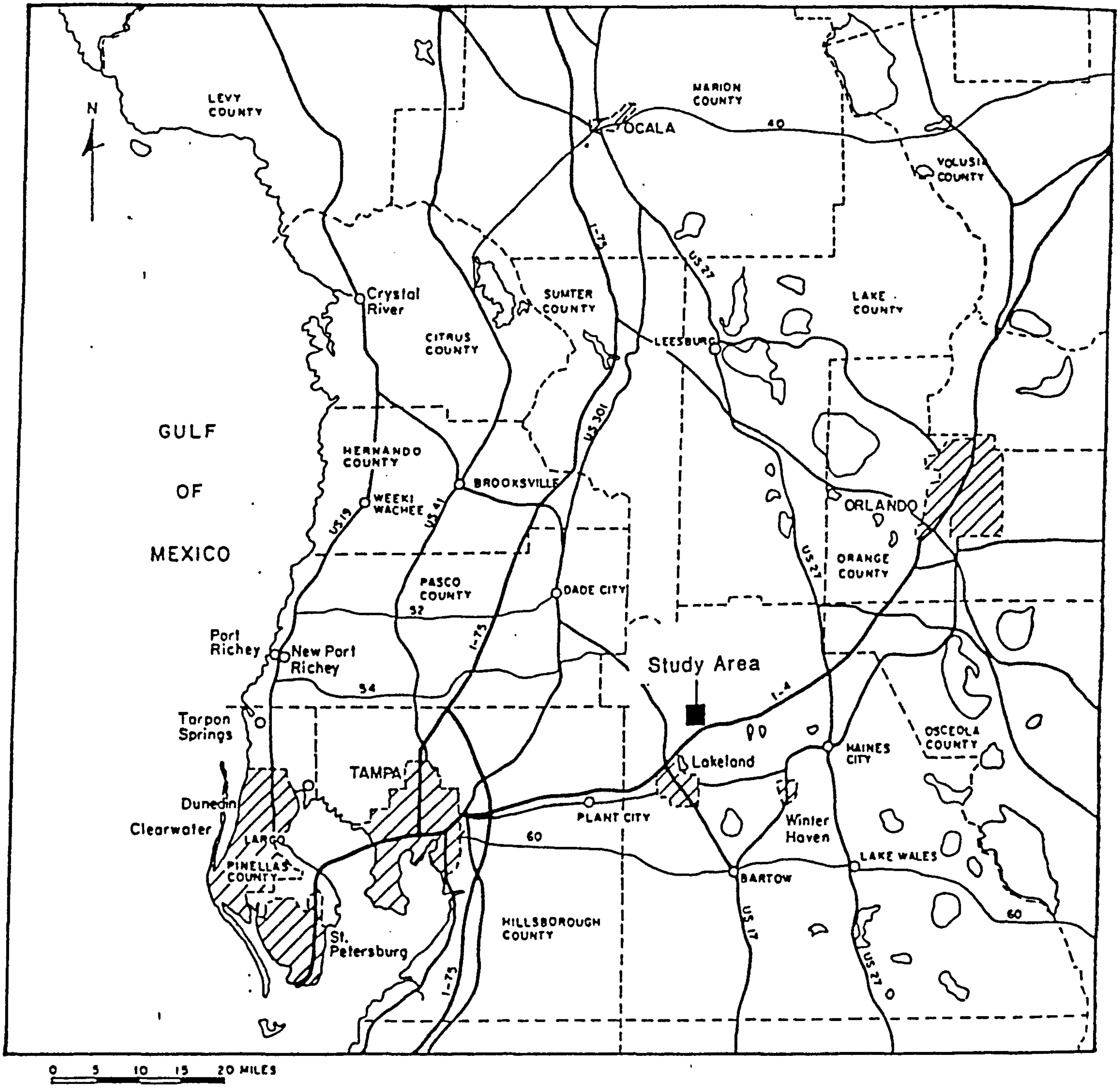

Figure 4.2. Location of the subdivision site in Polk County, Florida.

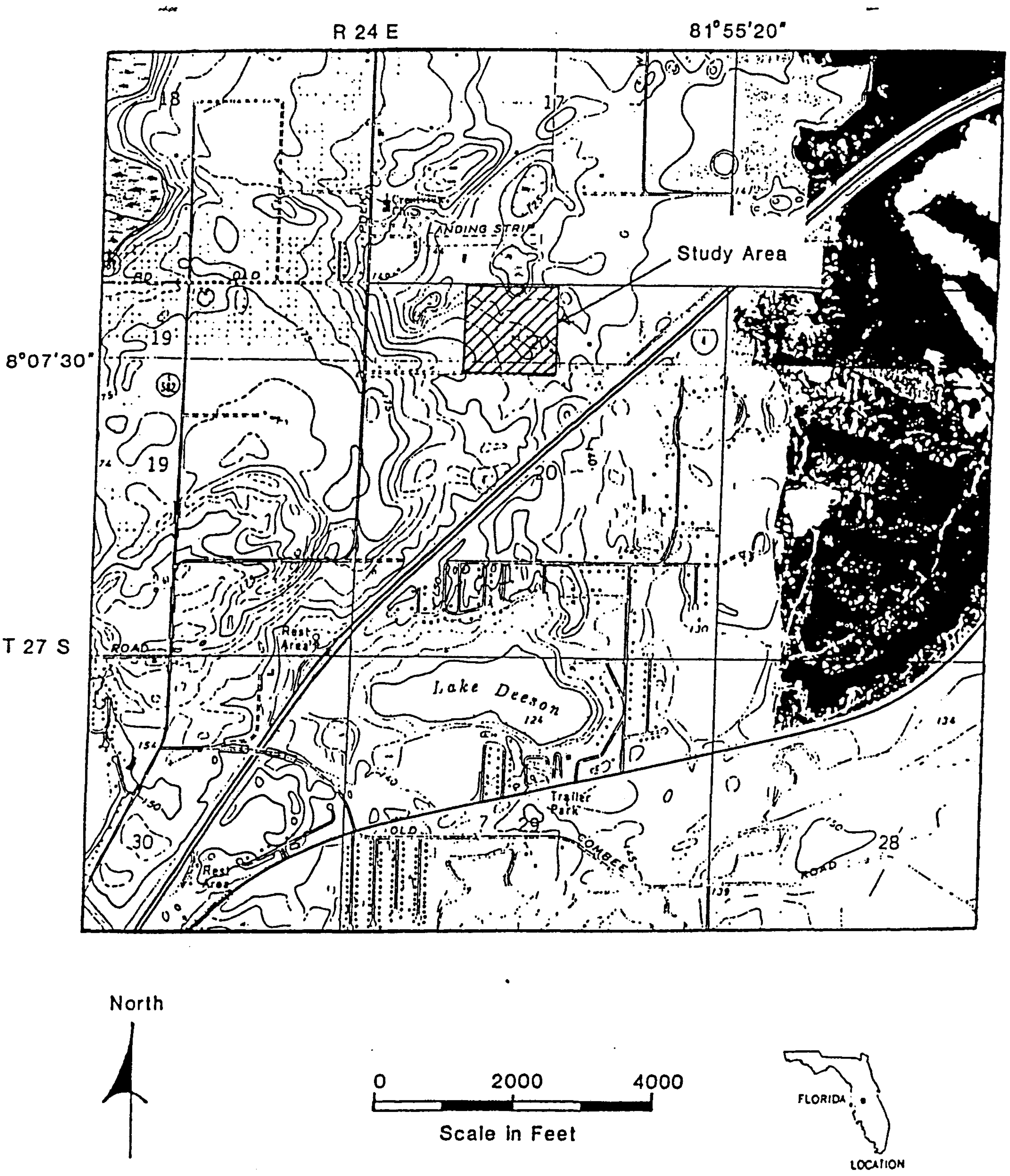

Figure 4.3. Topographic map of the subdivision site in Polk County.

The region is underlain by two major hydrogeologic units of differing lithologies. The uppermost unit consists of clastic sediments made up of poorly to moderately consolidated sands, clays, clayey sands and sandy phosphatic clays of Recent to Miocene Age. Over much of the area, sandy clays containing phosphatic gravel are overlain by sandy clays and sands that are leached of their phosphate content. The monitoring wells installed at the site penetrated no deeper than the leached sands and sandy clays. This upper unit is commonly referred to as the surficial or water table aquifer. Below the surficial aquifer, the sediments consist of sandy clays and phosphatic gravel which contain the majority of the phosphate mined in the region. Permeable units within this interval are generally of non-uniform thickness and lateral extent and may form intermediate aquifers in the area. Low yield wells completed in these aquifers generally produce water containing excessive concentrations of iron and radionuclides.

Underlying the surficial clastic sediments is the Hawthorn Formation which consists of massive, interbedded sandy clays and limestones. The clays are soft, sandy, phosphatic, and usually gray to dark bluish or greenish gray. The limestone units are light-cream to tan, very sandy, clayey, phosphatic, and may form intermediate artesian aquifers in localized areas of higher permeability. The Hawthorn is the primary confining unit between the surficial and Floridan aquifer and is found approximately 60 ft. below the surface in the site area.

Underlying the Hawthorn is a thick sequence of limestone and dolomite, commonly called the Floridan aquifer (Parker et al., 1955). The Floridan is of Miocene to Eocene age and is estimated to be well over 1,000 ft. thick in the study area. Ground water in the aquifer is confined by the overlying clays and sandy clays and therefore exhibits artesian characteristics. In recent years, the potentiometric surface of the upper part of the Floridan in this area has fluctuated from a low of 88 ft. above MSL (May 1984) to a high of 98 ft. above MSL (September 1986).

The direction of ground water flow is generally in a westerly direction towards the Gulf of Mexico. The majority of the water supplies for all types of usage in Polk County are obtained from the Floridan aquifer.

St. Johns County Subdivision --

A subdivision site in St. Johns County was selected to evaluate ground water impacts in a fine sand environment with a high water table. St. Johns County is located in northeastern Florida in the North Florida Flatwoods land resource unit.

The climate of St. Johns County is subtropical and is characterized by warm, humid summers and mild, dry winters with occasional frost from November to February. Annual average rainfall is approximately 54 in. Rainfall is seasonal with the majority falling during the months of June through September. During these months, the rain usually falls from localized heavy showers of short duration.

The subdivision site is located in the physiographic province referred to as the Coastal Lowlands. The general location of the study area is shown in Figure 4.4. The topography of the lowlands is controlled by a series of marine terraces (Cooke, 1945) which were formed during Pleistocene time. Terrace development occurred as the sea fluctuated above and below its present level in response to global climatic variations during the Ice Ages. As the sea retreated to a lower level, the sea floor emerged as a level plain or terrace. The landward edge of each terrace became an abandoned shoreline with an abrupt scarp separating it from the next terrace. Seven terraces are recognized in northeast Florida. Two of these, the Pamlico and Silver Bluff terraces, are encountered in the site area and form a low coastal plain with elevations from 0 to 25 ft. above MSL. Figure 4.5 is a topographic map of the study area.

Surface drainage in the area is primarily through the St. Johns River and its tributaries. The St. Johns River generally flows northward to the Jacksonville area where it turns sharply toward the east and empties into the Atlantic Ocean. The streams on the marine terraces generally flow north or south parallel to the coastline where beach ridges prevent the streams from draining directly into the ocean.

The surface water drainage at the site is restricted by its location on a relatively flat topographically high area. The extremely permeable unsaturated zone within the surficial sand units encourages very rapid rainfall infiltration. The majority of surface runoff within the subdivision is directed south-southeastward towards a local topographic depression referred to as the undeveloped area in Figure 4.5. Drainage ultimately enters the St. Johns River via Cunningham Creek.

The region is underlain by two major hydrogeologic units of differing lithologies. The uppermost unit consists of clastic sediments including poorly to moderately consolidated sand, clay and shell material of Miocene to Holocene age. This overlies a thick sequence of limestone and dolomite, commonly called the Floridan aquifer (Parker et al., 1955).

Undifferentiated sediments of Pleistocene and Holocene age blanket the majority of the area. These sediments were deposited during the formation of marine terraces and beach ridges and are primarily composed of medium to fine grained quartz sand with some local iron oxide staining. This lithology is typical of the surficial sediments in the site area. Other areas exhibit thin, gray, sandy clay beds, which may contain mollusk shells, or discontinuous layers of red-brown hardpan composed of slightly to well-indurated iron-oxide cemented quartz sand. The thickness of the Pleistocene and Holocene deposits in the area ranges from less than 10 to about 100 ft. (Fairchild, 1972).

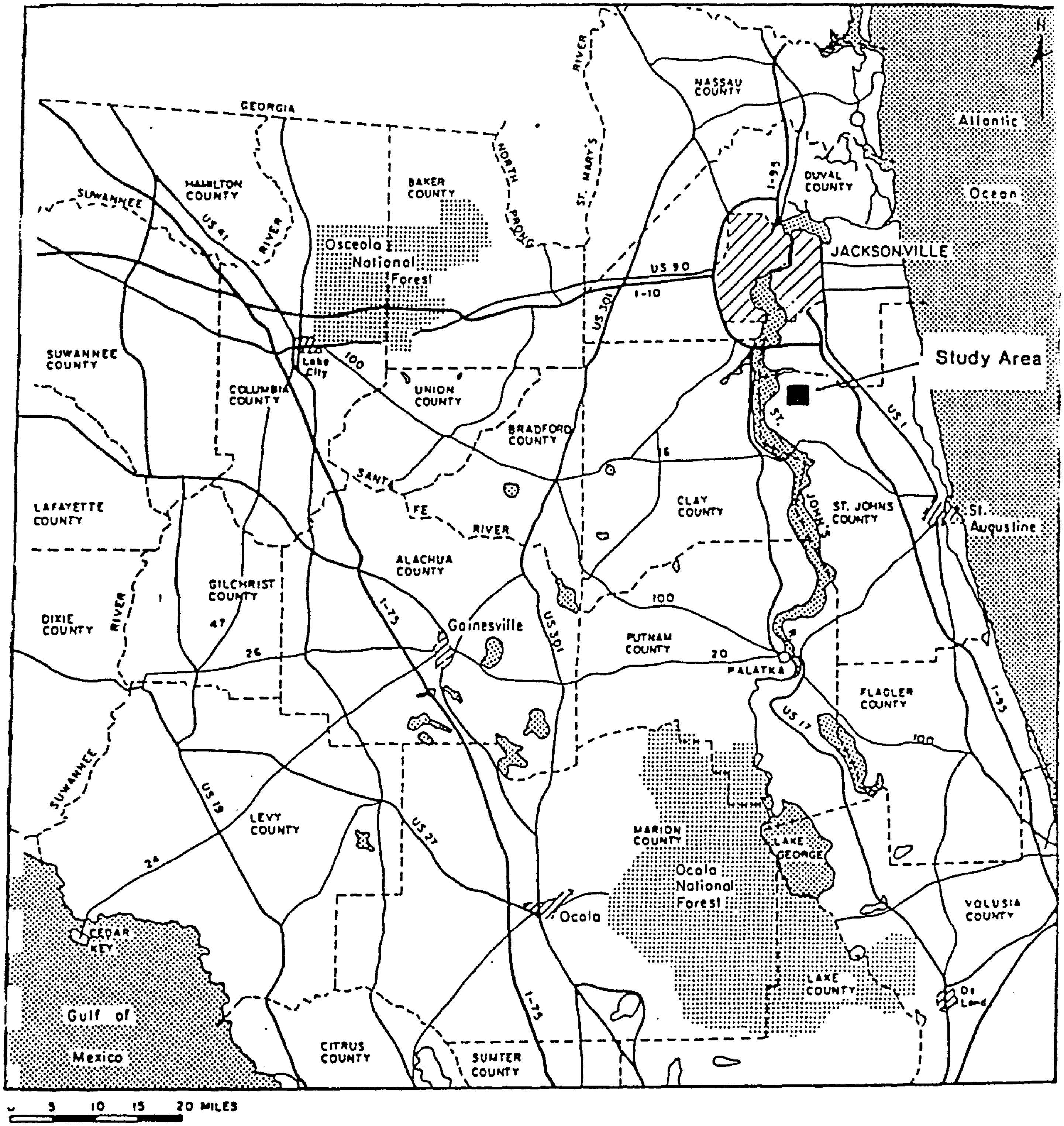

Figure 4.4. Location of the subdivision site in St. Johns County, Florida.

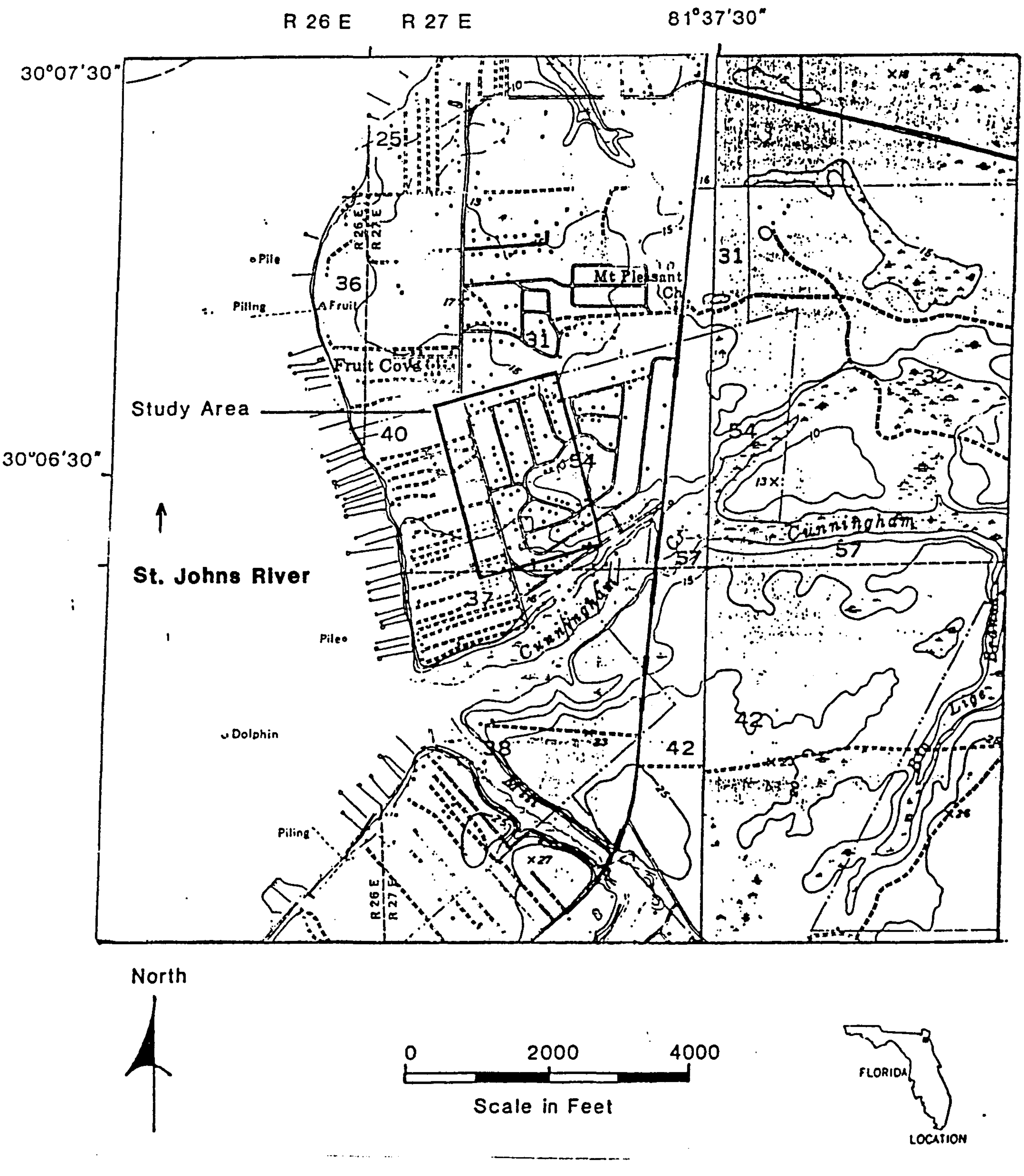

Figure 4.5. Topographic map of the subdivision site in St. Johns County.

Brevard County Subdivision --

The subdivision site in Brevard County was selected to determine the effects of OSDSs on ground water in a coastal area. The study area is shown in Figure 4.6 and is located within the Central and South Florida Flatwoods land resource unit.

The climate of Brevard County is subtropical and is characterized by warm humid summers and mild dry winters. Annual average rainfall is approximately 53 in. Rainfall is seasonal with the majority occurring during the months of May through October. During these months, the rain usually falls from localized heavy showers of short duration.

The subdivision site is located in the Coastal Lowlands physiographic province as classified by Cooke (1939). The principal geographical features are the St. Johns River valley and the Atlantic Coastal Ridge. The St. Johns River valley encompasses the central and western portion of the county. The source of the river is St. Johns marsh area in the southern part of Brevard County and adjacent counties to the south. Much of the land adjacent to the river is marshland. When the river is at flood stage this marshland functions as part of the river channel. The upland border of the marshland grades into a sandy or dry prairie zone (Davis, 1943). The prairie zone is part of the river's flood plain and floods frequently. Between the prairie zone and the more elevated coastal ridge is a wide flatwoods forest area of pines, scrub oak and palmetto. The forest area is relatively flat and poorly drained and has numerous intermittent lakes scattered throughout (Brown et al., 1962).

The site is located on the western flank of the Atlantic Coastal Ridge. The ridge ranges from 1.5 to 3 miles in width and is continuous along the length of Brevard County, paralleling the Atlantic coast. The area has a beach dune ridge influenced topography with parallel elongate ridges and intervening swales which contain numerous lakes and marshlands. The coastal ridge ranges in elevation from sea level to 55 ft. above MSL and is the highest land area east of the St. Johns River. Land surface elevation in the site vicinity is approximately 25 ft. above sea level. Figure 4.7 is a topographic map of the site vicinity.

Drainage in the area is influenced by the coastal ridge which forms a natural divide between the St. Johns and Indian River basins. A series of small streams flow eastward out of the ridge area and into the Indian River. Manmade canals which also drain into the Indian River enhance the natural surface water drainage system. The western slope of the ridge is drained by a series of small interconnected lakes which channel water into the St. Johns River.

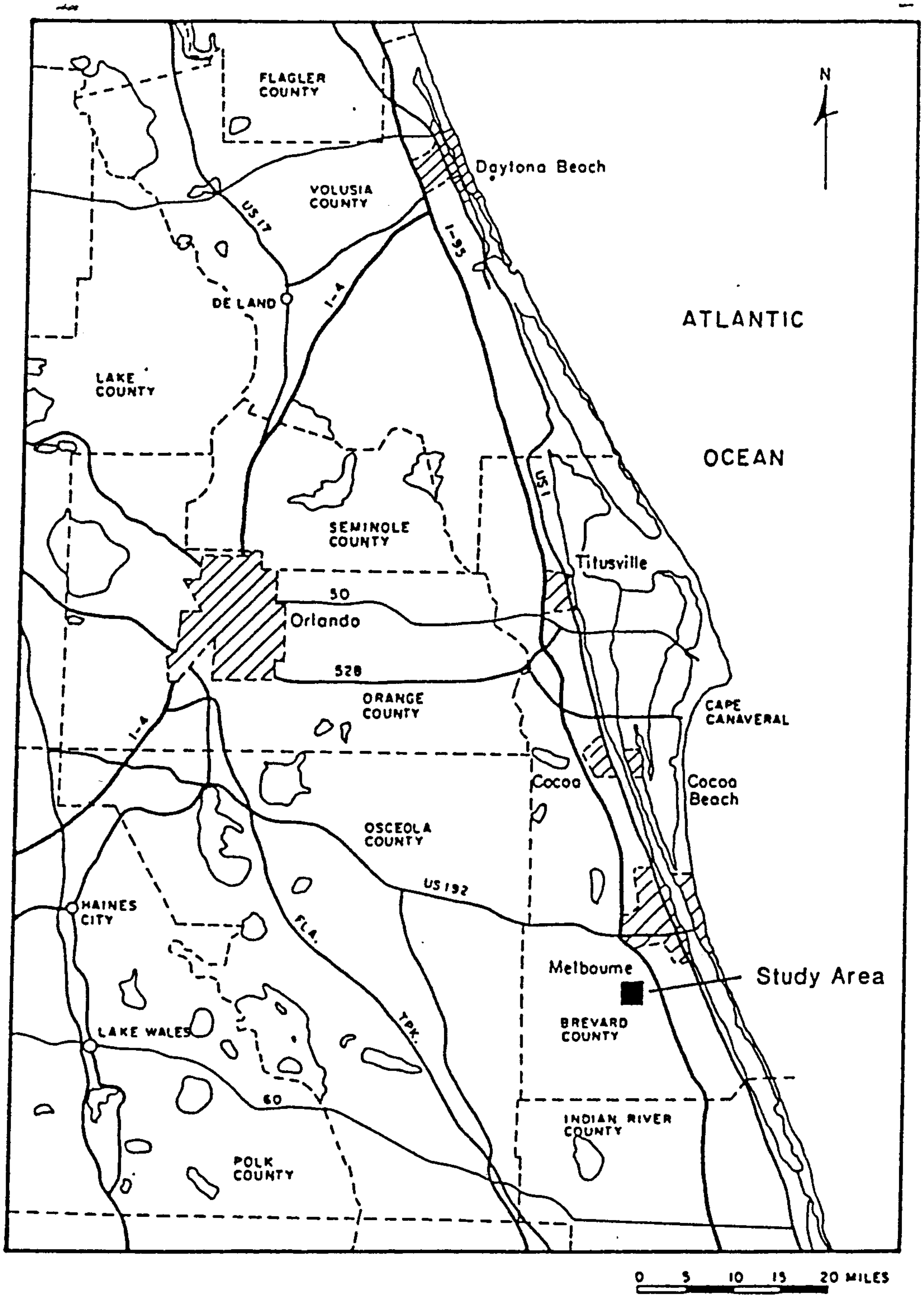

Figure 4.6. Location of the subdivision site in Brevard County, Florida.

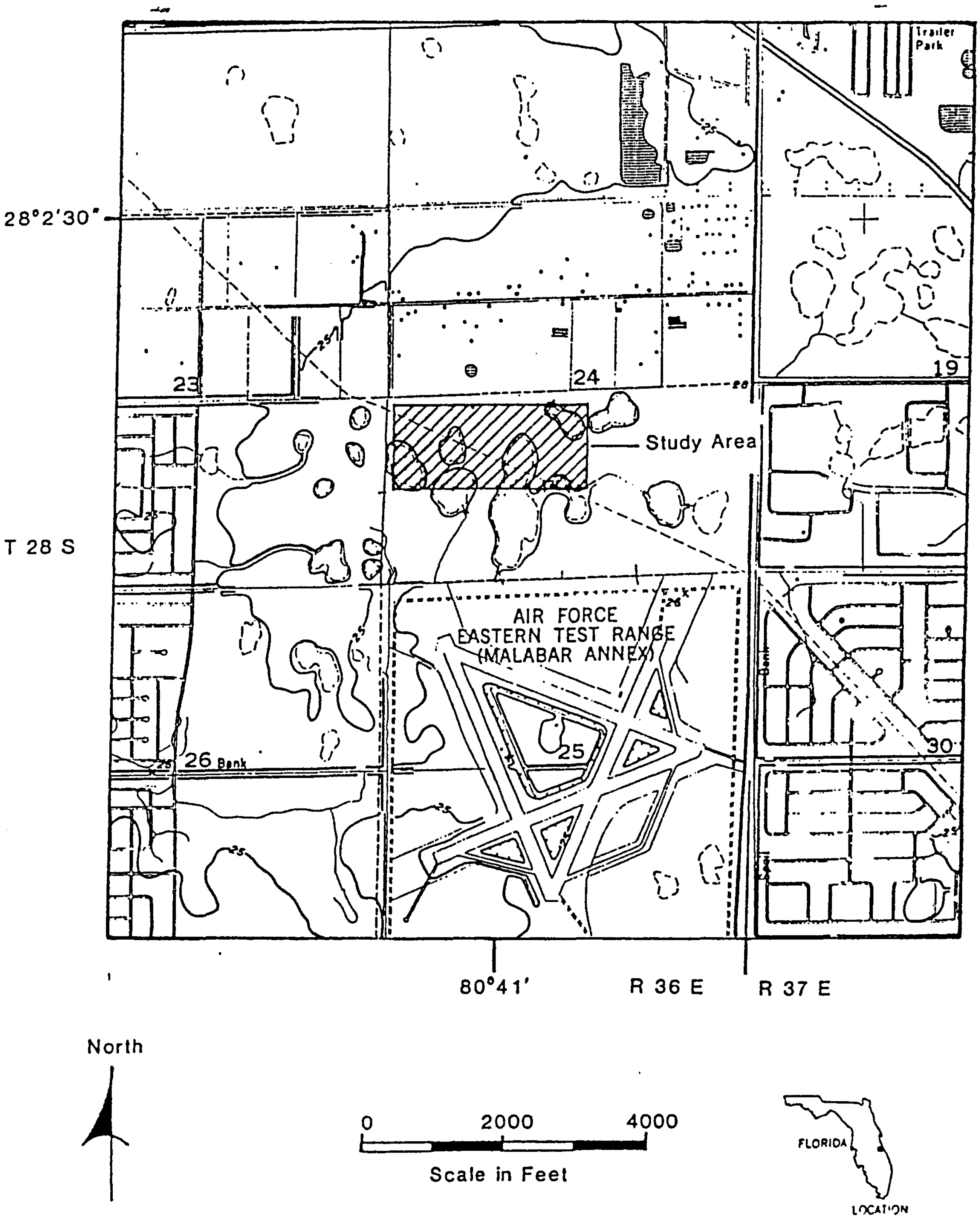

Figure 4.7. Topographic map of the subdivision site in Brevard County.

The natural surface water drainage at the site area is restricted by its location on the generally flat western flank of the coastal ridge. The permeable unsaturated zone within the surficial sand units encourages rapid rainfall infiltration beneath the site and decreasing surface water runoff. Stormwater drainage is directed northward towards a manmade canal which borders the site area.

Undifferentiated sediments of Pleistocene and Holocene age cover the study area and form the surfical or non-artesian aquifer. These sediments were deposited as marine terraces and beach ridges during previous eras of higher sea levels and are primarily composed of fine to medium grained quartz sand with varying percentages of shell fragments and organic material. This composition is typical of the sediments in the site vicinity. The thickness of these deposits in the area ranges from less than 10 to a maximum of 60 ft.

Dade County Subdivision --

The subdivision site in east central Dade County was selected to evaluate ground water quality in a shallow carbonate aquifer. The subdivision site is located in the Florida Everglades land resource area.

The climate in Dade County is subtropical and is characterized by warm humid summers and mild dry winters. Annual average rainfall is approximately 60 in. Rainfall is seasonal with the majority occurring during the months of June through October. During these months, the rain usually falls from localized heavy showers of short duration.

Dade County is subdivided by two physiographic divisions, the Miami Ridge and the Everglades as defined by White (1970). The general location of the study area is shown in Figure 4.8. The Miami Ridge is the southern extent of a persistent ridge which parallels the present shoreline of the east coast of Florida. The northern extent of the ridge is primarily composed of sand. Southward this changes character from almost entirely quartz and other detrital materials, to steadily increasing percentages of calcareous oolite. The north section of the ridge has been modified by wave action during higher stands of sea level and contains several relict beach ridges. Ridge elevations decrease southward coextensive with the mineralogy change and form a broad low swell a few miles wide and approximately 10 to 15 ft. high (White, 1970).

The Everglades is a broad, low lying solution-leveled region with elevations only slightly above the present sea level. A widespread blanket of peat has accumulated and overlies the limestone base throughout the area. This is caused by dissolution of the limestone to the water table, creating the swampy conditions conducive for plant growth and their preservation as peat (Parker & Cooke, 1944).

The OSDS subdivision site is located on the border of the Everglades and the southern extent of the Miami Ridge. Elevations in the site vicinity range from 7 to 10 ft. above MSL. Figure 4.9 is a topographic map of the study area.

The natural surface drainage of the area is poor due to the flat topography and lack of stream channel development. Man made drainage canals, control structures and pump houses almost entirely control the surface water flow in the eastern portion of the county including the site area. These canals generally flow eastward into the Atlantic Ocean. Drainage in west Dade County is primarily into the Everglades..

The area of investigation is underlain by the Biscayne aquifer which is composed chiefly of limestone, sandstone and carbonate sand of marine origin. The limestone units within the aquifer are highly permeable and capable of yielding large quantities of water. The thickness of the Biscayne aquifer is greatest along the coast of the Miami area and thins gradually southward and rapidly westward towards the Everglades. The aquifer generally shows nonartesian characteristics and is of Pliestocene to late Miocene age. It is also the primary supply of fresh water in the area.

## INDIVIDUAL OSDS MONITORING

### Site Selection

Two of the four subdivisions ultimately selected for ground water monitoring were also used for the individual OSDS monitoring phase of the research. The subdivisions in Polk and St. Johns counties were selected because those sites included fine, sandy soils with two extremes of water table and soil drainage conditions. These conditions were typical of those identified in earlier phases of the research as supporting large numbers of OSDSs and being of concern for potential ground water impacts.

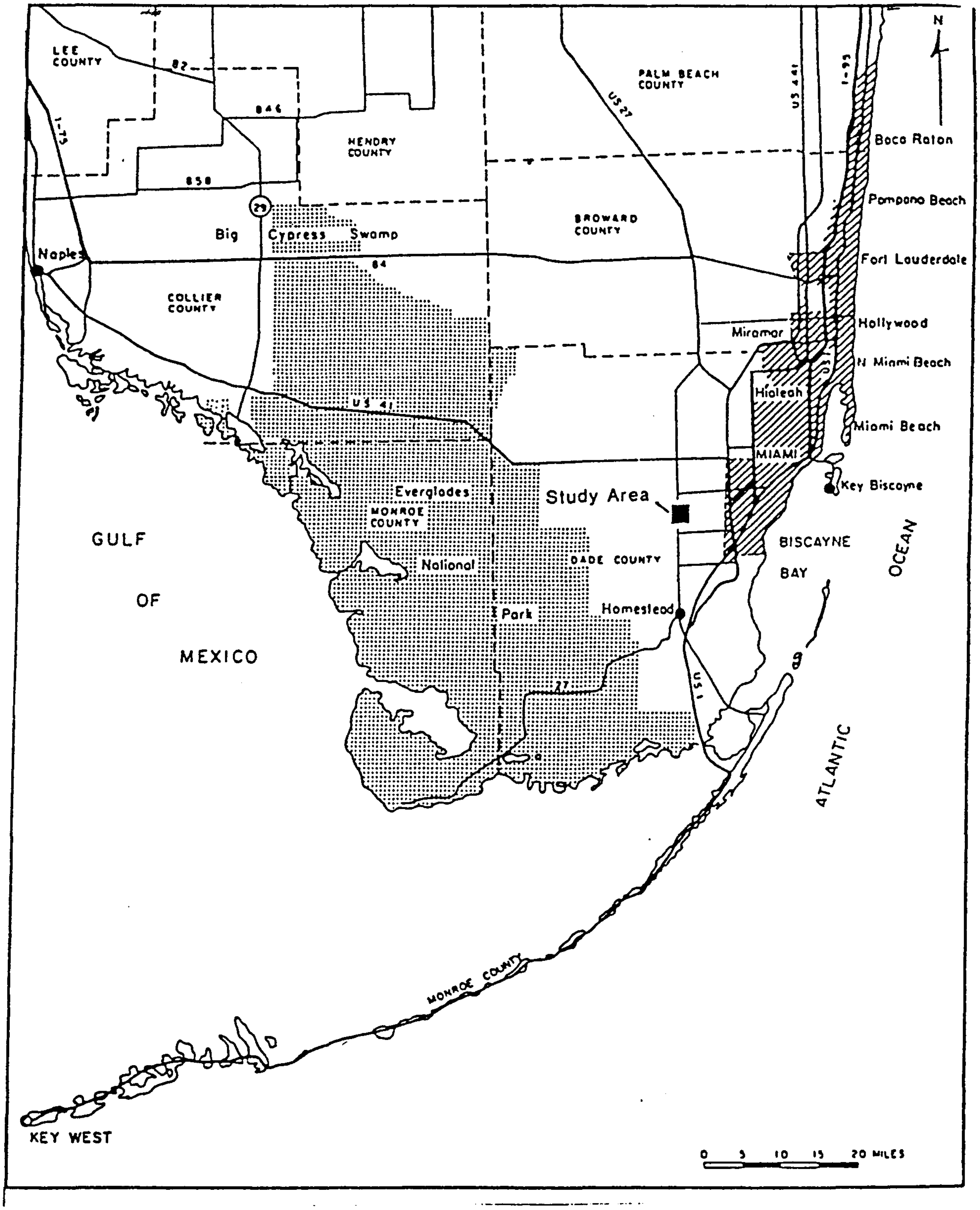

Figure 4.8. Location of the subdivision site in Dade County, Florida.

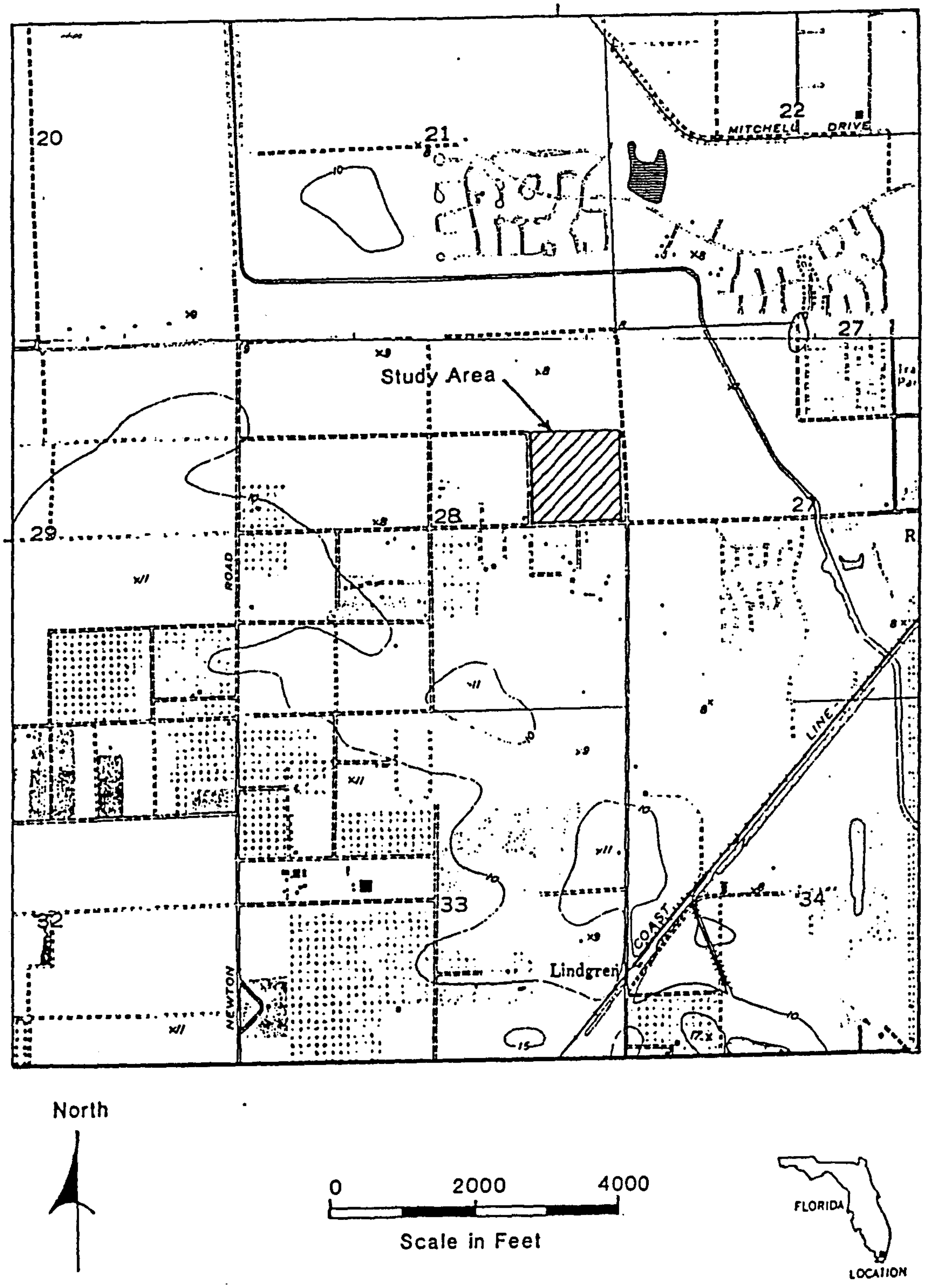

Figure 4.9. Topographic map of the subdivision site in Dade County.

General household characteristics in the subdivisions were determined through a survey questionnaire mailed to homeowners and by conversations with individual homeowners. A copy of the questionnaire is included in Appendix A. The responses to the survey were analyzed to determine mean and range statistics for use in describing the characteristics of each subdivision. These results are presented in Table 4.2 and briefly discussed below.

## Site Characteristics

The subdivision in St. Johns County was considerably larger than that in Polk County, and also had slightly larger average lot sizes (Table 4.2). The portion of the subdivisions which had been developed, based on total number of lots, was similar. The subdivision in St. Johns County had a slightly older average house age at 8.9 years, but the ages ranged from new to about 14 years in both subdivisions with the exception of one home in the subdivision in St. Johns County.

Based on the survey results, the average number of occupants per home was higher in both subdivisions than the State average of 2.5 (BEBR, 1985) and the national average of 2.7 (BEBR, 1986). The subdivision in Polk County had slightly higher household populations (3.4 per home) as compared to St. Johns County (3.1 per home). The distribution of occupant age within households showed a slightly younger average household in Polk County (Table 4.2).

The number and type of water using plumbing fixtures within homes were similar between subdivisions. The average home had two bathrooms, a dishwasher, and a clotheswasher along with other typical household fixtures. One difference between subdivisions appeared to be that fewer homes in Polk County had dishwashers but more had garbage disposals as compared to those in St. Johns County.

The survey questionnaire also addressed the question of septic tank cleanout. Homeowners in the subdivisions were asked how frequently they had their septic tanks pumped. It was common that homeowners had never had the septic tank at their home serviced. Considering the fact that the current occupants had lived in their homes an average of 5.8 years in Polk County and 6.7 years in St. Johns County, these data suggest that septic tanks are being serviced less frequently than the 3 to 5 year interval commonly recommended (U.S. EPA, 1980).

Table 4.2. Detailed characteristics of the study subdivisions in Polk and St. Johns County.[1]

| Description | Units | Polk County | St.Johns County |
|---|---|---|---|
| Subdivision | | | |
| Survey response | % | 45 | 34 |
| Total lots | no. | 118 | 300 |
| Existing homes | no. | 67 | 185 |
| Average lot size | acres | 0.26 | 0.34 |
| Homes | | | |
| Age - average | yr. | 7.6 | 8.9 |
| - range | yr. | 0 to 14 | 0 to 22[2] |
| Occupancy - average | yr. | 5.8 | 6.7 |
| - range | yr. | 0 to 13 | 1 to 13 |
| Residents | | | |
| Occupants - average | no./home | 3.4 | 3.1 |
| - range | no./home | 1 to 6 | 1 to 7 |
| Age - < 2 yr. | no./home | 0.2 | 0.1 |
| - 3-12 yr. | no./home | 0.6 | 0.4 |
| - 13-18 yr. | no./home | 0.5 | 0.5 |
| - > 18 yr. | no./home | 2.1 | 2.1 |
| Plumbing | | | |
| Kitchen sink | no./home | 1 | 1 |
| Dishwasher | no./home | 0.8 | 1 |
| Garbage disposal | no./home | 0.5 | 0.3 |
| Bathroom sink | no./home | 2 | 2.1 |
| Shower | no./home | 1.5 | 1.2 |
| Bathtub | no./home | 1.1 | 1.5 |
| Toilet | no./home | 1.9 | 2.1 |
| Laundry sink | no./home | 0.4 | 0.3 |
| Clotheswasher | no./home | 0.9 | 0.9 |

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[1] Based on the results of survey questionaires returned by homeowners between April and June 1987. A copy of a questionaire form may be found in Appendix A.

[2] Only one home was 22 years old. The next oldest home was 13 years old.

To aid in the selection of individual OSDSs for monitoring, the survey also included questioning as to whether the homeowner was interested in participating in the monitoring portion of the study. Homeowners that expressed an interest in becoming involved were interviewed further and ranked according to family size and age, level of interest and information provided, types and numbers of water using fixtures, and general location within the subdivision. It was desired to monitor homes with larger than average family size, young children, typical fixtures and with a genuine interest in participating in the study. The top ranking candidates were interviewed first by telephone and then by visiting the home. Knowledge of the location, size and condition of their OSDS was then gathered for use in final selection of homes to be monitored. Four homes in each of the two subdivisions were then chosen for monitoring based on these factors (Tables 4.3 and 4.4).

All eight homes selected for monitoring were single family dwellings and ranged in age from 2 to 14 years. Home 13 had 3 residents including one child, home 12 had 5 residents including 3 children, and the remaining homes all consisted of 4 person families with 2 children.

The homes had three bedrooms and two bathrooms with the exception of home 11 which had four bedrooms and two bathrooms. Lot sizes ranged from 0.26 to 0.47 acres and were smaller in Polk County than in St. Johns County. All homes had typical plumbing fixtures and water using appliances including automatic dishwashers and clotheswashers. Three of the four homes in Polk County had garbage disposals while none of the four homes in St. Johns County had them. Homes 12 and 21 were the only homes which included water softeners.

The OSDS information included on Tables 4.3 and 4.4 was based on information from the homeowners, local regulatory agency permit data, and field evaluations of the individual systems conducted at the time septic tank effluent (STE) monitoring apparatus was installed. As shown in the table, complete information on all systems was not available.

Of the eight systems monitored, six utilized conventional trench drainfields and two utilized conventional beds (Tables 4.3 and 4.4). In addition, at monitoring homes 11, 21, and 23, laundry wastewater was separated from the main OSDS serving the home. In the case of homes 21 and 23, this separation had been performed by the homeowner because of perceived OSDS malfunction. At home 11, a separate laundry OSDS had been permitted and installed at the time the home was constructed. Attempts to locate these systems proved futile and they were thus not monitored as part of this study. It should be mentioned that when homes were being evaluated for monitoring potential, an attempt was made to locate homes with all wastewater flowing to one OSDS. However, it was difficult to locate homes which met all selection criteria and the sites chosen for monitoring represented the most desirable locations available. Based on conversations with homeowners in the subdivision in St. Johns County, the separation of laundry wastewater from the OSDS appeared to be a rather common practice, especially if problems with the system had ever developed.

Table 4.3. Characteristics of the individual OSDS monitoring sites in the subdivision in Polk County.[1]

| Characteristics | Units | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|
| <u>Residents</u> | | | | | |
| Total | no. | 4 | 5 | 3 | 4 |
| Adults | no. | 2 | 2 | 2 | 2 |
| Children | no. | 2 | 3 | 1 | 2 |
| | yrs. | 4,8 | 1,3,7 | 2 | <1,11 |
| <u>Home</u> | | | | | |
| Lot Size | acres | 0.29 | 0.26 | 0.26 | 0.29 |
| Age of Home | years | 4 | 11 | 2 | 14 |
| Occupancy | years | 4 | 11 | 2 | 13 |
| Bedrooms | no. | 4 | 3 | 3 | 3 |
| Bathrooms | no. | 2 | 2 | 2 | 2 |
| Dishwasher | - | Yes | Yes | Yes | No |
| Clotheswasher | - | Yes | Yes | Yes | Yes |
| Garbage Disposal | - | Yes | No | Yes | Yes |
| Water Softener | - | No | Yes | No | No |
| <u>OSDS Type & Size</u> | | | | | |
| Septic Tank | gal. | 900 | ? | 900 | ? |
| Last Pumped | date | Never | 1987 | Never | 1986 |
| Separate Laundry | - | Yes | No | No | No |
| Drainfield Area | $ft^2$ | 180[2] | 150[3] | 210[3] | 288[3] |
| Type | - | Trench | Bed | Trench | Trench |

Home ID Number: 11, 12, 13, 14

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[1] Based on survey results returned during April to June 1987 and data gathered during monitoring period.

[2] Based onpermit data for main system. Area does not include separate laundry system area of 125 $ft^2$.

[3] Area determined in the field with a tile probe.

Table 4.4. Characteristics of individual OSDS monitoring sites in the subdivision in St. Johns County.[1]

| Characteristics | Units | Home ID Number<br>21 | 22 | 23 | 24 |
|---|---|---|---|---|---|
| Residents | | | | | |
| Total | no. | 4 | 4 | 4 | 4-3[2] |
| Adults | no. | 2 | 2 | 2 | 2 |
| Children | no. | 2 | 2 | 2 | 2 |
| | yrs. | 9,13 | <1,5 | 8,13 | 14,17 |
| Home | | | | | |
| Lot Size | acres | 0.34 | 0.47 | 0.34 | 0.34 |
| Age of Home | years | 11 | 11 | 12 | 12 |
| Occupancy | years | 11 | 5 | 12 | 5 |
| Bedrooms | no. | 3 | 3 | 3 | 3 |
| Bathrooms | no. | 2 | 2 | 2 | 2 |
| Dishwasher | - | Yes | Yes | Yes | Yes |
| Clotheswasher | - | Yes | Yes | Yes | Yes |
| Garbage Disposal | - | No | No | No | No |
| Water Softener | - | Yes | No | No | No |
| OSDS Type & Size | | | | | |
| Septic Tank | gal. | ? | ? | 900 | 900 |
| Last Pumped | date | 1987 | Never | 1985 | Never |
| Separate Laundry | - | Yes | No | Yes | No |
| Drainfield Area | $ft^2$ | 240[3] | 210[3] | 230[3] | 188[3] |
| Type | - | Bed | Trench | Trench | Trench |

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[1] Based on survey results returned during April to June 1987 and data gathered during monitoring period.

[2] One resident left home on September 1987 to attend college.

[3] Area determined in the field with a tile probe.

# SECTION 5
# SUBDIVISION GROUND WATER MONITORING

## INTRODUCTION

The objective of the subdivision ground water monitoring was to determine the effects of subdivisions served by OSDSs on shallow ground water quality. As discussed in Section 4, one subdivision located in each of four different hydrologic settings of Florida was studied. These subdivisions were located in Polk, St. Johns, Brevard, and Dade Counties. As discussed in this section, site hydrogeologic conditions and ground water quality impacts were assessed by surface geophysical methods and the installation and sampling of ground water piezometers and monitoring wells.

## METHODS

### Preliminary Review

Preliminary work was necessary prior to any onsite ground water monitoring activities. This involved initial screening of the site for accessibility to survey and drilling equipment, determining potential impacts to ground water from adjacent sources, assessing hydrogeologic conditions, and locating restrictive structures such as buried pipelines, power and telephone cables, and property easements. A site access and monitoring well drilling permission form together with a letter describing the objectives and nature of the research were distributed to every resident. Signed permission forms were secured prior to commencing field work.

### Test Boring and Piezometer Well Installation

Following the initial screening, a test boring program was initiated. An average of 10 test borings were installed by hand or power auger to determine the shallow soil characteristics beneath each site. The borings were approximately 4 to 6 in. diameter in. and about 5 to 18 ft. deep depending on local water table conditions. The borings which encountered ground water were completed as piezometer wells. These wells generally penetrated at least 1 to 2 ft. into the surficial or water table aquifer. The wells consisted of 1.5 to 2 in. diameter polyvinylchloride (PVC) casing with a 5 ft. long well screen with 0.010 in. slots. The screen interval was sand packed with clean graded sand to at least 1 ft. above the top of the screen. The remainder of the well annulus was back filled with native soil to land surface. The well was then either completed with a flush mounted protective cover or PVC riser pipe.

The wells were developed to ensure an adequate connection with the aquifer and measurements of temperature, specific conductance, and pH of the discharge ground water were collected. The measuring points (tops of casing) of the wells were surveyed to mean sea level (MSL) or common datum. Water level elevation data were collected from each well. The measurements were corrected to the datum and used to estimate the direction of horizontal ground water flow beneath the site.

## Geophysical Survey

Geophysical surveys of the subdivisions were completed to assist with the selection of monitoring well locations. The instrument used was a Geonics EM-31 which uses electromagnetic techniques to measure the apparent terrain conductivity of the shallow sediments and ground water. The one-man portable transmitter/receiver unit electromagnetically induces an electrical current in the ground which in turn generates a magnetic field. The instrument measures the strength of the magnetic field to determine the magnitude of the electrical current which is induced into the ground. This value corresponds to the bulk terrain conductivity or the ability of the soil and ground water to conduct an electrical current. The terrain conductivity values were compared or ground truthed to the specific conductance of ground water samples collected from the temporary piezometer wells. This procedure determines the relative contribution of soil versus ground water to the bulk terrain conductivity measured by the EM-31 survey. Once this is established, one can determine whether elevated conductivity regions are induced by lithologic or ground water conditions.

This method was used to rapidly collect terrain conductivity values within the subdivisions. The survey data were then contoured on a site diagram. The contour maps depicting apparent terrain conductivity were evaluated together with the ground water flow maps derived from the piezometer measurements, the lithologic logs and the ground water conductivity data to locate areas where water quality may have been altered. This made it possible to determine the optimum locations for the permanent ground water monitoring wells.

## Monitoring Well Installation

Monitoring wells were primarily located directly downgradient of OSDSs to detect potential impacts to the underlying surficial ground water. A smaller number of wells were located in areas thought to be unaffected by OSDSs in order to determine ambient ground water quality.

The wells were drilled by the hollow stem auger method (6 in. inside diameter auger) which does not require water or drilling mud. This method reduces the potential for cross-contamination between wells and reduction in well productivity caused by clogging of the screen and aquifer by the drilling mud. The well screens consisted of 10 ft. of 2 inch diameter, schedule 40 PVC, with 0.010 in. slots and a sufficient length of PVC casing to reach land surface. The screened interval of each well was placed such that there was 5 to 7 ft. of submergence into the water table. The screen was sand packed with clean graded sand to at least 1 ft. above the top of the screen. The remaining annular space to land surface was filled with neat cement to prevent downward migration of surface waters into the screened interval.

A locking steel cover was installed on the PVC casing to prevent unauthorized entry into the well. A flush mounted protective steel cover was cemented in place over the top of the well to prevent damage from vehicular traffic. The wells were developed by centrifugal or submersible pump for at least one hr or until the specific conductance and pH of the discharge water stabilized.

The measuring point elevations (top of casing) of the piezometer and monitoring wells were surveyed by a registered land surveyor to mean seal level (msl) in Polk, St. Johns and Dade County and to an arbitrary site datum (elevation = 50.0') in Brevard County.

## Sampling and Analytical

Ground water elevations were measured with an electric tape (oil/water interface probe). Water level measurements were collected from the wells during site visits and corrected mean seal level or the common site datum.

Baildown tests were conducted in two wells in each of the subdivisions as follows. In the subdivisions in Polk and Brevard Counties, a mini-submersible pump was placed in the well and ground water was extracted at approximately 5 gallons per minute (gpm) for 5 min. Then the pump was pulled and the water level recovery was observed. In the subdivision in St. Johns County, a bailer was used to purge 5 gallons from the well after which the water level recovery was observed. In the subdivision in Dade County, both methods were tried, but were unsuccessful due to the rapid conductivity of the water table aquifer. The data collected from the tests were analyzed by the Bouwer and Rice method (1976).

The seepage velocities for the water table aquifers beneath the subdivisions in Polk, St. Johns and Brevard County were estimated using the Darcy flow equation,

$$v = \frac{k * i}{n * 7.48} \qquad (1)$$

where,

v = average ground water seepage velocity, ft./d,
k = hydraulic conductivity, gpd/ft$^2$ ,
i = horizontal hydraulic gradient, ft./ft.,
n = aquifer porosity, dimensionless, and
7.48 = conversion factor.

The hydraulic conductivity was calculated from the results of the baildown tests. The horizontal hydraulic gradient was estimated from the water table elevation data collected in the general vicinity of the test well. The aquifer porosity was estimated at 30% based on the grain size of the material.

Ground water samples were collected from the monitoring wells at each of the four subdivisions between September 1987 and March 1988. A total of 111 water samples were collected from the wells and from subdivision water supplies. The numbers of sampling events varied for each subdivision depending on the date the wells were installed. A summary of the sampling dates for the sites and the analyses performed is presented in Table 5.1.

Table 5.1. Summary of ground water sampling events and analyses performed.

| | | Analyses Performed[1] | | |
|---|---|---|---|---|
| Subdivision Site | Dates Sampled | Field Analyses | Basic Analyses | Volatile Organics |
| Polk County | 09-29-87 | * | * | * |
| | 10-15-87 | * | * | |
| | 12-15-87 | * | * | * |
| | 03-08-88 | * | * | |
| St. Johns County | 10-05-87 | * | * | * |
| | 12-03-87 | * | * | * |
| | 03-07-88 | * | * | |
| Brevard County | 10-26-87 | * | * | |
| | 11-17-87 | | | * |
| | 12-08-87 | * | * | * |
| | 03-14-88 | * | * | |
| Dade County | 12-08-87 | * | * | * |
| | 03-15-88 | * | * | |

[1] The following tests were performed:
Field Analyses - temperature, pH, and specific conductance.
Basic Analytical Group - total dissolved solids (TDS), chloride, biochemical oxygen demand ($BOD_5$), surfactants (MBAS), total Kjeldahl nitrogen, nitrate nitrogen, total phosphorus, sulfate, and fecal coliform bacteria.
Volatile Organics Group - purgeable organics by gas chromatograph /mass spectrometer (U.S. EPA Method 624).

The analytical parameters were chosen based upon their known presence in septic tank effluent (STE) and to some extent, their relative mobility in ground water.

Ground water samples were collected from the monitoring wells at the four sites according to established sampling protocols. Prior to sample collection, three to five well volumes were purged with a submersible pump. A ground water sample was then collected using a 3 ft. long, 1.7 in. diameter PVC bailer (top unloading). Ground water from the bailer was then carefully poured into the appropriate sample containers which were labeled, inventoried, and placed on ice. Measurements were made onsite of temperature, pH and specific conductance. The sample collection equipment was field cleaned for use in the well during the next sampling event. All sample collection equipment was dedicated to a specific well to minimize the potential for cross-contamination of wells and samples.

Following completion of the sample collection activities, the samples were sealed in a labeled cooler and immediately transported to the laboratory where analyses were made for TDS, Chlorides, $BOD_5$, MBAS, TKN, $NO_3$, P, SO4, fecal coliforms and purgeable organics. Laboratory analyses were performed by State of Florida approved laboratories according to standard procedures (APHA, 1985; Federal Register, 1985; U.S.EPA, 1983).

## RESULTS

### Polk County Subdivision

Surficial Hydrogeology --

Sixteen test borings were installed within the subdivision, of which 12 were subsequently completed as temporary piezometers. The remaining four test borings did not encounter saturated sediments above the clay units and were subsequently abandoned. Figure 5.1 depicts the locations of the piezometers and wells installed at the site and the orientation of the geologic cross-sections shown in Figures 5.2 and 5.3. The sections were constructed from lithologic data collected during the installation of the borings and wells. The data generated by the GPR survey was "ground truthed" to the lithologic information and then used to correlate stratigraphy between the wells. Lithologic logs of the test borings and and monitoring wells are contained in Appendix B.

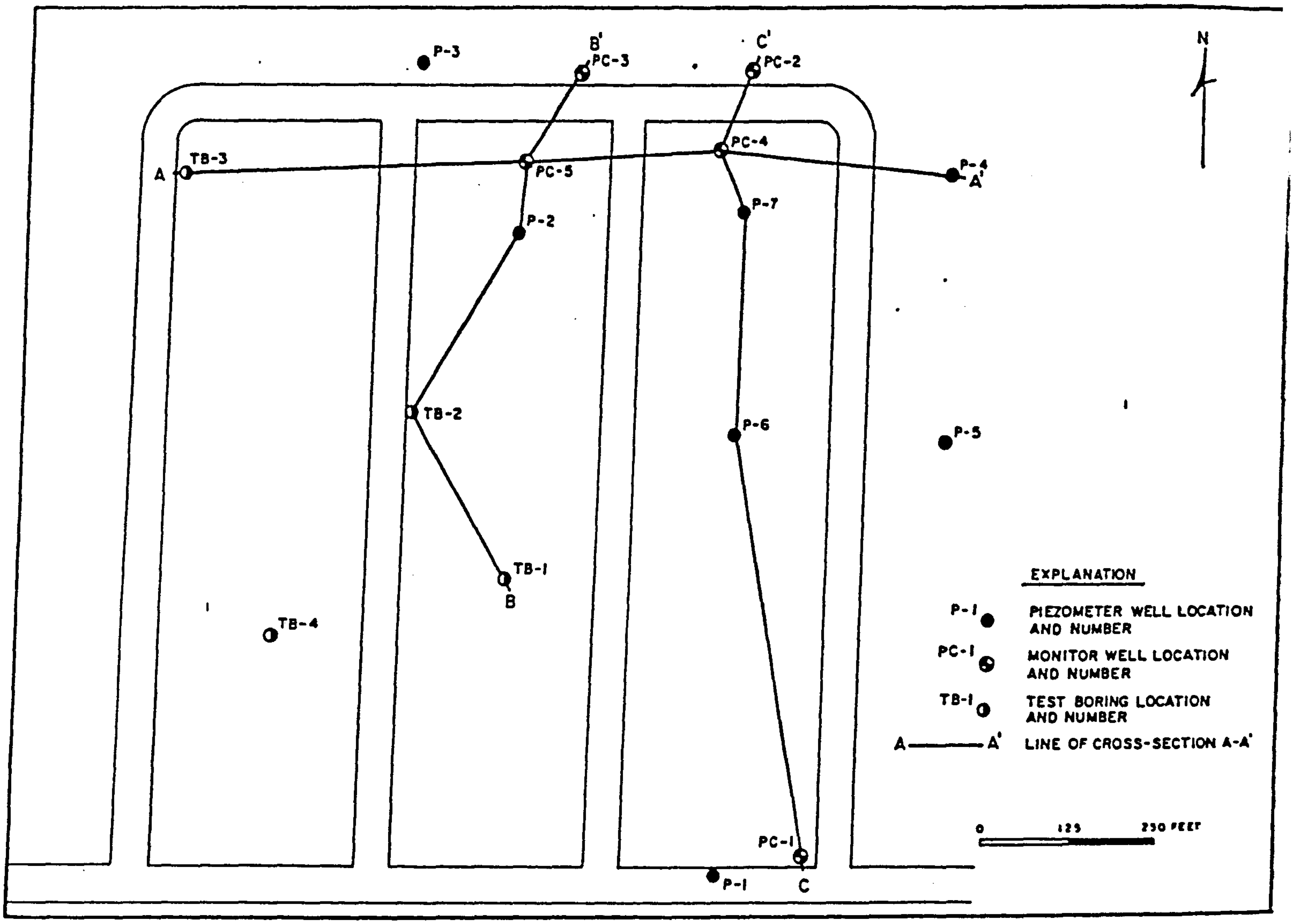

Figure 5.1. Locations of test borings, temporary piezometers and monitoring wells in the study subdivision in Polk County, Florida.

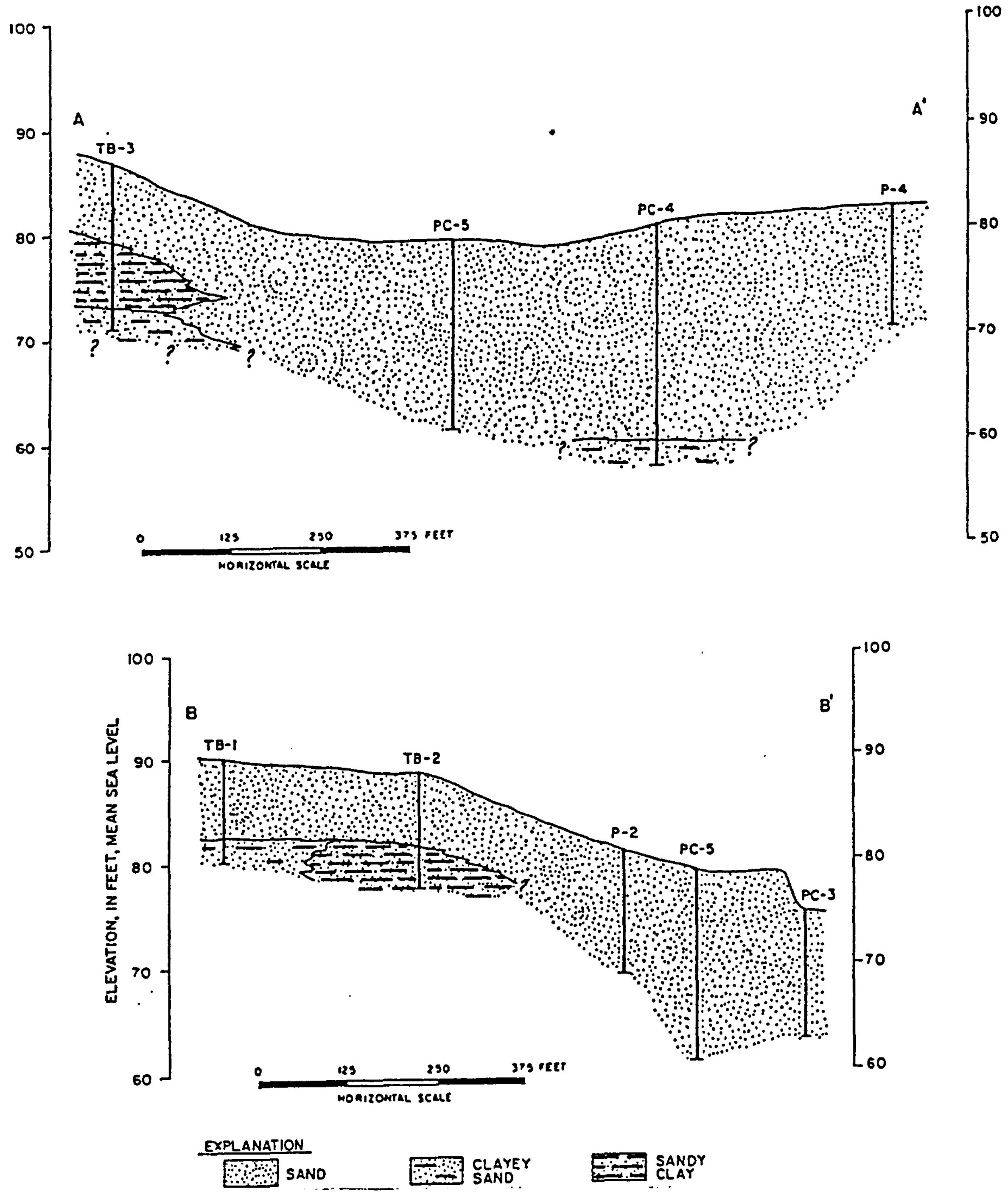

Figure 5.2. Geologic cross-section A-A' and B-B' of the subdivision in Polk County, Florida. (refer to Figure 5.1 for locations.)

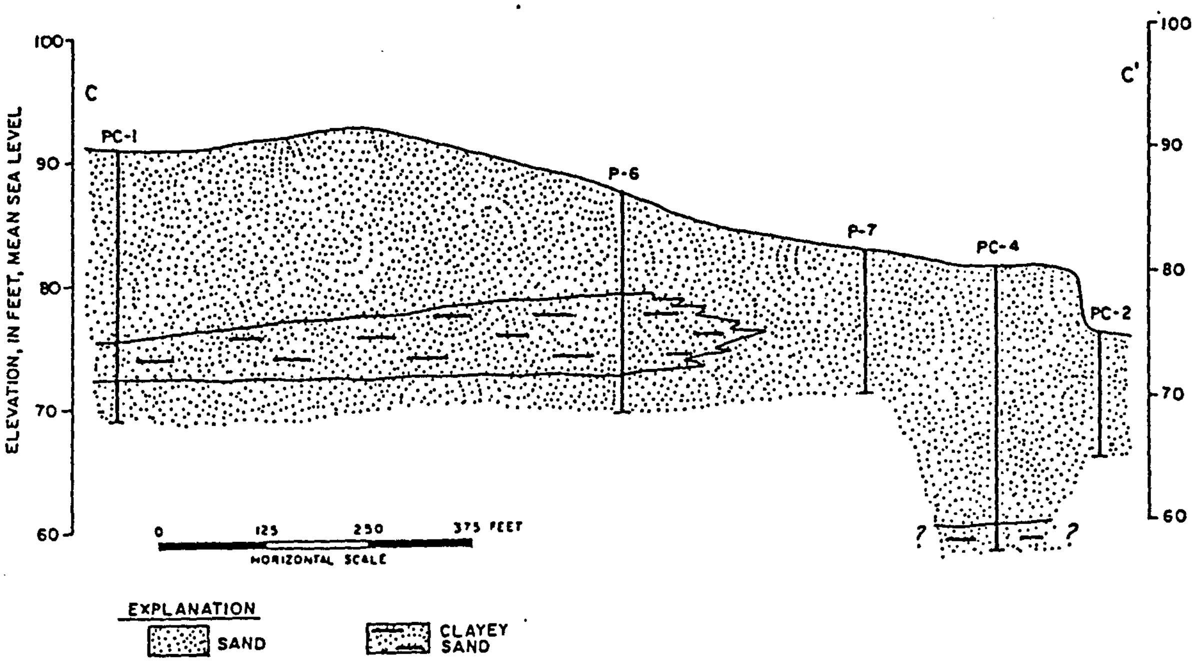

Figure 5.3. Geologic cross-section C-C' of the subdivision in Polk County, Florida. (refer to Figure 5.1 for locations.)

The surficial sediments are primarily composed of white to brown, fine grained, poorly to moderately consolidated sands with an extremely variable clay content. The percentage of clay and silt sized particles increases with depth throughout the study area. However, the soils southwest of a line drawn from piezometer well P-3 to a point approximately 300 ft. north of monitor well PC-1 exhibited a higher percentage of clay at depths commonly less than 10 ft. below land surface. Test borings and pits installed southwest of this line exhibited unsaturated or vadose conditions to the top of the first clay unit (Figure 5.3).

Monitoring well PC-1 was completed in a silty and clayey sand unit of relatively low permeability. The water table in this well is within low permeability sands. This situation affected the quantity and quality of the ground water pumped from the well.

The surficial sands in the extreme north and northeast portion of the subdivision are much more uniform and contain less clay and silt. The sands appear to thicken substantially toward the northern portion of the study area. The light brown, fine grained, and unconsolidated sands generally persisted to the total drilled depth of the majority of the wells drilled in this area.

The locations of the permanent monitoring wells were established based upon the information described above and data collected during a terrain conductivity survey of the entire study area. This survey technique was intended to delineate surficial aquifer ground water containing elevated levels of dissolved solids as could occur near OSDSs. The effectiveness of the survey was hindered by the presence of relatively shallow sandy clay or clayey sand units in the southern and southwestern portion of the subdivision. These sediments exhibit a response similar to that produced by more conductive ground water. The survey was much more effective in the northern vicinity of the site where the measurement of the conductance of the surficial aquifer water was not complicated by lithologic factors. Figure 5.4 is a contour map of the apparent terrain conductivity values measured during the survey. The contour lines connect points of approximately equal conductivity.

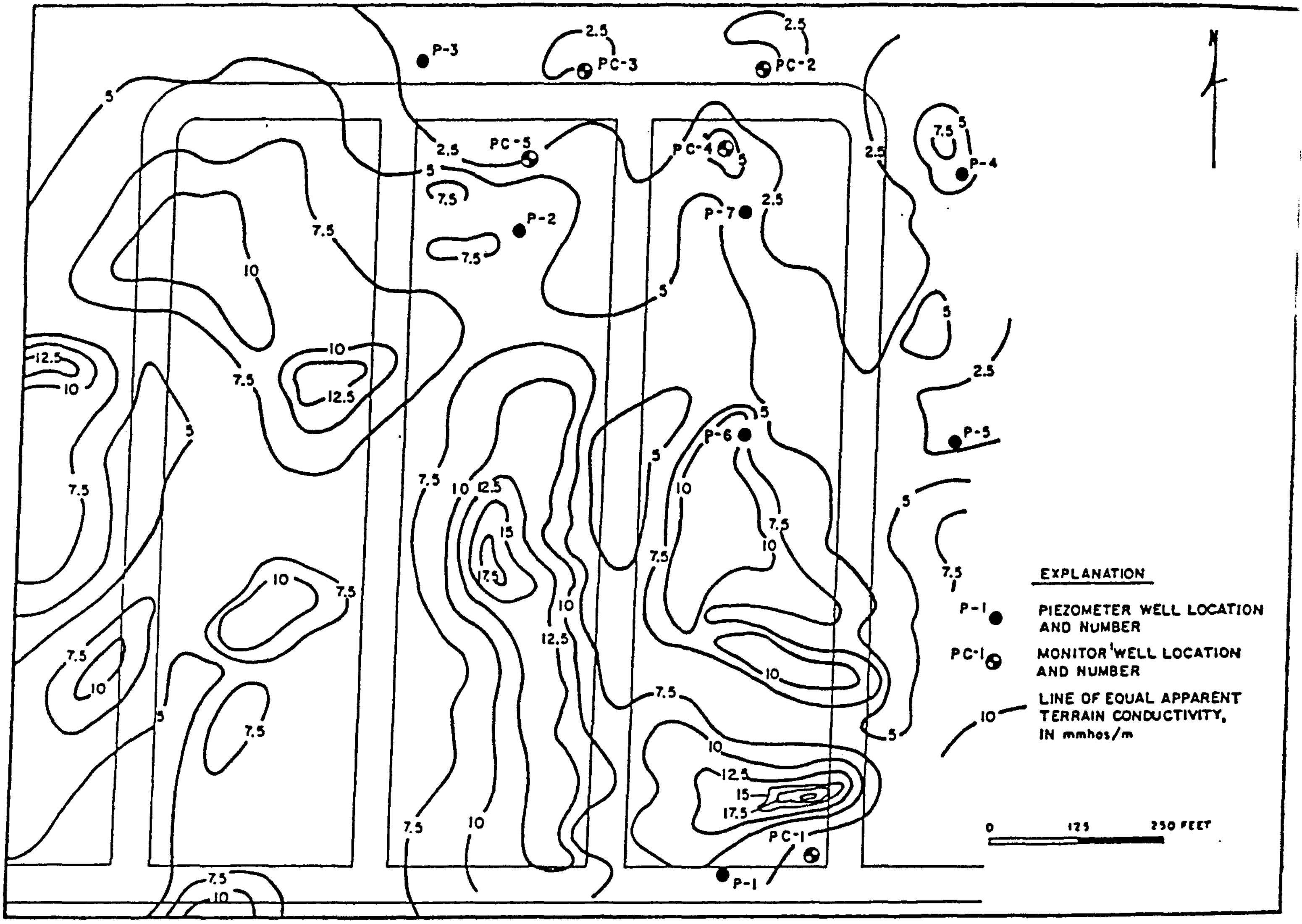

Figure 5.4. Apparent terrain conductivity contour map for the subdivision site in Polk County, Florida.

Water table elevation measurements were made on several dates (Appendix C, Table 5.2). Temporal variations were relatively small (i.e. < 1.0 ft.). The greatest variation appeared to be near well PC-1.

The water table data were used to determine the direction of ground water flow beneath the site by contouring the water level values on a site map and by solving three-point dip problems for the free water surface. Both methods indicated a direction of ground water flow generally toward the northwest as depicted in Figure 5.5. The direction of ground water flow in the vicinity of the lake may fluctuate in response to variations in the lake water level caused by extended periods of drought or rainfall. This situation appears to be limited to the vicinity of wells PC-2 and PC-3.

The flow direction appears to wrap around the lake to the north of the subdivision and reverse its direction toward the southeast in the vicinity of piezometer well P-3 (Figure 5.5). This indicates the presence of a subsurface feature which likely influences the surficial aquifer flow pattern in the northwestern area of the subdivision. This conforms with the general location of a sink or subsidence feature discovered during the GPR survey conducted by SCS in this subdivision. Two of the GPR survey transects in the northern portion of the study area showed reflections which are consistent with those produced by slumping or subsiding laminated sediments.

Table 5.2. Water level data collected at the subdivision site in Polk County, Florida.

| Well Number | Land Surface Elevation | Monitoring Date<br>9-17-87 | <br>9-24-87 | <br>1-22-88 | <br>3-8-88 |
|---|---|---|---|---|---|
| | ---------- | ---------- | ft. (msl) | ---------- | ---------- |
| P-2 | 132.9 | 122.96 | 122.85 | 122.39 | 122.65 |
| P-3 | 131.0 | 122.94 | 122.78 | 123.22 | 122.81 |
| P-4 | 133.6 | 123.39 | 123.23 | 122.93 | Dry |
| P-5 | 135.8 | 123.69 | 123.51 | 123.35 | 123.51 |
| P-6 | 138.3 | 123.61 | 123.43 | 122.59 | 123.08 |
| P-7 | 133.6 | 123.15 | 123.22 | 122.69 | 122.96 |
| PC-1 | 141.6 | 125.17 | 124.90 | 123.93 | 123.79 |
| PC-2 | 124.1 | 122.96 | 122.77 | 122.58 | 122.81 |
| PC-3 | 124.9 | 122.86 | 122.75 | 122.49 | 122.73 |
| PC-4 | 132.4 | ------ | 122.85 | 122.60 | 123.68 |
| PC-5 | 131.5 | ------ | 122.71 | 122.48 | 122.75 |
| PSG-1 | 128.05 | 123.05 | ------ | 122.60 | 122.80 |

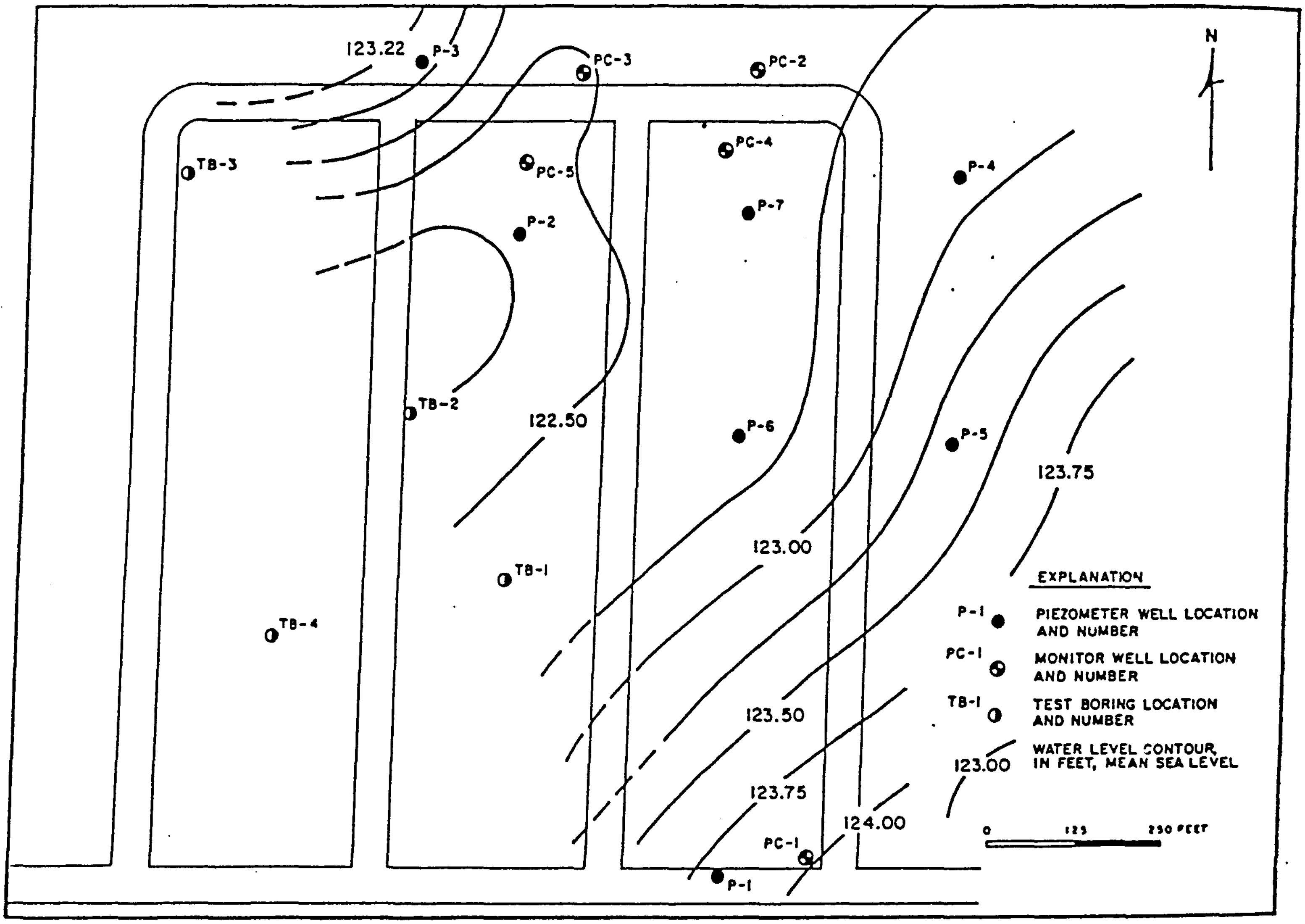

Figure 5.5. Direction of groundwater flow in the surficial aquifer beneath the subdivision in Polk County. (Based on measurements made on January 22, 1988).

Baildown tests conducted on monitoring wells PC-2 and PC-3 yielded hydraulic conductivity values of 41 and 38 gallons/day/ft$^2$ (gpd/ft$^2$), respectively. The average aquifer transmissivity was estimated to be approximately 790 gallons/day/ft (gpd/ft.). These values are consistent with the lithology of the aquifer.

The ground water seepage velocities were calculated to be approximately 2.0 and 5.6 ft./yr for wells PC-2 and PC-3, respectively. The seepage velocity in the southern area of the site could be greater due to the considerably higher horizontal gradients there.

Ground Water Quality --

The results of the analyses of ground water samples collected from the Polk County site are summarized in Table 5.3 with the results for the individual sample dates tabulated in Appendix E. The results of quality control sample analyses are summarized in Appendix F. This site has the thickest unsaturated zone of the four sites evaluated and would be expected to provide a high level of STE treatment assuming favorable soil treatment capabilities.

Ground water quality samples were collected on four occasions between September 1987 and March 1988. The results of analyses for a suite of constituents revealed wide fluctuations between sampling dates. The fluctuations were not consistent across constituents which seemingly ruled out simple dilution as a probable cause. These wide fluctuations in ground water quality between sampling dates, made evaluation of the individual well data for potential OSDS impacts difficult.

Well PC-1 is located at a point hydraulically upgradient of theOSDSs. The ground water from this well contained high concentrations of dissolved constituents (e.g. conductance, TDS, $SO_4$). While a source in the well vicinity is suggested by the electromagnetic survey data, it is possible that the source is located off site.

The other four wells were clustered together downgradient of the development (Figure 5.1). Review of the water quality data for these wells revealed no impacts which could <u>clearly</u> be attributed to OSDS operation (Table 5.3). Well PC-3 is located hydraulically downgradient of a pond at the north end of the site and the ground water flow appears to be from an area unaffected by OSDS. There is a potential for some influence by stormwater runoff but a review of the data show it to have the lowest levels of TDS, chlorides and nitrates that were reported. Comparison of data at this preliminary stage were therefore made under the assumption that PC-3 water quality represents ambient surficial aquifer conditions.

Review of the data for the remaining wells, indicated that wells PC-2 and PC-4 may have had comparatively higher concentrations of some constituents commonly associated with STE (e.g. TDS, Cl, $NO_3$, P, $SO_4$). Total phosphorus was elevated in all wells but this is believed to be due to the location of the site in an area where phosphate deposits occur naturally.

Table 5.3. Ground water quality beneath the subdivision in Polk County.[1]

| Well | Statistic | Elev. | Temp. | pH | Conduct. | TDS | Cl | BOD5 | TKN | NO3 | TP | SO4 | MBAS | F.coli. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ft. | oC | units | umho/cm | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | #/100mL |
| PC1 | Average | 124.52 | 24.5 | | 214 | 147 | 12 | | 0.47 | 6.32 | 2.91 | 37 | | |
| | Std.Dev. | 0.53 | 2.9 | | 9 | 9 | 4 | | 0.12 | 6.16 | 3.43 | 7 | | |
| | Maximum | 125.03 | 26.4 | 6.28 | 225 | 160 | 16 | <1.0 | 0.57 | 13.00 | 7.90 | 45 | <0.05 | <10 |
| | Minimum | 123.79 | 20.1 | 6.02 | 205 | 139 | 8 | <1.0 | 0.31 | 0.86 | 0.55 | 31 | <0.05 | <1 |
| | No. | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 4 | 3 | 4 | 3 | 3 | 4 |
| PC2 | Average | 123.69 | 23.6 | | 87 | 84 | | | 1.11 | 7.99 | 2.22 | 18 | | |
| | Std.Dev. | 1.75 | 2.8 | | 15 | 49 | | | 0.66 | 12.13 | 1.70 | 3 | | |
| | Maximum | 126.31 | 26.5 | 5.35 | 105 | 130 | 9 | 1.1 | 1.90 | 22.00 | 4.20 | 21 | <0.05 | 10 |
| | Minimum | 122.81 | 20.0 | 4.85 | 69 | 34 | <1 | <1.0 | 0.51 | 0.88 | 0.46 | 16 | <0.05 | <1 |
| | No. | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 3 | 3 | 4 |
| PC3 | Average | 122.75 | 23.7 | | 49 | 44 | | | 1.37 | | 1.44 | 9 | | |
| | Std.Dev. | 0.15 | 1.6 | | 13 | 28 | | | 0.88 | | 1.48 | 9 | | |
| | Maximum | 122.92 | 25.4 | 5.00 | 63 | 72 | 3 | <1.0 | 2.40 | 0.45 | 3.00 | 19 | <0.05 | <10 |
| | Minimum | 122.56 | 21.8 | 4.05 | 37 | 18 | <1 | <1.0 | 0.63 | <0.02 | 0.08 | 3 | <0.05 | <1 |
| | No. | 4 | 4 | 3 | 4 | 4 | 3 | 4 | 4 | 3 | 4 | 3 | 3 | 4 |
| PC4 | Average | 121.91 | 24.1 | | 157 | 103 | 14 | | 1.12 | 2.07 | 8.11 | 22 | | |
| | Std.Dev. | 2.04 | 1.3 | | 33 | 24 | 3 | | 0.56 | 0.74 | 8.60 | 5 | | |
| | Maximum | 123.11 | 24.8 | 6.28 | 195 | 130 | 17 | <1.0 | 1.90 | 2.90 | 20.00 | 27 | <0.05 | <10 |
| | Minimum | 118.86 | 22.1 | 5.10 | 115 | 78 | 12 | <1.0 | 0.61 | 1.50 | 0.63 | 17 | <0.05 | <1 |
| | No. | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 4 | 3 | 4 | 3 | 3 | 4 |
| PC5 | Average | 122.78 | 24.1 | | 60 | 54 | 3 | | 0.96 | 0.41 | 4.49 | | | |
| | Std.Dev. | 0.15 | 1.7 | | 15 | 26 | 1 | | 0.85 | 0.27 | 3.49 | | | |
| | Maximum | 122.96 | 25.8 | 6.43 | 82 | 88 | 4 | <1.0 | 2.00 | 0.71 | 8.80 | 12 | <0.05 | <10 |
| | Minimum | 122.61 | 21.8 | 5.35 | 47 | 30 | 2 | <1.0 | 0.30 | 0.20 | 0.34 | <2 | <0.05 | <1 |
| | No. | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 4 | 3 | 4 | 3 | 3 | 4 |

[1] Refer to Figure 5.1 for well locations.

[2] Refer to Appendix D for detailed ground water quality data.

Fecal coliform bacteria were only detected on one occasion in one well (PC-2) and at low concentration (10 organisms/100 mL). VOCs were not detected in any of the samples at the detection limits shown in Appendix E.

## St. Johns County Subdivision

### Surficial Hydrogeology --

The locations of the monitoring points and the cross sections are shown in Figure 5.6. The general lithology of the surficial sands and location of the water table is shown on the hydrogeologic cross-sections of the study area depicted in Figures 5.7 and 5.8. The cross-sections were constructed from lithologic data collected during the piezometer and monitor well installation program. Lithologic logs of the wells are contained in Appendix B.

The terrain conductivity survey indicated areas of relatively high terrain conductivity values that may have been associated with individual OSDSs (Figure 5.9). These values normally decreased with distance from the systems and increased depth to ground water. With this in mind, monitor wells were placed in pairs downgradient of an isolated area of relatively high conductivity. One well was located within this area and a second well was placed immediately downgradient.

Water level measurements collected from the temporary piezometers and monitoring wells at the St. Johns County site are summarized in Tables 5.4 and 5.5 and Appendix C. The direction of ground water flow in the surficial aquifer is apparently controlled by topography and by the undeveloped detention area at the southeastern corner of the site (Figure 5.10). The detention area appears to be a discharge point for the surficial aquifer and induces flow towards it in the south and southeast part of the site. This situation may temporarily reverse during periods of excessive rainfall. During these events, the increased runoff to the detention area and consequent recharge to the surficial aquifer may cause a temporary mounding and flow alteration within the aquifer.

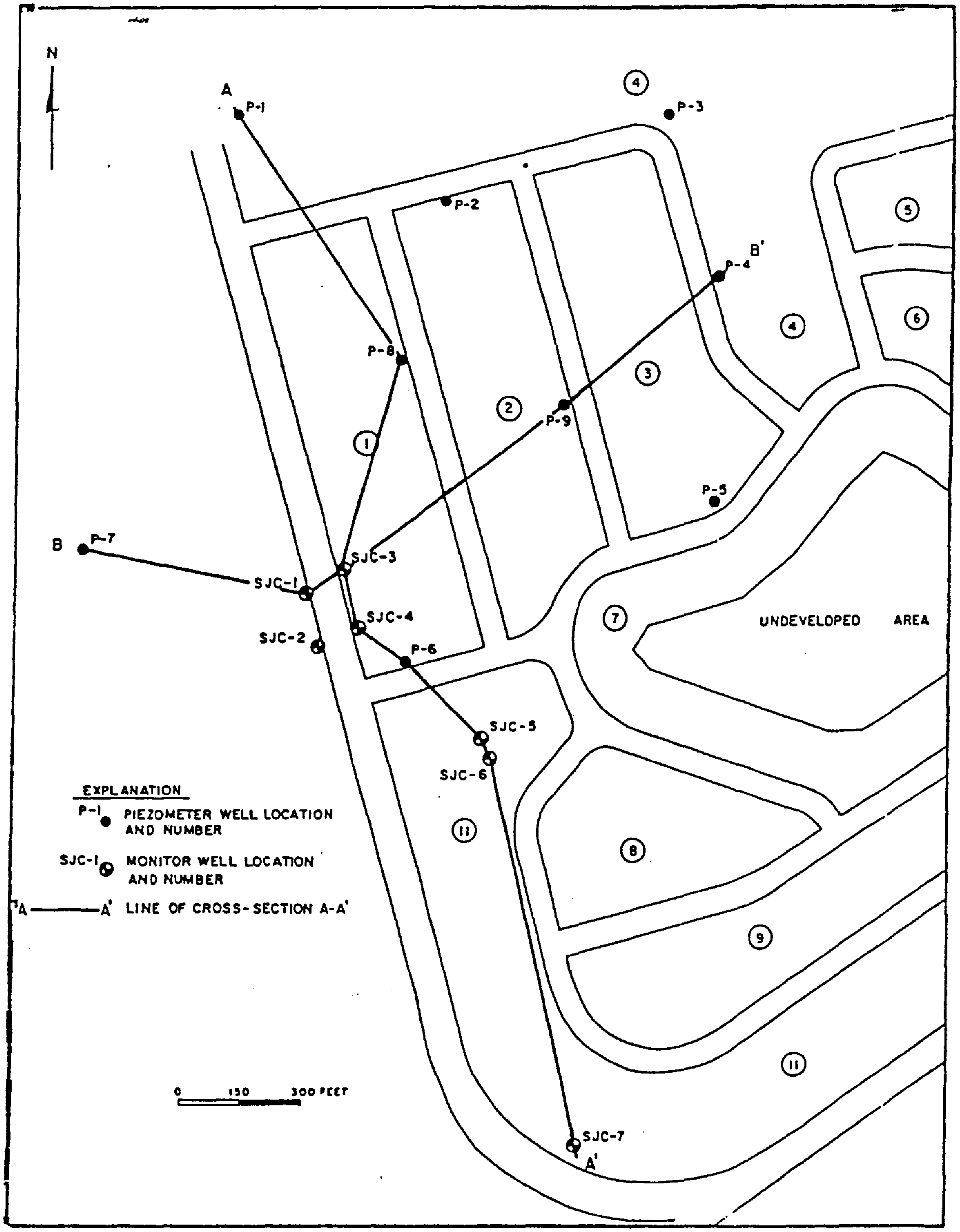

Figure 5.6. Locations of test borings, temporary piezometers and monitoring wells in the study subdivision in St. Johns County, Florida.

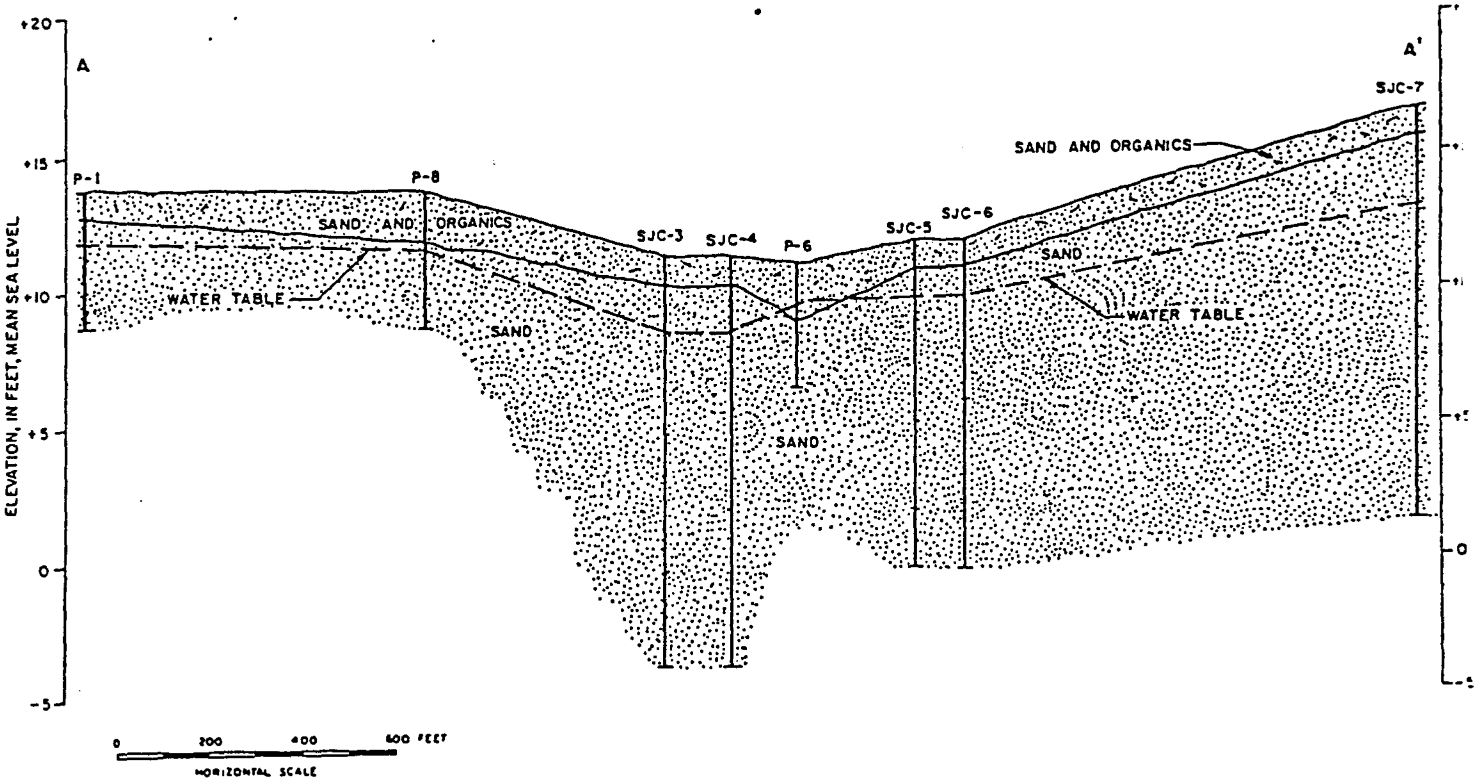

Figure 5.7. Geologic cross-section A-A' of the St. Johns County study site. (see Figure 5.6 for cross-section location.)

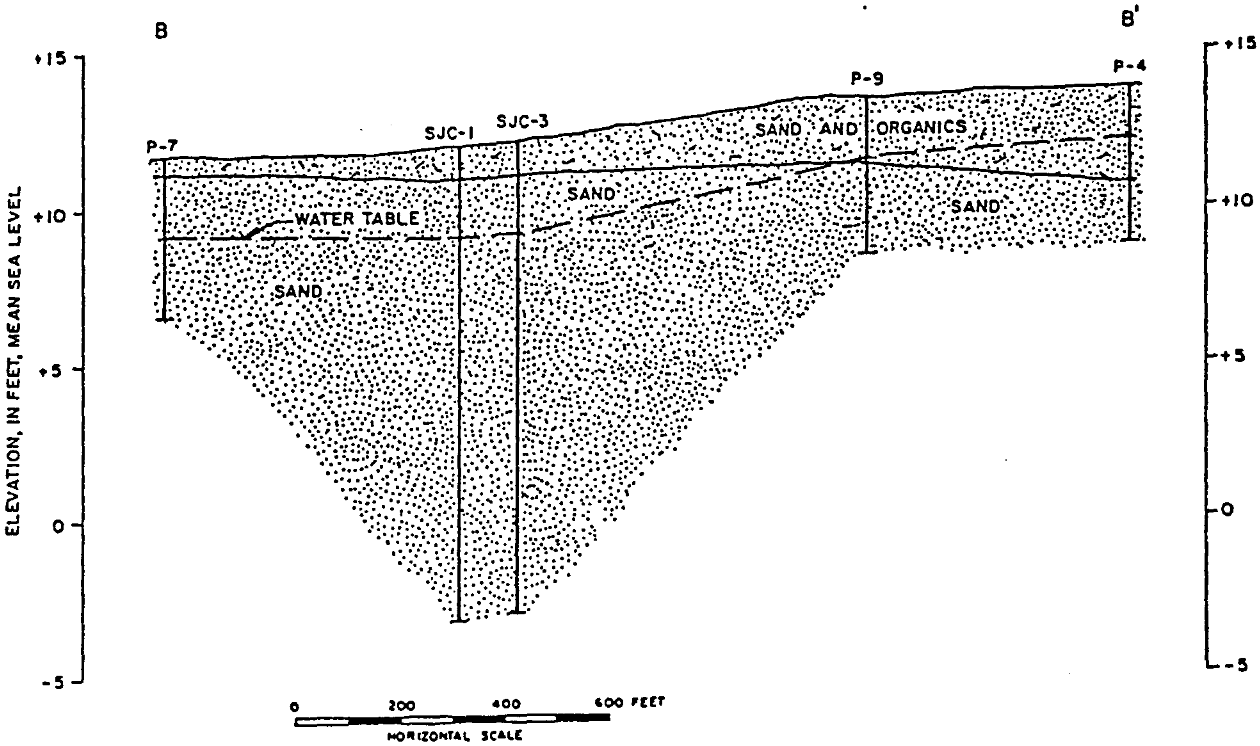

Figure 5.8. Geologic cross-section B-B' of the St. Johns County study site. (see Figure 5.6 for cross-section location.)

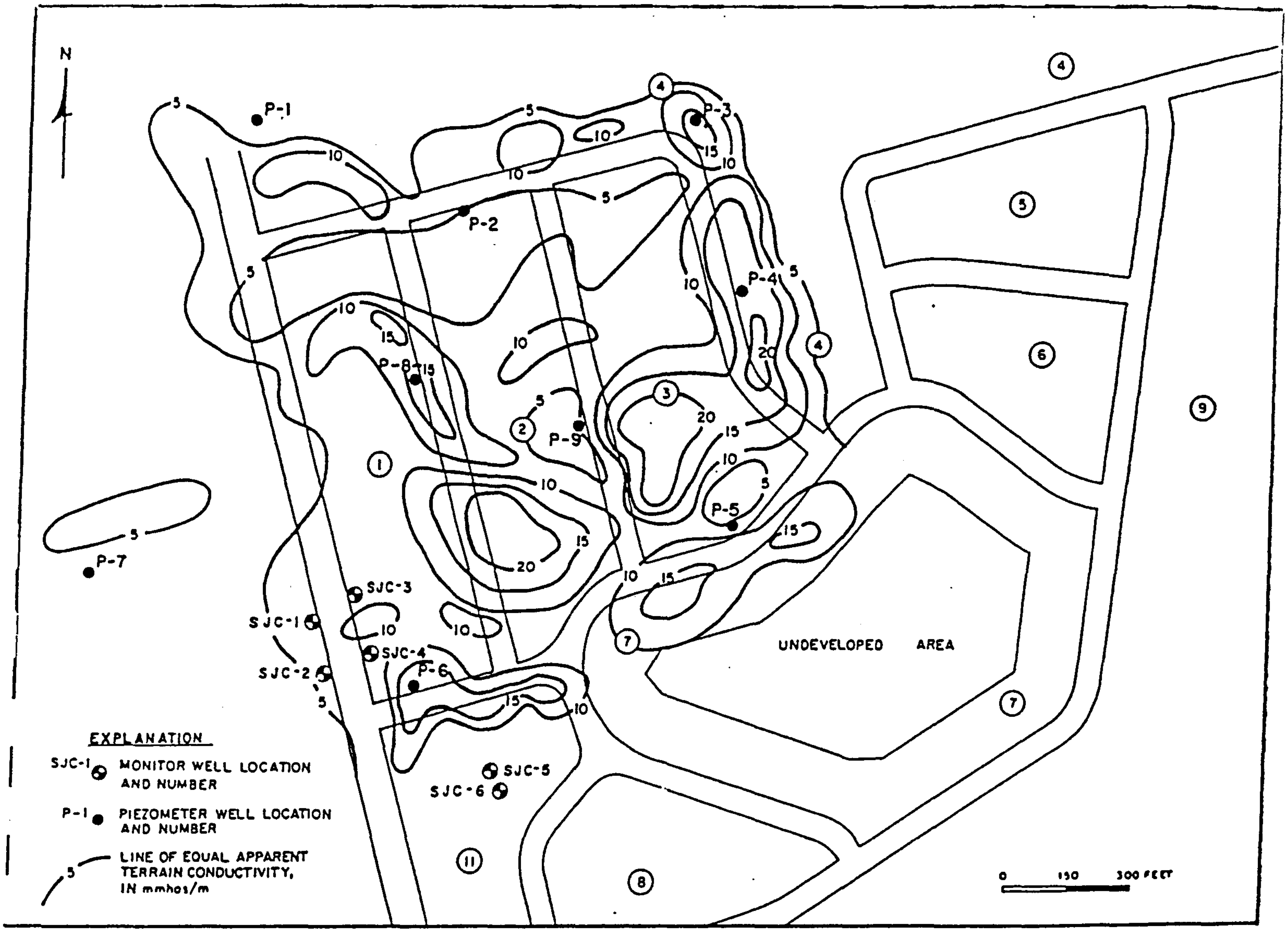

Figure 5.9. Apparent terrain conductivity contour map for the study site in St. Johns County.

Table 5.4. Water level data collected from the temporary piezometer wells at the St.Johns County study site.[1]

| Well Number | Land Surface Elevation | Monitoring Date | | | |
|---|---|---|---|---|---|
| | | 6-5-87 | 6-12-87 | 7-7-87 | 3-7-88 |
| | ft. (msl) | | | | |
| P-01 | 14.4 | 10.56 | 10.31 | 10.57 | 10.79 |
| P-02 | 14.6 | 10.86 | 10.62 | 11.08 | 11.47 |
| P-03 | 14.9 | 11.14 | 10.89 | 11.79 | 12.33 |
| P-04 | 13.3 | 10.23 | 9.97 | 10.85 | 11.35 |
| P-05 | 11.4 | 8.84 | 8.59 | 9.21 | 9.47 |
| P-06 | 10.9 | 8.39 | 8.13 | 9.13 | *[2] |
| P-07 | 12.4 | 7.76 | 7.50 | 6.89 | 7.51 |
| P-08 | 13.8 | 9.80 | 9.56 | 10.29 | 10.73 |
| P-09 | 13.2 | 9.66 | 9.42 | 10.16 | * |

[1] Refer to Figure 5.6 for piezometer locations.

[2] "*" indicates well inaccessible on this date.

Table 5.5. Water level data collected from the monitoring wells at the St. Johns County study site.[1]

| Well Number | Land Surface Elevation | Monitoring Date | | |
|---|---|---|---|---|
| | | 10-05-87 | 12-03-87 | 03-07-88 |
| | ft. (msl) | | | |
| SJC-1 | 12.8 | 6.95 | 7.56 | 9.35 |
| SJC-2 | 11.9 | 6.85 | 7.45 | 9.27 |
| SJC-3 | 14.3 | 7.19 | 7.77 | 9.58 |
| SJC-4 | 12.8 | 6.98 | 7.64 | 9.47 |
| SJC-5 | 11.6 | 7.35 | 7.87 | 9.63 |
| SJC-6 | 12.5 | 7.39 | 7.91 | 9.65 |
| SJC-7 | 15.5 | 7.18 | 7.31 | 9.13 |

[1] Refer to Figure 5.6 for well locations.

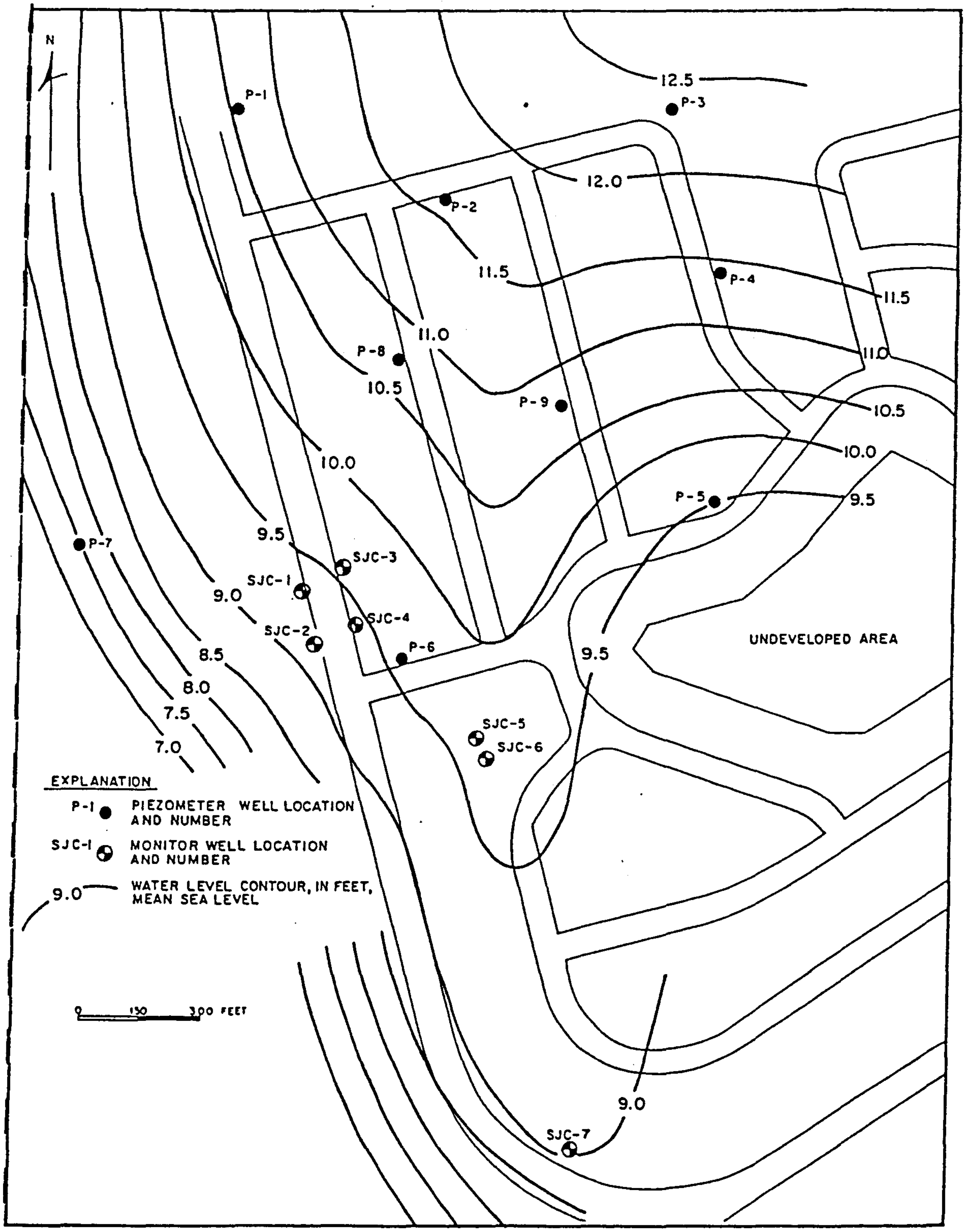

Figure 5.10. Direction of ground water flow in the surficial aquifer beneath the St. Johns County study site. (Based on measurements made on March 7, 1988).

Baildown tests conducted on monitoring wells SJC-3 and SJC-7 yielded hydraulic conductivity values of 12 and 71 gpd/ft$^2$, respectively. The aquifer transmissivity was approximately 750 gpd/ft. in SJC-3 and 4,200 gpd/ft. in SJC-7. This range in values is consistent with the fine sand lithology of the aquifer.

The ground water seepage velocities were calculated to be 4.9 and 21.9 ft./yr, for wells SJC-3 and SJC-7, respectively.

Ground Water Quality --

The St. Johns County site differs from the Polk County site in several respects. First, the unsaturated zone is the thinnest among the four sites, giving it the lowest potential for renovation of OSDS effluent, other factors being equal. In general, the depth to water decreased towards the topographic low referred to as the undeveloped area in Figure 5.6. Also, the number of mound OSDSs increased in this area of high water table. A large number of these mound systems at the site were installed at the prompting of the St. Johns County Health Department prior to adoption of the current Chapter 10D-6 requirements.

A second factor which is not present at the other sites is the character of the water supply in the subdivision. Many of the homes have private wells which tap a water bearing unit below the surficial aquifer. The water contains high levels of sulfate which subsequently appear in the surficial aquifer likely through irrigation and OSDS throughput.

Ground water samples were collected on three occasions between October 1987 and March 1988. The results of ground water monitoring are summarized in Table 5.6 while detailed results may be found in Appendix D and E.

Of the seven wells installed in the subdivision, six are downgradient of the development (i.e. SJC-1 to SJC-6, Figure 5.6). The concentrations of TDS, Cl, TKN and $NO_3$ in wells SJC-1 and SJC-2 were significantly lower than in wells located near the OSDS drainfields (i.e. wells SJC-3 to JSC-6). These downgradient wells appear to be beyond the body of affected ground water. The water quality data from wells SJC-1 and SJC-2 were therefore considered to represent ambient conditions within the surficial aquifer for the purposes of this preliminary review.

In this context, wells SJC-4,5 and 6 had substantially elevated concentrations of many constituents commonly associated with STE, including TDS, Cl, TKN, $NO_3$, and $SO_4$. Fecal coliform bacteria were only detected once in one well (SJC-4) at a low value of 4 organisms/100 mL. The VOC, chloroform, was detected in one sample at 1.8 ug/L. This VOC was also present in the subdivision water supply. No other VOCs were detected (Appendix E).

Table 5.6.--Ground water quality beneath the subdivision in St. Johns County, Florida.[1]

| Well | Statistic | Elev. | Temp. | pH | Conduct. | TDS | Cl | BOD5 | TKN | NO3 | TP | SO4 | MBAS | F.coli. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ft. | oC | units | umho/cm | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | #/100mL |
| SJC1 | Average | 7.95 | 23.5 | | 97 | 101 | 4 | | 1.00 | 0.32 | 1.29 | 18 | | |
| | Std.Dev. | 1.25 | 3.3 | | 13 | 45 | 2 | | 0.75 | 0.14 | 0.44 | 8 | | |
| | Maximum | 9.35 | 27.1 | 6.76 | 110 | 152 | 6 | <1.0 | 1.70 | 0.43 | 1.60 | 24 | 0.06 | <10 |
| | Minimum | 6.95 | 20.5 | 5.99 | 84 | 64 | 3 | <1.0 | 0.21 | 0.16 | 0.98 | 9 | <0.05 | <1 |
| | No. | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 |
| SJC2 | Average | 7.86 | 22.7 | | 134 | 118 | 10 | | 0.43 | 0.14 | 0.18 | 26 | | |
| | Std.Dev. | 1.26 | 2.9 | | 24 | 8 | 7 | | 0.21 | 0.20 | 0.21 | 13 | | |
| | Maximum | 9.27 | 25.1 | 6.92 | 157 | 123 | 15 | 1.2 | 0.67 | 0.37 | 0.42 | 37 | <0.05 | <10 |
| | Minimum | 6.85 | 19.5 | 6.00 | 110 | 108 | 2 | <1.0 | 0.30 | 0.01 | 0.05 | 12 | <0.05 | <1 |
| | No. | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3.00 | 3 | 3 | 3 | 3 | 3 |
| SJC3 | Average | 8.18 | 22.1 | | 289 | 210 | 22 | | 0.85 | | 0.08 | 99 | | |
| | Std.Dev. | 1.25 | 2.1 | | 75 | 41 | 9 | | 0.57 | | 0.06 | 22 | | |
| | Maximum | 9.58 | 24.0 | 5.30 | 373 | 248 | 32 | <1.0 | 1.50 | 3.90 | 0.15 | 123 | <0.05 | <10 |
| | Minimum | 7.19 | 19.8 | 4.85 | 229 | 166 | 17 | <1.0 | 0.48 | <0.01 | 0.04 | 79 | <0.05 | <1 |
| | No. | 3 | 3 | 2 | 3 | 3 | 3 | 4 | 3 | 3 | 3 | 3 | 3 | 3 |
| SJC4 | Average | 8.03 | 22.3 | | 805 | 716 | 53 | | 3.37 | 19.90 | 0.32 | 298 | | |
| | Std.Dev. | 1.29 | 3.1 | | 512 | 576 | 40 | | 2.54 | 26.35 | 0.51 | 124 | | |
| | Maximum | 9.47 | 25.2 | 6.46 | 1390 | 1380 | 100 | 1.7 | 6.30 | 50.00 | 0.91 | 435 | <0.05 | 4 |
| | Minimum | 6.98 | 19.1 | 5.53 | 440 | 354 | 28 | <1.0 | 1.80 | 1.00 | 0.03 | 193 | <0.05 | <2 |
| | No. | 3 | 3 | 2 | 3 | 3 | 3 | 4 | 3 | 3 | 3 | 3 | 3 | 3 |
| SJC5 | Average | 8.28 | 21.2 | | 464 | 373 | 15 | | 2.27 | 1.17 | 1.20 | 146 | | |
| | Std.Dev. | 1.19 | 3.5 | | 129 | 102 | 7 | | 1.19 | 0.64 | 0.14 | 81 | | |
| | Maximum | 9.63 | 24.0 | 6.21 | 585 | 464 | 21 | 1.1 | 3.60 | 1.90 | 1.30 | 220 | <0.05 | <10 |
| | Minimum | 7.35 | 17.3 | 5.64 | 328 | 262 | 8 | <1.0 | 1.30 | 0.80 | 1.10 | 60 | <0.05 | <1 |
| | No. | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 |
| SJC6 | Average | 8.32 | 21.3 | | 478 | 351 | 78 | | 0.49 | | 0.38 | 137 | | |
| | Std.Dev. | 1.18 | 2.5 | | 99 | 40 | 11 | | 0.20 | | 0.54 | 62 | | |
| | Maximum | 9.65 | 23.5 | 4.69 | 545 | 392 | 88 | <1.0 | 0.72 | 0.03 | 1.00 | 195 | <0.05 | <10 |
| | Minimum | 7.39 | 18.5 | 4.42 | 365 | 312 | 66 | <1.0 | 0.35 | <0.01 | 0.05 | 72 | <0.05 | <1 |
| | No. | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| SJC7 | Average | 7.87 | 23.1 | | 278 | 211 | 13 | | 0.84 | 4.50 | 0.55 | 78 | | |
| | Std.Dev. | 1.09 | 2.8 | | 104 | 31 | 2 | | 0.56 | 1.01 | 0.73 | 13 | | |
| | Maximum | 9.13 | 25.7 | 6.47 | 395 | 232 | 14 | 1.2 | 1.30 | 5.60 | 1.40 | 92 | 0.11 | <10 |
| | Minimum | 7.18 | 20.1 | 5.85 | 195 | 176 | 11 | <1.0 | 0.22 | 3.60 | 0.10 | 68 | <0.05 | <1 |
| | No. | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

[1] Refer to Figure 5.6 for well locations.

[2] Refer to Appendix D for detailed ground water quality data.

Brevard County Subdivision

Surficial Hydrogeology --

An integrated approach similar to that conducted at the other subdivision monitoring sites was used to determine the hydrogeology of the shallow sediments comprising the surficial aquifer beneath the site. A ground penetrating radar (GPR) survey was not performed at this site due to scheduling conflicts.

Twenty test borings were installed at the site during the course of the investigation (Figure 5.11). Eleven of the borings were completed as temporary piezometer wells and used to establish the direction of ground water flow within the surficial aquifer.

The results of the electromagnetic survey indicated areas where ground water contained elevated levels of dissolved solids such as could be found adjacent to and downgradient of an OSDS drainfield (Figure 5.12). However, some of the areas with high conductivity values may have been caused by use of fertilizers by home owners. Other areas of high conductivity may reflect variation in lithology. These data were used to select optimum locations for nine monitoring wells (Figure 5.11).

Water level measurements were collected from the wells during several visits to the site (Table 5.7, Appendix C). The corrected values were contoured on a site diagram and used to solve three-point dip problems for the free water surface to determine the direction of ground water flow (Figure 5.13). Comparisons of high versus low water level data indicates that the direction illustrated in Figure 5.13 is relatively constant and is not significantly affected by recharge from rainfall events (Appendix C). In general, the direction of ground water flow reflects land surface elevation variations and is greatly affected by the drainage ditches and canals in the study area.

Baildown tests conducted on monitoring wells BC-1 and BC-6 revealed hydraulic conductivity values of approximately 14 and 140 gpd/ft$^2$ , respectively. The aquifer transmissivity was estimated at 550 and 5,600 gpd/ft, respectively. The calculated seepage velocities were 6.1 and 95.6 ft./yr. This wide range in velocity reflects the imprecision in the test procedure as well as the variation in hydraulic conductivity and ground water gradient across the site.

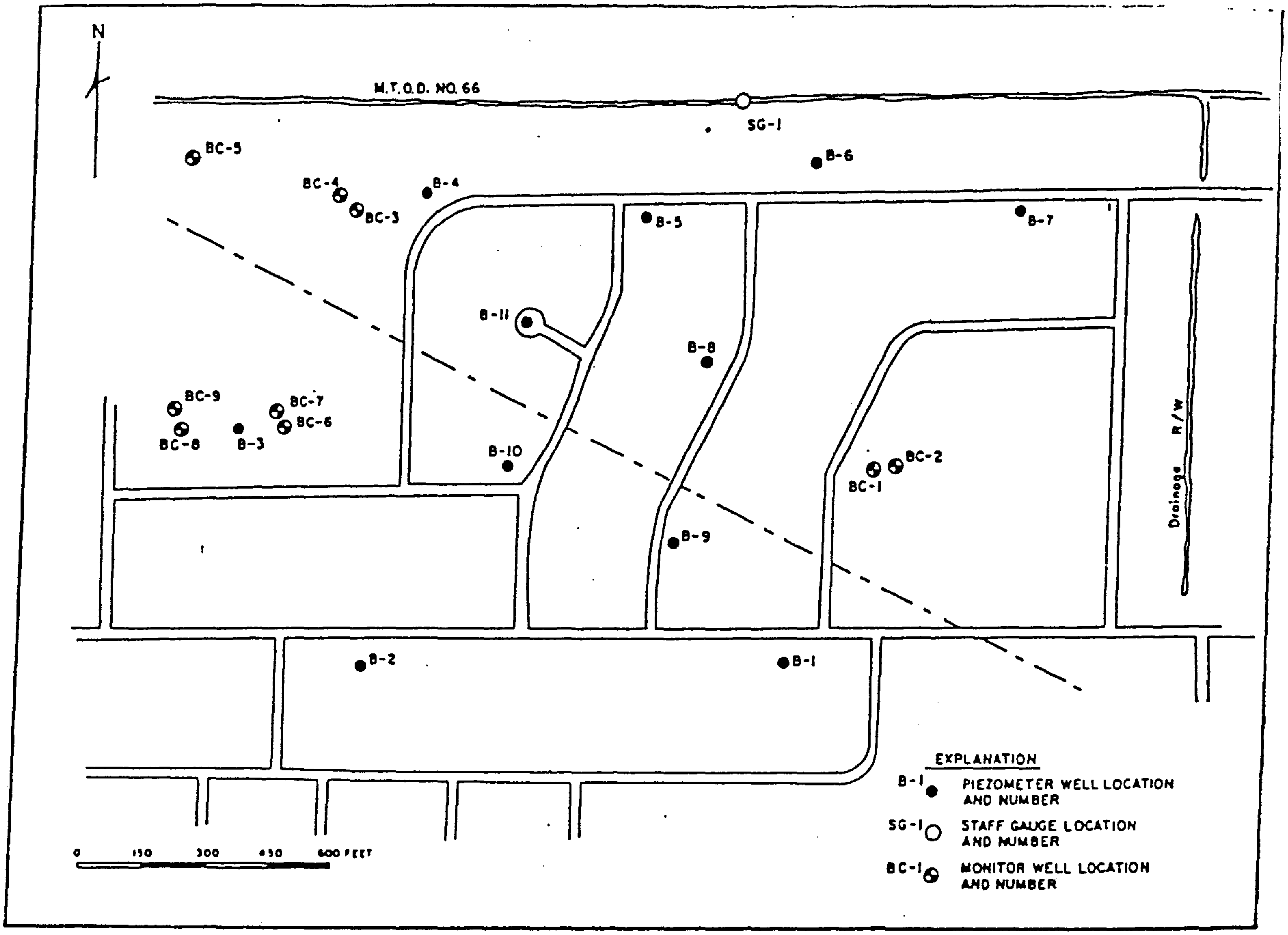

Figure 5.11. Locations of piezometers and monitoring wells in the subdivision in Brevard County, Florida.

Table 5.9.[2] Ground water quality beneath the subdivision in Brevard County, Florida.[1]

| Well | Statistic | Elev. | Temp. | pH | Conduct. | TDS | Cl | BOD5 | TKN | NO3 | TP | SO4 | MBAS | F.coli. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ft. | oC | units | umho/cm | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | #/100mL |
| BC1 | Average | 49.61 | 25.2 | | 683 | 571 | 28 | 5.4 | 6.00 | 1.21 | | | | |
| | Std.Dev. | 0.78 | 2.7 | | 19 | 80 | 2 | 3.6 | 1.06 | 0.77 | | | | |
| | Maximum | 50.78 | 27.2 | 6.40 | 705 | 660 | 29 | 9.3 | 7.20 | 2.10 | 0.13 | 16 | 0.14 | <10 |
| | Minimum | 49.13 | 22.1 | 6.29 | 670 | 506 | 26 | 2.1 | 5.20 | 0.72 | <0.01 | <2 | <0.05 | <10 |
| | No. | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| BC2 | Average | 49.98 | 25.3 | | 508 | 451 | 11 | 3.6 | 7.00 | 0.14 | 0.19 | 32 | 0.14 | |
| | Std.Dev. | 1.2 | 1.4 | | 4 | 86 | 1 | 1.8 | 0.85 | 0.20 | 0.07 | 9 | 0.02 | |
| | Maximum | 51.77 | 26.3 | 6.12 | 510 | 512 | 11 | 4.9 | 7.60 | 0.37 | 0.24 | 38 | 0.15 | <10 |
| | Minimum | 49.32 | 24.3 | 6.07 | 505 | 390 | 10 | 2.3 | 6.40 | 0.01 | 0.14 | 25 | 0.12 | <10 |
| | No. | 4 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 2 |
| BC3 | Average | 48.45 | 22.0 | | 508 | 597 | 85 | | 4.60 | 1.59 | 0.86 | 32 | | |
| | Std.Dev. | 1.02 | 4.3 | | 187 | 293 | 50 | | 2.71 | 2.60 | 0.35 | 15 | | |
| | Maximum | 49.58 | 25.0 | 5.65 | 640 | 872 | 140 | 4.2 | 7.40 | 4.60 | 1.20 | 45 | 0.13 | 150 |
| | Minimum | 47.59 | 18.9 | 5.30 | 375 | 288 | 43 | < 1.0 | 2.00 | 0.08 | 0.50 | 15 | <0.05 | <10 |
| | No. | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| BC4 | Average | 48.44 | 22.2 | | 80 | 258 | 19 | | 2.80 | 0.39 | 0.38 | | | |
| | Std.Dev. | 0.72 | 2.5 | | 10 | 167 | 9 | | 1.40 | 0.27 | 0.35 | | | |
| | Maximum | 49.46 | 24.0 | 5.30 | 91 | 440 | 25 | 2.3 | 3.80 | 0.70 | 0.78 | 11 | 0.09 | 300 |
| | Minimum | 47.92 | 19.4 | 4.92 | 73 | 113 | 9 | < 1.0 | 1.20 | 0.20 | 0.11 | <2 | <0.05 | <10 |
| | No. | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| BC5 | Average | 47.80 | 22.3 | | 120 | 249 | 11 | | 1.90 | 0.41 | 0.62 | | | |
| | Std.Dev. | 0.74 | 2.8 | | 23 | 172 | 4 | | 0.79 | 0.60 | 0.32 | | | |
| | Maximum | 48.74 | 24.0 | 6.51 | 145 | 444 | 14 | 3.7 | 2.80 | 1.10 | 0.84 | 12 | 0.10 | <10 |
| | Minimum | 47.18 | 19.1 | 5.92 | 100 | 116 | 7 | <1.0 | 1.30 | 0.02 | <1.0 | <10 | <0.05 | <10 |
| | No. | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 |
| BC6 | Average | 49.13 | 25.0 | | 702 | 419 | 40 | | 3.47 | 0.35 | 0.22 | | | |
| | Std.Dev. | 1.24 | 2.3 | | 308 | 116 | 17 | | 0.83 | 0.25 | 0.11 | | | |
| | Maximum | 50.91 | 27.2 | 6.49 | 1050 | 534 | 51 | 8.6 | 4.40 | 0.60 | 0.35 | 11 | 0.11 | <10 |
| | Minimum | 48.20 | 22.7 | 6.00 | 465 | 302 | 20 | <1.0 | 2.80 | 0.10 | 0.13 | <10 | <0.05 | <10 |
| | No. | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| BC7 | Average | 48.60 | 22.7 | | 490 | 433 | 46 | 5.4 | 2.33 | 1.71 | 0.27 | | | |
| | Std.Dev. | 0.98 | 3.3 | | 148 | 149 | 25 | 0.9 | 0.55 | 2.77 | 0.11 | | | |
| | Maximum | 49.98 | 25.5 | 6.76 | 660 | 544 | 64 | 6.2 | 2.70 | 4.90 | 0.37 | 51 | 0.10 | 10 |
| | Minimum | 47.78 | 19.1 | 5.20 | 390 | 264 | 17 | 4.5 | 1.70 | 0.02 | 0.16 | <2 | <0.05 | <10 |
| | No. | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

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[1] Refer to Figure 5.11 for well locations.

[2] Refer to Appendix D for detailed ground water quality data.

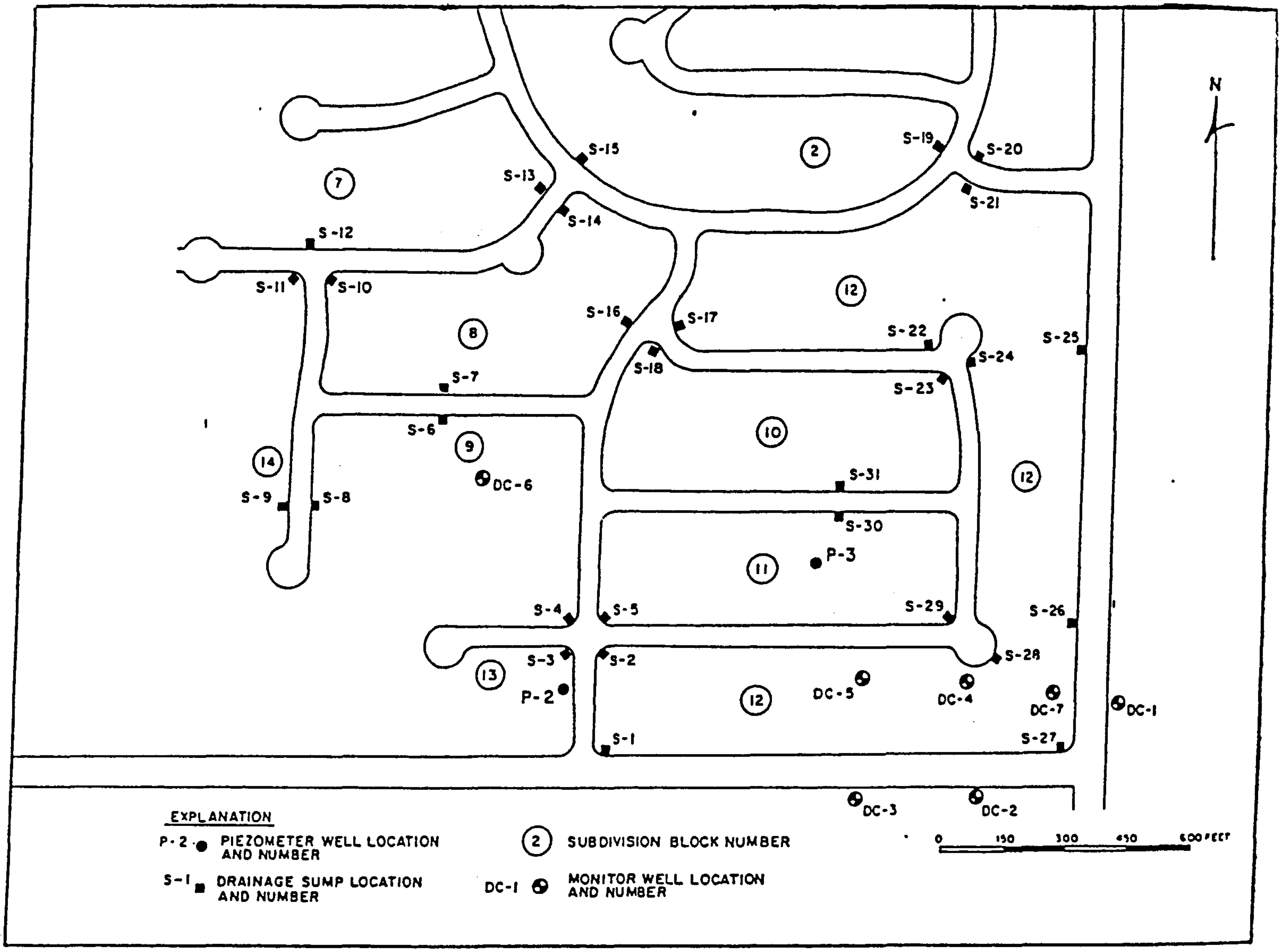

Figure 5.14. Locations of the drainage sumps, piezometer and monitoring wells in the subdivision site in Dade County, Florida.

Ground Water Quality --

Ground water quality samples were collected on three occasions between October 1987 and March 1988, the results of which are summarized in Table 5.9 and Appendix D.

A total of seven wells were placed within the subdivision. For the purposes of this preliminary evaluation, wells BC-4 and BC-5 were considered to most closely represent ambient surficial aquifer water quality. These wells appeared, at this time, to be sufficiently far downgradient and beyond the influence of OSDSs and irrigation water.

Ground water quality in many of the wells exhibited notably high concentrations of constituents associated with STE, including TDS, $BOD_5$, and TKN. Fecal coliform bacteria were measured in three of the wells on the same date, March 14, 1988, at levels of 10 to 300 organisms/100 mL. The water table elevation measured on this date was at its highest during the monitoring period. Most of these constituents were significantly elevated at several of the wells which were drilled at locations thought to be near or within the influence of OSDS drainfields. VOCs were not detected in any of the samples from any of the wells (Appendix E).

## Dade County Subdivision

Surficial Hydrogeology --

During the initial screening of the subdivision, the field investigators discovered that the storm drains indicated in Figure 5.14 were actually unlined sumps which were dug into the limestone underlying the site. These sumps are not connected to buried drainage pipe as is normally the case, but are simply installed in direct connection with the aquifer. The extremely high permeability of the aquifer accounts for the ability of these "go away holes", as they are called, to handle the surface runoff generated within the subdivision. This method of surface water runoff management is apparently common to all subdivisions examined in the vicinity of the study area.

Table 5.7. Water level data collected from the temporary piezometer wells at the Brevard County study site.[1]

| Well Number | Land Surface Elevation | Monitoring Date<br>6-5-87 | 6-30-87 | 10-9-87 | 3-14-88 |
|---|---|---|---|---|---|
| | ft. (common datum) | | | | |
| B1 | 50.3 | 47.80 | 47.82 | 48.17 | 49.44 |
| B2 | 50.4 | 47.38 | 48.12 | 47.79 | 49.83 |
| B3 | 51.0 | 47.90 | 47.32 | 48.36 | 50.79 |
| B4 | 50.7 | 48.13 | 47.90 | | |
| B5 | 51.0 | 47.81 | 47.81 | 47.92 | 49.19 |
| B6 | 51.4 | 47.82 | 47.60 | 48.39 | 48.11 |
| B7 | 51.4 | 47.37 | 47.16 | 48.07 | 50.06 |
| B8 | 51.8 | 48.90 | 48.74 | 50.44 | 50.86 |
| B9 | 52.9 | 50.14 | 49.77 | 50.34 | 52.11 |
| B10 | 50.2 | 47.93 | 47.85 | 48.33 | 49.70 |
| B11 | 50.3 | 47.93 | 47.92 | | |

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[1] Refer to Figure 5.11 well piezometer locations.

Table 5.8. Water level data collected from the monitoring wells at the Brevard County study site.[1]

| Well Number | Land Surface Elevation | Monitoring Date<br>10-26-87 | 11-17-87 | 12-8-87 | 3-14-88 |
|---|---|---|---|---|---|
| | ft. (common datum) | | | | |
| BC1 | 52.0 | 49.13 | 49.21 | 49.32 | 50.78 |
| BC2 | 51.7 | 49.32 | 49.32 | 49.50 | 51.77[2] |
| BC3 | 50.9 | 47.59 | | 48.19 | 49.58 |
| BC4 | 50.7 | 47.92 | 47.94 | 48.44 | 49.46 |
| BC5 | 50.5 | 47.18 | 47.24 | 48.03 | 48.74 |
| BC6 | 51.4 | 49.02 | 48.20 | 48.39 | 50.91 |
| BC7 | 51.2 | 48.61 | 47.78 | 48.04 | 49.98 |

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[1] Refer to Figure 5.11 for monitoring well locations.

[2] Vicinity of BC-2 was flooded by a previous heavy rainfall.

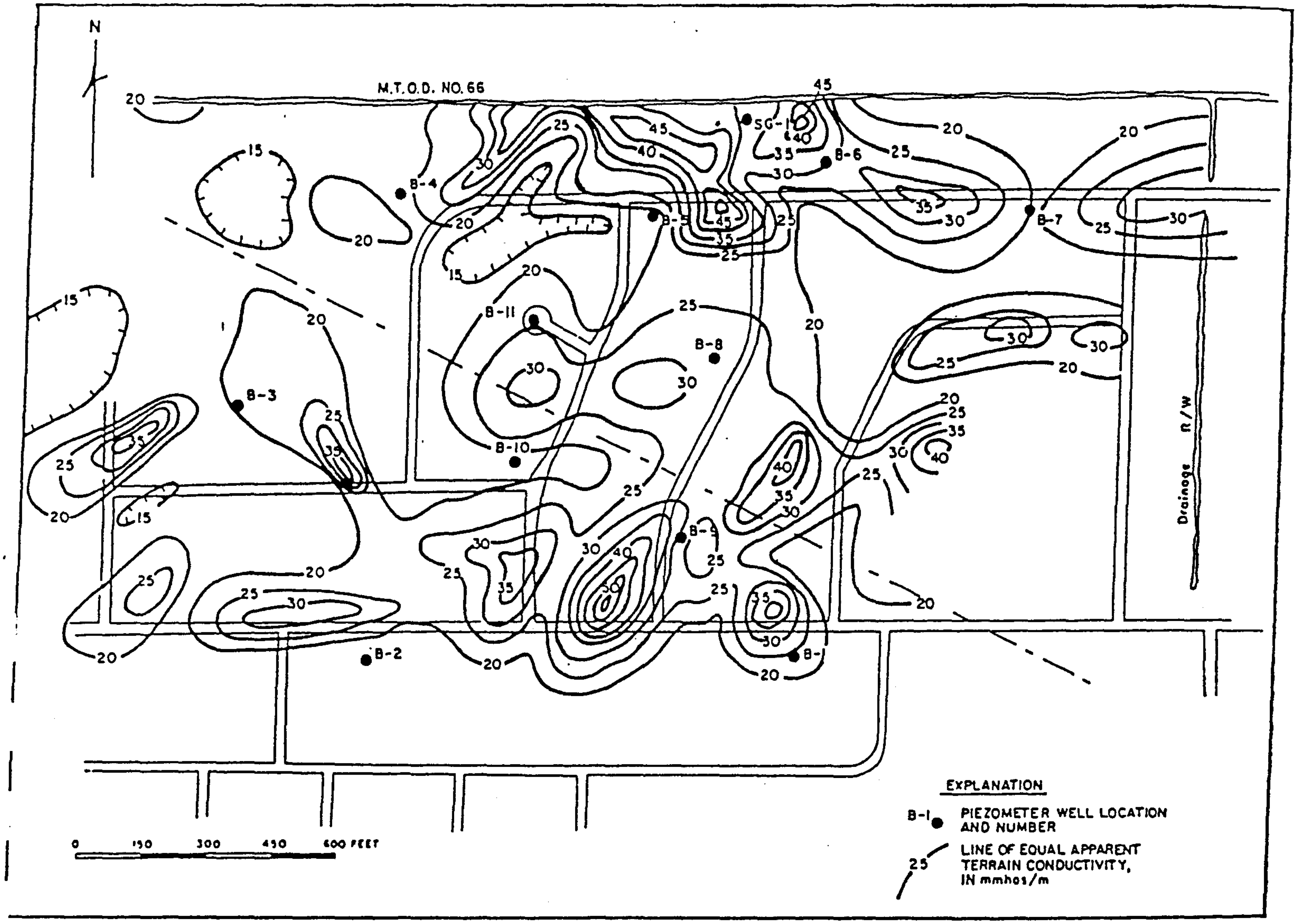

Figure 5.12. Apparent terrain conductivity contour map of the subdivision site in Brevard County.

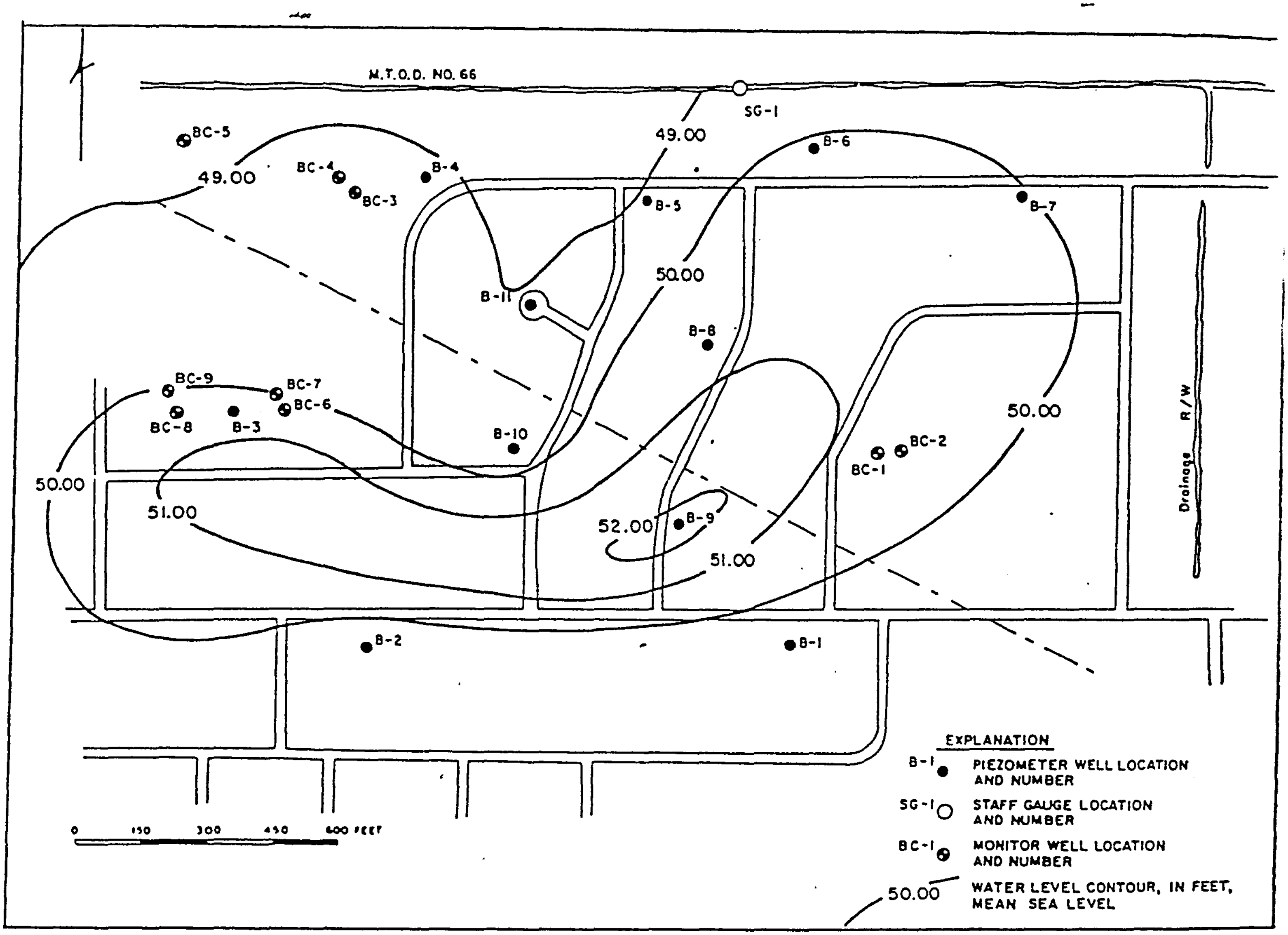

Figure 5.13. Direction of ground water flow in Brevard County study site. (Based on measurements made on March 14, 1988).

A thin layer of fine to medium grain clayey sand with large limestone fragments blankets the site area. The thickness of the surficial sand ranges from six inches to approximately five feet. Underlying this sand is the limestone of the Biscayne aquifer.

Four piezometer wells were installed at the locations shown in Figure 5.14 to determine the connection of the drainage sumps with the underlying aquifer. Once the hydraulic connection of the sumps and the aquifer was confirmed, it was decided to include the drainage sumps in the water elevation monitoring network. This increased the number and density of monitoring points while limiting the number of wells required.

The terrain conductivity survey revealed areas of relatively high conductivity values potentially associated with individual OSDSs (Figure 5.15). These values normally decreased with lateral distance from the systems.

The ground water flow direction map and the apparent terrain conductivity map were used to determine the monitoring well locations shown in Figure 5.14. The monitoring wells were installed within or immediately downgradient of areas which exhibited elevated terrain conductivity.
Water elevations were obtained on several occasions as highlighted in Table 5.10 and summarized in Appendix C. The water table was approximately 3 to 5 ft. below ground surface across much of the site. Water level measurements were contoured on a site diagram to determine the direction of ground water flow beneath the site. These data were further checked by solving three-point dip problems for the free water surface. The inferred direction of ground water flow in the surficial aquifer beneath the site is shown in Figure 5.16.

Baildown tests were conducted on two monitoring wells at the site with inconclusive results. The water levels within the wells recovered too rapidly to quantify the hydraulic conductivity of the aquifer. Hyraulic conductivity values were estimated from aquifer transmissivity and thickness data supplied by repesentatives of Dade County Department of Environmental Resources management (Hernandez, 1989). Darcy flux velocity (specific discharge) calculations based on the water table gradients indicated in Figure 5.16 were roughly 670 ft./yr.

Table 5.10. Water level data collected from monitoring wells at the Dade County study site.[1]

| Well Number | Ground Surface Elevation | Monitoring Date 11-18-87 | 12-08-87 | 03-15-88 |
|---|---|---|---|---|
| | ft. (msl) | | | |
| DC-01 | 7.84 | ----- | 4.12 | 4.25 |
| DC-02 | 9.04 | ----- | 4.14 | 4.36 |
| DC-03 | 9.29 | ----- | 4.12 | 4.34 |
| DC-04 | 8.74 | ----- | 4.15 | 4.36 |
| DC-05 | 8.94 | ----- | 4.17 | 4.38 |
| DC-06 | 9.52 | ----- | 4.22 | 4.51 |
| DC-07 | | 4.40 | 4.17 | 4.37 |

[1] Refer to Figure 5.14 for well locations. See Appendix C for complete listing of piezometer well and drainage sump data.

Ground Water Quality --

The Dade County subdivision site was chosen for its unique hydrogeologic setting with the Biscayne aquifer existing at shallow depth. It was the only site where OSDSs were installed directly above a limestone aquifer as opposed to silica sand as at the other three sites. The water quality data were also unique in that they were the most uniform of the four sites.

Ground water samples were collected on only two occasions, once in December 1987 and once in March 1988. The results of these analyses are detailed in Appendix D and highlighted in Table 5.11.

Ground water quality measurements for most constituents were relatively consistent between wells and sampling dates. However, notable concentrations of several constituents associated with STE were detected, including BOD5, TKN, and fecal coliform bacteria (Table 5.11). Fecal coliforms were detected in a total of 7 of 14 samples collected from five of seven wells. The concentrations ranged from a 5 to 17,000 organisms/100 mL. VOCs were not detected in any of the samples from any of the wells.

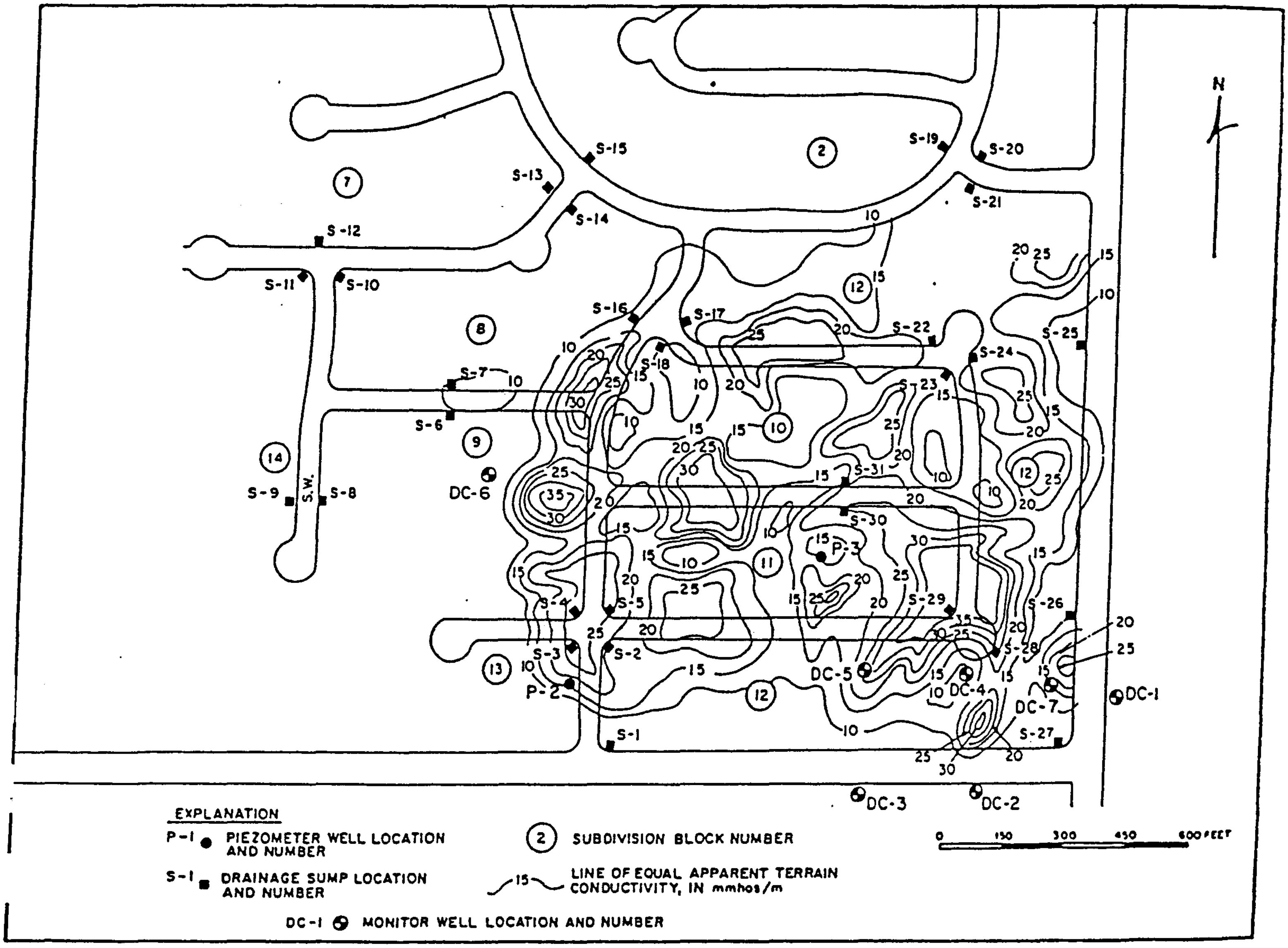

Figure 5.15. Apparent terrain conductivity contour map of study site in Dade County, Florida.

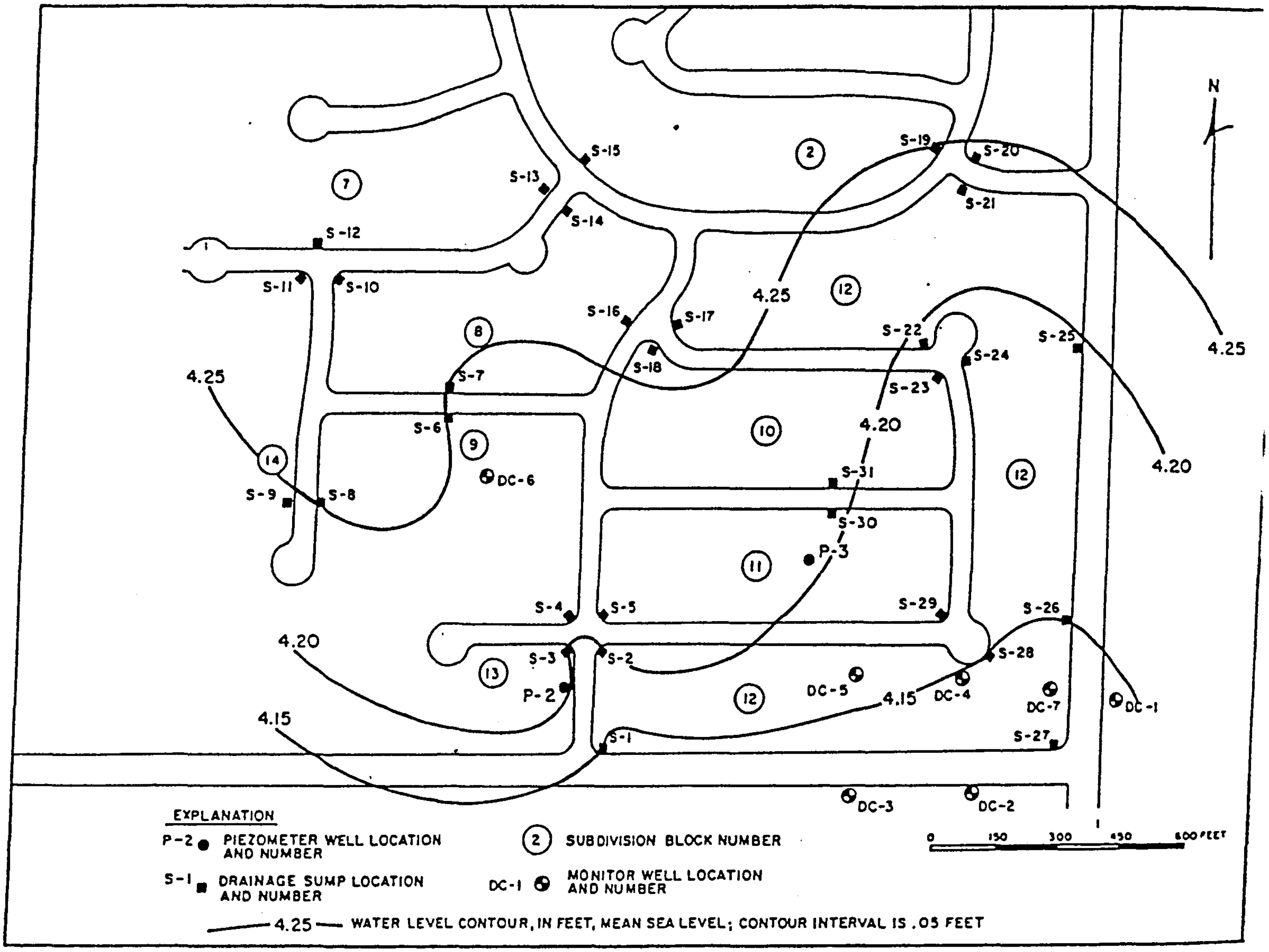

Figure 5.16. Direction of flow of ground water beneath the study site in Dade County, Florida. (Based on measurements made on December 8, 1987).

Table 5.11. Ground water quality beneath the subdivision in Dade County, Florida.[1]

| Well | Statistic | Elev. | Temp. | pH | Conduct. | TDS | Cl | BOD5 | TKN | NO3 | TP | SO4 | MBAS | F.coli. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ft. | oC | units | umho/cm | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | #/100mL |
| DC1 | Average | 4.19 | 24.6 | | 655 | 330 | 36 | 1.3 | 1.00 | 0.61 | 0.45 | 45 | | |
| | Std.Dev. | 0.09 | 0.7 | | 92 | 54 | 2 | 0.2 | 0.00 | 0.14 | 0.41 | 17 | | |
| | Maximum | 4.25 | 25.1 | 6.90 | 720 | 368 | 37 | 1.4 | 1.00 | 0.71 | 0.74 | 57 | <0.05 | 2400 |
| | Minimum | 4.12 | 24.1 | 6.90 | 590 | 292 | 34 | 1.1 | 1.00 | 0.51 | 0.16 | 33 | <0.05 | <10 |
| | No. | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| DC2 | Average | 4.25 | 24.7 | | 618 | 366 | 36 | 1.5 | 1.05 | 0.82 | 0.42 | 49 | | |
| | Std.Dev. | 0.16 | 1.3 | | 74 | 51 | 2 | 0.5 | 0.35 | 0.69 | 0.44 | 16 | | |
| | Maximum | 4.36 | 25.6 | 7.16 | 670 | 402 | 37 | 1.8 | 1.30 | 1.30 | 0.73 | 60 | <0.05 | 170 |
| | Minimum | 4.14 | 23.8 | 6.80 | 565 | 330 | 34 | 1.1 | 0.80 | 0.33 | 0.11 | 37 | <0.05 | <1 |
| | No. | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| DC3 | Average | 4.23 | 24.4 | | 603 | 377 | 37 | 1.7 | 0.73 | 0.80 | 0.18 | 47 | | |
| | Std.Dev. | 0.16 | 1.6 | | 53 | 33 | 1 | 0.5 | 0.01 | 0.85 | 0.17 | 9 | | |
| | Maximum | 4.34 | 25.5 | 6.90 | 640 | 400 | 38 | 2.0 | 0.74 | 1.40 | 0.30 | 53 | <0.05 | <1 |
| | Minimum | 4.12 | 23.2 | 6.90 | 565 | 354 | 36 | 1.3 | 0.72 | 0.20 | 0.06 | 40 | <0.05 | <1 |
| | No. | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| DC4 | Average | 4.26 | 24.8 | | 586 | 355 | 37 | 2.2 | 3.10 | | 0.32 | 41 | | |
| | Std.Dev. | 0.15 | 2.1 | | 34 | 49 | 3 | 1.2 | 2.12 | | 0.09 | 16 | | |
| | Maximum | 4.36 | 26.2 | 7.05 | 610 | 390 | 39 | 3.0 | 4.60 | 0.81 | 0.38 | 52 | 0.06 | 17000 |
| | Minimum | 4.15 | 23.3 | 6.80 | 562 | 320 | 35 | 1.3 | 1.60 | <0.01 | 0.25 | 30 | <0.05 | 3900 |
| | No. | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| DC5 | Average | 4.28 | 24.8 | | 625 | 356 | 37 | 2.7 | 1.71 | 0.29 | 0.76 | 49 | | |
| | Std.Dev. | 0.15 | 1.8 | | 99 | 31 | 1 | 0.4 | 1.26 | 0.38 | 0.49 | 16 | | |
| | Maximum | 4.38 | 26.0 | 6.90 | 696 | 378 | 37 | 3.0 | 2.60 | 0.56 | 1.10 | 60 | 0.15 | 270 |
| | Minimum | 4.17 | 23.5 | 6.70 | 555 | 334 | 36 | 2.4 | 0.82 | 0.02 | 0.41 | 38 | <0.05 | 20 |
| | No. | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| DC6 | Average | 4.37 | 24.7 | | 598 | 369 | 40 | | 0.73 | 0.18 | 0.33 | 48 | | |
| | Std.Dev. | 0.21 | 0.8 | | 60 | 38 | 5 | | 0.04 | 0.08 | 0.19 | 18 | | |
| | Maximum | 4.51 | 25.2 | 6.90 | 640 | 396 | 43 | 1.2 | 0.75 | 0.23 | 0.46 | 60 | 0.05 | <10 |
| | Minimum | 4.22 | 24.1 | 6.40 | 555 | 342 | 36 | <1.0 | 0.70 | 0.12 | 0.19 | 35 | <0.05 | <1 |
| | No. | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| DC7 | Average | 4.27 | 24.2 | | 618 | 371 | 36 | | 3.11 | 1.75 | 0.63 | 37 | | |
| | Std.Dev. | 0.14 | 1.5 | | 60 | 27 | 2 | | 3.52 | 0.21 | 0.81 | 6 | | |
| | Maximum | 4.37 | 25.2 | 6.95 | 660 | 390 | 37 | 3.5 | 5.60 | 1.90 | 1.20 | 41 | <0.05 | 5 |
| | Minimum | 4.17 | 23.1 | 6.85 | 575 | 352 | 34 | <1.0 | 0.62 | 1.60 | 0.05 | 33 | <0.05 | <10 |
| | No. | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |

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[1] Refer to Figure 5.14 for well locations.

[2] Refer to Appendix D for detailed ground water quality data.

DISCUSSION

The results of monitoring ground water beneath four subdivisions are summarized in Table 5.12 and discussed briefly below.

In the subdivision in Polk County, the water table typically occurred at depths over 9 ft. while in the other three subdivisions the water table depths were often less than 5 ft. Thus, the unsaturated soil depth for renovation of OSDS STE was limited by these water table depths.

In the subdivisions located in Polk, St. Johns and Brevard Counties, the water table aquifer occurred in fine sandy materials and the ground water seepage velocities were estimated to be typically below 25 ft./yr (Table 5.12). In Dade County, the velocities were higher at 670 ft./yr due to the limestone aquifer present there. This indicated that in all likelihood, the maximum concentrations of contaminants in the shallow ground water below the subdivisions in Polk, St. Johns and Brevard County would not be reached for many years. The renovated STE entering the ground water from individual OSDSs would yield a hydraulic and possibly a quality impact which could grow in extent over time. Both of these impacts could be imperceptible due to low initial concentrations in the percolate from the OSDSs or through dilution, retardation and degradation in the ground water system. Only after many years of operation, would the downgradient ground water be expected to exhibit the maximum concentrations that conceivably could occur based on the ground water seepage velocities calculated in this study.

The monitoring within the subdivisions seems to have generally confirmed the above described behavior. Pairs of wells downgradient of OSDSs and the subdivision as a whole revealed only localized ground water quality impacts. Attributing the impacts without question to one or more OSDSs is difficult since many of the constituents present in OSDS STE are also derived from other anthropogenic and natural sources. However, sufficient evidence exists to suggest that inadequately treated OSDS STE may be at least partially the cause.

The most notable potential ground water quality impacts were in those subdivisions with limited unsaturated soil depth for treatment (i.e. in Brevard, Dade and to some extent St. Johns Counties). Not only were notable concentrations of reduced (i.e. unoxidized) chemical constituents found (e.g. $BOD_5$, TKN), but also levels of fecal coliform bacteria. VOCs were not detected in the ground water, but the concentrations of VOCs in household STE were extremely low. Samples have been collected for virus analyses in Polk and St. Johns County, but data compilation and analysis has yet to be completed.

On several occasions during the monitoring period, the ground water table appeared to be within 2 ft. or closer to the OSDS infiltrative surfaces in the subdivisions in St. Johns and Brevard County. Considering the capillary fringe height in the fine sands present, it is likely that the substantially unsaturated soil depth available for STE purification would be less than 2 ft. for substantial portions of the year. Removal and degradation of chemical and biological constituents by this soil treatment would not be expected to be as complete as that which could occur in greater depths of unsaturated soil.

Clearly, there is need for further sampling of existing wells as well as installtion and monitoring of additional wells. Current concepts regarding the further work required are outlined in Section 8.

Table 5.12. Summarized results of ground water monitoring in four subdivisions in Florida.[1]

| Characteristic | County in Which Subdivision Was Monitored | | | |
|---|---|---|---|---|
| | Polk | St. Johns | Brevard | Dade |
| Soil Characteristics | | | | |
| Soil Texture | f.sand | f.sand | sand | sand |
| Water Table Depth, ft. | 9 - 18 | 2 - 7 | 1 - 4 | 3 - 5 |
| Ground Water Flow | | | | |
| Aquifer Materials | sand | sand | sand | limestone |
| Conductivity, gpd/ft$^2$ | 38; 41 | 12; 71 | 14; 140 | 172,000 |
| Transmissivity, gpd/ft | 790 | 750; 4200 | 550; 5600 | - |
| Seepage Velocity, ft/yr | 2.0; 5.6 | 4.9; 21.9 | 6.1; 95.6 | 670 |
| Ground Water Quality | | | | |
| Monitoring Wells, no. | 5 | 7 | 7 | 7 |
| Samples/Well, no. (typ.) | 4 | 3 | 3 | 2 |
| OSDS Impacts? | Maybe | Maybe | Likely | Likely |

# SECTION 6
# INDIVIDUAL OSDS MONITORING

## INTRODUCTION

During this research activity, individual OSDSs were studied at four homes in each of the Polk County and St. Johns County subdivisions. At each home, the household and OSDS characteristics were determined, the STE and septage were characterized, and the operation of the OSDS was assessed. At two of the individual OSDSs in each of these subdivisions, soil sampling was conducted at and beneath the STE infiltrative surfaces.

## METHODS

### Household and OSDS Characterization

The characteristics of each of the eight homes monitored were determined through written questionaires and personal interviews. A sample questionaire may be found in Appendix A. The characteristics of these eight homes were described previously in Section 4 (Tables 4.3 and 4.4). Maps indicating the location of the homes in each subdivision are shown in Figures 6.1 and 6.2.

The characteristics and layout of each OSDS were determined, as much as possible, by interviews with homeowners and local HRS Environmental Health officials and by subsurface probing at each home. During excavation of the systems for monitoring basin and observation port installation, details on the construction of the systems were gathered as well.

### Soils Characterization

The soils in the subdivisions in Polk and St. Johns County were examined by USDA Soil Conservation Service (SCS) and Ayres Associates soil scientists to determine soil morphology and soil characteristics affecting the performance of OSDSs. These examinations included inspection of backhoe excavated test pits and hand borings, and conducting ground penetrating radar (GPR) scans. General soil conditions were based on direct observations of testpits and borings, and these data were the basis of detailed mapping as provided by SCS staff. The GPR data were used mainly for confirmation and extension of these results.

### Wastewater Characterization

Water Use --

In the Polk County subdivision, water use data were collected due to the availability of water meters on the municipal water supply to each home.

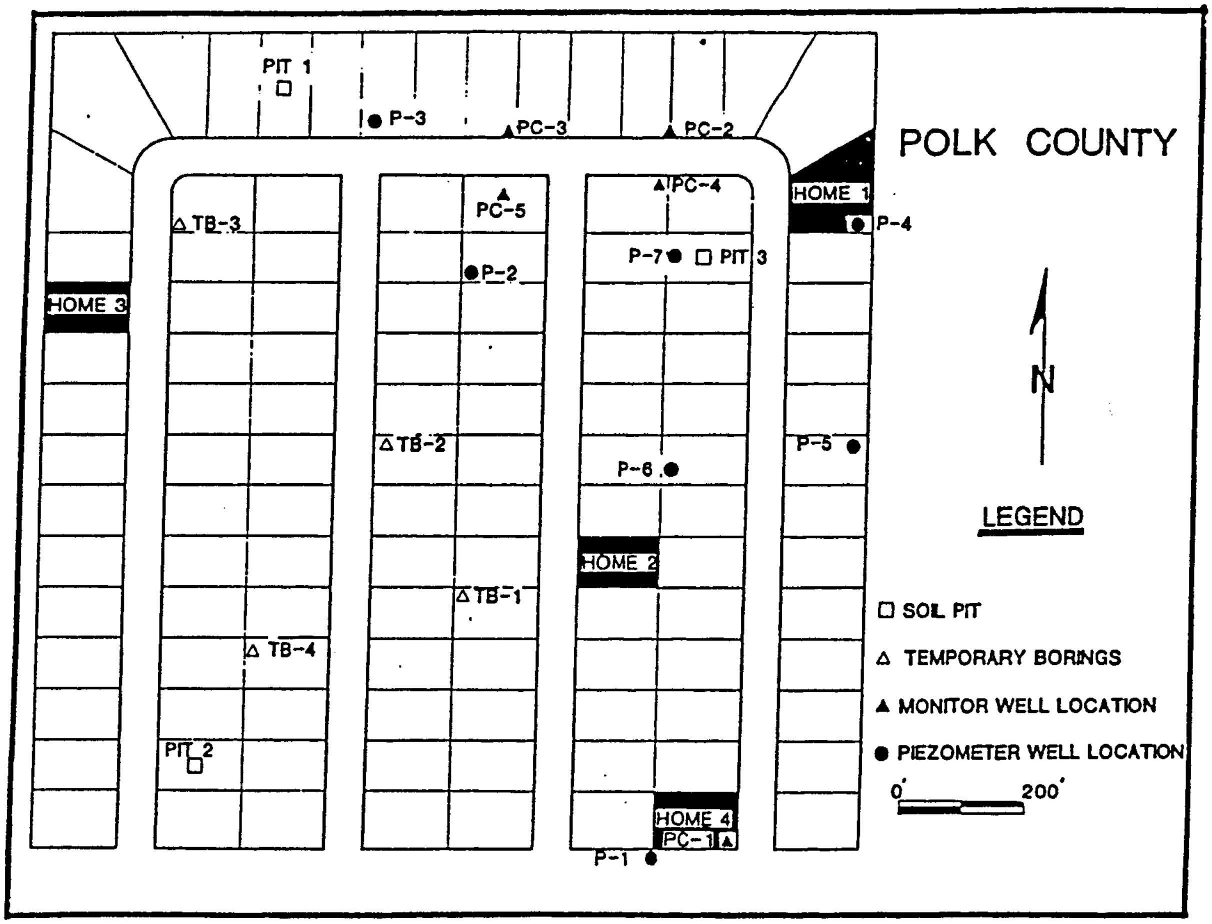

Figure 6.1. Location of individual OSDSs monitored in Polk County.

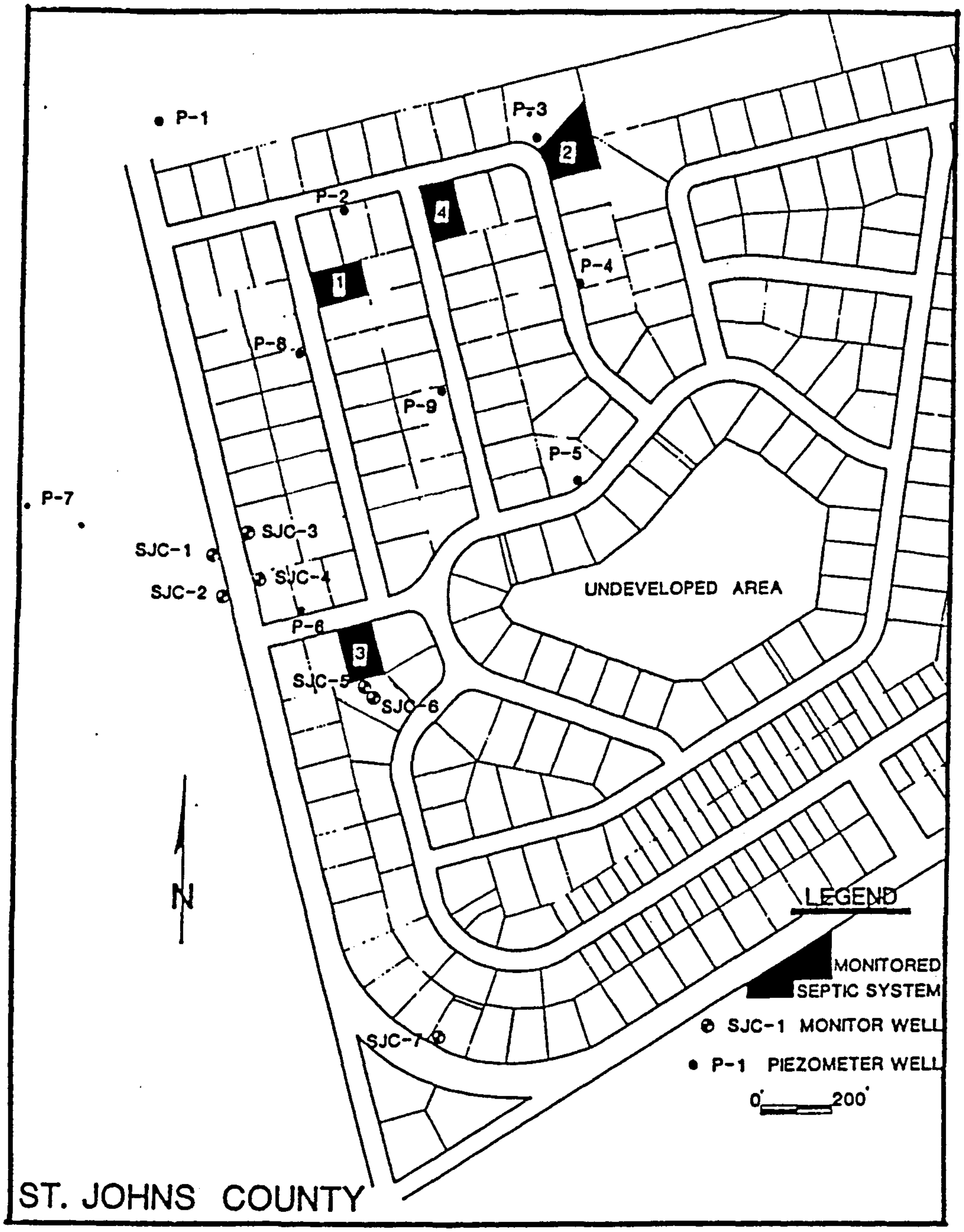

Figure 6.2. Location of individual OSDSs monitored in St. Johns County.

Exterior water use at homes 12 and 13 were obtained by installing meters on the exterior hose bibs. Exterior water use was monitored at homes 12 and 13 for a portion of the monitoring period.

## Septic Tank Effluent Quality --

To allow sample access to septic tank effluent (STE) over the study period, a small polyethylene basin (approx. 2 to 5 gal.) was installed in the drain line on the effluent side of the septic tank or distribution box. A 4 in. diameter polyvinylchloride (PVC) riser pipe was fitted to the basin to bring the access point within 6 in. of ground surface. The 4 in. PVC pipe was fitted with a removable cap and the entire assembly was finished off at grade with the use of a plastic water meter box.

STE flowed through the sampling basin and to the OSDS infiltration unit. Upon arriving at a site to sample, the STE basin was pumped out and allowed to refill with fresh STE before taking grab samples. Samples for VOCs were always taken first by carefully dipping a 250-mL Pyrex beaker into the STE without splashing, and then transferring the contents slowly to standard 40-mL volatile organic analysis (VOA) vials with Teflon lined caps. These vials were placed on ice in a sample cooler for shipment to the laboratory for analysis. After obtaining the necessary VOC aliquots, samples for conventional analyses were taken by pumping out of the STE monitoring basin with a small hand operated diaphram pump. A 1-L polyethylene bottle was filled for subsequent laboratory analyses of $BOD_5$, TSS, TDS, $NO_2$+$NO_3$, $Cl^-$ and MBAS. This aliquot was preserved by placing the bottle on ice in a sample cooler immediately after sampling and until arrival at the laboratory for analysis. A 0.5-L polyethylene bottle containing sufficient sulfuric acid to adjust the sample to $pH<2$ was filled for TKN and P analyses and also placed on ice in the sample cooler. Two sterile plastic bags (118 mL, Nasco Whirl-pak) were filled for fecal coliform analyses and also preserved by cooling on ice. A 0.5-L glass beaker was also filled and temperature, pH and conductivity were measured on that portion in the field.

Sample coolers were either shipped by bus or delivered by field personnel to the laboratory for analyses. Chain of custody forms were utilized with all sample containers to track samples as needed. In general samples arrived at the laboratory within twelve hours of sampling, and consistently within 24 hr. All laboratories used for sample analyses were approved by Florida HRS and Department of Environmental Regulation (DER) for the parameters analyzed.

Quality control (QC) samples were taken as a check on laboratory results and sampling procedures. External QC sampling consisted of taking field blanks, trip blanks, and splitting samples between laboratories and for analyses. In addition, internal QC was practiced at each laboroaty using blanks, spikes, and duplicates.

Sampling of STE for virus has also been conducted at the homes monitored. The results of this sampling are incomplete at this time and will be discussed in the final report on this phase of the study.

## Septage Characterization

Grab samples of septage from each of the eight study homes were collected during August 1988. This was accomplished by removing the lid from the septic tank and then manually mixing the contents of the tank. Samples of the mixed material were then taken as described above for the STE characterization. Samples were handled and analyzed in a similar fashion.

## Infiltration System Performance

Observation ports were installed within each OSDS to enable determination of the occurrence and magnitude of any wastewater effluent ponding. These measurements provided a cursory indication of system hydraulic performance. The observation ports were checked at the time of each site visit and measurements of any ponding were recorded. Figure 6.3 shows a schematic of a typical observation port.

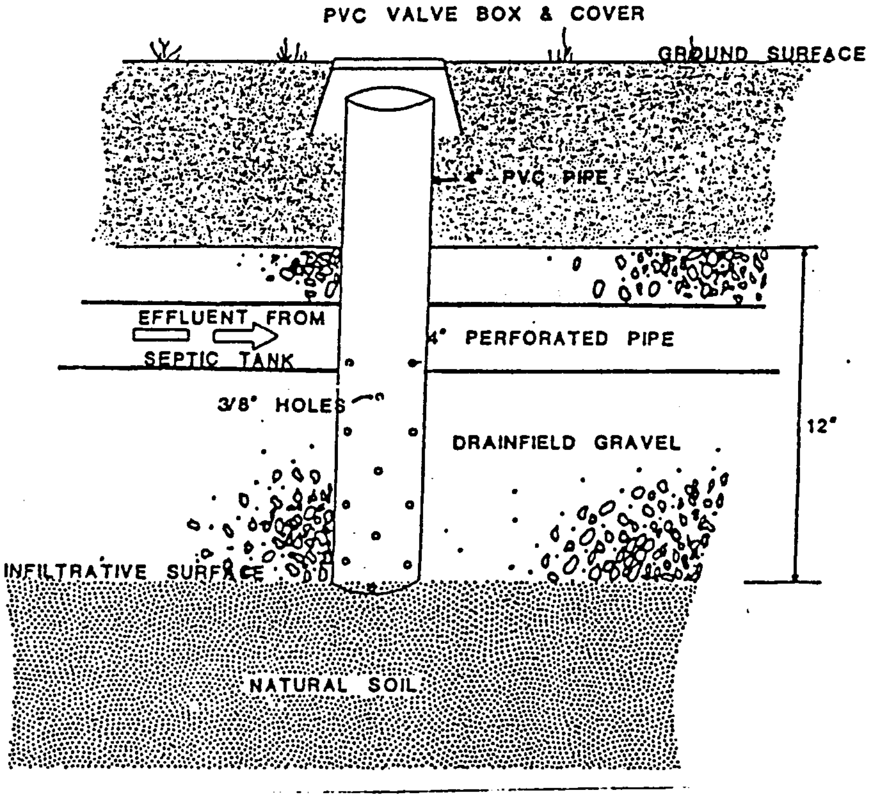

Figure 6.3. Profile schematic of an observation port within an infiltration system trench.

To investigate the treatment of STE in unsaturated soil below the infiltration system, soil sampling was performed at several of the homes where STE characteristics had been monitored. Basically, this part of the subdivision monitoring was designed to provide preliminary insight into the downward vertical migration of contaminants in unsaturated soils beneath operating OSDSs in sandy soils in Florida. It was desired to determine if potential contaminants were migrating downward to 2 ft. or more below the infiltrative surface.

In designing this part of the experiment, a key premise was STE contaminants present in the soil at a given depth would be an indication that the contaminant had migrated there in association with the applied STE. If a given contaminant was not detected, at least two explanations could apply. First, the contaminant had not migrated to the location sampled due to its retardation and degradation in the unsaturated zone between the infiltrative surface and the sample point. Second, the contaminant had migrated to the location sampled but was no longer detectable since it had either been degraded at the location sampled, or had migrated away in the soil profile, perhaps into the underlying ground water. Detection of a contaminant at a given depth could therefore be interpreted as positive evidence of contaminant migration to that depth, but nondetection could not be interpreted as positive evidence that the contaminant had not migrated to that depth. However, for contaminants which had been continuously applied to the system at relatively high levels prior to sampling, it was much more likely that nondetection or a reduction in concentration with depth was associated with retardation and degradation in the unsaturated zone.

Four of the eight OSDSs where STE monitoring had been performed were included in this soil sampling effort. Two of these were within the subdivision in Polk County and two were within the subdivision in St. Johns County.

At two separate locations within each OSDS infiltration system area soil samples were collected at three depths (Figure 6.4). The sample depths included the wastewater infiltrative surface and at approximately 2 and 4 ft. beneath it. This was done to enable development of contaminant profiles with depth. Analyses were conducted for a suite of physical, chemical and biological parameters which would enable determination of the recent exposure of the soil to wastewater effluent as well as the total contaminant concentrations remaining. Analyses were also conducted to facilitate assessment of contaminant comparisons between depths and locations.

The depth of 2 ft. below the infiltrative surface was important as it was equal to the minimum depth to high ground water under which OSDSs can be installed in Florida. If contaminants were detected at 2 ft. and especially also at 4 ft., it could be interpreted to mean that the contaminants could have migrated into the ground water if it were present at the permitted 2 ft. beneath the infiltrative surface.

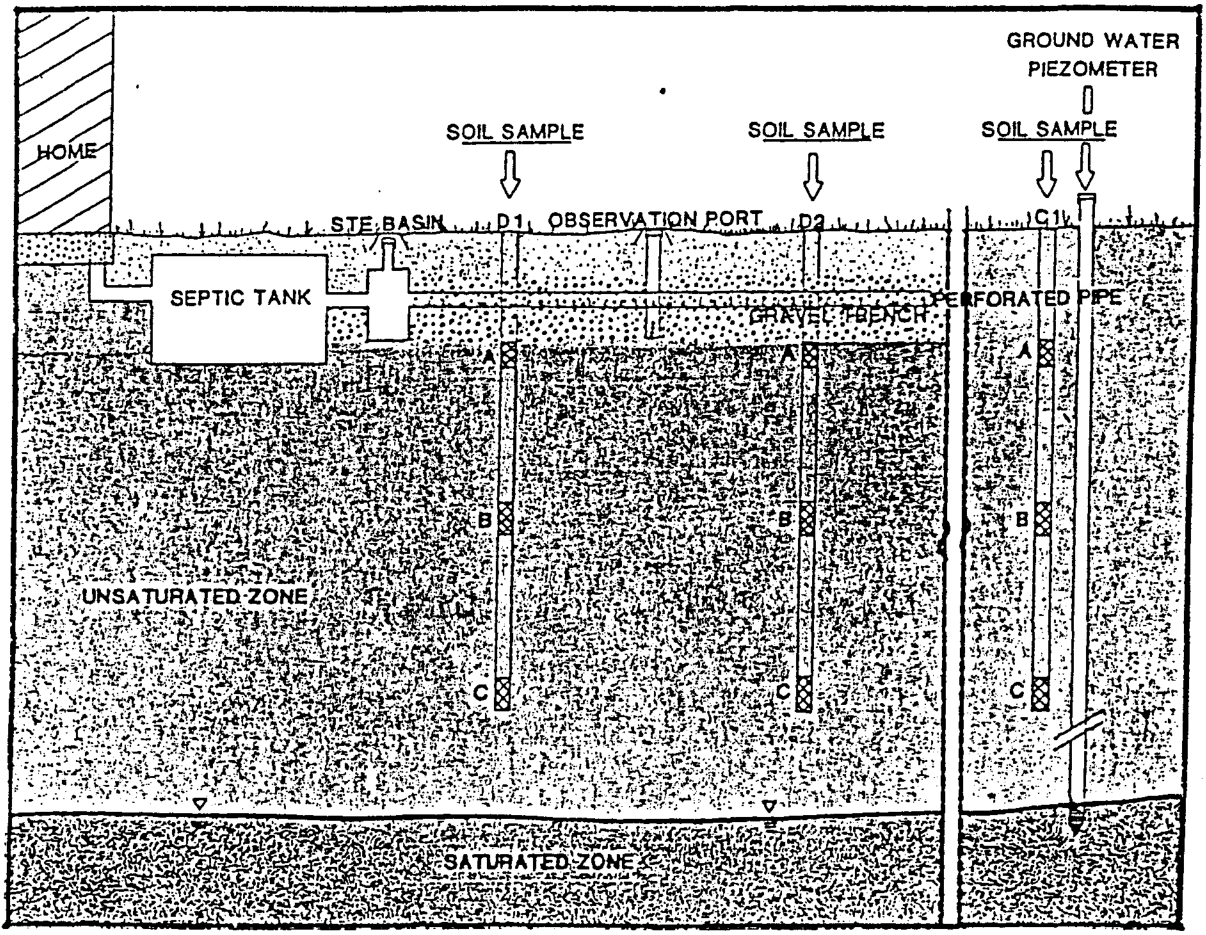

Figure 6.4. Profile schematic of sub-infiltration system sampling locations.

Soil samples were collected from each sample location according to the following protocol.

Upon arrival at an OSDS to be monitored, sample locations were carefully selected. A background sample location (C1) was established in proximity to but apart from the OSDS. Two sample locations were established within the infiltration area of the OSDS. One location was within approximately 5 ft. of the inlet to the infiltration trench or bed (location D1). A second location was approximately 15 to 20 ft. from the inlet (D2) and within the same portion of the OSDS (e.g. same trench). A tile probe was used to verify the location of the intended sample points relative to the OSDS. The sample locations were located using reference points on the property and standard surveying techniques.

A work area was established near the monitoring locations. A work table surface was covered with clean polyethylene film. A source of tapwater from the residence was used for cleaning equipment. The three locations were sampled sequentially from the likely lowest contaminated sample location to the highest (i.e. C1, D2, D1).

A plastic tarp was laid on the ground adjacent to the intended sample location. A tile spade was used to remove a plug of sod and the surface soil to create a hole approximately 1 to 2 ft. in diameter down to the top of the infiltration system gravel. If the drainfield depth was too great for excavation with the tile spade, a post-hole digger or 4-in. bucket auger was utilized to reach the top of the system. The top of the infiltration system was readily identified by contact with the cover fabric (geotextile or paper) and coarse aggregate. The coarse aggregate was removed with a post-hole digger or by hand. Then a 6-in. diameter by 2 ft. long section of galvanized pipe was inserted vertically into the excavation and pressed through the soil infiltrative surface of the OSDS by approximately 2 to 6 in. This pipe section served as a casing to prevent aggregate or debris from the infiltration system entering the boring used for sampling. Prior to use at each sample point, all hand-excavation tools and pipe casings were cleaned with a tapwater flush, detergent wash (trisodium phosphate base), final tapwater rinse and then air-drying.

Once the infiltrative surface was exposed, a second 4-in. bucket auger was used to bore down to the desired sample depth. A stainless steel soil recovery auger (Art's Manufacturing and Supply, American Falls, ID) was then utilized to extract relatively undisturbed soil cores at each sample depth. This sampler was similar in size and geometry to a standard 3.25-in. sand auger, but was machined such that a removable sleeve could be inserted into it from the top end (opposite of the cutting bits). After insertion, a cap was screwed onto the auger head which in turn enabled attachment of appropriate auger handles.

The removable sleeves employed in this study were fabricated from clear plastic with the following dimensions: 10 in. long, 2.9 in. in diameter with 0.06 in. wall thickness.

To collect a soil sample, the assembled auger was carefully inserted inside the casing and rotated downward to fill the auger body with a soil core. The auger was retracted from the boring hole and then disassembled. The clear plastic sleeve was carefully withdrawn from the auger with an intact soil core inside. The soil core was visually inspected and then soil materials from the upper and lower core ends were scooped out with a precleaned stainless steel spoon and wasted. Approximately 2 in. of soil were wasted from the top of the core while approximately 1 in. of soil were wasted from the bottom.

Two smaller, clear plastic sleeves were then inserted into the soil core within the larger plastic sleeve. The smaller plastic cores had the following dimensions: 7 in. long, 0.9 in. diameter and 0.03 in. wall thickness. After insertion, the top ends of the small cores were sealed with aluminum foil. A pencil-size thermometer was then inserted into the core center from the bottom. Then the two small cores were removed from the large core. Immediately upon removal, the bottom of each small core was covered with foil. The balance of the soil within the large core was left in the core temporarily. This core was inverted and placed vertically within a precleaned stainless steel bowl and its upper end was temporarily sealed with aluminum foil.

The soil within each of the two small cores was carefully transferred directly into a 40-mL VOA vial with a precleaned stainless steel spoon. Two vials were filled with soil, one vial for each core. The soil in these vials was analyzed in the laboratory for purgeable organics (VOCs).

The temperature of the soil within the larger core was observed and recorded and then the soil was emptied into a precleaned and disinfected stainless steel bowl. The soil material was quickly mixed and a sterile wood spatula was used to transfer the soil into sample containers. Samples for virus analyses were placed in 8 oz. glass canning jars and capped with metal gasketed screw-top lids. Samples for analyses of selected physical, chemical and biological parameters were placed in 500 mL amber glass jars and capped with screw top-lids.

A profile schematic of the soil core samplers showing relative sample locations is presented in Figure 6.5.

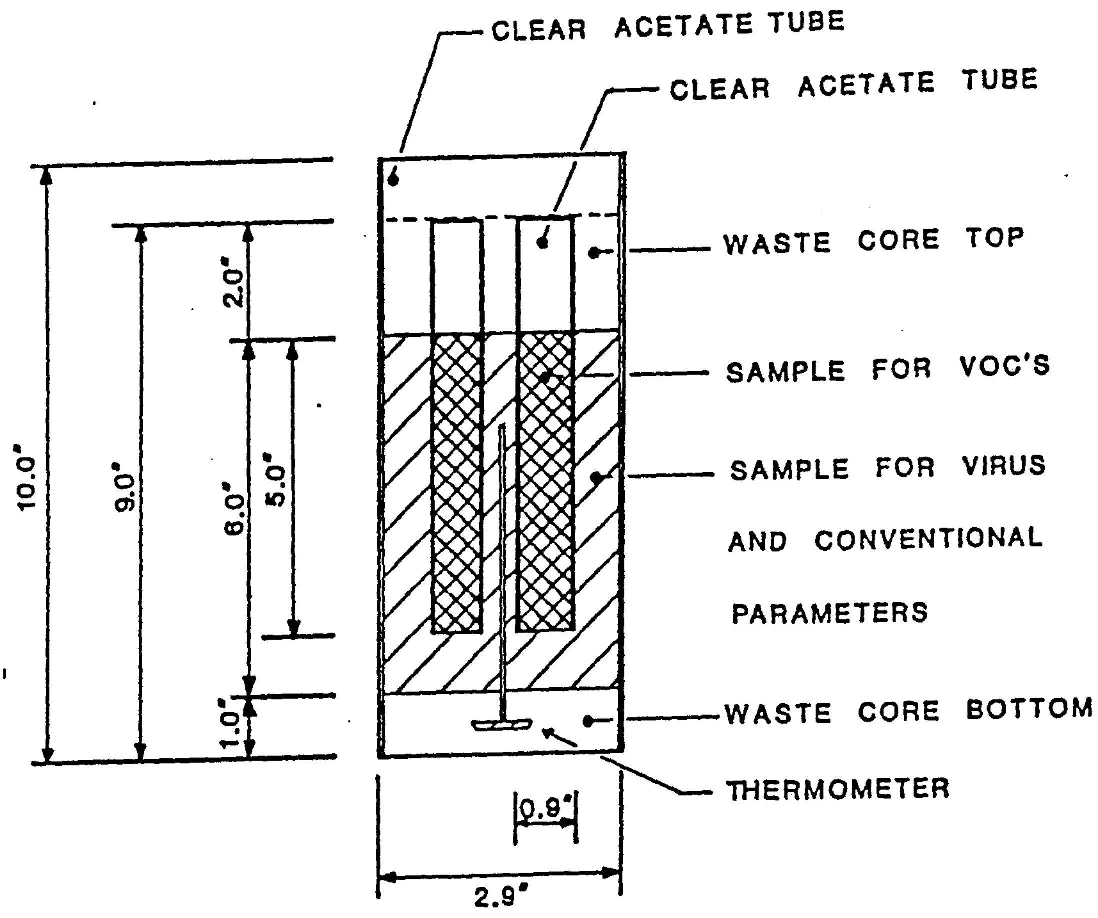

Figure 6.5. Profile schematic of the soil core sampling sleeves and relative location of soil samples.

Appropriate identification information was attached to each sample container. They were then placed in coolers refrigerated with ice and shipped by public carrier to appropriate analytical laboratories. Chain-of-custody protocols were followed as with the STE sampling.

Special precautions were taken during sampling to minimize extraneous sample contamination and/or cross-contamination between sampling points. The work table surface was cleaned after each sample was collected by wiping the surface clean with distilled water and then allowing it to air dry. The stainless steel sampling spoons and plastic sleeves were precleaned in the laboratory prior to visiting each monitoring home. The cleaning protocol employed was: (1) tapwater rinse, (2) detergent wash (trisodium phosphate base), (3) tapwater rinse, (4) acid rinse (0.1 N reagent grade HCL)(spoons only), (5) triple distilled water rinse, (5) wipe dry, (6) air dry.

The other sampling utensils were cleaned onsite in between each sample point. This included the soil recovery auger head, stainless steel bowl and thermometer. The zero contamination auger head was cleaned according to the following protocol: (1) tapwater rinse, (2) detergent wash (trisodium phosphate base), (3) tapwater rinse, (4) distilled water rinse, (5) wipe dry, (6) air dry. The stainless steel bowl and thermometer were similarly cleaned except that after the detergent wash, the utensils were rinsed with tapwater and then sprayed with a concentrated chlorine bleach solution. After this, the utensils were cleaned per steps (3) to (6).

Quality control samples were taken as follows. Two field blanks were prepared. During sampling at home 22, distilled water was rinsed down the interior of an assembled soil recovery auger and directed into four sample containers (same as those used for the soil samples). These were later analyzed for the same parameters as the soil samples. During sampling at home 12, distilled water was rinsed down the interior sidewalls of a clean 3.25-in. diameter plastic sleeve across the cutting bits of the soil recovery auger and directed into 40-mL VOA vials. These were analyzed for VOCs. Finally, a trip blank was included with each cooler used for storing samples to be analyzed for VOCs. This was prepared by the laboratory responsible for the VOC analyses and consisted of two, 40-mL VOA vials filled with organic free water.

Laboratory analyses were performed by State of Florida approved laboratories according to standard procedures (APHA, 1985; Federal Register, 1985; U.S.EPA, 1983; Black, 1965; Page, 1982).

## RESULTS

### OSDS Characteristics

The characteristics determined for each household and OSDS were presented previously in Section 4 (Tables 4.3 and 4,4).

### Soil Characteristics

The soil series characteristics observed at the sites of the individual OSDSs studied are listed in Table 6.1 and discussed below.

Polk County Subdivision --

The soils in the subdivision were derived from interbedded marine sands. The morphology of these soils is dominated by sandy characteristics although sandy clay to sandy clay loam materials are present with depth at some locations. Elsewhere in the study area these clayey soils are either deeper than the depth of soil development or are non-existent. In the northwestern part of the subdivision a potential sinkhole feature exists and organic soils have been mapped. Five distinct soil series were mapped in the entire subdivision (Figure 6.6).

Table 6.1. Soil series characteristics for locations of OSDS study homes in Polk and St.Johns County.[1]

| Soil Series (Homes) | Texture (USDA) | Profile Drainage | Normal Depth to Ground Water |
|---|---|---|---|
| Tavares<br>(12, 14, 21, 24) | Sand | Moderately well drained , rapid profile permeability | > 40 - 80 in. |
| Candler<br>(13) | Fine Sand | Excessively drained | > 80 in. |
| Ona<br>(11) | Sand | Poorly drained[2], moderately rapid profile permeability | 10 - 40 in.<br>> 6 mon/yr |
| Adamsville<br>(22, 23) | Fine Sand | Somewhat poorly drained, rapid profile permeability | 20 - 40 in.<br>2 to 6 mon.<br>> 40 in.<br>balance |

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[1] Refer to Figures 6.6 and 6.7 for spatial locations within each subdivision.

[2] Due to drop in ground water level, current description most likely that of a moderate to well drained sandy soil (see narrative).

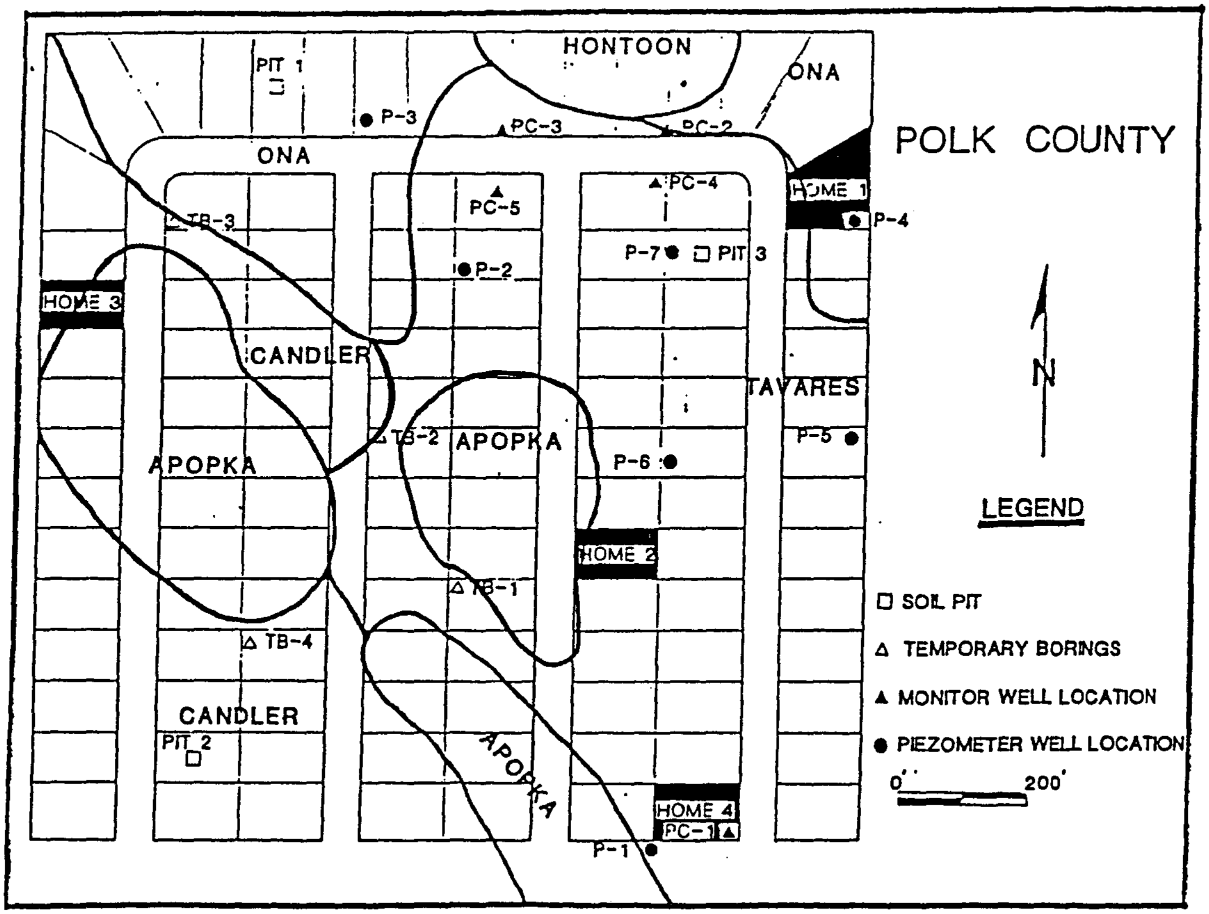

Figure 6.6. Soil series mapped in the study subdivision within Polk County.

Approximately 84 percent of the subdivision area consisted of Candler, Apopka and Tavares fine sands. These soils are classified as excessively drained, well drained, and moderately well drained, respectively, by USDA SCS descriptions. The SCS limitations for conventional septic system drainfields are classified as slight for Candler and Apopka, and moderate for Tavares.

Of the four individual OSDSs monitored in Polk County, two are located in soils mapped as Tavares, one in soils mapped as Candler, and one in soils mapped as Ona. It is important to note here that the drainage class assigned to the Ona and Tavares series in general does not seem to apply to Ona and Tavares soils mapped in the subdivision in Polk County at this time. Evidently, ground water levels in the area decreased significantly in the late 1950's and have never returned to "normal", despite several hurricanes since that time (Reed, 1977). The reason for this is not clear. Therefore, although the soil profile and texture descriptions still fit the Ona and Tavares series as reported in SCS soil surveys, the water table levels do not in most locations of the subdivision. In the case of the OSDS at home 11, the current soil drainage description would more likely be that of a moderately well to well drained fine sandy soil.

<u>Homes 12 and 14:</u> The OSDSs at homes 12 and 14 are located in Tavares soils, as confirmed by hand auger borings. The Tavares series is a moderately well drained soil with rapid profile permeability. The water table typically occurs in the Tavares profile at a depth of 40 to 80 in. below grade for more than 6 months of the year, and below that depth for the remainder of the year. The typical Tavares soil has a texture of sand throughout the profile with little or no profile development. Soil mottling, indicative of seasonal wetness, typically occurs at 30 to 40 in. below grade. In this subdivision test pit number 3 exhibits general Tavares characteristics although no mottling was observed. The testpit description for this location is presented in Appendix G. At the time of inspection (September 21, 1987), ground water was observed in testpit 3 at 10 ft. below grade.

<u>Home 13:</u> The OSDS at home 13 was located in Candler soil. The Candler series is an excessively drained soil typically found in undulating or gently rolling upland areas. The typical Candler soil has a fine sand texture with the water table at a depth greater than 80 in. year round. Testpit 2 exhibits characteristics of the Candler series. The profile description for this test pit is included in Appendix G. No ground water was observed in this backhoe pit at the time of inspection.

<u>Home 11:</u> The OSDS at home 11 was located in soils mapped as Ona, a poorly drained soil series with moderately rapid profile permeability. The typical Ona profile is sandy throughout with a "spodic" horizon in the subsoil which is dark brown due to the staining of the sand grains by organic matter and iron and aluminum oxides. Soil mottles are frequently observed in the 10 to 20 in. zone as the water table is typically 10 to 40 in. below grade for more than 6 months of the year. Testpit 1 typifies the Ona series characteristics, however, ground water was observed at 10 ft. below grade in this pit on September 21, 1987 (see Appendix G).

St. Johns County --

In the subdivision in St. Johns County, the soils are derived from sandy marine sediments. The morphology of the soils are dominated by these sandy materials, especially in the part of the subdivision where individual OSDSs are being monitored. Six distinct soil series were mapped on the entire subdivision as shown in Figure 6.7.

Over 75 percent of the entire subdivision area and all of the area under study consisted of Tavares, Adamsville, and Ona fine sands. The drainage class of these soils are moderately well drained, somewhat poorly drained, and poorly drained, respectively. The SCS limitations for conventional septic system drainfields are classified as moderate, severe, and severe, respectively, with the limitations due to the wetness and poor filtration. In comparison to the moderate to excessively drained soils of the Polk County subdivision, the soils in St. Johns County would be considered much less desirable for conventional OSDS use.

Of the four individual OSDSs monitored in St.Johns County, two are constructed in Tavares soils and two are in Adamsville soils (see Table 6.1 and Figure 6.7).

Homes 21 and 24: The OSDSs at homes 21 and 24 are located in Tavares soils, as confirmed by hand auger borings. The Tavares series was described in the previous section on Polk County. This series is a moderately well drained soil with rapid profile permeability. A mottled color pattern, indicative of seasonal wetness, frequently occurs at depths of 30 to 40 in. below grade. No testpits were excavated in this subdivision. Detailed soil profile descriptions were recorded based on boring observations for each OSDS site and are provided in Appendix G. At the time of inspection (September 23, 1987), ground water was observed at a depth of 55 in. at both OSDS sites 21 and 24.

Homes 2 and 3: The OSDSs at homes 22 and 23 were confirmed to be constructed in Adamsville soils. The Adamsville series is a somewhat poorly drained soil with rapid profile permeability. The water table is typically at 20 to 40 in. below grade for approximately 2 to 6 months of the year, and below 40 in. for the rest of the year. The typical Adamsville profile has a fine sand texture throughout. A mottled color pattern may occur as shallow as 10 to 20 in. and is generally well correlated with the seasonal high water table. The description for the profiles observed at OSDS sites 22 and 23 are presented in Appendix G. At the time of inspection ground water was observed at 40 in. and 35 in. below grade at these respective sites.

As mentioned previously, the SCS drainage class for the Tavares and Ona soils in Polk County is misleading due to the drop in water table elevation in the area of the site. One needs to bear in mind this difference in drainage when comparing site and OSDS characteristics between the subdivisions in Polk and St. Johns Counties. Although both subdivisions contained appreciable areas of Tavares and Ona soils, ground water monitoring data showed significant differences between the two subdivisions in the depth to water table present.

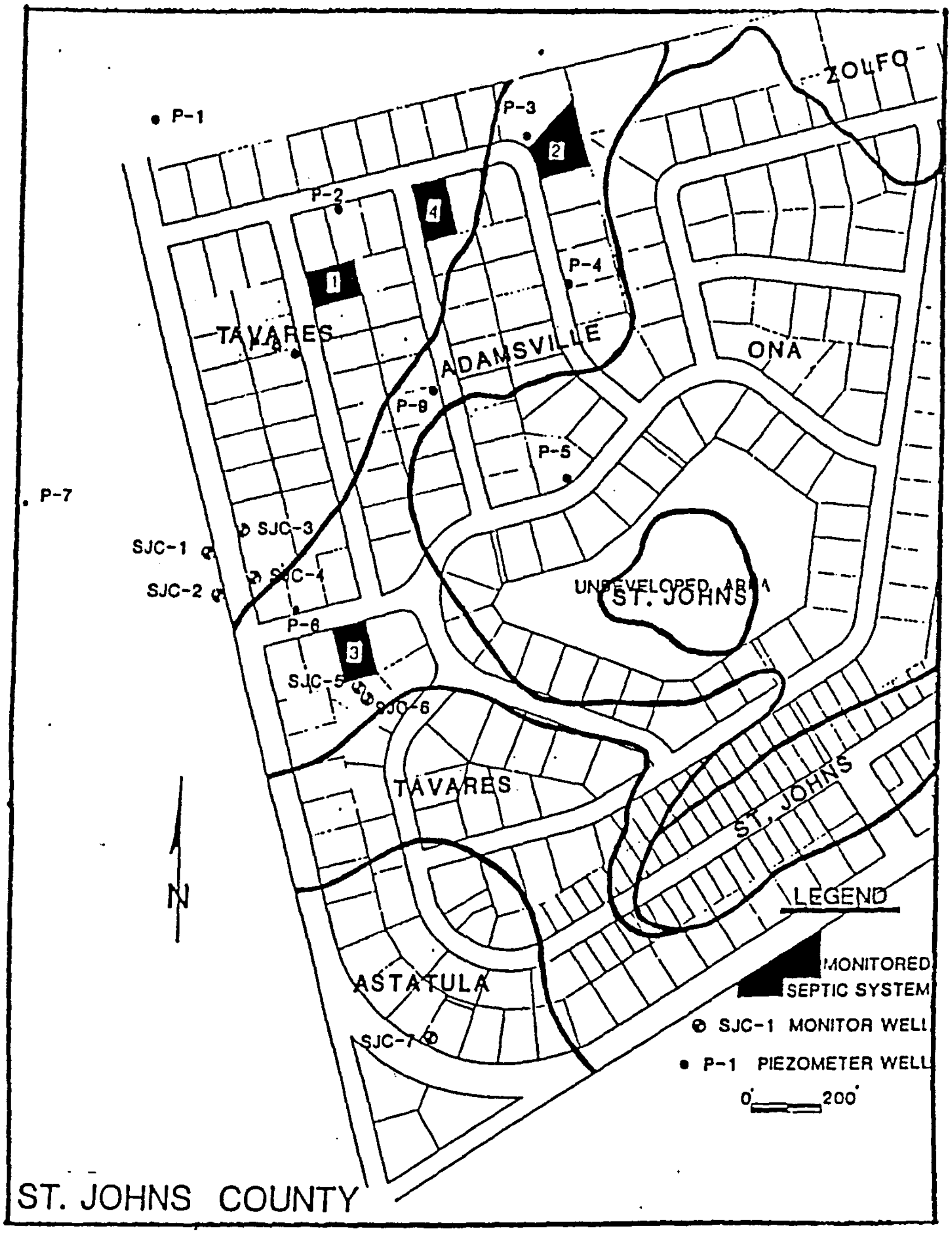

Figure 6.7. Soil series mapped in the study subdivision in St. Johns County.

Water table elevations of 9 to 12 ft. below grade were observed for Tavares soil in Polk County as compared to 3 to 7 ft. below grade in St. Johns County. For Ona soils, water table elevations of 7 to 10 ft. below grade in Polk County contrasted significantly with the 2 to 3 ft. below grade measured in St. Johns County.

These results show that ground water monitoring data can be very important in addition to soil morphology when evaluating site characteristics for OSDS use. This is especially true in Florida where man-induced drainage and development patterns have altered natural drainage conditions in many locations.

## Wastewater Characteristics

Total water use at the homes in Polk County ranged from 239 to 732 gallons/day (gpd) and 60 to 244 gallons/capita/day (gpcd). Home 13 water use is extremely high and is related to the fact that the residents cared for 4 to 5 additional children during the day over the course of the OSDS monitoring. Exterior water use was monitored at homes 12 and 13 for a portion of the monitoring period and resulted in average exterior water use of 90 and 341 gpd, respectively. This water usage at home 13 is again high due to the actual number of users. The exterior water use monitoring at home 12 resulted in an average interior water use of approximately 232 gpd or 46 gpcd over the period monitored. This value compares very well with the 44 gpcd reported in the U.S. EPA Design Manual for OSDS (U.S. EPA, 1980) and is a good estimate for per capita daily wastewater flow.

The equipment for STE monitoring was installed on individual OSDSs in August and September, 1987. In the Polk County subdivision, all four individual OSDSs had concrete distribution boxes (d-box) molded integrally with the septic tank. Drainlines for infiltration trenches were connected to individual outlets on these distribution boxes. All systems utilized black, corrugated, 4-inch diameter perforated plastic pipe as drainlines. The connection of the drainlines to the distribution box was typically made by simply inserting the 4-inch diameter drainpipe into the 6-inch diameter hole in the distribution box and then filling around the drainline with grout. This connection had failed on at least one line on two of the four systems excavated in the Polk County subdivision. Effluent was seeping out of the d-box around the bottom of the drain pipe as a result.

When installing the STE monitoring basin on the drainlines, a 12-inch long section was cut out near the d-box for insertion of the basin in the line. At that time the short section at the d-box was removed, rotated 180 so the perforations faced up and then regrouted into the d-box opening. This was done to insure effluent flow into the STE basin for sampling.

The OSDSs monitored in the subdivision in St. Johns County were very similar in construction to those in Polk County. The major difference was that no distribution box was used. Instead, a single header pipe was used from the septic tank and lines were split off this header with tee or el fittings to distribute STE to the individual trenches or drainlines. Similar problems with leaky grout fittings at the connection to the septic tank were found, however. The STE basins for these systems were installed on an individual drainline just as they were in Polk County.

Sampling of STE began in August 1987 in the Polk County subdivision and in October 1987 in the St. Johns County subdivision. A summary of the average results for conventional parameters at each home is given in Tables 6.2 to 6.4 and graphically depicted in Figures 6.8 and 6.9. Individual sample results are included in Appendix H through J.

The results from this study compare favorably with previous investigations of STE quality with few exceptions. Table 6.5 lists the average results for all homes from this study with previous results from the literature.

Differences with previous studies exist mostly for temperature and total suspended solids (TSS). Temperatures measured for STE in this study were notably higher than those measured in more nothern climates (Harkin et al, 1979). These increased temperatures could result in increased biological activity in both the septic tank and soil infiltration system. In fact, TSS measurements in this study were appreciably higher than those reported previously (Table 6.3). One reason for the increased average TSS values was the high average of TSS measurements at home 13. The average TSS concentrations of the seven sites excluding home 13 was approximately 100 mg/L. This value is still slightly high, but closer to what has been described in the literature. One could speculate that this might be attibutable to increased reaction rates in the septic tank which might have could have yielded more TSS in the STE.

The results of this study for fats, oils, and greases (FOG) and methylene blue active substances (MBAS) are a needed addition to the literature. Values for both appear to be in the range which has been reported in the limited literature available (Bicki et al, 1984; Siegrist et al, 1984).

Of the 35 different VOCs analyzed for, only four were routinely deteicted in the STE: toluene, chloroform, methylene chloride and 1,4-dichlorobenzene (Appendix I). Toluene was detected most often, then chloroform, methylene chloride, and 1,4-dichlorobenzene in decreasing order of occurrence. Toluene was measured at levels above detection limits at every monitoring home and in almost every STE sample taken. The specific source of toluene in the STE is unknown but toluene is a common ingredient in products used around the home such as cleaning solvents, paint thinners, and certain dyes and organic chemicals.

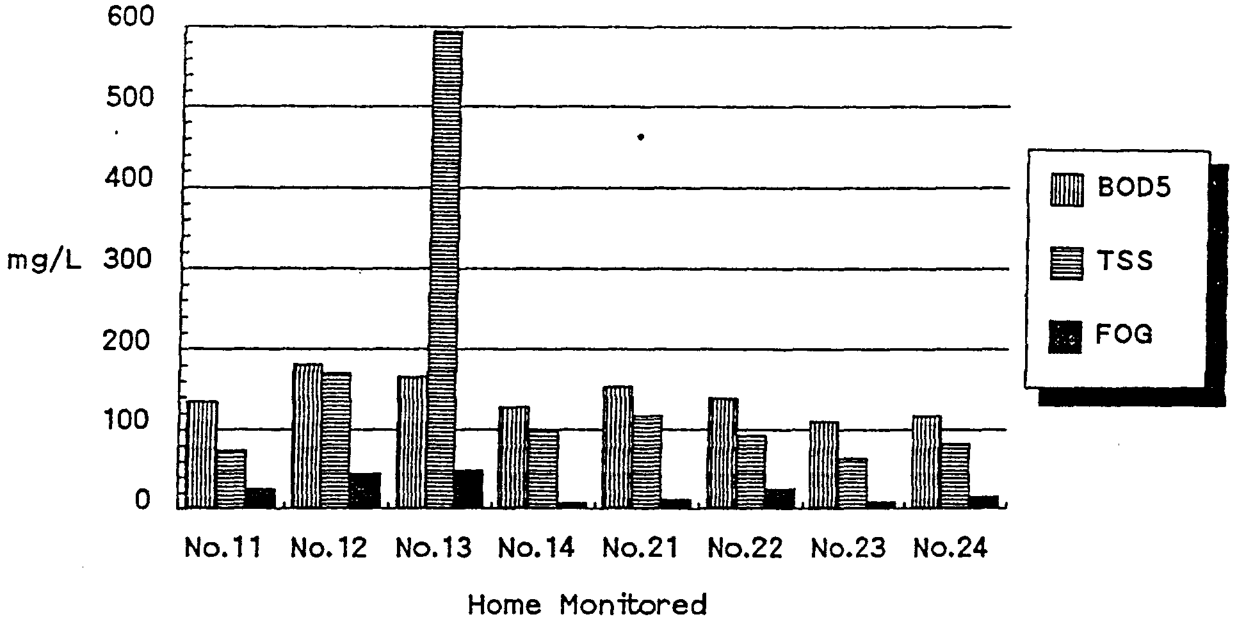

Figure 6.8. Average concentrations of $BOD_5$, suspended solids and fats, oil and grease in the septic tank effluents.

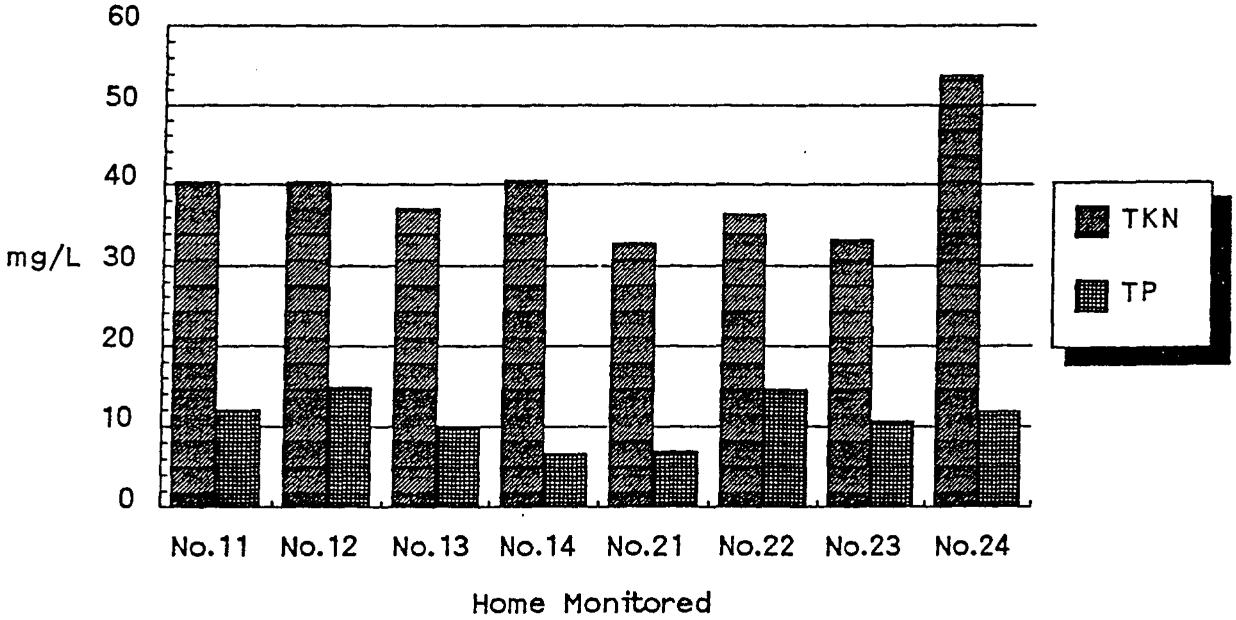

Figure 6.9. Average concentrations of nutrients in septic tank effluents monitored as part of this study.

Table 6.2. Septic tank effluent temperature, pH, specific conductance and chlorides.

| Home | Statistic | Temp. | pH | Conductance | Chlorides |
|---|---|---|---|---|---|
| | | °C | Units | umhos/cm | mg/L |
| Polk County | | | | | |
| Home 11 | Average | 27 | 6.8-7.2 | 804 | 40 |
| | Std.Dev. | 4.2 | - | 60.2 | 9.0 |
| | Number | 7 | 7 | 7 | 4 |
| Home 12 | Average | 26.4 | 6.8-7.4 | 5317 | 1734 |
| | Std.Dev. | 4.6 | - | 1477 | 408 |
| | Number | 6 | 6 | 6 | 5 |
| Home 13 | Average | 26.3 | 7.0-7.5 | 837 | 48 |
| | Std.Dev. | 4.4 | - | 109 | 11.6 |
| | Number | 6 | 6 | 6 | 5 |
| Home 14 | Average | 26.8 | 6.8-7.3 | 1034 | 44 |
| | Std.Dev. | 4.7 | - | 102 | 24.2 |
| | Number | 7 | 7 | 7 | 4 |
| St.Johns County | | | | | |
| Home 21 | Average | 25.2 | 6.6-7.1 | 540 | 28 |
| | Std.Dev. | 0.5 | - | 14.1 | 2.1 |
| | Number | 4 | 4 | 4 | 4 |
| Home 22 | Average | 25.5 | 7.0-7.2 | 712 | 24 |
| | Std.Dev. | 2.9 | - | 99 | 3.6 |
| | Number | 5 | 5 | 5 | 5 |
| Home 23 | Average | 25.4 | 7.1-7.4 | 1000 | 10 |
| | Std.Dev. | 1.9 | - | 41 | 2.6 |
| | Number | 4 | 4 | 4 | 4 |
| Home 24 | Average | 23.2 | 8.0-8.9 | 959 | 29 |
| | Std.Dev. | 3.0 | - | 69 | 11.5 |
| | Number | 5 | 5 | 5 | 5 |

Table 6.3. Septic tank effluent concentrations of BOD$_5$ and solids.

| Home | Statistic | BOD$_5$ | TDS | TSS | FOG |
|---|---|---|---|---|---|
| | | mg/L | mg/L | mg/L | mg/L |
| Polk County | | | | | |
| Home 11 | Average | 134 | 468 | 73 | 25 |
| | Std.Dev. | 30.4 | 24.8 | 25.6 | 10.3 |
| | Number | 4 | 4 | 4 | 2 |
| Home 12 | Average | 181 | 2266 | 170 | 44 |
| | Std.Dev. | 60.6 | 1256 | 138.5 | 30.0 |
| | Number | 5 | 5 | 5 | 3 |
| Home 13 | Average | 165 | 627 | 594 | 49 |
| | Std.Dev. | 36.3 | 127 | 255. | 39.9 |
| | Number | 5 | 5 | 5 | 3 |
| Home 14 | Average | 128 | 674 | 97 | 7.6 |
| | Std.Dev. | 18.6 | 82 | 49.2 | 2.9 |
| | Number | 4 | 4 | 4 | 2 |
| St.Johns County | | | | | |
| Home 21 | Average | 153 | 360 | 117 | 111 |
| | Std.Dev. | 27.5 | 67 | 22.2 | 89.2 |
| | Number | 4 | 4 | 4 | 3 |
| Home 22 | Average | 139 | 415 | 93 | 25 |
| | Std.Dev. | 24.5 | 62 | 24.0 | 8.9 |
| | Number | 5 | 5 | 5 | 4 |
| Home 23 | Average | 111 | 640 | 64 | 9.3 |
| | Std.Dev. | 21.6 | 56 | 30.6 | 7.9 |
| | Number | 4 | 4 | 4 | 3 |
| Home 24 | Average | 117 | 550 | 83 | 16 |
| | Std.Dev. | 14.4 | 53 | 39.5 | 7.2 |
| | Number | 5 | 5 | 5 | 4 |

Table 6.4. Septic tank effluent concentrations of nutrients, surfactants and bacteria.

| Home | Statistic | TKN | $NO_2$+$NO_3$ | Total P | MBAS | F.Coli. |
|---|---|---|---|---|---|---|
| | | mg-N/L | mg-N/L | mg-P/L | mg/L | Log#/L |
| Polk County | | | | | | |
| Home 11 | Average | 40.2 | 0.08 | 12.0 | 1.3 | 6.0-6.8 |
| | Std.Dev. | 20.3 | 0.06 | 0.82 | 0.7 | - |
| | Number | 4 | 4 | 4 | 4 | 4 |
| Home 12 | Average | 40.2 | 0.14 | 15.0 | 6.8 | 6.0-6.8 |
| | Std.Dev. | 15.7 | 0.17 | 3.16 | 3.9 | - |
| | Number | 5 | 5 | 5 | 5 | 5 |
| Home 13 | Average | 37.1 | 0.13 | 9.8 | 2.2 | 6.5-7.6 |
| | Std.Dev. | 22.8 | 0.16 | 4.44 | 1.0 | - |
| | Number | 5 | 5 | 5 | 5 | 5 |
| Home 14 | Average | 40.5 | 0.04 | 6.63 | 2.4 | 5.1-6.3 |
| | Std.Dev. | 21.3 | 0.04 | 0.63 | 0.8 | - |
| | Number | 4 | 4 | 4 | 4 | 4 |
| St.Johns County | | | | | | |
| Home 21 | Average | 32.8 | 0.03 | 6.88 | 1.56 | 6.3-6.5 |
| | Std.Dev. | 11.4 | 0.02 | 0.48 | 0.8 | - |
| | Number | 4 | 4 | 4 | 4 | 4 |
| Home 22 | Average | 36.4 | 0.06 | 14.6 | 5.0 | 7.6-8.2 |
| | Std.Dev. | 14.8 | 0.06 | 1.82 | 2.2 | - |
| | Number | 5 | 5 | 5 | 4 | 5 |
| Home 23 | Average | 33.2 | 0.07 | 10.63 | 2.1 | 6.4-7.1 |
| | Std.Dev. | 12.4 | 0.04 | 3.09 | 0.5 | - |
| | Number | 4 | 4 | 4 | 4 | 4 |
| Home 24 | Average | 53.8 | 0.05 | 11.8 | 3.4 | 6.5-7.3 |
| | Std.Dev. | 19.15 | 0.04 | 2.39 | 2.0 | - |
| | Number | 5 | 5 | 5 | 4 | 5 |

Table 6.5. Concentrations of selected constituents in STE as measured in this study versus previous studies.

| | Study Reference and Location | | | | |
|---|---|---|---|---|---|
| Parameter (Units) | SSWMP, 1978 Wisc. | Harkin et al., 1979 Wisc. | Bowne, 1982 Oregon | Brown et al., 1977 Texas | This Study, 1989 Florida |
| Temperature | -[1] | 13 | - | - | - |
| (°C) | - | 0-23 | - | - | 18.0-33.8 |
| | - | 141 | - | - | 8 |
| $BOD_5$ | 138 | 132 | - | - | 141 |
| (mg/L) | 7-480 | - | 118-189 | - | 111-181 |
| | 150 | 145 | - | - | 8 |
| TSS | 49 | 87 | - | - | 161 |
| (mg/L) | 10-695 | - | 36-75 | - | 64-594 |
| | 148 | 164 | - | - | 8 |
| TKN | 45 | 82[2] | - | 30 | 39 |
| (mg-N/L) | 9-125 | - | 41-50 | - | 33-54 |
| | 99 | 127 | - | - | 8 |
| $NO_2$+$NO_3$ | 0.4 | 0.95 | 0.5 | 0.2 | 0.08 |
| (mg-N/L) | 0.1-74 | - | - | - | 0.6-0.14 |
| | 114 | 215 | - | - | 8 |
| P | 13 | 21.8 | - | 8.2 | 11 |
| (mg-P/L) | 0.7-90 | - | - | - | 7-15 |
| | 99 | 215 | - | - | 8 |
| FOG | - | - | - | - | 36 |
| (mg/L) | - | - | 16-65 | - | 8-111 |
| | - | - | - | - | 8 |
| MBAS | - | - | - | - | 3.1 |
| (mg/L) | - | - | - | - | 1.3-6.8 |
| | - | - | - | - | 8 |
| F.Coliforms | 7.7 | 6.8 | - | 7.0 | - |
| (Log#/L) | 3.0-9.2 | - | - | - | 5.1-8.2 |
| | 151 | 205 | - | - | 8 |

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[1] "-" indicates no data available. Data shown for each parameter and study correspond to average, range and number of samples.

[2] Total nitrogen, not Kjeldahl nitrogen.

Chloroform was measured at all homes monitored Polk County, but only home 24 in St. Johns County. The results for the subdivision in Polk County are not surprising considering that chloroform was also measured in the tapwater supply. The occurrence of chloroform in municipal supplies is not uncommon and is generally the result of by-products formed during disinfection by chlorination of water containing organics. Chloroform is also an ingredient in products used in the home such as solvents, cleaners and fire extinquishers.

Methylene chloride was detected in the STE from three homes in Polk County and one in St. Johns County. This compound is also a common by-product of chlorine disinfection although it was not measured in the tap water supply in either subdivision.

Home 22 was the only one where 1,4-dichlorobenzene was detected. This organic compound is an ingredient in certain insecticidal fumigants which may be used in the home.

The results described here for VOCs in STE are in general agreement with other investigations of VOCs in residential sewage (Greer and Boyle, 1988; Tomson et al, 1984; and DeWalle et al, 1985). DeWalle et al also reported toluene, chloroform and methylene chloride as the most prevalent VOCs in STE in a study of toxic chemicals from household septic tanks for the U.S. EPA published in 1985.

Concentrations of VOCs routinely measured in this study are summarized in Table 6.6. Not only was toluene detected in STE most frequently, it was also detected at the highest concentrations of all VOC's measured. Mean STE concentrations of toluene ranged from a low of 7 ppb (ug/L) at home 23 to a high of 64 ppb (ug/L) at home 11. The individual sample maximum was 110 ppb (ug/L) on one sample from home 13. The other VOCs detected were generally at much lower concentrations (Table 6.6). The concentration of VOCs measured in STE in this study are also in agreement with other investigators (Greer and Boyle, 1988; DeWalle et al, 1985).

## Septage Characteristics

The characteristics of the septic tanks as observed during the septage sampling are summarized in Table 6.7. The scum and sludge accumulations were notably low in Polk County. In all eight septic tanks, the sludge accumulations were very low, even in septic tanks which had been in service for 12 years and never pumped. There were no correlations with age of the home or date of last septic tank pumping.

Table 6.6. Summary of VOCs detected in septic tank effluents.

| | | Compound Detected | | | |
|---|---|---|---|---|---|
| Home | Statistic | Chloroform | 1,4-Dichloro-benzene | Methylene Chloride[1] | Toluene |
| Polk County | | ug/L | | | |
| Home 11 | Average | 5.5 | BDL[2] | 5.9 | 64 |
| | Std.Dev. | 1.7 | BDL | na[3] | 21 |
| | Range | 3.7-6.9 | BDL | na | 48-92 |
| | Number[4] | 3/4 | 0/4 | 1/4 | 4/4 |
| Home 12 | Average | 10.3 | BDL | 4.5 | 11 |
| | Std.Dev. | 1.3 | BDL | na | na |
| | Range | 8.8-11 | BDL | 3.6-5.4 | 9.2-13 |
| | Number | 3/4 | 0/4 | 2/4 | 2/4 |
| Home 13 | Average | 7.9 | BDL | 7 | 50 |
| | Std.Dev. | 6.1 | BDL | na | 42 |
| | Range | 2.5-16.0 | BDL | 3.0-11.0 | 14-110 |
| | Number | 4/4 | 0/4 | 2/4 | 4/4 |
| Home 14 | Average | 3.5 | BDL | 4.2 | 24 |
| | Std.Dev. | 1.6 | BDL | na | 14 |
| | Range | 2.3-5.4 | BDL | na | 12-44 |
| | Number | 3/4 | 0/4 | 1/4 | 4/4 |
| St.Johns County | | | | | |
| Home 21 | Average | BDL | BDL | BDL | 40 |
| | Std.Dev. | BDL | BDL | BDL | 14 |
| | Range | BDL | BDL | BDL | 29-61 |
| | Number | 0/4 | 0/4 | 0/4 | 4/4 |
| Home 22 | Average | BDL | 27 | BDL | 40 |
| | Std.Dev. | BDL | na | BDL | 14 |
| | Range | BDL | 21-33 | BDL | 12-44 |
| | Number | 0/4 | 2/4 | 0/4 | 4/4 |
| Home 23 | Average | BDL | BDL | 2.0 | 7 |
| | Std.Dev. | BDL | BDL | na | 1.4 |
| | Range | BDL | BDL | na | 5.7-8.7 |
| | Number | 0/4 | 0/4 | 1/4 | 4/4 |
| Home 24 | Average | 5.3 | BDL | 1.9 | 20 |
| | Std.Dev. | na | BDL | na | 3.8 |
| | Range | na | BDL | na | 15-24 |
| | Number | 1/4 | 0/4 | 1/4 | 4/4 |

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[1] Laboratory detection limit was 50 ug/L for first two sampling events after which a new laboratory was used.

[2] "BDL" indicates compound not detected at method detection limit. Refer to Appendix I for method detection limit.

[3] "na" indicates statistic not applicable due to limited number of samples.

[4] Positive samples/total samples. Calculation of standard deviation based on positive samples only.

The results of analyses of septage samples are summarized in Table 6.8 to 6.10. These data indicate appreciable concentrations of organic matter and solids in the septage from all eight homes. Concentrations of most constituents (e.g. $BOD_5$, TKN, TP) were 5 to 10 times higher than those in the STE. Concentrations of TSS and FOG were approximately 20 times higher.

Table 6.7. Characteristics of septic tanks as observed during septage sampling.

| | Tank Dimensions | | | Sludge and Scum | | |
|---|---|---|---|---|---|---|
| Home | G.L.[1] to Lid | Total Depth | Water Depth | Scum Depth | Sludge Depth | Comment |
| | in. | in. | in. | in. | in. | |
| Polk County | | | | | | |
| Home 11 (4, never)[2] | 8-10 | 54 | 46 | 4 | 4 | Firm scum, black |
| Home 12 (11, 1987) | 10 | 53 | 45 | 0 | 3 | No scum, wispy sludge |
| Home 13 (2, never) | 6-8 | 51 | 44 | 0 | 3 | No scum, |
| Home 14 (14, 1986) | 8-10 | 56 | 48 | 3 | 3 | Very dense, dark brown scum |
| St.Johns County | | | | | | |
| Home 21 (11, 1987) | 22 | 56 | 56 | 11 | 5 | Heavy scum, baffle was submerged. |
| Home 22 (11, never) | 4 | 58 | 49 | 14 | 8 | Very heavy scum and sludge |
| Home 23 (12, 1985) | 6 | 58 | 49 | 7 | 3 | Very heavy brown scum |
| Home 24 (12, never) | 6-8 | 57 | 50 | 14 | 0 | Reddish brown scum |

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[1] G.L. = ground level.

[2] Numbers in parenthesis indicate age of home in years and date of last pumping of the septic tank.

The results of this study are compared to those reported previously for septage in Table 6.11. The septage concentrations measured in this study were consistently low compared to those previously reported. The reason for this is unknown, but it is speculated to be due to the high temperatures present and increased reaction rates and digestion of the waste solids.

The total VOCs measured ranged from 49 to 418 ug/L (Table 6.9). The individual VOCs routinely detected included toluene (8 of 8 samples positive), xylenes (5 of 8), 1,4-dichlorobenzene (5 of 8), chloroform (3 of 8 samples) and methylene chloride (3 of 8). Bromodichloroethane, 1,1-dichloroethane and 1,1,1-trichloroethane were each detected in one sample (Table 6.12). These are essentially the same VOCs which were detected in the STEs (Table 6.6).

Table 6.8. Septage temperature, pH and specific conductance.

| Home | Temp. | pH | Conductance |
|---|---|---|---|
| | oC | units | umhos/cm |
| Polk County | | | |
| Home 11 | 30 | 6.8 | 1000 |
| Home 12 | 31 | 6.6 | 1400 |
| Home 13 | 32 | 6.8 | 1000 |
| Home 14 | 30 | 7.0 | 1250 |
| St.Johns County | | | |
| Home 21 | 27 | 6.3 | 350 |
| Home 22 | 29 | 6.7 | 1050 |
| Home 23 | 29 | 5.4 | 1200 |
| Home 24 | 29 | 6.8 | 1200 |

Table 6.9. Septage concentrations of $BOD_5$ and solids.

| Home | $BOD_5$ | TS | TSS | FOG |
|---|---|---|---|---|
| | mg/L | mg/L | mg/L | mg/L |
| Polk County | | | | |
| Home 11 | 1690 | 7750 | 7130 | 866 |
| Home 12 | 446 | 1300 | 490 | 92 |
| Home 13 | 1150 | 3600 | 2960 | 342 |
| Home 14 | 1200 | 5600 | 4550 | 529 |
| St.Johns County | | | | |
| Home 21 | 1500 | 1800 | 1160 | 529 |
| Home 22 | 1060 | 5900 | 4690 | 1290 |
| Home 23 | 611 | 2600 | 1620 | 216 |
| Home 24 | 4410 | 7400 | 5880 | 1983 |
| Average | 1508 | 4494 | 3560 | 731 |
| Std.Dev. | 1243 | 2510 | 2381 | 633 |

Table 6.10. Septage concentrations of nutrients, surfactants and VOCs.

| Home | TKN | TP | MBAS | VOCs |
|---|---|---|---|---|
| | mg-N/L | mg-P/L | mg/L | ug/L |
| Polk County | | | | |
| Home 11 | 339 | 76 | 16 | 416 |
| Home 12 | 111 | 54 | 15 | 56 |
| Home 13 | 91 | 26 | 61 | 294 |
| Home 14 | 185 | 60 | 22 | 331 |
| St.Johns County | | | | |
| Home 21 | 99 | 19 | 1.4 | 210 |
| Home 22 | 278 | 144 | 52 | 418 |
| Home 23 | 104 | 19 | 2.8 | 49 |
| Home 24 | 308 | 123 | 29 | 363 |
| Average | 189 | 65 | 25 | 267 |
| Std.Dev. | 104 | 47 | 22 | 148 |

The results of this study are compared to those reported previously for septage in Table 6.11. The septage concentrations measured in this study were consistently low compared to those previously reported. The reason for this is unknown, but it is speculated to be due to the high temperatures present and increased reaction rates and digestion of the waste solids.

Table 6.11. Septage concentrations observed in this study compared to those previously reported.

| Parameter | Units | U.S. EPA Design Manual (1980) | Average of this Study |
|---|---|---|---|
| pH | units | 6 - 7 (Typical) | 5.4 - 7.0 |
| $BOD_5$ | mg/L | 3,150<br>4,790<br>5,890 | 1,580 |
| TS | mg/L | 11,600<br>22,400<br>39,500 | 4,494 |
| TSS | mg/L | 2,350<br>9,500<br>13,060<br>21,120 | 3,560 |
| TKN | mg-N/L | 410<br>472<br>650<br>820 | 189 |
| TP | mg-P/L | 172<br>190<br>214<br>351 | 65 |
| FOG | mg/L | 3,850<br>9,560 | 731 |

The total VOCs measured ranged from 49 to 418 ug/L (Table 6.9). The individual VOCs routinely detected included toluene (8 of 8 samples positive), xylenes (5 of 8), 1,4-dichlorobenzene (5 of 8), chloroform (3 of 8 samples positive) and methylene chloride (3 of 8). Bromodichloroethane, 1,1-dichloroethane and 1,1,1-trichloroethane were each detected in one sample (Table 6.12). These are the same VOCs which were detected in the STEs (Table 6.6).

Table 6.12. Concentrations of individual VOCs detected in septage.

| Compound | Home Monitored | | | |
|---|---|---|---|---|
| | ug/L | | | |
| Polk County | 11 | 12 | 13 | 14 |
| Toluene | 410 | 40 | 190 | 210 |
| Xylenes | 1.5 | 1.6 | 1.1 | 2.3 |
| 1,4-Dichlorobenzene | <1 | 2.5 | 35 | 59 |
| Chloroform | 1.2 | 6.9 | 31 | <1 |
| Methylene Chloride | 3.8 | 2.1 | <1 | 1.1 |
| Bromodichloroethane | <1 | <1 | 2.1 | <1 |
| 1,1-Dichloroethane | <1 | <1 | <1 | <1 |
| 1,1,1-Trichloroethane | <1 | <1 | <1 | <1 |
| | 416 | 56 | 294 | 331 |
| St.Johns County | 21 | 22 | 23 | 24 |
| Toluene | 210 | 250 | 41 | 360 |
| Xylenes | <1 | <1 | <1 | 3.5 |
| 1,4-Dichlorobenzene | <1 | 84 | 2.4 | <1 |
| Chloroform | <1 | <1 | <1 | <1 |
| Methylene Chloride | <1 | <1 | <1 | <1 |
| Bromodichloroethane | <1 | <1 | <1 | <1 |
| 1,1-Dichloroethane | <1 | <1 | 2.4 | <1 |
| 1,1,1-Trichloroethane | <1 | <1 | 1.1 | <1 |
| | 210 | 418 | 49 | 363 |

## Infiltration System Performance

Table 6.13 summarizes the operation and performance data collected on the eight individual OSDSs over the monitoring period. Figures 6.10 to 6.17 show site plans of the OSDSs monitored and indicate the sampling locations.

### Hydraulic Loading and Soil Clogging --

Based on the interior water use data collected or using the 46 gpcd estimate, hydraulic loading rates to the infiltration systems at the eight homes were estimated to range from 0.5 to 1.9 gal/ft$^2$/day (bottom area basis). These loading rates are based on infiltration areas measured in the field with the exception of home 11 which was based on OSDS permit data.

Wastewater ponding in the infiltration areas was measured in the observation ports at each site visit, if present. The systems with the most notable ponding problems were homes 13 and 21. Infiltration systems at homes 11 and 12 exhibited ponding very infrequently and only to about 1 in. in depth. The other four infiltration systems showed no signs of soil clogging as measured by wastewater ponding.

The OSDS at home 13 consisted of two trenches, one of which was ponded at the time of observation port installation in August 1987. As monitoring progressed, the other trench eventually became ponded as well. The first trench was continuously ponded to at least 6 inches of depth over the last five site visits from October 1987 to April 1988. There are several reasons suspected for the hydraulic performance of this system. First, the hydraulic loading rate on the infiltration system was estimated to be the highest of the eight systems monitored at 1.9 gpd/ft$^2$. This value is much higher than that typically recommended for fine sandy soils (Otis et al, 1980). Second, the system also had the highest STE suspended solids concentration and one of the highest $BOD_5$ concentrations of the systems monitored. Combined with the high hydraulic loading, this system received mass loadings of $BOD_5$ and TSS in a range reported to be of concern for infiltration system malfunction (Siegrist et al, 1985; Siegrist etal, 1986; Siegrist and Boyle, 1987).

The OSDS at home 21 appeared to have soil clogging problems related to system siting and design rather than loading. The infiltration system for this OSDS was of bed geometry (8 ft. by 30 ft.) Effluent ponding was present to the top of the 12-in. thick gravel bed at the time of observation port installation in September 1987 and continued throughout the monitoring period. In fact, at times as much as 16 to 18 in. of STE was measured in the observation port due to surcharging of effluent in the bed.

Table 6.13. Individual OSDS operation summary.

| Parameter | Units | Home Monitored | | | |
|---|---|---|---|---|---|
| Polk County | | Home 11 | Home 12 | Home 13 | Home 14 |
| Monitoring Period[1] | - | 8/87 to 4/88 | 8/87 to 4/88 | 8/87 to 4/88 | 8/87 to 4/88 |
| Water Use[2] | gpd | 334 | 325 | 732 | 239 |
| | gpcd | 84 | 65 | 244[6] | 60 |
| Area for Infiltration | ft$^2$ | 350[3] | 150 | 210 | 288 |
| Loading | gpd/ft$^2$ | 0.5[4] | 1.6[5] | 1.9[5] | 0.6[4] |
| Ponding Depth | in. | | | | |
| Trench 1 | | 0-1 | 0-1 | 4-8 | 0 |
| Trench 2 | | na | na | 0-4 | 0 |
| Trench 3 | | na | na | na | na |
| Unsaturated Soil Depth | ft. | 6.6 to >10.3 | >15 | >15 | >14 |
| St. Johns County | | Home 21 | Home 22 | Home 23 | Home 24 |
| Monitoring Period[1] | - | 6/87 to 3/88 | 6/87 to 3/88 | 7/87 to 3/88 | 6/87 to 3/88 |
| Water Use[2] | gpd | na | na | na | na |
| | gpcd | na | na | na | na |
| Area for Infiltration | ft$^2$ | 240 | 210 | 230 | 188 |
| Loading | gpd/ft$^2$ | 0.8[4] | 0.9[4] | 0.8[4] | 1.0[4] |
| Ponding Depth | in. | | | | |
| Trench 1 | | 9-18 | 0 | 0 | 0 |
| Trench 2 | | na | 0 | 0 | 0 |
| Trench 3 | | na | 0 | 0 | 0 |
| Unsaturated Soil Depth | ft. | <0.2 to 2.4 | 0.4 to 3.4 | 0. to 2.2 | 0.3 to > 3.7 |

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[1] Monitoring dates vary for different measurement parameters.

[2] Total water use = interior plus exterior.

[3] Based on permit data. In field, could not locate total area.

[4] Estimated based on interior water use (gpcd) of home 12.

[5] Estimated based on actual measured interior water use.

[6] Resident routinely cared for 4-5 additional children during day.

One of the reasons suspected for the poor performance of this system was its deep installation. The infiltrative surface of the bed was over four ft. below grade. The deep installation combined with a bed geometry and the relatively high ground water elevations at the subdivision in St. Johns County may have limited aeration below the system and contributed to its malfunction. Of course, the deep installation was also responsible for the lack of any plumbing system backups in the home served by the system. The homeowner reportedly had the septic tank pumped in February 1987 but perceived no problems since that time.

Table 6.13 also shows the range of unsaturated soil depths which occurred below each of the systems over the monitoring period. This unsaturated depth was determined based on piezometers or ground water monitoring wells which were installed near the individual OSDSs studied and the infiltrative surface elevation measured at each OSDS. In the subdivision in Polk County, unsaturated soil depths were consistently greater than 14 ft. except at home 11, the lowest OSDS in elevation monitored at that subdivision. The unsaturated zone ranged from 6.6 to over 10 ft. at that location. Sufficient unsaturated soil for proper STE treatment appeared to be present at all times at the systems monitored and most likely at all systems in the subdivision.

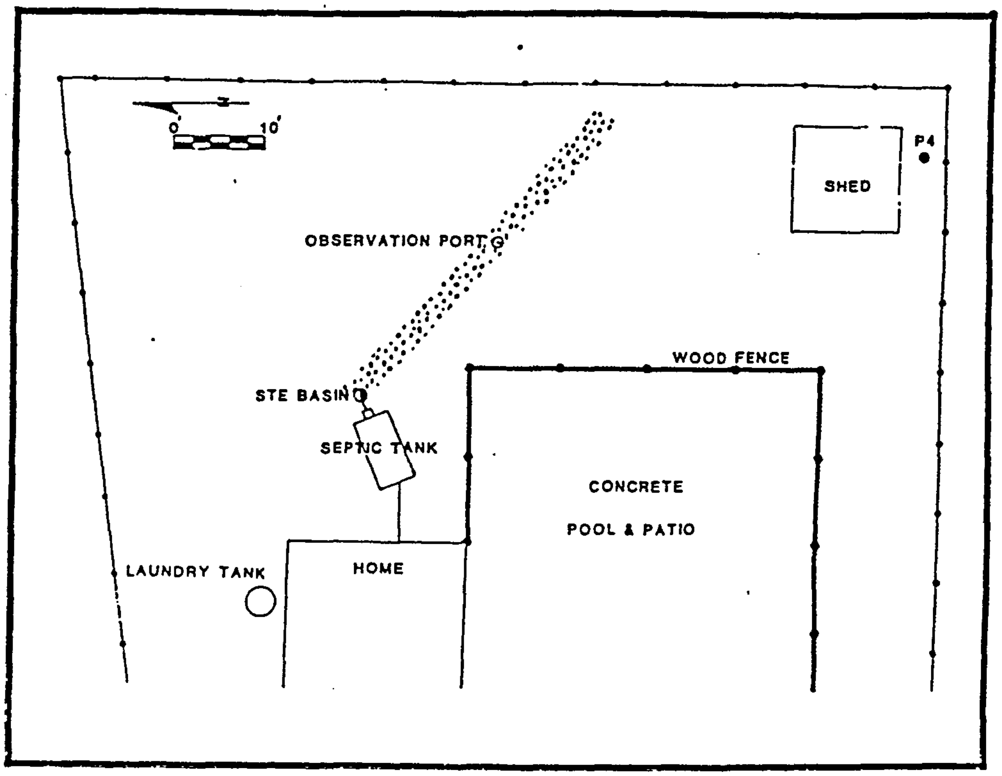


Figure 6.10. Site plan of the OSDS at home 11 in Polk County.

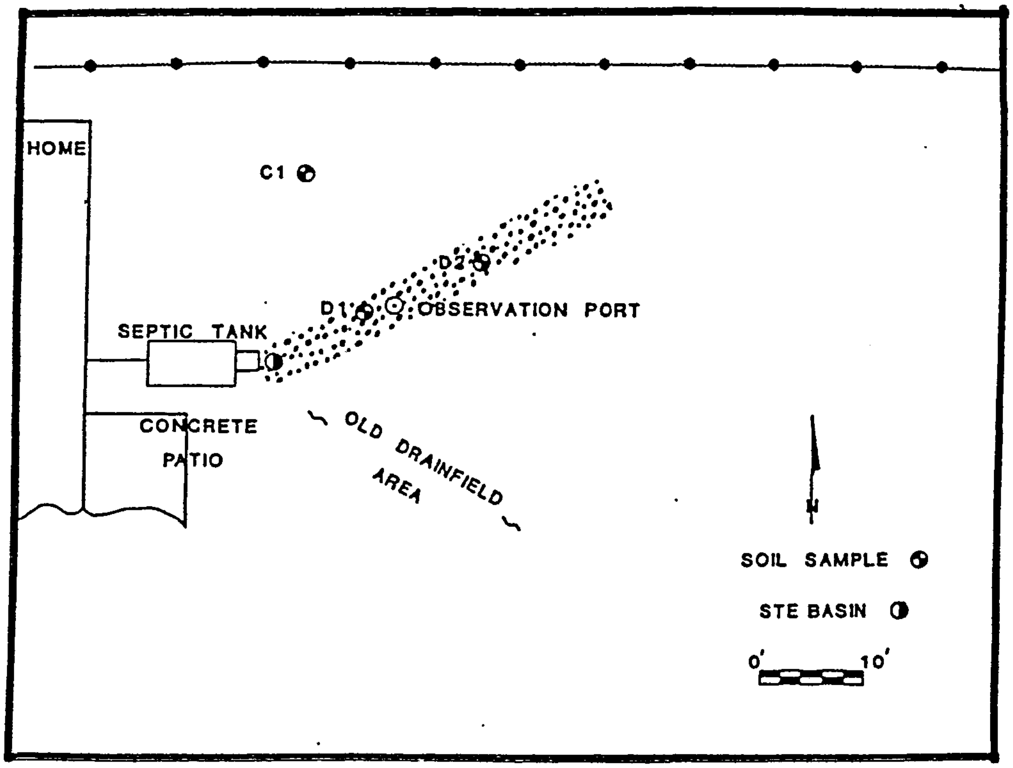


Figure 6.11. Site plan of the OSDS at home 12 in Polk County.

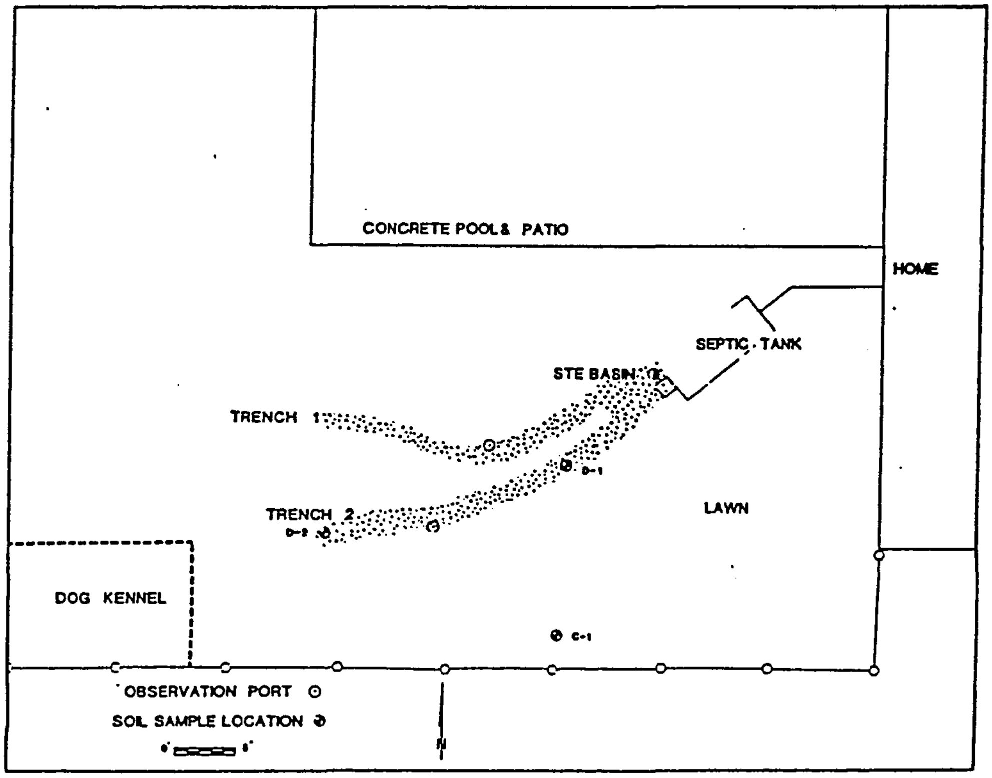


Figure 6.12. Site plan of the OSDS at home 13 in Polk County.

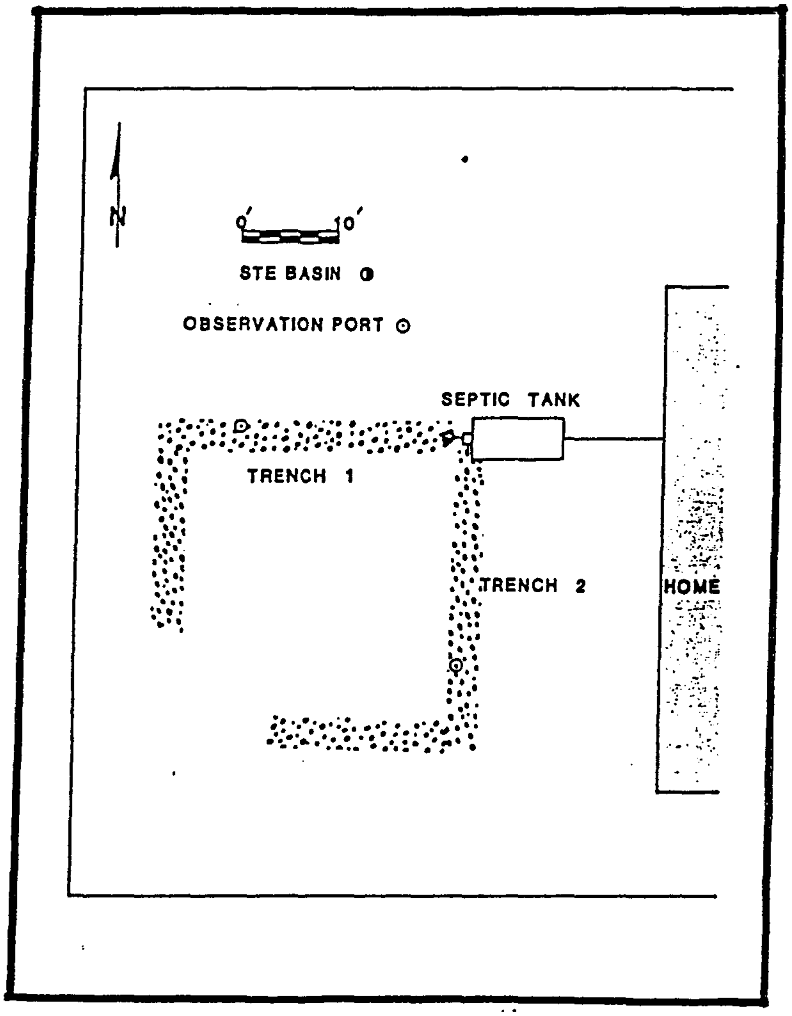


Figure 6.13. Site plan of the OSDS at home 14 in Polk County.

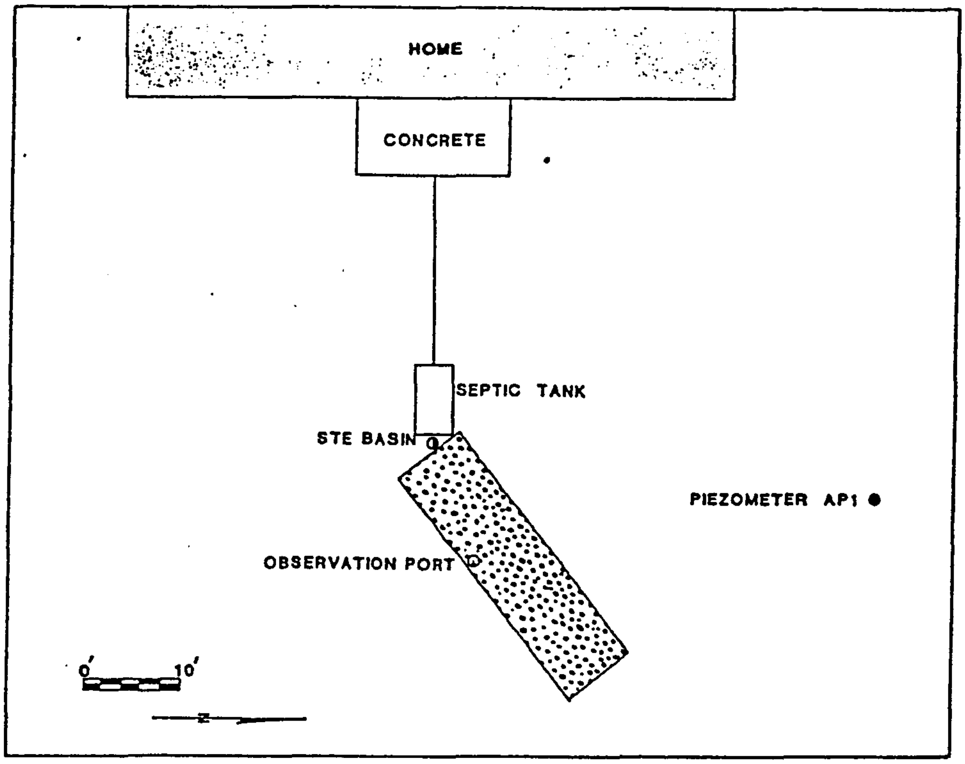


Figure 6.14. Site plan of the OSDS at home 21 in St. Johns County.

In contrast, unsaturated zones under OSDS infiltration areas in St. Johns County were on occasion, less than desirable, ranging from 0 to 4 ft. or so. The infiltration system at home 23 was estimated to be in the saturated zone and the systems at homes 21, 22 and 24 very near (0.2, 0.4 and 0.3 feet respectively) the saturated zone in March 1988. Unsaturated zones at homes 21 and 23 were often less than 2 ft. thick during the monitoring period. These results suggest that the treatment of STE by many OSDS in the subdivision in St. Johns County may be less than desirable at certain times of the year due to insufficient depth or total lack of unsaturated, aerobic soil below the OSDS.

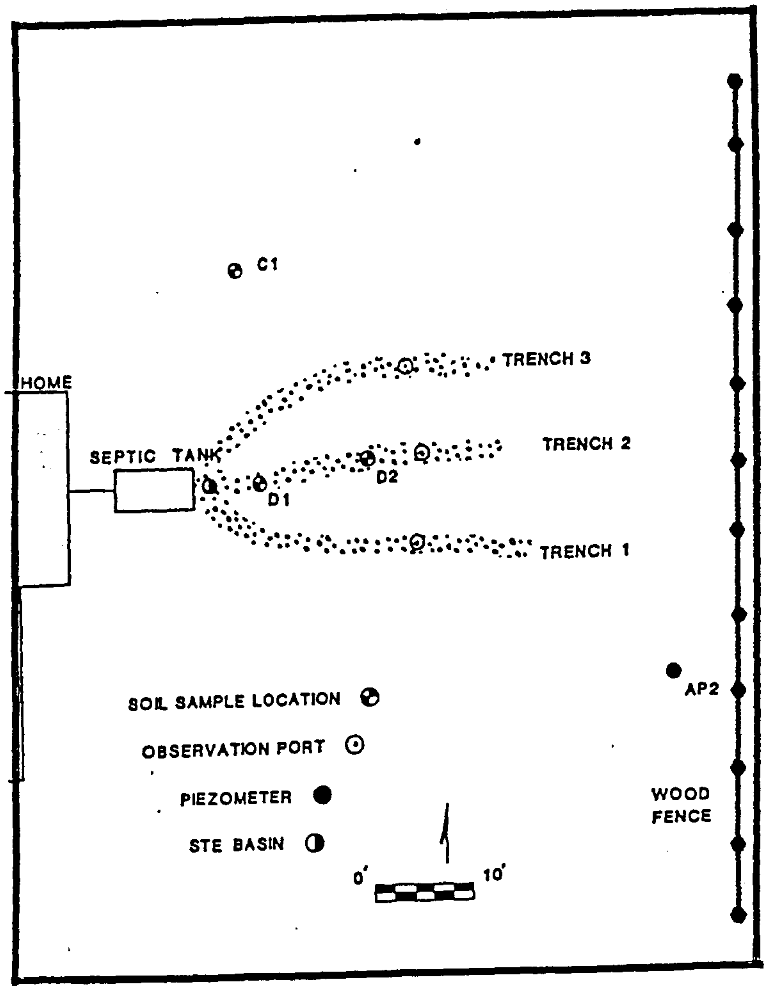


Figure 6.15. Site plan of the OSDS at home 22 in St. Johns County.

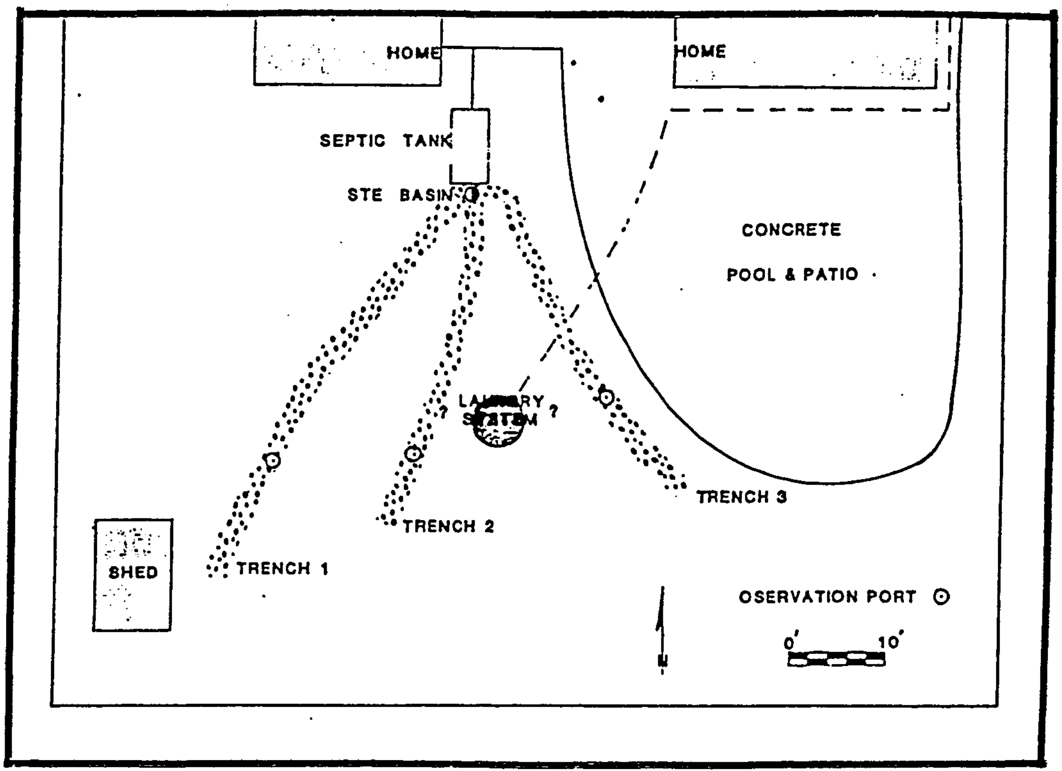


Figure 6.16. Site plan of the OSDS at home 23 in St. Johns County.

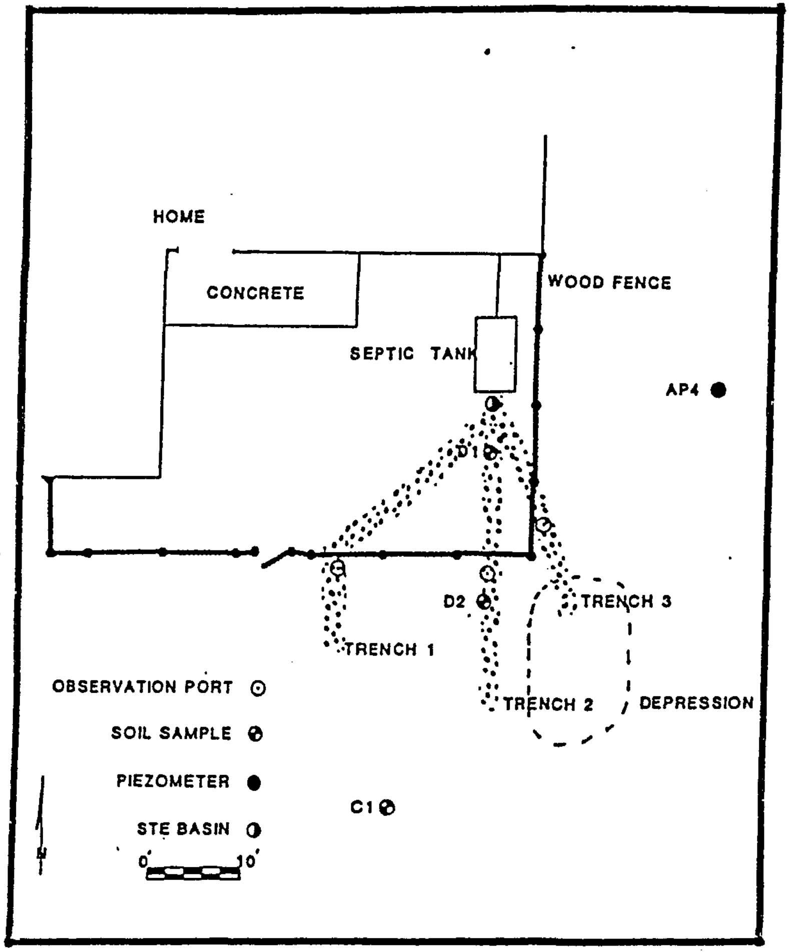


Figure 6.17. Site plan of the OSDS at home 24 in St. Johns County.

Sub-Infiltration System Soil Sampling --

Soil sampling was conducted below the OSDS infiltration systems at homes 12 and 13 in the subdivision in Polk County and homes 22 and 24 in the subdivision in St. Johns County. The purpose of this work was to investigate the treatment of STE as it moved through unsaturated, fine sandy soils. Sampling was performed in January 1988 and results for each of the four homes are discussed below.

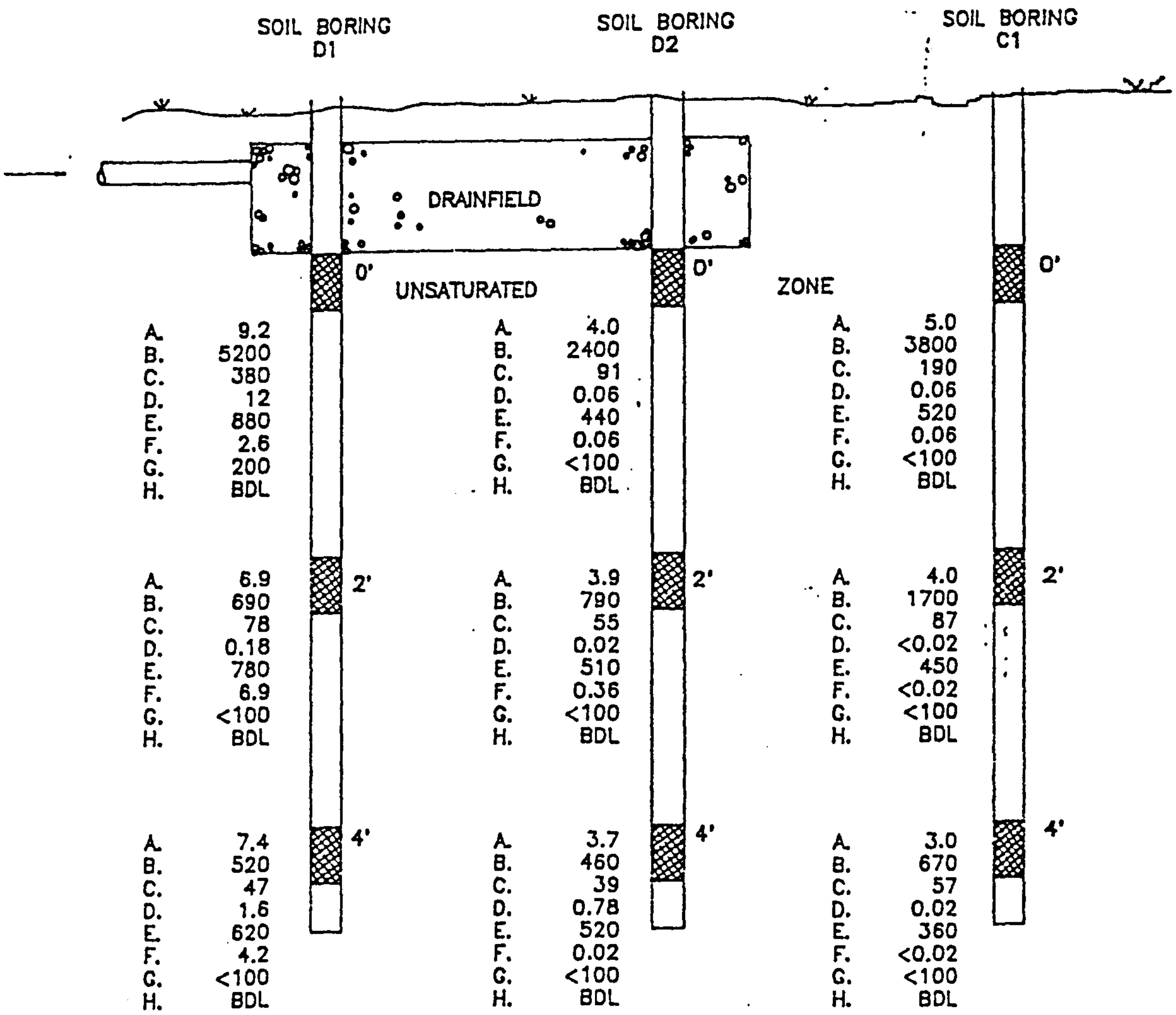
Home 12: Soil Samples were collected at home 12 located in the subdivision in Polk County on January 12, 1988. The location of this OSDS in the subdivision was shown previously in Figure 6.1. During the field sampling, the weather was clear and cool (16°C) with a light northerly breeze.

A total of nine soil samples were collected, representing three depths at each of three locations. Two sample locations (D1 and D2) were within the perimeter of the operating OSDS infiltration area. Background soil properties were assessed by sampling a location approximately 10 ft. away from OSDS (C). These sample locations are depicted in the site plan shown in shown previously in Figure 6.11. The sample results are tabulated in detail in Appendix K, while selected results are highlighted in Figure 6.18.

Excavation into the OSDS at home 12 revealed a layer of geotextile fabric at a depth below ground surface of approximately 2 ft. The coarse aggregate layer of the drainfield appeared to be only 0.6 ft. thick at the sample points. Based on the measured depths to the infiltrative surface at points D1 (closest to the inlet to the OSDS) and D2 (further away), the infiltrative surface appeared to have a 4% slope away from the inlet end. At the time of inspection, there were no indications of wastewater effluent at either sampling location (D1 or D2). The infiltrative surface exhibited some black discoloration and a slight septic odor at location D1.

Soil texture (USDA) was loamy fine sand at a depth of approximately 1.9 to 2.8 ft. transitioning to fine sand at 3.6 ft. and below (Figure 6.18, Appendix K). Soil colors (moist Munsell color) were typically dark brown in the shallower zones to pale brown with depth. Soil temperatures were in the range of 21 °C with little variation associated with depth across the shallow zone of sampling.

Concentrations of most parameters measured in the soil samples were highest at sample location D1, closest to the septic tank outlet. It appeared that this area of the system had received more effluent based on the physical appearance of the infiltrative system. The elevated soil moisture content at D1A gives credance to this assumption as do the increased values of the parameters which were found in STE. Moisture content of the soil decreased with depth at D1 but even at a depth of over 4 ft. below the infiltrative surface (D1C), moisture content was more than 3% higher than location D2A, at the infiltrative surface. Concentrations of key STE parameters generally decreased with depth at all sample locations, including the control. The effect of the water softener in home 12 can clearly be seen in the chloride data at locations D1 and D2 in comparison to the control.



<u>STE Quality</u>:

TOC = 83 mg/L
TKN = 40 mg-N/L
P = 15 mg-P/L
F.Coli.= $10^5$ org./100mL
VOCs = 26 ug/L

<u>Soil Analyses</u>:

A. = Soil Moisture, % by wt.
B. = TOC, mg-C/kg soil
C. = TKN, mg-N/kg soil
D. = $NO_3$, mg-N/kg soil
E. = P, mg-P/kg soil
F. = Leachable ortho-P, mg-P/kg soil
G. = F. Coli., org./g soil
H. = VOCs, ug/kg soil

Ground water > 15 ft. below OSDS.
BDL = below detection limit.

Figure 6.18. Profile schematic of sample locations and selected results for home 12 in Polk County.

Home 13: On January 13, 1988, soil samples were collected at home 13 located in Polk County. The location of this OSDS was shown previously in Figure 6.1 During the field sampling, the weather was clear, warm (24°C) and calm. A total of nine soil samples were collected, representing three depths at each of three locations, as at home 12. These sample locations are depicted in the site plan shown previously in Figure 6.12.

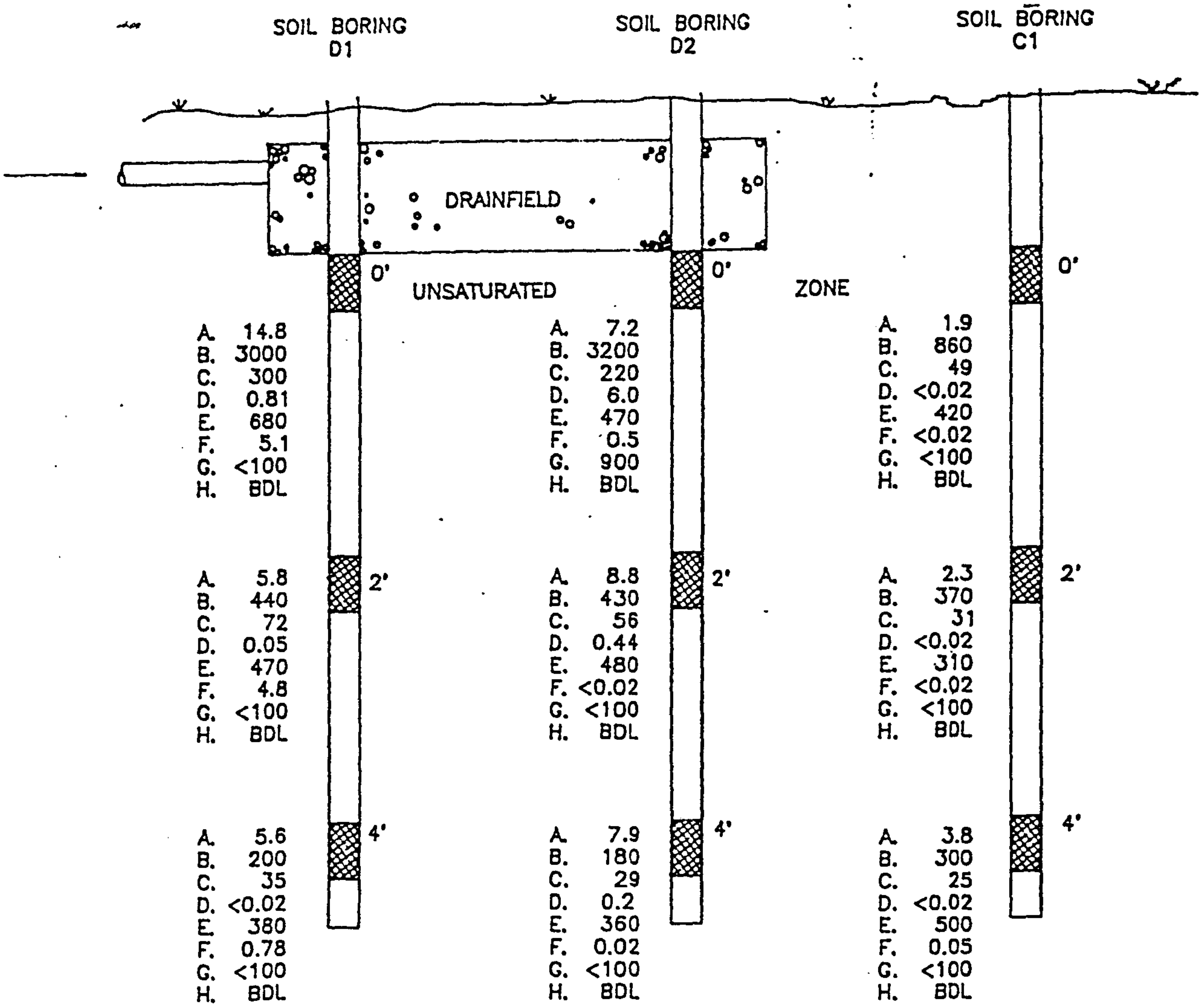
Excavation into the OSDS revealed a layer of geotextile fabric at a depth below ground surface of approximately 2.5 ft. The coarse aggregate layer of the drainfield appeared to be 1 ft. thick. A 4-in. diameter pipe laid within the aggregate was visible near one edge of the excavation. Based on the measured depths to the infiltrative surface at points D1 (closest to the inlet to the OSDS) and D2 (further away), the infiltrative surface appeared to have a 2% slope away from the inlet end.

At the time of inspection, wastewater effluent was present in the OSDS at sampling location D1, but not at location D2. The depth of ponding was approximately 3 in. The infiltrative surface zone to a depth of approximately 7 in. was very dark grayish brown in color. Fine root channels (approx. .25 in. diameter) extended to a depth of 12 in. or more. The zone around the entire length of the root channel exhibited a discoloration similar to that observed near the infiltrative surface.

The sample depths, field properties and results of soil analyses are detailed in Appendix K while selected results are summarized in Figure 6.19. Beneath the OSDS, the soil texture was loamy fine sand at a depth of approximately 3 ft. transitioning to fine sand at a depth of 5 ft. and below (Figure 6.19, Appendix K). Soil colors (moist Munsell color) were typically very dark grayish brown at the infiltrative surface to brownish yellow at depth. Soil temperatures were in the range of 16 to 24°C. Soil temperatures at the ponded location (D1) were about 2°C cooler than those at corresponding depths at the unponded location (D2). Soil temperatures at both OSDS sample locations were cooler than those of the background location.

Concentrations of most parameters measured in the soil samples were highest at D1, next highest at D2, and lowest at the control, C1. Unlike home 12, however, it appeared that STE was reaching both sampling locations in the infiltration trench based on soil moisture content. Values at D1 and D2 were both significantly higher than the control. Results at D1A indicated very high moisture content, as would be expected under the ponded conditions at sampling.

The effect of the infiltrative surface clogging can be seen in the soil moisture results. While location D1 had a soil moisture content of almost 15% (wt./wt.) at the infiltrative surface, it had decreased to less than 6% at the 2 foot depth range. The higher content at the infiltrative surface was a result of effluent ponding in the infiltration trench due to the clogged infiltrative surface. This clogging restricts the amount of flow to the unsaturated zone below, hence the lower soil moisture at 2 feet. In contrast, at location D2 where no effluent ponding existed, soil moisture was higher than the control due to wastewater application, but a more uniform moisture content was measured with depth (Figure 6.19).



STE Quality:

TOC = 56 mg/L
TKN = 37 mg-N/L
P = 9.8 mg-P/L
F.Coli.=$10^5$-$10^6$ org./100mL
VOCs = 65 ug/L

Soil Analyses:

A. = Soil Moisture, % by wt.
B. = TOC, mg-C/kg soil
C. = TKN, mg-N/kg soil
D. = $NO_3$, mg-N/kg soil
E. = P, mg-P/kg soil
F. = Leachable ortho-P, mg-P/kg soil
G. = F. Coli., org./g soil
H. = VOCs, ug/kg soil

Ground water > 15 ft. below OSDS.
BDL = below detection limit.

Figure 6.19. Profile schematic of sample locations and selected results for home 13 in Polk County.

Concentrations of key STE parameters generally decreased with depth at all sample locations, as reported for home 12. The soil pH appeared to increase as contact with STE increased at both homes 12 and 13 but this result is more pronounced at home 13. This result would be expected since the STE pH was typically an order of magnitude higher than that measured in the control soil samples.

Home 22: Soil samples were collected at home 22 in St. Johns County on January 14, 1988. The location of this OSDS in the subdivision was shown previously in Figure 6.2. During the field sampling, the weather was mostly cloudy, very cool (13 °C) and moderately breezy. A total of six soil samples were collected, representing two depths at each of three locations. Two sample locations (D1 and D2) were within the perimeter of the operating OSDS infiltration area. Background soil properties were assessed by sampling a location approximately 10 ft. away from the OSDS (C). These sample locations are depicted in the site plan shown previously in Figure 6.15.

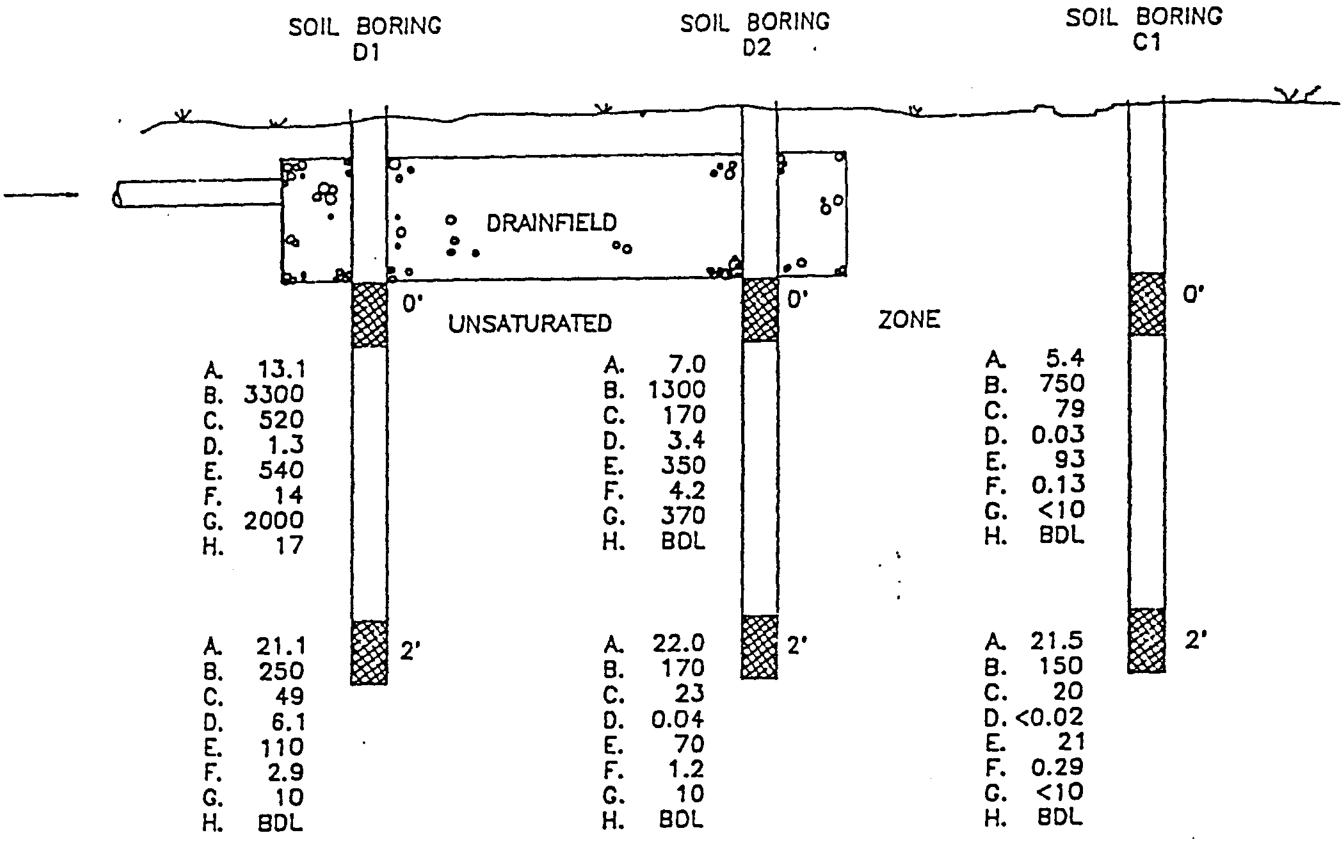
Excavation and sampling in the background location (C1) revealed a zone of saturation at a depth of 4.6 ft. below grade. Ground water was observed at the same elevation at piezometer AP2 (see Figure 6.15 for locations). As a result of this shallow depth to ground water, only two samples were taken with depth at each location. The deepest samples taken were within the capillary fringe very near the saturated zone. The distance from the infiltrative surface to the saturated zone was approximately 2.5 ft. (30 in.) at the time of sampling.

Excavation into the OSDS revealed a layer of building paper at a depth below ground surface of approximately 1.5 ft. The coarse aggregate layer of the drainfield appeared to be about 1 ft. thick. A 4-in. diameter pipe laid within the aggregate was visible near one edge of the excavation. Based on the measured depths to the infiltrative surface at points D1 (closest to the inlet to the OSDS) and D2 (further away), the infiltrative surface appeared to the horizontal.

At the time of inspection, wastewater effluent was not present in the OSDS at either sampling location (D1 or D2). The infiltrative surface zone was pale brown in color.

The sample depths, field properties and results of soil analyses are detailed in Appendix K while selected results are summarized in Figure 6.20. The soil textures observed were typically fine to very fine sand (Figure 6.20, Appendix K). Soil colors (moist Munsell color) were typically pale brown at a depth of 2.5 ft. and light brownish gray at a depth of 4.5 ft. Soil temperatures were in the range of 15 to 18 °C.

As reported at the previous homes, concentrations of most parameters were highest in the soil samples closest to the septic tank outlet. The exception to this appeared to be chloride. Chloride concentrations in soil samples at this home were highest at the control location, C1. The reason for this result is unclear.



<u>STE Quality</u>:

TOC = 56 mg/L
TKN = 36 mg-N/L
P = 14.6 mg-P/L
F.Coli.=$10^6$-$10^7$ org./100mL
VOCs = 56 ug/L

<u>Soil Analyses</u>:

A. = Soil Moisture, % by wt.
B. = TOC, mg-C/kg soil
C. = TKN, mg-N/kg soil
D. = $NO_3$, mg-N/kg soil
E. = P, mg-P/kg soil
F. = Leachable ortho-P, mg-P/kg soil
G. = F. Coli., org./g soil
H. = VOCs, ug/kg soil

Ground water 2.5 ft. below OSDS.
BDL = below detection limit.

Figure 6.20. Profile schematic of sample locations and selected results for home 22 in St. Johns County.

Soil moisture content in the samples near the infiltrative surface was significantly higher at D1 than D2, indicating that perhaps the majority of the effluent was infiltrating in the portion of the trenches closest to the septic tank. The sample at D2A had a moisture content only slightly higher than the control, C1A.

The significant increase in moisture content with depth at this home is of course due to the proximity of the deeper samples to the saturated zone. As the results show, these samples were near or at saturation at all locations, much in contrast to the results at the subdivision in Polk County. This is significant because the samples were taken just over 2 ft. below the infiltrative surface and approximately 2 ft. of unsaturated soil existed at the time of sampling. One might suspect therefore, that certain STE contaminants present in the samples at D1B and D2B could be transported to ground water at this OSDS site. Organic materials as measured by TOC, kjedahl and nitrate nitrogen, phosphorous, and fecal coliform bacteria all occurred in sample D1B at levels considerably higher than the control, and may be suspect for ground water contamination at this location.

Home 24: On January 15, 1988, soil samples were collected at home 24 located in the study subdivision in St. Johns County. The location of this OSDS in the subdivision was shown previously in Figure 6.2. During the field sampling, the weather was mostly cloudy, cold (7 $^{0}$C) and moderately breezy. A total of six soil amples were collected, representing two depths at each of three locations, ad described for home 22. These sample locations are depicted in the site plan shown previously in Figure 6.17.

Excavation and sampling in the background location (C1) revealed a zone of saturation at a depth of 6.0 ft. below grade. Ground water was observed at the same elevation at piezometer AP4 (see Figure 6.17 for locations). As a result of this shallow depth to ground water, the deepest samples taken were at a depth of approximately 5.0 ft. The distance from the infiltrative surface to the saturated zone was approximately 3.3 ft. (40 in.) at the time of sampling.

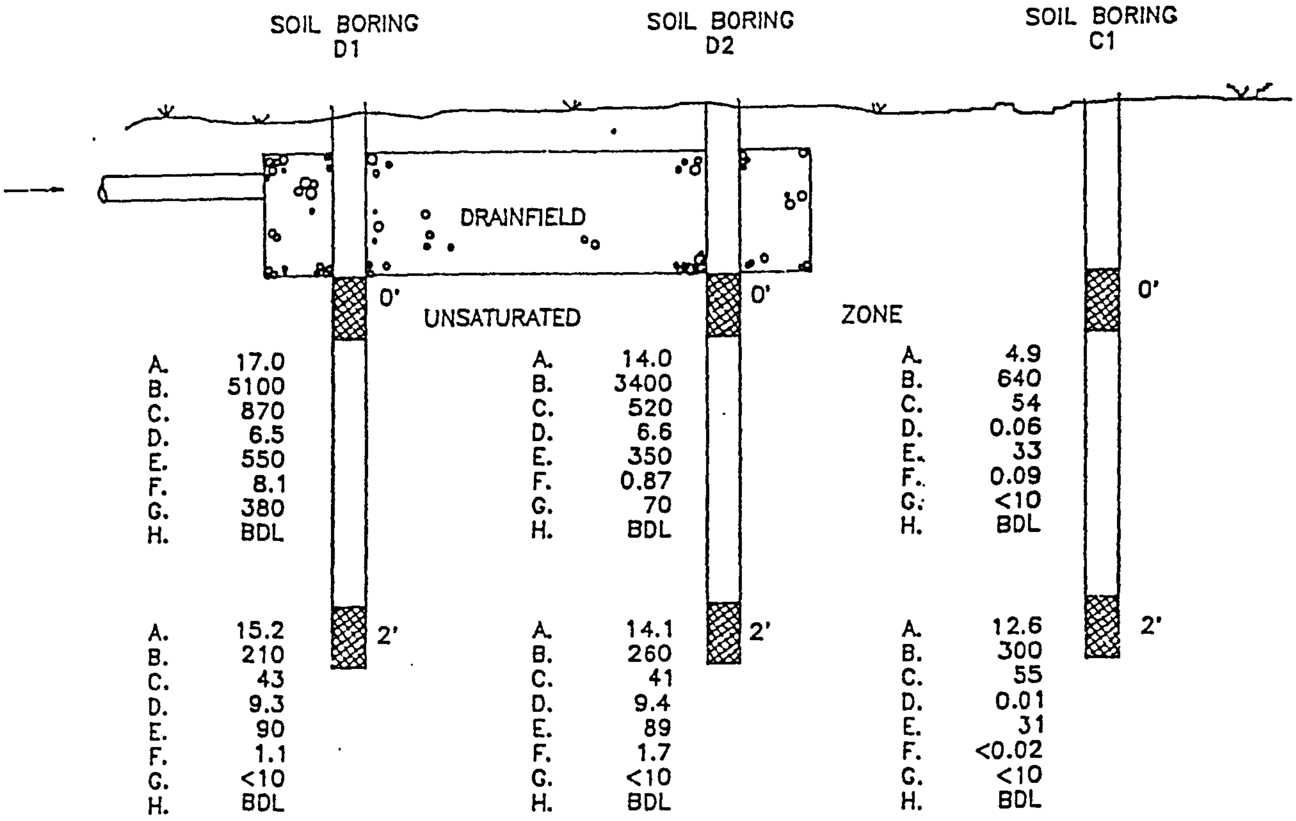
Excavation into the OSDS revealed no sign of any layer of building paper or geotextile fabric. The top of the coarse aggregate layer was encountered at a depth of approximately 1.8 ft. Coarse aggregate layer of the drainfield appeared to be 1 ft. thick. A 4-in. diameter pipe laid within the aggregate was visible near one edge of the excavation. Based on the relative elevations of the infiltrative surface at points D1 (closest to the inlet to the OSDS) and D2 (further away), the infiltrative surface appeared to the horizontal.

At the time of inspection, wastewater effluent was not present in the OSDS at either sampling location (D1 or D2). The sample depths, field properties and results of soil analyses are detailed in Appendix H while selected results are summarized in Figure 6.21.

The soil textures observed were typically fine sand. At the infiltrative surface, loamy fine sand textures were observed, possibly due to accumulations of organic matter within that zone. Beneath the OSDS, soil colors were grayish brown to dark brown near the infiltrative surface and pale brown to light gray at depth. Soil colors in the background sample were brownish yellow to very pale brown. Soil temperatures were in the range of 16 to 18°C at the sample locations beneath the OSDS compared to 13 to 16°C at the background location.

The results for almost all parameters in the soil samples were highest at location D1, next highest at D2, and lowest at C1, the control. These results match the trends observed at the other OSDSs monitored. Soil moisture content was similar at D1 and D2 with D1 slightly higher at both A and B depths. Soil moisture was not nearly as high at the 2 ft. level as was measured at home 22, due to the additional 1 ft. or so of unsaturated zone below the infiltrative surface. Soil moisture content actually decreased slightly with depth at location D1, nearest the septic tank. Even so, soil moisture at the 2-ft. depth at all sample locations was much higher than that measured at the same depth in Polk County OSDSs.

As observed elsewhere, concentrations of key STE parameters such as TOC, chloride, nitrogen, and phosphorus in the soil decreased considerably with depth below the infiltration surface. Even so, at the 2 ft. depth concentrations of these same parameters were higher than the control location, indicating the potential for these contaminants to enter ground water should it rise to that elevation.



| | | | |
|---|---|---|---|
| | SOIL BORING D1 | SOIL BORING D2 | SOIL BORING C1 |
| 0' | | | |
| A. | 17.0 | 14.0 | 4.9 |
| B. | 5100 | 3400 | 640 |
| C. | 870 | 520 | 54 |
| D. | 6.5 | 6.6 | 0.06 |
| E. | 550 | 350 | 33 |
| F. | 8.1 | 0.87 | 0.09 |
| G. | 380 | 70 | <10 |
| H. | BDL | BDL | BDL |
| 2' | | | |
| A. | 15.2 | 14.1 | 12.6 |
| B. | 210 | 260 | 300 |
| C. | 43 | 41 | 55 |
| D. | 9.3 | 9.4 | 0.01 |
| E. | 90 | 89 | 31 |
| F. | 1.1 | 1.7 | <0.02 |
| G. | <10 | <10 | <10 |
| H. | BDL | BDL | BDL |

<u>STE Quality</u>:

TOC = 42 mg/L
TKN = 54 mg-N/L
P = 11.8 mg-P/L
F.Coli.=$10^5$-$10^6$ org./100mL
VOCs = 27 ug/L

<u>Soil Analyses</u>:

A. = Soil Moisture, % by wt.
B. = TOC, mg-C/kg soil
C. = TKN, mg-N/kg soil
D. = $NO_3$, mg-N/kg soil
E. = P, mg-P/kg soil
F. = Leachable ortho-P, mg-P/kg soil
G. = F. Coli., org./g soil
H. = VOCs, ug/kg soil

Ground water 3.3 ft. below OSDS.
BDL = below detection limit.

Figure 6.21. Profile schematic of sample locations and selected results for home 24 in St. Johns County.

## DISCUSSION

The analyses of STE and septage revealed these waste streams to be substantially similar to those characterized previously by other investigators. The concentrations in the STE were at the higher end of the range of reported values while those in the septage were at the lower end of the range. The significance of this finding and the reasons for it are unknown. However, it could be related to increased reaction rates associated with the relatively higher waste temperatures observed (typically 27 to 32 °C) as compared to earlier studies, most of which were conducted in more northerly climates.

Inspection of individual OSDS infiltration systems revealed the characteristics shown in Table 6.14. Soil sampling beneath the infiltrative surface revealed results generally in line with expectations. Soil moisture results indicated an increase in soil moisture at the wastewater infiltrative surface. Moisture values decreased with depth at the homes in Polk County. In St. Johns County just the opposite was observed, most likely due to the higher water table elevation. The increase in soil moisture content at the infiltrative surface was most pronounced at home 13, location D1A. This was the only sample taken where soil clogging had progressed to the point where effluent was ponded in the infiltration system.

Table 6.14. Summary characteristics of the OSDSs monitored.

| | Home Monitored | | | |
|---|---|---|---|---|
| Characteristic | 12 | 13 | 22 | 24 |
| Depth to Aggregate, ft. | 2.0 | 2.5 | 1.5 | 1.8 |
| Geotextile? | Yes | Yes | Bld.Paper | No |
| Aggregate Depth, ft. | 0.6 | 1.0 | 1.0 | 1.0 |
| Slope of I.S. | 4% away | 2% away | 0 | 0 |
| Ponding Depth, pt., in. | None | D1- 3 | None | None |
| I.S.[1] Discoloration? | Black | D.Gray | | |
| Soil Texture | Loamy fine sand | Loamy fine sand | Fine sand - Loamy fs | Fine sand |
| Unsaturated Soil Depth beneath I.S., ft. | > 10 | > 10 | 2.5 | 3.3 |

[1] I.S. = infiltrative surface.

In general, almost every wastewater constituent present in STE showed an increase near the infiltrative surface. The exception was location D2 at home 12. It was suspected that effluent may not have reached that portion of the infiltration area.

At the 2 ft. sample locations (D1B and D2B) considerable increases in TOC and TKN were measured at homes 13 and 22, but not at the other two OSDS. These two systems also had the highest infiltrative surface moisture content. Chlorides were increased considerably at the deeper sampling locations at all homes except 22. Nitrates, also a very mobile ion, showed increases in the deeper samples at homes 12, 22 and 24 but not at home 13. The effluent ponding at home 13 combined with high TKN and TOC values measured suggest that aerobic conditions may not have been present in the 2 foot zone below the ponded trench. As a result, nitrates could not be produced.

Total phosphorus values generally were at increased levels below the infiltration systems at all locations, but this might be expected based on its affinity to sorb on soil particles. The more interesting result is that of the ortho-phosphorus leaching procedure, which gives a better indication of phosphorus availability (Olsen and Sommers, 1982). The results of this procedure indicated orthophosphate may be released to ground water below those OSDSs if it reached the 2 to 4 ft. depth below the infiltrative surface. Values ranged from 1 to 7 milligrams phosphorus released per kilogram dry soil.

Increased levels of fecal coliform bacteria were found in soil samples near the infiltrative surface (D1A and D2A) in at least one location in every infiltration area. These increases ranged from 100 to 1990 organisms per gram of soil. These concentrations of fecal coliforms seem low considering the high concentrations in the applied STE (i.e. $10^5$ to $10^8$ organisms/100 mL). There may have been much higher levels at the infiltrative surface which were attenuated in the samples collected due to the sampling depth of approximately 15 cm. Fecal coliforms were measured only in one soil sample collected from the 2 ft. depth at one home in St. Johns County. Results in the subdivision in Polk County should be viewed with regard to the fact that minimum levels of fecal coliforms detectable were 100 organisms per gram of soil due to unsatisfactory dilutions of the sample. This was corrected before the St. Johns County analyses. These results suggest satisfactory attenuation of fecal coliforms is occurring in fine sandy soils below these OSDSs in Polk and St. Johns County.

Low levels of the volatile organic compounds were detected in the STE at most of the homes monitored. However, STE application, infiltration and percolation appeared to volatilize or yield near-complete degradation of the VOCs. Only one soil sample yielded any VOCs above detection limits. 1,4-dichlorobenzene was detected at 17 ug/kg (ppb) in the infiltrative surface sample nearest the septic tank outlet (D1A) at home 22 in St. Johns County. This VOC was also detected in the STE at home 22 on 2 occasions.

## SECTION 7
## CONCLUSIONS

During this phase of a multi-year research project in Florida, the work included monitoring ground water beneath four specific subdivisions in four different hydrogeologic regimes and monitoring the performance of eight individual OSDSs in two of these. The ground water conditions varied between subdivisions with a high, well drained sand ridge setting in Polk County; a low, somewhat poorly drained flatwoods area in St. Johns County; a relict beach ridge environment in Brevard County and a shallow limestone aquifer (Biscayne) in Dade County. The monitoring of individual OSDSs to date has occurred at each of four homes in the study subdivisions in Polk County and in St. Johns County. These two study sites were characterized by fine sandy soil profiles which were well drained and somewhat poorly drained, respectively. These subdivisions were chosen since they were thought to be representative of those developed largely under the requirements of the 1983 revisions to Chapter 10D-6, Florida Administrative Code, Standards for Onsite Sewage Disposal Systems.

This progress report presents the first results of field monitoring of subdivision ground water and individual OSDSs. Several parts of the scope of work remain, including virus analysis. Interpretation of the current results as discussed herein may need further analysis and refinement in light of this. Therefore, the following conclusions and recommendations are offered at this time based only on the results presented in this progress report.

### Subdivision Ground Water Monitoring

o The depth to the water table beneath the four study subdivisions varied from a high of nearly 18 ft. in Polk County to a low of less one ft. in Brevard County. In several instances, OSDSs within the study subdivisions were found to be installed such that the infiltrative surfaces were within 2 ft. of the ground water table continuously or at some time during the year.

o Due to topographic variations, ground water depths varied across the subdivisions. Temporal fluctuations in ground water levels were typically less than two feet. Due to the limited number of monitoring events, characterization of the impact of rainfall events was not possible.

o Low ground water seepage velocities were observed in the subdivisions monitored in Polk (2 to 6 ft./yr), St. Johns (5 to 22 ft./yr) and Brevard Counties (6 to 96 ft./yr). The estimated velocity was higher in the subdivision in Dade County (670 ft./yr) due to the aquifer occurring in cavernous and vugular limestone.

- The ground water concentrations of many constituents varied widely between different wells on a given date and at a given well on different dates. Variations of an order of magnitude or more for pH, chlorides, nitrogen and phosphorus were not uncommon. The fluctuations were not consistent across all parameters ruling out simple dilution, possibly associated with precipitation events, as a probable cause.

- Monitoring wells located in close proximity to OSDSs revealed notable concentrations of constituents commonly associated with septic tank effluent (STE) (e.g. $BOD_5$, TKN, P). These constituents are not exclusively derived from STE, but have other anthropogenic and natural sources in the environment. Nevertheless, the concentrations were high enough in certain wells in all four subdivisions to suggest that STE ~~might have been~~ a contributor. For example, in the subdivisions in Brevard and Dade County, the concentrations of $BOD_5$ and TKN were routinely in the several part per million (ppm) range.

- Fecal coliform bacteria were detected on one or more occasions in at least one well in each of the four subdivisions. In each of Polk and St. Johns County, a single sample from a single well revealed very low bacteria concentrations of 10 organisms/100 mL or less. In the subdivisions in Brevard and Dade County, 3 and 4 shallow ground water monitoring wells revealed fecal coliforms, respectively. The concentrations in the shallow ground water below the subdivision in Dade County was as high as 17,000 organisms/100 mL.

- Volatile organic compounds (VOCs) were not detected in any of the ground water samples collected (method detection limits typically 5 micrograms/L or less) with the exception of one sample in St. Johns County (1.8 ug/L chloroform).

- Ground water quality in the vicinity of relatively new subdivisions (i.e. < 20 yr. old) served by individual OSDSs has not suffered substantial widespread contamination. However, localized areas of potential impact have been observed in all four subdivisions, particularly those in Brevard and Dade Counties. The ground water monitoring data suggests that it is more appropriate to focus on individual OSDSs and/or small groups of OSDSs, rather than a subdivision as a whole. Based on the low seepage velocities, the contaminant migration of even mobile contaminants (e.g. chlorides, nitrates) would be expected to be limited since the subdivisions monitored were relatively young in age (i.e. < 20 yr. old). In these settings, the downgradient, horizontal distances that contaminants theoretically could travel was correspondingly low. As a result, these younger subdivisions may not exhibit single plumes of ground water impact, but rather many individual plumes, possibly from each household.

## Individual OSDS Monitoring

- Based on a homeowner survey, the characteristics of the eight homes studied appeared to be typical of single family dwellings common to Florida. Household populations were higher than average for the State and all homes had children in the family. Homes ranged from 4 to 14 years of age and all had typical water using appliances.

o Based on the same survey, it appeared that it was relatively common for homeowners to have never serviced the septic tank during their occupancy in the home.

o Based on the soils characterization and ground water monitoring in the two subdivisions it was found that soils ~~of~~ the same series name (Ona and Tavares) had distinctly different water table characteristics and drainage classifications between subdivisions. This was apparently due to significant water table changes in the Polk County subdivision over the last 20 years.

o Septic tank effluent (STE) contained appreciable concentrations of organics, solids, nutrients and bacteria. Additionally, trace levels of volatile organic compounds (VOCs) were measured. The average total VOCs at each home ranged from 9 to 75 micrograms per liter (ug/L). Toluene was found in almost every sample, while chloroform, and methylene chloride were routinely detected. 1,4-dichlorobenzene was detected at one home.

o The STE concentrations were generally found to be within the range of those reported in the literature from other locations in the USA. Notable exceptions were STE temperature and TSS which were substantially higher.

o Septage sampling revealed characteristics consistently lower than those in the literature. This may have been due in part to the relatively high septage temperatures observed (27 to 32°C). Concentrations of most constituents in the septage (e.g. $BOD_5$, TKN, P, VOCs) were about 5 to 10 times higher than those in the STE. Concentrations of TSS and FOG were approximately 20 times higher.

o OSDS infiltration areas in the subdivision in St. Johns County were commonly closer than 2 ft. to ground water during parts of the year. One of the systems monitored appeared to have been in the saturated zone during part of this study based on monitoring well and OSDS data collected.

o Total concentrations of various contaminants in soil samples collected beneath OSDS infiltration areas generally decreased considerably with depth. Fecal coliform bacteria were measured at the 2 ft. depth beneath one OSDS in St. Johns County. VOCs were not measured above detection limits in samples 2 ft. or more below the infiltrative surface of the OSDSs studied.

## SECTION 8
## REFERENCES

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# SECTION 9
# APPENDIX

# APPENDIX A

## SAMPLE HOMEOWNER QUESTIONAIRE FORM

## HOMEOWNER'S QUESTIONNAIRE

The following questionnaire is designed to give us more information about the homes in your subdivision so that we can better characterize the results of our study here. Please answer the questions honestly and to the best of your knowledge. Return the completed questionnaire to the following address at your earliest convenience:

Kevin Sherman, Research Coordinator
Environmental Health Program
1317 Winewood Blvd.
Tallahassee, FL 32301

**Please return within two (2) weeks.**

1. How long have you lived in your present home? Since ________ (month), 198__ (yr)
2. When was your home constructed? ____________ (month) 19__ (yr).
3. How many persons live in your home?
   1__ 2__ 3__ 4__ 5__ 6__ 7__ 8__
4. How many in each age group? Less than 2 yrs.______ 3-12 yrs. ___
   13 - 18 yrs. _____ 19 yrs. & older ______
5. What water-using fixtures and appliances are in your home? List number if more than 1.

   Kitchen: Sink _____
   Dishwasher _____
   Garbage Disposal _____
   Bathroom(s): Sink(s) _____
   Shower(s) _____
   Tub(s) _____
   Toilet(s) _____
   Laundry: Sink _____
   Washer _____

   Other: ______________________________

6. Do you know the location of your septic tank and drainfield?
   Yes___ No___ If yes, sketch their location below in relation to the house and street.
7. How often do you have your septic tank pumped out?
   every year___ every 2-3 years___ every 4-5 years___
   never___ Date of last pump-out:____________
8. What is the name and phone number of the septic tank contractor who installed or services your septic system?
   Name: ____________________
   Tel. ____________________
9. We are looking for volunteers to allow us access to their property for installation of monitoring wells and/or sampling of their septic tank and drainfield. This would involve some excavation in your yard but any disturbance would be replaced to its original condition and owners would be compensated in some way for participating in the study. Would you be interested in more details and possibly volunteering to participate in this program?
   Yes____ No_____ If yes, we will contact you shortly.
10. Please give your name, address, and telephone number.

    Name: ______________________________
    Address: ______________________________
    ______________________________
    Telephone: ______________________________

Thank you very much for taking the time to complete this survey. Participation in this study will in no way effect the performance of your septic system or its permit status. We hope we can talk to you soon about further involvement in our study.

32687-homeownr.sur

# APPENDIX B

# LITHOLOGIC LOGS OF TEST BORINGS

POLK COUNTY STUDY SITE

Lithologic logs of the piezometer and monitoring wells installed at the study subdivision in Polk County, Florida are detailed below.

| Depth (ft) | Description |
|---|---|
| P-1 | |
| 0 - 1 | Sand, dark brown to brown, medium to fine grain, unconsolidated, silty, root and plant material. |
| 1 - 5 | Sand, brown to light brown, medium to fine grain, unconsolidated, trace root material, trace iron staining. |
| 5 - 6 | Sand, light brown to light beige, medium to coarse grain, unconsolidated, trace iron stain. |
| 6 - 7 | Sand, light beige, coarse grain semi consolidated quartz with iron stained nodules and some pebble to gravel sized quartz. |
| 7 - 9 | Clayey sand, light beige, trace iron staining, becoming less clayey at bottom of interval. |
| 9 - 12 | Sand, light beige, coarse grain, unconsolidated to semi consolidated, trace iron staining. |
| 12 - 15.5 | Sand, clear to white, very fine grain, angular unconsolidated quartz, trace silt, trace black minerals. |
| P-2 | |
| 0 - 2 | Sand, light to dark grey-black, very fine to fine grain, unconsolidated quartz, organic material. |
| 2 - 4 | Sand, light brown to tan, very fine grain, unconsolidated quartz, silty, trace black minerals. |
| 4 - 11.5 | Sand, light grey to white to clear, very fine to fine grain, unconsolidated angular quartz, trace black minerals. |
| P-3 | |
| 0 - 2 | Sand, grey, fine grain, unconsolidated quartz, with abundant organic material. |
| 2 - 3 | Sand, dark to medium red-brown, fine grain, unconsolidated quartz. |
| 3 - 4 | Sand, brown, fine grain, unconsolidated quartz. |
| 4 - 6.5 | Sand, light brown to brown, fine to medium grain, unconsolidated quartz. |
| 6.5 - 7 | Sand, dark red-brown, fine to medium grain, unconsolidated quartz. |
| 7 - 11 | Sand, light brown to brown, fine to medium grain, unconsolidated quartz. |

| Depth (ft.) | Description |
|---|---|
| P-4 | |
| 0 - 2 | Sand, dark brown, fine grain, unconsolidated quartz, organic material. |
| 2 - 2.5 | Sand, brown, very fine to fine grain, unconsolidated quartz, trace organic material. |
| 2.5 - 3 | Sand, light brown to brown, fine grain, unconsolidated quartz, well sorted. |
| 3 - 7 | Sand, light brown, medium to fine grain, unconsolidated quartz, well sorted. |
| 7 - 8 | Sand, light beige, medium to fine grain, unconsolidated quartz, well sorted, clean. |
| 8 - 8.5 | Sand, light beige, to white, medium grain, unconsolidated quartz, clean. |
| 8.5 - 9.5 | Sand, brown, medium grain, unconsolidated quartz. |
| 9.5 - 11.5 | Sand, brown to dark brown, medium grain, unconsolidated quartz. |
| P-5 | |
| 0 - 2 | Sand, grey to black, fine grain, unconsolidated quartz, organic material. |
| 2 - 7.5 | Sand, light brown, fine to medium grain, unconsolidated quartz. |
| 7.5 - 8.5 | Sand, light grey, fine to medium grain, semiconsolidated to unconsolidated quartz, trace clay and red-brown iron stain. |
| 8.5 - 9.5 | Sand, light grey, fine to medium grain, semiconsolidated to unconsolidated quartz; clayey slightly cohesive, slightly sticky. |
| 9.5 - 12 | Sand, light brown, fine to medium grain, semiconsolidated to unconsolidated quartz with trace clay and iron staining. |
| 12 - 13.5 | Sand, light brown, fine to medium grain, unconsolidated quartz with trace clay. |
| 13.5 - 14.5 | Sand, white to light brown, fine to medium grain, unconsolidated quartz. |

| Depth (ft.) | Description |
|---|---|
| P-6 | |
| 0 - 2 | Sand, dark brown, fine grain, unconsolidated angular, organic, root and plant material, silt. |
| 2 - 3 | Sand, light brown. |
| 3 - 6 | Sand, cream. |
| 6 - 8 | Sand, white, fine grain, unconsolidated, angular quartz, trace clay, trace sandstone nodules with phosphate specks. |
| 8 - 8.5 | Clay content is increasing; dry, crumbly. |
| 8.5 - 9 | Sand, white, clean, very fine to fine grain, unconsolidated angular quartz, moderate amount of clay - content is increasing with depth; becoming moist at approximately 9' bls. |
| 9 - 14.5 | Clayey sand, white, very fine grain, slight grey-green tint, clay is slightly sticky, noncohesive. |
| 14.5 - 17.5 | Sand, white, very fine grain, unconsolidated quartz with trace of clay. |
| P-7 | |
| 0 - 1.5 | Sand, light to dark grey, fine grain, angular, unconsolidated quartz with abundant root and organic material. |
| 1.5 - 2 | Sand, light brown, fine grain angular, unconsolidated quartz with minor silt. |
| 2 - 10 | Sand, cream, fine to medium grain, angular, unconsolidated, very clean quartz with abundant black minerals; wet at approximately 6.5', saturated at approximately 10'. |
| 10 - 11.5 | Sand, white, fine grain, angular unconsolidated, clean quartz with abundant black minerals. |
| TB-1 | |
| 0 - 2 | Sand, brown to grey, very fine grain, unconsolidated quartz with abundant organic material. |
| 2 - 7 | Sand, brown to light brown, fine to medium grain, unconsolidated quartz, mottled iron staining. |
| 7 - 7.5 | Sand, white to clear, fine grain, angular unconsolidated quartz, very clean. |
| 7.5 - 8.3 | Clayey sand, light grey, very fine to fine grain, iron stained. |
| 8.3 - 9.5 | Clayey sand, very iron stained, clay content increasing. |
| 9.5 - 10 | Clayey sand, light grey, very fine grain, angular loosely consolidated quartz. |
| | * No saturated soil encountered. |

| Depth (ft.) | Description |
|---|---|
| TB-2 | |
| 0 - 2 | Sand, light grey to dark grey, very fine to fine grain, unconsolidated quartz with abundant organic material. |
| 2 - 6 | Sand, light brown to tan, very fine grain, unconsolidated quartz with silt and root material. |
| 6 - 7 | Sand, light grey, fine to medium grain, unconsolidated quartz, very clean sand. |
| 7 - 11 | Sandy clay, white to beige, cohesive, iron stained, dry. |
| | * No saturated soil encountered. |
| TB-3 | |
| 0 - 1.5 | Sand, black to grey, fine grain, unconsolidated, organic material. |
| 1.5 - 2 | Sand, brown, fine grain, unconsolidated, trace root material. |
| 2 - 7 | Sand, light brown, fine grain, unconsolidated quartz. |
| 7 - 7.5 | Sand, white, fine grain, unconsolidated, well sorted quartz. |
| 7.5 - 9 | Clay, red-brown, iron streaks, trace sand unconsolidated, trace nodules of consolidated sandstone. |
| 9 - 10.75 | Sandy clay, light beige, iron streaks, nodules of semi consolidated sandstone, fairly dry. |
| 10.75-11.75 | Sandy clay, light beige, nodules of semiconsolidated sandstone, fairly dry. |
| 11.75 - 14 | Sand, white, fine to very fine grain, unconsolidated quartz, very clayey. |
| 14 - 16 | Sand, white, very fine to fine grain, unconsolidated quartz, less clay. |
| | * No saturated soil encountered. |
| TB-4 | |
| 0 - 2 | Sand, grey to brown, fine grain, unconsolidated quartz, organic material. |
| 2 - 3 | Sand, brown, fine to medium grain, unconsolidated quartz. |
| 3 - 6 | Sand, light brown to brown, fine to medium grain, unconsolidated quartz. |
| 6 - 7.5 | Sand, white to light beige, fine to medium grain, unconsolidated quartz, clean. |
| 7.5 - 8.5 | Sand, white to light beige, fine to medium grain, unconsolidated quartz, iron staining, trace clay. |
| 8.5 - 15.5 | Clayey sand, white to light beige, iron stained, mottled, very dense. |
| | * No saturated soil encountered. |

| Depth (ft.) | Description |
|---|---|
| PC-1 | |
| 0 - 4 | Sand, brown, fine grain, unconsolidated angular quartz, slightly silty, trace root and plant material. |
| 4 - 10 | Sand, tan to beige, fine to very fine grain, angular unconsolidated quartz, trace of iron cemented pebbles at 8 - 10 feet below land surface, trace phosphate specs. |
| 10 - 15 | Sand, tan to beige, fine grain, unconsolidated quartz, slightly silty, trace sandstone pebbles and black phosphate specks. |
| 15 - 16 | Sand, tan to beige, fine grain, unconsolidated quartz, slightly silty, trace sandstone pebbles and black phosphate specs with increasing percentage of silt and clay. |
| 16 - 22 | Sand, white, clean, fine grain, unconsolidated angular quartz, trace black phosphate specs, silt, and clay. |
| PC-2 | |
| 0 - 1 | Sand, light brown, fine grain, unconsolidated angular quartz, silty, trace root and plant material. |
| 1 - 4 | Sand, light brown, fine grain, unconsolidated angular quartz, silty, trace phosphate specs. |
| 4 - 10 | Sand, light brown to tan, fine to very fine grain, unconsolidated angular quartz, trace silt, trace phosphate specks. |
| PC-3 | |
| 0 - 1 | Sand, light brown to brown, fine grain, unconsolidated angular quartz, trace silt, trace plant and root material. |
| 1 - 4 | Sand, light brown to brown, fine grain, unconsolidated angular quartz, trace silt. |
| 4 - 6 | Sand, brown to light brown, fine grain, trace very fine grain, unconsolidated angular quartz, trace silt. |
| 6 - 10 | Sand, brown, fine grain, unconsolidated angular quartz, trace silt and phosphate specks. |
| 10 - 12 | Sand, brown, fine to very fine grain, trace medium grain, unconsolidated angular quartz, trace silt and phosphate specks. |

| Depth (ft.) | Description |
|---|---|
| PC-4 | |
| 0 - 1.5 | Sand, brown to dark brown, very fine to fine grain, unconsolidated angular quartz, silt, root and plant material, humic. |
| 1.5 - 3 | Sand, light brown to brown, very fine to fine grain, unconsolidated angular quartz, silt, less root and plant material. |
| 3 - 13.5 | Sand, light brown to tan, fine to medium grain, unconsolidated angular quartz, trace silt. |
| 13.5 - 21 | Sand, tan to grey, fine to medium grain, unconsolidated angular quartz, trace silt. |
| 21 - 23 | Sand, grey, fine to medium grain, unconsolidated angular quartz, trace silt and grey clay. |
| PC-5 | |
| 0 - 2 | Sand, brown to light brown, very fine grain, unconsolidated angular quartz, silt, root and plant material. |
| 2 - 7 | Sand, light brown to brown, very fine grain, unconsolidated angular quartz, silt. |
| 7 - 13 | Sand, tan, fine to medium grain, unconsolidated angular quartz, trace silt. |
| 13 - 18 | Sand, grey to light grey, fine to medium grain, unconsolidated angular quartz, clean. |

ST. JOHNS COUNTY STUDY SITE

Lithologic logs of the piezometer and monitoring wells installed at the study subdivision in St. Johns County, Florida are detailed below.

| Depth (ft.) | Description |
|---|---|
| P-1 | |
| 0 - 1 | Sand, light grey to brown, fine grain; organics, leaf and twig material. |
| 1 - 3 | Sand, light brown to beige, fine to medium grain; some iron stain, saturated at approximately 3'. |
| 3 - 5 | Sand, beige to white, fine to medium grain, well sorted, clean. |
| P-2 | |
| 0 - 1 | Sand, white to grey, fine to medium grain; organics, black to brown leaf and twig material. |
| 1 - 1.5 | Sand, grey to brown, fine to medium grain, some iron stain, dirty appearance. |
| 1.5 - 4 | Sand, beige to light brown, fine to medium grain. |
| 4 - 5 | Sand, beige to light brown, fine to medium grain, mottled iron stain. |
| P-3 | |
| 0 - 2 | Sand, light grey to brown, fine grain; organics, leaf and twig material. |
| 2 - 2.5 | Sand, brown to beige, fine to medium grain, clean. |
| 2.5 - 5 | Sand, light grey, fine grain, very mottled iron stain. |
| P-4 | |
| 0 - 3 | Sand, grey to black, fine grain; organics, leaf and twig material. |
| 3 - 5 | Sand, grey, fine to medium grain, dirty, strong odor. |
| P-5 | |
| 0 - 1 | Sand, light grey, fine to medium grain, organics, root material. |
| 1 - 2 | Sand, grey to white, fine grain; organics, black to brown with leaf and twig material. |
| 2 - 2.5 | Sand, brown, fine to medium grain; organics, root material. |
| 2.5 - 5 | Sand, beige, fine to medium grain, clean. |

| Depth (ft.) | Description |
|---|---|
| P-6 | |
| 0 - 2 | Sand, fine grain, black to brown organics, trace of clay. |
| 2 - 2.5 | Sand, brown, fine grain, trace of organics. |
| 2.5 - 4.5 | Sand, light grey, fine grain, well sorted, saturated at approximately 2.5'. |
| P-7 | |
| 0 - 0.5 | Sand, light grey, fine grain; organics. |
| 0.5 - 1 | Sand, light brown to grey, fine grain, some iron stain. |
| 1 - 5 | Sand, light brown to beige, fine to medium grain, slight iron stain, small amount of black specks, saturated at approximately 4.5'. |
| P-8 | |
| 0 - 1.5 | Sand, grey to white, fine grain, organics, black, trace clay with iron streaks. |
| 1.5 - 2.5 | Sand, medium brown, fine to medium grain, dirty. |
| 2.5 - 5 | Sand, white to light grey, fine grain, clean, well sorted. |
| P-9 | |
| 0 - 2 | Sand, light grey, fine to medium grain, trace of organics. |
| 2 - 2.5 | Sand, light brown, fine to medium grain, some iron stain. |
| 2.5 - 5 | Sand, light grey to beige, fine grain, trace iron stain. |
| SJ-1 | |
| 0 - 1 | Sand, light grey to brown, unconsolidated, fine to very fine grain; trace of silt, organics. |
| 1 - 15 | Sand, light brown to beige grading to brown, fine to very fine grain; trace of silt. |
| SJ-2 | |
| 0 - 1 | Sand, light grey to brown, unconsolidated, fine to very fine grain; trace of silt, organics. |
| 1 - 5 | Sand, grey, fine to very fine grain; trace of silt. |
| 5 - 13 | Sand, light to medium grey, fine to very fine grain, well sorted. |

| Depth (ft.) | Description |
|---|---|
| SJ-3 | |
| 0 - 1 | Sand, light grey to brown, unconsolidated, fine to very fine grain; trace of silt, organics, root material. |
| 1 - 5 | Sand, dark brown grading to beige, fine to very fine fine grain sand; trace of silt. |
| 5 - 15 | Sand, beige, fine to very fine grain, well sorted. |
| SJ-4 | |
| 0 - 1 | Sand, light grey to brown, unconsolidated, fine to very fine grain; trace of silt, organics, root material. |
| 1 - 10 | Sand, grey to brown, fine to very fine grain; trace of silt. |
| 10 - 12 | Sand, brown to light brown, fine to very fine grain, well sorted. |
| SJ-5 | |
| 0 - 1 | Sand, light grey to brown, unconsolidated, fine to very fine grain; trace of silt, organics, root material. |
| 1 - 5 | Sand, grey to brown, fine to very fine grain; trace of silt, organics, root material. |
| 5 - 12 | Sand, light brown, fine to very fine grain, well sorted. |
| SJ-6 | |
| 0 - 1 | Sand, light grey to brown, unconsolidated, fine to very fine grain; trace of silt, organics, root material. |
| 1 - 5 | Sand, light brown, fine to very fine grain; trace of silt. |
| 5 - 12 | Sand, beige to white, fine to very fine grain, well sorted. |
| SJ-7 | |
| 0 - 1 | Sand, light grey to brown, unconsolidated, fine to very fine grain; trace of silt, organics, root material. |
| 1 - 5 | Sand, brown, fine to very fine grain; trace of silt, organics, root material. |
| 5 - 15 | Sand, beige to white, fine to very fine grain; well sorted. |

BREVARD COUNTY STUDY SITE

Lithologic logs of the piezometer and monitoring wells installed at the study subdivision in Brevard County, Florida are detailed below.

| Depth (ft.) | Description |
|---|---|
| B-1 | |
| 0 - 1 | Sand, light to dark grey, fine to medium grain, angular, unconsolidated quartz with abundant root and organic material. |
| 1 - 5 | Sand, clear to white, coarse grain, angular unconsolidated quartz with minor tan sand becoming very fine to fine grain toward bottom. |
| B-2 | |
| 0 - 0.3 | Sand, tan, fine grain, angular, silty, organic with abundant shell material. |
| 0.3 - 1.3 | Sand, dark grey, fine grain, angular, silty, organic, unconsolidated quartz. |
| 1.3 - 2 | Organic material and peat, dark brown, very woody and fibrous with dark brown sand and silt. |
| 2 - 3.5 | Sand, medium brown, very fine to fine grain, angular, moderately consolidated with abundant silt and organic material. Very strong Rx odor. |
| 3.5 - 4.5 | Sand, tan to light brown, very fine to fine grain, angular, unconsolidated quartz, saturated at 4.0'. |
| 4.5 - 6.5 | Sand, light brown to grey, very fine to fine grain, angular, unconsolidated quartz, slightly silty with a trace of shell materials. |
| 6.5 - 6.75 | Clay, light grey to green, slightly sticky and cohesive, very sandy with abundant shell material. |
| B-3 | |
| 0 - 1 | Sand, grey, fine grain. |
| 1 - 1.5 | Sand, light grey, fine grain. |
| 1.5 - 3 | Sand, dark brown, fine grain, black organics, slightly silty. |
| 3 - 3.25 | Sand, brown, fine grain, slightly silty. |
| 3.25 - 3.75 | Sand, grey-green, fine grain, silty with traces of clay. |
| 3.75 - 6 | Sand, grey-green, fine grain, silty. |

| Depth (ft.) | Description |
|---|---|
| B-4 | |
| 0 - 2 | Sand, white to light grey, fine to medium grain, angular unconsolidated quartz with minor silt. |
| 2 - 5 | Sand, light to medium brown, fine grain, angular, unconsolidated quartz with abundant silt and minor organics. |
| 5 - 6 | Sand, light grey to grey-green, fine grain, angular, poorly consolidated quartz with silt and clay. |
| B-5 | |
| 0 - 1.25 | Sand, light grey, fine grain, angular, unconsolidated quartz. |
| 1.25 - 2.5 | Sand, light brown to tan, medium grain, angular, unconsolidated quartz. |
| 2.5 - 2.75 | Sand, white to clear, medium to coarse grain. |
| 2.75 - 3.75 | Sand, dark brown, fine to medium grain, subangular, loosely consolidated, slightly silty quartz with abundant brown organic and silty material. |
| 3.75 - 4.5 | Sand, clear to white, medium to coarse grain, angular, unconsolidated quartz. |
| 4.5 - 6.75 | Sand, light tan to brown, very fine to fine grain, slightly silty, unconsolidated quartz. |
| B-6 | |
| 0 - 2 | Sand, light grey, fine grain, angular unconsolidated quartz with minor silt and organics. |
| 2 - 2.5 | Sand, dark brown, organics, fine to medium grain, angular, poorly consolidated. |
| 2.5 - 5.5 | Sand, light brown, fine grain, angular, unconsolidated quartz with minor silt and grey- green clay. |
| B-7 | |
| 0 - 1.5 | Sand, grey, fine grain with root material. |
| 1.5 - 4 | Sand, dark brown, medium grain, silty, organic. |
| 4 - 4.5 | Sand, brown, coarse grain, slightly silty. |
| 4.5 | Sand, light green to grey, coarse grain, silty. |

| Depth (ft.) | Description |
|---|---|
| B-8 | |
| 0 - 1.5 | Sand and fill material, light grey to brown, fine grain, angular, poorly consolidated. |
| 1.5 - 2.0 | Sand, white to clear, fine to coarse grain, subangular to subround, damp. |
| 2.0 - 2.5 | Organic material and peat, dark brown, woody, fibrous material. |
| 2.5 - 4.0 | Sand and organic material, medium to dark brown, medium grain, poorly consolidated quartz with abundant silt, damp. |
| 4.0 - 7.0 | Sand, light brown (slightly grey), fine grain, angular, silty, unconsolidated quartz, saturated. |
| 7.0 - 7.5 | Sand and shell, grey to green, fine grain, angular, slightly silty and clayey with abundant shell tests and fragments. |
| B-9 | |
| 0 - 1.5 | Sand, grey, fine grain. |
| 1.5 - 2 | Sand, silty, black organics. |
| 2 - 3.5 | Sand, dark brown, slightly silty. |
| 3.5 - 5.5 | Mottled sand, grey-green, fine grain, silty, iron stained. |
| 5.5 | Mottled clayey sand with shells, green. |
| B-10 | |
| 0 - 2 | Sand, light to dark grey, fine to medium grain, angular, unconsolidated quartz with abundant root material and organics. |
| 2 - 2.75 | Sand and organic material, dark brown, fine grain, angular loosely consolidated quartz with abundant root and organic material. |
| 2.75 - 6.5 | Sand, light brown to light grey, very fine to fine grain, angular, unconsolidated quartz with trace silt and light grey clay. |
| B-11 | |
| 0 - 1 | Sand, grey, coarse grain. |
| 1 - 2 | Sand, light grey, coarse grain. |
| 2 - 3.5 | Sand, brown, medium grain, slightly silty. |
| 3.5 | Sand, grey-green, medium to coarse grain with trace of roots. |

| Depth (ft.) | Description |
|---|---|
| BC-1 | |
| 0 - 1 | Sand, dark grey to black, fine grain, unconsolidated, silty, plant and root material. |
| 1 - 1.5 | Sand, brown, fine grain, unconsolidated, slightly silty, shell fragments, (fill material). |
| 1.5 - 3 | Sand, dark brown, fine grain, unconsolidated, silty. |
| 3 - 4.5 | Sand, dark grey, fine grain, unconsolidated, silty. |
| 4.5 - 11 | Sand, grey, fine grain, unconsolidated, slightly silty. |
| 11 - 12.5 | Clayey sand, grey, slight to medium cohesiveness, silty, fine to very fine grain, unconsolidated quartz sand. |
| BC-2 | |
| 0 - 1 | Sand, dark grey to black, fine grain, unconsolidated, silty, plant and root material. |
| 1 - 1.5 | Sand, brown, fine grain, unconsolidated, slightly silty, shell fragments, (fill material). |
| 1.5 - 3 | Sand, dark brown, fine grain, unconsolidated, silty. |
| 3 - 4.5 | Sand, dark grey, fine grain, unconsolidated, silty. |
| 4.5 - 11 | Sand, grey, fine grain, unconsolidated, slightly silty. |
| 11 - 12.5 | Clayey sand, grey, slight to medium cohesiveness, silty, fine to very fine grain, unconsolidated quartz sand. |
| BC-3 | |
| 0 - 1.5 | Sand, grey, fine to medium grain, unconsolidated, slightly silty, root and plant material. |
| 1.5 - 3 | Sand, dark brown, fine to medium grain, unconsolidated, slightly silty. |
| 3 - 4.5 | Sand, brown, medium grain, trace fine grain, unconsolidated, slightly silty. |
| 4.5 - 8 | Sand, grey, grey brown, medium to fine grain, unconsolidated, slightly silty. |
| 8 - 12 | Sand, grey, grey brown, medium to fine grain, unconsolidated, slightly silty, shell fragments. |
| BC-4 | |
| 0 - 1.5 | Sand, grey, fine to medium grain, unconsolidated, slightly silty, root and plant material. |
| 1.5 - 3 | Sand, dark brown, fine to medium grain, unconsolidated, slightly silty. |
| 3 - 4.5 | Sand, brown, medium grain, trace fine grain, unconsolidated, slightly silty. |
| 4.5 - 8 | Sand, grey, grey brown, medium to fine grain, unconsolidated, slightly silty. |
| 8 - 12 | Sand, grey, grey brown, medium to fine grain, unconsolidated, slightly silty, shell fragments. |

| Depth (ft.) | Description |
|---|---|
| BC-5 | |
| 0 - 2.25 | Sand, tan, fine grain, unconsolidated, root and plant material. |
| 2.25 - 3 | Sand, dark brown, fine grain, unconsolidated, silty. |
| 3 - 4 | Sand, brown, fine grain, unconsolidated, slightly silty. |
| 4 - 8 | Sand, grey, grey brown, fine grain, unconsolidated, slightly silty. |
| 8 - 13 | Sand, grey, grey brown, fine to medium grain, unconsolidated, slight silty. |
| BC-6 | |
| 0 - 1 | Sand, grey, medium to fine grain, unconsolidated, subangular to angular quartz, slightly silty, root fragments. |
| 1 - 2 | Sand, grey, medium to fine grain, unconsolidated, subangular quartz. |
| 2 - 3 | Sand, dark grey, fine grain, unconsolidated, subangular quartz, slightly silty. |
| 3 - 5.5 | Sand, brown to dark brown, fine grain, unconsolidated, subangular quartz, slightly silty. |
| 5.5 - 10.5 | Sand, dark brown to black, fine grain, unconsolidated, subangular quartz, silty. |
| 10.5 - 11.5 | Sand, brown, fine grain, unconsolidated, subangular quartz, slightly silty, shell fragments. |
| BC-7 | |
| 0 - 1 | Sand, grey, medium to fine grain, unconsolidated, subangular to angular quartz, slightly silty, root fragments. |
| 1 - 2 | Sand, grey, medium to fine grain, unconsolidated, subangular quartz. |
| 2 - 3 | Sand, dark grey, fine grain, unconsolidated, subangular quartz, slightly silty. |
| 3 - 5.5 | Sand, brown to dark brown, fine grain, unconsolidated, subangular quartz, slightly silty. |
| 5.5 - 10.5 | Sand, dark brown to black, fine grain, unconsolidated, subangular quartz, silty. |
| 10.5 - 11.5 | Sand, brown, fine grain, unconsolidated, subangular quartz, slightly silty, shell fragments. |

DADE COUNTY STUDY SITE

Lithologic logs of the piezometer and monitoring wells installed at the study subdivision in Dade County, Florida are detailed below.

| Depth (ft.) | Description |
|---|---|
| P-2 | |
| 0 - 1 | Sand, tan, silty, fine grain with limestone fragments. |
| 2 - 4 | Sand, brown, fine grain, clayey with abundant limestone fragments. |
| 4 - 6 | Limestone, cream, hard, massive, fossiliferous. |
| P-3 | |
| 0 - 2 | Sand, brown to tan, fine grain with cream to white limestone fragments. |
| 2 - 7 | Limestone, cream to beige, massive, weathered, fossiliferous. |
| DC-1 | |
| 0 - 2 | Sand, light brown, fine to medium grain, clayey with large limestone fragments, trace of organics. |
| 2 - 13 | Limestone, beige, massive, weathered, vugular, with fine to medium grain sand. |
| DC-2 | |
| 0 - 1 | Sand, brown, fine to medium grain, clayey, with large limestone fragments, trace of organics. |
| 1 - 13 | Limestone, beige, massive, weathered, vugular trace of sand. |
| DC-3 | |
| 0 - 1 | Sand, brown, fine to medium grain, clayey, with large limestone fragments, trace of organics. |
| 1 - 13 | Limestone, beige, massive, weathered, vugular trace of sand. |
| DC-4 | |
| 0 - 4.5 | Sand, brown, fine to medium grain, clayey with large limestone fragments, trace of organics. |
| 4.5 - 12 | Limestone, beige, massive, weathered, vugular fossiliferous trace of sand. |

| Depth (ft.) | Description |
|---|---|
| DC-5 | |
| 0 - 3 | Sand, brown, fine to medium grain, clayey with large limestone fragments, trace of organics. |
| 3 - 12 | Limestone, beige to cream, massive, weathered, fossiliferous vugular limestone, trace of sand. |
| DC-6 | |
| 0 - 0.5 | Sand, light brown, fine to medium grain, clayey with large limestone fragments, trace of organics. |
| 0.5 - 12.5 | Limestone, beige, massive, weathered, vugular fossiliferous trace of sand. |
| DC-7 | |
| 0 - 2 | Sand, brown, fine grain, silty with large tan limestone fragments, trace of organic material. |
| 2 - 4 | Limestone, light brown, massive, vugular, trace of sand. |
| 4 - 7 | Limestone, tan, massive, fossilferous, sandy. |
| 7 - 13 | Limestone, cream to tan, massive to fossilferous, micritic in part with white to cream, soft, unconsolidated clay and large cavernous interval 7-9 feet. |

# APPENDIX C

# GROUND WATER ELEVATION DATA

Table C1. Ground water elevation measurements in Polk County.

| | | Monitoring Date | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Well | T.O.C.[1] | 5/7/87 | 7/1/87 | 9/17/87 | 9/24/87 | 9/29/87 | 10/15/87 | 12/15/87 | 1/22/88 | 3/8/88 |
| | | - | - | - | - | ft. | (msl) | - | - | - |
| PC1 | 141.10 | | | 125.17 | 124.90 | 124.71 | 124.56 | 125.03 | 123.93 | 123.79 |
| PC2 | 128.61 | | | 122.96 | 122.77 | 122.82 | 122.82 | | 122.58 | 122.81 |
| PC3 | 128.07 | | | 122.86 | 122.75 | 122.56 | 122.77 | 122.92 | 122.49 | 122.73 |
| PC4 | 131.95 | | | | | 122.73 | 122.95 | 123.11 | 122.60 | 123.68 |
| PC5 | 131.02 | | | | | 122.61 | 122.81 | 122.96 | 122.48 | 122.75 |
| P2 | 135.21 | 121.41 | 123.12 | 122.96 | 122.85 | | | | 122.39 | 122.65 |
| P3 | 131.42 | 120.66 | 122.73 | 122.94 | 122.78 | | | | 123.22 | 122.81 |
| P4 | 132.91 | 119.69 | 121.46 | 123.39 | 123.23 | | | | 122.93 | |
| P5 | 136.53 | 122.39 | 124.64 | 123.69 | 123.51 | | | | 123.35 | 123.51 |
| P6 | 138.16 | | | 123.61 | 123.43 | | | | 122.59 | 123.08 |
| P7 | 133.13 | | | 123.15 | 123.22 | | | | 122.69 | 122.96 |
| SG | | | | 123.05 | | | | | 122.60 | 122.80 |

[1] T.O.C. = top of well casing.

Table C2. Ground water elevation measurements in St. Johns County.

| | | Monitoring Date | | | | | |
|---|---|---|---|---|---|---|---|
| Well | T.O.C.[1] | 6/5/87 | 6/12/87 | 7/7/87 | 10/5/87 | 12/3/87 | 3/7/88 |
| | | - | - | - | - | ft. | (msl) - - - |
| SJC1 | 12.74 | | | | 6.95 | 7.56 | 9.35 |
| SJC2 | 11.76 | | | | 6.85 | 7.45 | 9.27 |
| SJC3 | 14.16 | | | | 7.19 | 7.77 | 9.58 |
| SJC4 | 12.48 | | | | 6.98 | 7.64 | 9.47 |
| SJC5 | 11.42 | | | | 7.35 | 7.87 | 9.63 |
| SJC6 | 12.48 | | | | 7.39 | 7.91 | 9.65 |
| SJC7 | 15.14 | | | | 7.18 | 7.31 | 9.13 |
| P1 | 13.96 | 10.12 | 9.87 | 10.57 | | | 10.79 |
| P2 | 14.17 | 10.43 | 10.19 | 11.08 | | | 11.47 |
| P3 | 14.65 | 10.89 | 10.64 | 11.79 | | | 12.33 |
| P4 | 13.12 | 10.05 | 9.97 | 10.85 | | | 11.35 |
| P5 | 11.26 | 8.70 | 8.45 | 9.21 | | | 9.47 |
| P6 | 10.83 | 8.32 | 8.06 | 9.13 | | | |
| P7 | 11.53 | 6.89 | 6.63 | 6.89 | | | 7.51 |
| P8 | 13.60 | 9.60 | 9.36 | 10.29 | | | 10.73 |
| P9 | 12.92 | 9.38 | 9.14 | 10.16 | | | |

[1] T.O.C. = top of well casing.

Table C3. Ground water elevation measurements in Brevard County.

| | | Monitoring Date | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Well | T.O.C.[1] | 6/5/87 | 6/16/87 | 6/30/87 | 9/15/87 | 10/9/87 | 10/26/87 | 11/17/87 | 12/8/87 | 3/14/88 |
| | | - | - | - | - | ft. | (msl) | - | - | - |
| BC1 | 51.56 | | | | | | 49.13 | 49.21 | 49.32 | 50.78 |
| BC2 | 51.27 | | | | | | 49.32 | 49.32 | 49.50 | 51.77 |
| BC3 | 50.47 | | | | | | 47.59 | | 48.19 | 49.58 |
| BC4 | 50.20 | | | | | | 47.92 | 47.94 | 48.44 | 49.46 |
| BC5 | 50.02 | | | | | | 47.18 | 47.24 | 48.03 | 48.74 |
| BC6 | 50.91 | | | | | | 49.02 | 48.20 | 48.39 | 50.91 |
| BC7 | 50.72 | | | | | | 48.61 | 47.78 | 48.04 | 49.98 |
| B1 | 52.36 | 47.80 | 47.32 | 47.82 | 49.16 | 48.17 | | | | 49.44 |
| B2 | 51.50 | 47.38 | 46.84 | 48.12 | 49.57 | 47.79 | | | | 49.83 |
| B3 | 52.86 | 47.90 | 47.25 | 47.32 | 50.39 | 48.36 | | | | 50.79 |
| B4 | 53.70 | 48.13 | 47.61 | 47.90 | | | | | | |
| B5 | 53.55 | 47.81 | 47.46 | 47.81 | 48.63 | 47.92 | | | | 49.19 |
| B6 | 52.81 | 47.82 | 47.35 | 47.60 | 48.39 | 48.11 | | | | 50.11 |
| B7 | 53.61 | 47.37 | 46.94 | 47.16 | 49.61 | 48.07 | | | | 50.06 |
| B8 | 55.54 | 48.90 | 48.42 | 48.74 | 50.44 | 49.04 | | | | 50.86 |
| B9 | 54.87 | 50.14 | 49.64 | 49.77 | 50.72 | 50.34 | | | | 52.11 |
| B10 | 51.92 | 47.93 | 47.43 | 47.85 | 49.16 | 48.33 | | | | 49.70 |
| B11 | 49.81 | 47.93 | 47.61 | 47.92 | | | | | | |
| SG | | 44.20 | 44.15 | 43.30 | dry | dry | | | | missing |

[1] T.O.C. = top of well casing.

Table C4. Ground water elevation measurements in Dade County.

| | | Monitoring Date | | |
|---|---|---|---|---|
| Well | T.O.C.[1] | 11/18/87 | 12/8/87 | 3/15/88 |
| | | - - - ft. (msl) - - - | | |
| DC1 | 8.00 | | 4.12 | 4.25 |
| DC2 | 9.00 | | 4.14 | 4.36 |
| DC3 | 9.23 | | 4.12 | 4.34 |
| DC4 | 8.46 | | 4.15 | 4.36 |
| DC5 | 8.66 | | 4.17 | 4.38 |
| DC6 | 9.51 | | 4.22 | 4.51 |
| DC7 | | 4.40 | 4.17 | 4.37 |
| P2 | | 4.44 | 4.22 | 4.42 |
| P3 | | 4.42 | 4.21 | 4.40 |
| S1 | | 4.39 | 4.16 | 4.37 |
| S2 | | 4.44 | 4.20 | 4.40 |
| S3 | | 4.43 | 4.20 | 4.36 |
| S4 | | 4.43 | 4.21 | 4.45 |
| S6 | | 4.47 | 4.25 | 4.48 |
| S7 | | 4.47 | 4.25 | 4.46 |
| S8 | | 4.46 | 4.25 | 4.48 |
| S9 | | 4.45 | 4.24 | 4.46 |
| S10 | | 4.43 | 4.26 | 4.49 |
| S11 | | 4.43 | 4.26 | 4.50 |
| S13 | | 4.39 | 4.27 | 4.52 |
| S14 | | 4.38 | 4.27 | 4.51 |
| S16 | | 4.40 | 4.26 | 4.49 |
| S17 | | 4.41 | 4.26 | 4.50 |
| S19 | | 4.39 | 4.25 | 4.50 |
| S20 | | 4.38 | 4.24 | 4.49 |
| S21 | | 4.39 | 4.22 | 4.50 |
| S22 | | 4.37 | 4.18 | 4.43 |
| S23 | | 4.36 | 4.18 | 4.41 |
| S24 | | 4.36 | 4.19 | 4.43 |
| S25 | | 4.39 | 4.22 | |
| S26 | | 4.37 | 4.15 | 4.37 |
| S27 | | 4.37 | 4.13 | 4.25 |
| S28 | | 4.39 | 4.15 | 4.37 |
| S29 | | 4.48 | 4.17 | 4.38 |
| S30 | | 4.44 | 4.22 | 4.43 |
| S31 | | 4.43 | 4.23 | 4.46 |

[1] T.O.C. = top of well casing.

# APPENDIX D

# GROUND WATER QUALITY DATA

Table D1. Ground water quality measurements in Polk County.

| Well | Date | Elev. (ft.) | Temp. (oC) | pH (units) | Conduct. (umho/cm) | TDS (mg/L) | Cl (mg/L) | BOD5 (mg/L) | TKN (mg/L) | NO3 (mg/L) | TP (mg/L) | SO4 (mg/L) | MBAS (mg/L) | F.coli. (#/100mL) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PC1 | 9/29/87 | 124.71 | 25.9 | 6.28 | 210 | 148 |  | <1.0 | 0.57 |  | 2.40 |  |  | <10 |
|  | 10/15/87 | 124.56 | 26.4 | 6.10 | 215 | 139 | 8 | <1.0 | 0.56 | 0.86 | 7.90 | 45 | <0.05 | < 1 |
|  | 12/15/87 | 125.03 | 25.5 | 6.25 | 225 | 142 | 16 | <1.0 | 0.43 | 13.00 | 0.77 | 36 | <0.05 | < 1 |
|  | 3/8/87 | 123.79 | 20.1 | 6.02 | 205 | 160 | 12 | <1.0 | 0.31 | 5.10 | 0.55 | 31 | <0.05 | < 1 |
|  | Average | 124.52 | 24.5 |  | 214 | 147 | 12 |  | 0.47 | 6.32 | 2.91 | 37 |  |  |
|  | Std. Dev | 0.53 | 2.9 |  | 9 | 9 | 4 |  | 0.12 | 6.16 | 3.43 | 7 |  |  |
|  | Maximum | 125.03 | 26.4 | 6.28 | 225 | 160 | 16 | <1.0 | 0.57 | 13.00 | 7.90 | 45 | <0.05 | <10 |
|  | Minimum | 123.79 | 20.1 | 6.02 | 205 | 139 | 8 | <1.0 | 0.31 | 0.86 | 0.55 | 31 | <0.05 | < 1 |
|  | No. | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 4 | 3 | 4 | 3 | 3 | 4 |
| PC2 | 9/29/87 | 122.82 | 26.5 | 5.35 | 69 | 120 |  | <1.0 | 1.40 |  | 4.20 |  |  | 10 |
|  | 10/15/87 | 122.82 | 24.8 | 5.35 | 90 | 34 | <1 | <1.0 | 0.64 | 0.88 | 1.20 | 16 | <0.05 | <1 |
|  | 12/15/87 | 126.31 | 23.0 | 4.85 | 105 | 130 | 9 | <1.0 | 1.90 | 22.00 | 3.00 | 21 | <0.05 | <1 |
|  | 3/8/87 | 122.81 | 20.0 | 5.20 | 82 | 50 | 6 | 1.1 | 0.51 | 1.10 | 0.46 | 16 | <0.05 | <1 |
|  | Average | 123.69 | 23.6 |  | 87 | 84 |  |  | 1.11 | 7.99 | 2.22 | 18 |  |  |
|  | Std. Dev | 1.75 | 2.8 |  | 15 | 49 |  |  | 0.66 | 12.13 | 1.70 | 3 |  |  |
|  | Maximum | 126.31 | 26.5 | 5.35 | 105 | 130 | 9 | 1.1 | 1.90 | 22.00 | 4.20 | 21 | <0.05 | 10 |
|  | Minimum | 122.81 | 20.0 | 4.85 | 69 | 34 | <1 | <1.0 | 0.51 | 0.88 | 0.46 | 16 | <0.05 | < 1 |
|  | No. | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 4 | 3 | 4 | 3 | 3 | 4 |
| PC3 | 9/29/87 | 122.56 | 25.4 |  | 40 | 72 |  | <1.0 | 1.80 |  | 3.00 |  |  | <10 |
|  | 10/15/87 | 122.77 | 24.7 | 4.85 | 63 | 22 | <1 | <1.0 | 0.64 | <0.02 | 0.08 | 3 | <0.05 | < 1 |
|  | 12/15/87 | 122.92 | 22.9 | 4.05 | 56 | 64 | 2 | <1.0 | 2.40 | 0.30 | 2.40 | 19 | <0.05 | < 1 |
|  | 3/8/87 | 122.73 | 21.8 | 5.00 | 37 | 18 | 3 | <1.0 | 0.63 | 0.45 | 0.26 | 4 | <0.05 | < 1 |
|  | Average | 122.75 | 23.7 |  | 49 | 44 |  |  | 1.37 |  | 1.44 | 9 |  |  |
|  | Std. Dev | 0.15 | 1.6 |  | 13 | 28 |  |  | 0.88 |  | 1.48 | 9 |  |  |
|  | Maximum | 122.92 | 25.4 | 5.00 | 63 | 72 | 3 | <1.0 | 2.40 | 0.45 | 3.00 | 19 | <0.05 | <10 |
|  | Minimum | 122.56 | 21.8 | 4.05 | 37 | 18 | <1 | <1.0 | 0.63 | <0.02 | 0.08 | 3 | <0.05 | < 1 |
|  | No. | 4 | 4 | 3 | 4 | 4 | 3 | 4 | 4 | 3 | 4 | 3 | 3 | 4 |
| PC4 | 9/29/87 | 122.73 | 24.8 | 6.28 | 195 | 130 |  | <1.0 | 1.90 |  | 20.00 |  |  | <10 |
|  | 10/15/87 | 122.95 | 24.7 | 5.25 | 152 | 88 | 17 | <1.0 | 0.61 | 1.50 | 0.63 | 21 | <0.05 | < 1 |
|  | 12/15/87 | 123.11 | 24.8 | 5.10 | 165 | 114 | 12 | <1.0 | 0.86 | 2.90 | 3.20 | 27 | <0.05 | < 1 |
|  | 3/8/87 | 118.86 | 22.1 | 5.75 | 115 | 78 | 13 | <1.0 | 1.10 | 1.80 | 8.60 | 17 | <0.05 | < 1 |
|  | Average | 121.91 | 24.1 |  | 157 | 103 | 14 |  | 1.12 | 2.07 | 8.11 | 22 |  |  |
|  | Std. Dev | 2.04 | 1.3 |  | 33 | 24 | 3 |  | 0.56 | 0.74 | 8.60 | 5 |  |  |
|  | Maximum | 123.11 | 24.8 | 6.28 | 195 | 130 | 17 | <1.0 | 1.90 | 2.90 | 20.00 | 27 | <0.05 | <10 |
|  | Minimum | 118.86 | 22.1 | 5.10 | 115 | 78 | 12 | <1.0 | 0.61 | 1.50 | 0.63 | 17 | <0.05 | < 1 |
|  | No. | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 4 | 3 | 4 | 3 | 3 | 4 |
| PC5 | 9/29/87 | 122.61 | 25.8 | 6.43 | 55 | 88 |  | <1.0 | 2.20 |  | 8.80 |  |  | <10 |
|  | 10/15/87 | 122.81 | 24.8 | 5.35 | 82 | 38 | 4 | <1.0 | 0.30 | 0.32 | 0.34 | 12 | <0.05 | < 1 |
|  | 12/15/87 | 122.96 | 24.0 | 5.50 | 55 | 58 | 2 | <1.0 | 0.76 | 0.20 | 5.00 | <2 | <0.05 | < 1 |
|  | 3/8/87 | 122.75 | 21.8 | 5.52 | 47 | 30 | 2 | <1.0 | 0.58 | 0.71 | 3.80 | 9 | <0.05 | < 1 |
|  | Average | 122.78 | 24.1 |  | 60 | 54 | 3 |  | 0.96 | 0.41 | 4.49 |  |  |  |
|  | Std. Dev | 0.15 | 1.7 |  | 15 | 26 | 1 |  | 0.85 | 0.27 | 3.49 |  |  |  |
|  | Maximum | 122.96 | 25.8 | 6.43 | 82 | 88 | 4 | <1.0 | 2 | 1 | 9 | 12 | <0.05 | <10 |
|  | Minimum | 122.61 | 21.8 | 5.35 | 47 | 30 | 2 | <1.0 | 0 | 0 | 0 | <2 | <0.05 | < 1 |
|  | No. | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 4 | 3 | 4 | 3 | 3 | 4 |

Table D2. Ground water quality measurements in St. Johns County.

| Well | Date | Elev. (ft.) | Temp. (oC) | pH (units) | Conduct. (umho/cm) | TDS (mg/L) | Cl (mg/L) | BOD5 (mg/L) | TKN (mg/L) | NO3 (mg/L) | TP (mg/L) | SO4 (mg/L) | MBAS (mg/L) | F.coli. (#/100mL) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SJC1 | 10/5/87 | 6.95 | 27.1 | | 110 | 64 | 4 | <1.0 | 0.21 | 0.43 | <0.01 | 20 | <0.05 | <1 |
| | 12/3/87 | 7.56 | 23.0 | 5.99 | 97 | 88 | 6 | <1.0 | 1.70 | 0.16 | 1.60 | 24 | 0.06 | <2 |
| | 3/7/88 | 9.35 | 20.5 | 6.76 | 84 | 152 | 3 | <1.0 | 1.10 | 0.36 | 0.98 | 9 | <0.05 | <10 |
| | Average | 7.95 | 23.53 | | 97 | 101 | 4 | | 1.00 | 0.32 | 1.29 | 18 | | |
| | Std. Dev | 1.25 | 3.33 | | 13 | 45 | 2 | | 0.75 | 0.14 | 0.44 | 8 | | |
| | Maximum | 9.35 | 27.1 | 6.76 | 110 | 152 | 6 | <1.0 | 1.70 | 0.43 | 1.60 | 24 | 0.06 | <10 |
| | Minimum | 6.95 | 20.5 | 5.99 | 84 | 64 | 3 | <1.0 | 0.21 | 0.16 | 0.98 | 9 | <0.05 | < 1 |
| | No. | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 |
| SJC2 | 10/5/87 | 6.85 | 25.1 | | 157 | 108 | 13 | <1.0 | 0.33 | 0.01 | 0.08 | 30 | <0.05 | <1 |
| | 12/3/87 | 7.45 | 23.6 | 6.00 | 135 | 122 | 15 | <1.0 | 0.30 | 0.03 | 0.05 | 37 | <0.05 | <2 |
| | 3/7/88 | 9.27 | 19.5 | 6.92 | 110 | 123 | 2 | 1.2 | 0.67 | 0.37 | 0.42 | 12 | <0.05 | <10 |
| | Average | 7.86 | 22.73 | | 134 | 118 | 10 | | 0.43 | 0.14 | 0.18 | 26 | | |
| | Std. Dev | 1.26 | 2.90 | | 24 | 8 | 7 | | 0.21 | 0.20 | 0.21 | 13 | | |
| | Maximum | 9.27 | 25.1 | 6.92 | 157 | 123 | 15 | 1.2 | 0.67 | 0.37 | 0.42 | 37 | <0.05 | <10 |
| | Minimum | 6.85 | 19.5 | 6.00 | 110 | 108 | 2 | <1.0 | 0.30 | 0.01 | 0.05 | 12 | <0.05 | < 1 |
| | No. | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| SJC3 | 10/5/87 | 7.19 | 24.0 | | 373 | 248 | 32 | <1.0 | 0.56 | <0.01 | 0.04 | 123 | <0.05 | <1 |
| | 12/3/87 | 7.77 | 22.4 | 4.85 | 229 | 166 | 17 | <1.0 | 0.48 | 1.30 | 0.04 | 79 | <0.05 | <2 |
| | 3/7/88 | 9.58 | 19.8 | 5.30 | 265 | 216 | 17 | <1.0 | 1.50 | 3.90 | 0.15 | 95 | <0.05 | <10 |
| | Average | 8.18 | 22.07 | | 289 | 210 | 22 | | 0.85 | | 0.08 | 99 | | |
| | Std. Dev | 1.25 | 2.12 | | 75 | 41 | 9 | | 0.57 | | 0.06 | 22 | | |
| | Maximum | 9.58 | 24.0 | 5.30 | 373 | 248 | 32 | <1.0 | 1.50 | 3.90 | 0.15 | 123 | <0.05 | <10 |
| | Minimum | 7.19 | 19.8 | 4.85 | 229 | 166 | 17 | <1.0 | 0.48 | <0.01 | 0.04 | 79 | <0.05 | < 1 |
| | No. | 3 | 3 | 2 | 3 | 3 | 3 | 4 | 3 | 3 | 3 | 3 | 3 | 3 |
| SJC4 | 10/5/87 | 6.98 | 25.2 | | 585 | 414 | 28 | <1.0 | 6.30 | 8.70 | 0.03 | 265 | <0.05 | 4 |
| | 12/3/87 | 7.64 | 22.7 | 5.53 | 440 | 354 | 32 | <1.0 | 1.80 | 1.00 | 0.03 | 193 | <0.05 | <2 |
| | 3/7/88 | 9.47 | 19.1 | 6.46 | 1390 | 1380 | 100 | 1.7 | 2.00 | 50.00 | 0.91 | 435 | <0.05 | <10 |
| | Average | 8.03 | 22.33 | | 805 | 716 | 53 | | 3.37 | 19.90 | 0.32 | 298 | | |
| | Std. Dev | 1.29 | 3.07 | | 512 | 576 | 40 | | 2.54 | 26.35 | 0.51 | 124 | | |
| | Maximum | 9.47 | 25.2 | 6.46 | 1390 | 1380 | 100 | 1.7 | 6.30 | 50.00 | 0.91 | 435 | <0.05 | 4 |
| | Minimum | 6.98 | 19.1 | 5.53 | 440 | 354 | 28 | <1.0 | 1.80 | 1.00 | 0.03 | 193 | <0.05 | <2 |
| | No. | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| SJC5 | 10/5/87 | 7.35 | 24.0 | | 585 | 464 | 17 | <1.0 | 1.30 | 0.80 | <0.01 | 220 | <0.05 | <1 |
| | 12/3/87 | 7.87 | 22.2 | 5.64 | 480 | 392 | 21 | <1.0 | 3.60 | 1.90 | 1.30 | 157 | <0.05 | <2 |
| | 3/7/88 | 9.63 | 17.3 | 6.21 | 328 | 262 | 8 | 1.1 | 1.90 | 0.80 | 1.10 | 60 | <0.05 | <10 |
| | Average | 8.28 | 21.17 | | 464 | 373 | 15 | | 2.27 | 1.17 | 1.20 | 146 | | |
| | Std. Dev | 1.19 | 3.47 | | 129 | 102 | 7 | | 1.19 | 0.64 | 0.14 | 81 | | |
| | Maximum | 9.63 | 24.0 | 6.21 | 585 | 464 | 21 | 1.1 | 3.60 | 1.90 | 1.30 | 220 | <0.05 | <10 |
| | Minimum | 7.35 | 17.3 | 5.64 | 328 | 262 | 8 | <1.0 | 1.30 | 0.80 | 1.10 | 60 | <0.05 | < 1 |
| | No. | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 |

Table D2 cont. Ground water quality measurements in St. Johns County.

| Well | Date | Elev. (ft.) | Temp. (oC) | pH (units) | Conduct. (umho/cm) | TDS (mg/L) | Cl (mg/L) | BOD5 (mg/L) | TKN (mg/L) | NO3 (mg/L) | TP (mg/L) | SO4 (mg/L) | MBAS (mg/L) | F.coli. (#/100mL) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SJC6 | 10/5/87 | 7.39 | 23.5 | | 525 | 350 | 66 | <1.0 | 0.35 | <0.01 | 0.08 | 195 | <0.05 | <1 |
| | 12/3/87 | 7.91 | 21.8 | 4.42 | 545 | 392 | 80 | <1.0 | 0.41 | 0.03 | 0.05 | 143 | <0.05 | <2 |
| | 3/7/88 | 9.65 | 18.5 | 4.69 | 365 | 312 | 88 | <1.0 | 0.72 | 0.03 | 1.00 | 72 | <0.05 | <10 |
| | Average | 8.32 | 21.27 | | 478 | 351 | 78 | | 0.49 | | 0.38 | 137 | | |
| | Std. Dev | 1.18 | 2.54 | | 99 | 40 | 11 | | 0.20 | | 0.54 | 62 | | |
| | Maximum | 9.65 | 23.5 | 4.69 | 545 | 392 | 88 | <1.0 | 0.72 | 0.03 | 1.00 | 195 | <0.05 | <10 |
| | Minimum | 7.39 | 18.5 | 4.42 | 365 | 312 | 66 | <1.0 | 0.35 | <0.01 | 0.05 | 72 | <0.05 | < 1 |
| | No. | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| SJC7 | 10/5/87 | 7.18 | 25.7 | | 245 | 176 | 11 | <1.0 | 0.22 | 4.30 | 0.10 | 73 | <0.05 | <1 |
| | 12/3/87 | 7.31 | 23.4 | 5.85 | 395 | 226 | 13 | <1.0 | 1.00 | 5.60 | 1.40 | 92 | 0.11 | <2 |
| | 3/7/88 | 9.13 | 20.1 | 6.47 | 195 | 232 | 14 | 1.2 | 1.30 | 3.60 | 0.16 | 68 | <0.05 | <10 |
| | Average | 7.87 | 23.07 | | 278 | 211 | 13 | | 0.84 | 4.50 | 0.55 | 78 | | |
| | Std. Dev | 1.09 | 2.81 | | 104 | 31 | 2 | | 0.56 | 1.01 | 0.73 | 13 | | |
| | Maximum | 9.13 | 25.7 | 6.47 | 395 | 232 | 14 | 1.2 | 1.30 | 5.60 | 1.40 | 92 | 0.11 | <10 |
| | Minimum | 7.18 | 20.1 | 5.85 | 195 | 176 | 11 | <1.0 | 0.22 | 3.60 | 0.10 | 68 | <0.05 | < 1 |
| | No. | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

Table D3. Ground water quality measurements in Brevard County.

| Well | Date | Elev. (ft.) | Temp. (oC) | pH (units) | Conduct. (umho/cm) | TDS (mg/L) | Cl (mg/L) | BOD5 (mg/L) | TKN (mg/L) | NO3 (mg/L) | TP (mg/L) | SO4 (mg/L) | MBAS (mg/L) | F.coli. (#/100mL) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BC1 | 10/26/87 | 49.13 | 27.2 | 6.30 | 705 | 506 | 26 | 2.1 | 5.20 | 0.72 | <0.01 | <2 | 0.14 | <10 |
| | 11/17/87 | 49.21 | 26.3 | 6.29 | 675 | | | | | | | | | |
| | 12/8/87 | 49.32 | | | | 660 | 28 | 4.9 | 5.60 | 2.10 | 0.13 | 11 | <0.05 | <10 |
| | 3/14/88 | 50.78 | 22.1 | 6.40 | 670 | 548 | 29 | 9.3 | 7.20 | 0.80 | 0.07 | 16 | 0.08 | <10 |
| | Average | 49.61 | 25.2 | | 683 | 571 | 28 | 5.4 | 6.00 | 1.21 | | | | |
| | Std. Dev | 0.78 | 2.7 | | 19 | 80 | 2 | 3.6 | 1.06 | 0.77 | | | | |
| | Maximum | 50.78 | 27.2 | 6.40 | 705 | 660 | 29 | 9.3 | 7.20 | 2.10 | 0.13 | 16 | 0.14 | <10 |
| | Minimum | 49.13 | 22.1 | 6.29 | 670 | 506 | 26 | 2.1 | 5.20 | 0.72 | <0.01 | <2 | <0.05 | <10 |
| | No. | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| BC2 | 10/26/87 | 49.32 | 26.3 | 6.12 | 505 | 390 | 11 | 2.3 | 6.40 | 0.01 | 0.14 | 38 | 0.15 | <10 |
| | 11/17/87 | 49.32 | 24.3 | 6.07 | 510 | | | | | 0.03 | | | | |
| | 12/8/87 | 49.50 | | | | 512 | 10 | 4.9 | 7.60 | 0.37 | 0.24 | 25 | 0.12 | <10 |
| | 3/14/88 | 51.77 | | | | | | | | | | | | |
| | Average | 49.98 | 25.3 | | 508 | 451 | 11 | 3.6 | 7.00 | 0.14 | 0.19 | 32 | 0.14 | |
| | Std. Dev | 1.20 | 1.4 | | 4 | 86 | 1 | 1.8 | 0.85 | 0.20 | 0.07 | 9 | 0.02 | |
| | Maximum | 51.77 | 26.3 | 6.12 | 510 | 512 | 11 | 4.9 | 7.60 | 0.37 | 0.24 | 38 | 0.15 | <10 |
| | Minimum | 49.32 | 24.3 | 6.07 | 505 | 390 | 10 | 2.3 | 6.40 | 0.01 | 0.14 | 25 | 0.12 | <10 |
| | No. | 4 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 2 |
| BC3 | 10/26/87 | 47.59 | 25.0 | 5.65 | 640 | 630 | 140 | <1.0 | 2.00 | 0.08 | 0.89 | 36 | 0.13 | <10 |
| | 11/17/87 | | | | | | | | | | | | | |
| | 12/8/87 | 48.19 | | | | 872 | 43 | <1.0 | 4.40 | 0.10 | 1.20 | 15 | <0.05 | <10 |
| | 3/14/88 | 49.58 | 18.9 | 5.30 | 375 | 288 | 71 | 4.2 | 7.40 | 4.60 | 0.50 | 45 | <0.05 | 150 |
| | Average | 48.45 | 22.0 | | 508 | 597 | 85 | | 4.60 | 1.59 | 0.86 | 32 | | |
| | Std. Dev | 1.02 | 4.3 | | 187 | 293 | 50 | | 2.71 | 2.60 | 0.35 | 15 | | |
| | Maximum | 49.58 | 25.0 | 5.65 | 640 | 872 | 140 | 4.2 | 7.40 | 4.60 | 1.20 | 45 | 0.13 | 150 |
| | Minimum | 47.59 | 18.9 | 5.30 | 375 | 288 | 43 | <1.0 | 2.00 | 0.08 | 0.50 | 15 | <0.05 | <10 |
| | No. | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| BC4 | 10/26/87 | 47.92 | 24.0 | 5.28 | 73 | 220 | 9 | <1.0 | 1.20 | 0.28 | 0.25 | <2 | 0.09 | <10 |
| | 11/17/87 | 47.94 | 23.2 | 4.92 | 91 | | | | | | | | | |
| | 12/8/87 | 48.44 | | | | 440 | 25 | <1.0 | 3.80 | 0.20 | 0.11 | 11 | 0.05 | <10 |
| | 3/14/88 | 49.46 | 19.4 | 5.30 | 76 | 113 | 23 | 2.3 | 3.40 | 0.70 | 0.78 | <10 | <0.05 | 300 |
| | Average | 48.44 | 22.2 | | 80 | 258 | 19 | | 2.80 | 0.39 | 0.38 | | | |
| | Std. Dev | 0.72 | 2.5 | | 10 | 167 | 9 | | 1.40 | 0.27 | 0.35 | | | |
| | Maximum | 49.46 | 24.0 | 5.30 | 91 | 440 | 25 | 2.30 | 3.80 | 0.70 | 0.78 | 11 | 0.09 | 300 |
| | Minimum | 47.92 | 19.4 | 4.92 | 73 | 113 | 9 | <1.0 | 1.20 | 0.20 | 0.11 | <2 | <0.05 | <10 |
| | No. | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| BC5 | 10/26/87 | 47.18 | 23.9 | 6.51 | 115 | 188 | 7 | <1.0 | 1.30 | 0.02 | <1.0 | 12 | 0.10 | <10 |
| | 11/17/87 | 47.24 | 24.0 | 5.92 | 145 | | | | | | | | | |
| | 12/8/87 | 48.03 | | | | 444 | 14 | 1.1 | 1.60 | 0.10 | 0.39 | 5 | <0.05 | <10 |
| | 3/14/88 | 48.74 | 19.1 | 6.00 | 100 | 116 | 13 | 3.7 | 2.80 | 1.10 | 0.84 | <10 | <0.05 | <10 |
| | Average | 47.80 | 22.3 | | 120 | 249 | 11 | | 1.90 | 0.41 | 0.62 | | | |
| | Std. Dev | 0.74 | 2.8 | | 23 | 172 | 4 | | 0.79 | 0.60 | 0.32 | | | |
| | Maximum | 48.74 | 24.0 | 6.51 | 145 | 444 | 14 | 3.7 | 2.80 | 1.10 | 0.84 | 12 | 0.10 | <10 |
| | Minimum | 47.18 | 19.1 | 5.92 | 100 | 116 | 7 | <1.0 | 1.30 | 0.02 | <1.0 | <10 | <0.05 | <10 |
| | No. | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

Table D3 cont. Ground water quality measurements in Brevard County.

| Well | Date | Elev. (ft.) | Temp. (oC) | pH (units) | Conduct. (umho/cm) | TDS (mg/L) | Cl (mg/L) | BOD5 (mg/L) | TKN (mg/L) | NO3 (mg/L) | TP (mg/L) | SO4 (mg/L) | MBAS (mg/L) | F.coli. (#/100mL) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BC6 | 10/26/87 | 49.02 | 27.2 | 6.49 | 465 | 422 | 20 | <1.0 | 3.20 | 0.34 | 0.19 | 11 | 0.11 | <10 |
| | 11/17/87 | 48.20 | 25.2 | 6.47 | 1050 | | | | | | | | | |
| | 12/8/87 | 48.39 | | | | 534 | 51 | 3.3 | 2.80 | 0.60 | 0.13 | 6 | 0.08 | <10 |
| | 3/14/88 | 50.91 | 22.7 | 6.00 | 590 | 302 | 48 | 8.6 | 4.40 | 0.10 | 0.35 | <10 | <0.05 | <10 |
| | Average | 49.13 | 25.0 | | 702 | 419 | 40 | | 3.47 | 0.35 | 0.22 | | | |
| | Std. Dev | 1.24 | 2.3 | | 308 | 116 | 17 | | 0.83 | 0.25 | 0.11 | | | |
| | Maximum | 50.91 | 27.2 | 6.49 | 1050 | 534 | 51 | 8.6 | 4.40 | 0.60 | 0.35 | 11 | 0.11 | <10 |
| | Minimum | 48.20 | 22.7 | 6.00 | 465 | 302 | 20 | <1.0 | 2.80 | 0.10 | 0.13 | <10 | <0.05 | <10 |
| | No. | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| BC7 | 10/26/87 | 48.61 | 25.5 | 6.70 | 660 | 544 | 56 | 6.2 | 2.60 | 0.02 | 0.27 | 51 | 0.10 | <10 |
| | 11/17/87 | 47.78 | 23.5 | 6.76 | 420 | | | | | | | | | |
| | 12/8/87 | 48.04 | | | | 490 | 17 | 5.6 | 1.70 | 0.20 | 0.16 | <2 | 0.05 | <10 |
| | 3/14/88 | 49.98 | 19.1 | 5.20 | 390 | 264 | 64 | 4.5 | 2.70 | 4.90 | 0.37 | 29 | <0.05 | 10 |
| | Average | 48.60 | 22.7 | | 490 | 433 | 46 | 5.4 | 2.33 | 1.71 | 0.27 | | | |
| | Std. Dev | 0.98 | 3.3 | | 148 | 149 | 25 | 0.9 | 0.55 | 2.77 | 0.11 | | | |
| | Maximum | 49.98 | 25.5 | 6.76 | 660 | 544 | 64 | 6.2 | 2.70 | 4.90 | 0.37 | 51 | 0.10 | 10 |
| | Minimum | 47.78 | 19.1 | 5.20 | 390 | 264 | 17 | 4.5 | 1.70 | 0.02 | 0.16 | <2 | <0.05 | <10 |
| | No. | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

Table D4. Ground water quality measurements in Dade County.

| Well | Date | Elev. (ft.) | Temp. (oC) | pH (units) | Conduct. (umho/cm) | TDS (mg/L) | Cl (mg/L) | BOD5 (mg/L) | TKN (mg/L) | NO3 (mg/L) | TP (mg/L) | SO4 (mg/L) | MBAS (mg/L) | F.coli. (#/100mL) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DC1 | 12/8/87 | 4.12 | 25.1 | 6.90 | 720 | 292 | 34 | 1.4 | 1.00 | 0.71 | 0.16 | 57 | <0.05 | 2400 |
| | 3/15/88 | 4.25 | 24.1 | 6.90 | 590 | 368 | 37 | 1.1 | 1.00 | 0.51 | 0.74 | 33 | <0.05 | <10 |
| | Average | 4.19 | 24.6 | | 655 | 330 | 36 | 1.3 | 1.00 | 0.61 | 0.45 | 45 | | |
| | Std. Dev | 0.09 | 0.7 | | 92 | 54 | 2 | 0.2 | 0.00 | 0.14 | 0.41 | 17 | | |
| | Maximum | 4.25 | 25.1 | 6.90 | 720 | 368 | 37 | 1.4 | 1.00 | 0.71 | 0.74 | 57 | <0.05 | 2400 |
| | Minimum | 4.12 | 24.1 | 6.90 | 590 | 292 | 34 | 1.1 | 1.00 | 0.51 | 0.16 | 33 | <0.05 | <10 |
| | No. | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| DC2 | 12/8/87 | 4.14 | 25.6 | 6.80 | 670 | 402 | 34 | 1.8 | 0.80 | 1.30 | 0.11 | 60 | <0.05 | <1 |
| | 3/15/88 | 4.36 | 23.8 | 7.16 | 565 | 330 | 37 | 1.1 | 1.30 | 0.33 | 0.73 | 37 | <0.05 | 170 |
| | Average | 4.25 | 24.7 | | 618 | 366 | 36 | 1.5 | 1.05 | 0.82 | 0.42 | 49 | | |
| | Std. Dev | 0.16 | 1.3 | | 74 | 51 | 2 | 0.5 | 0.35 | 0.69 | 0.44 | 16 | | |
| | Maximum | 4.36 | 25.6 | 7.16 | 670 | 402 | 37 | 1.8 | 1.30 | 1.30 | 0.73 | 60 | <0.05 | 170 |
| | Minimum | 4.14 | 23.8 | 6.80 | 565 | 330 | 34 | 1.1 | 0.80 | 0.33 | 0.11 | 37 | <0.05 | <1 |
| | No. | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| DC3 | 12/8/87 | 4.12 | 25.5 | 6.90 | 640 | 400 | 36 | 2.0 | 0.72 | 1.40 | 0.06 | 53 | <0.05 | <1 |
| | 3/15/88 | 4.34 | 23.2 | 6.90 | 565 | 354 | 38 | 1.3 | 0.74 | 0.20 | 0.30 | 40 | <0.05 | <1 |
| | Average | 4.23 | 24.4 | | 603 | 377 | 37 | 1.7 | 0.73 | 0.80 | 0.18 | 47 | | |
| | Std. Dev | 0.16 | 1.6 | | 53 | 33 | 1 | 0.5 | 0.01 | 0.85 | 0.17 | 9 | | |
| | Maximum | 4.34 | 25.5 | 6.90 | 640 | 400 | 38 | 2.0 | 0.74 | 1.40 | 0.30 | 53 | <0.05 | < 1 |
| | Minimum | 4.12 | 23.2 | 6.90 | 565 | 354 | 36 | 1.3 | 0.72 | 0.20 | 0.06 | 40 | <0.05 | < 1 |
| | No. | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| DC4 | 12/8/87 | 4.15 | 26.2 | 6.80 | 610 | 390 | 35 | 1.3 | 1.60 | 0.81 | 0.25 | 52 | 0.06 | 17000 |
| | 3/15/88 | 4.36 | 23.3 | 7.05 | 562 | 320 | 39 | 3.0 | 4.60 | <0.01 | 0.38 | 30 | <0.05 | 3900 |
| | Average | 4.26 | 24.8 | | 586 | 355 | 37 | 2.2 | 3.10 | | 0.32 | 41 | | |
| | Std. Dev | 0.15 | 2.1 | | 34 | 49 | 3 | 1.2 | 2.12 | | 0.09 | 16 | | |
| | Maximum | 4.36 | 26.2 | 7.05 | 610 | 390 | 39 | 3.0 | 4.60 | 0.81 | 0.38 | 52 | 0.06 | 17000 |
| | Minimum | 4.15 | 23.3 | 6.80 | 562 | 320 | 35 | 1.3 | 1.60 | <0.01 | 0.25 | 30 | <0.05 | 3900 |
| | No. | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| DC5 | 12/8/87 | 4.17 | 26.0 | 6.70 | 695 | 378 | 36 | 2.4 | 2.60 | 0.56 | 0.41 | 60 | 0.15 | 270 |
| | 3/15/88 | 4.38 | 23.5 | 6.90 | 555 | 334 | 37 | 3.0 | 0.82 | 0.02 | 1.10 | 38 | <0.05 | 20 |
| | Average | 4.28 | 24.8 | | 625 | 356 | 37 | 2.7 | 1.71 | 0.29 | 0.76 | 49 | | |
| | Std. Dev | 0.15 | 1.8 | | 99 | 31 | 1 | 0.4 | 1.26 | 0.38 | 0.49 | 16 | | |
| | Maximum | 4.38 | 26.0 | 6.90 | 695 | 378 | 37 | 3.0 | 2.60 | 0.56 | 1.10 | 60 | 0.15 | 270 |
| | Minimum | 4.17 | 23.5 | 6.70 | 555 | 334 | 36 | 2.4 | 0.82 | 0.02 | 0.41 | 38 | <0.05 | 20 |
| | No. | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |

Table D4 cont. Ground water quality measurements in Dade County.

| Well | Date | Elev. (ft.) | Temp. (oC) | pH (units) | Conduct. (umho/cm) | TDS (mg/L) | Cl (mg/L) | BOD5 (mg/L) | TKN (mg/L) | NO3 (mg/L) | TP (mg/L) | SO4 (mg/L) | MBAS (mg/L) | F.coli. (#/100mL) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DC6 | 12/8/87 | 4.22 | 25.2 | 6.40 | 640 | 396 | 36 | 1.2 | 0.70 | 0.23 | 0.19 | 60 | 0.05 | <1 |
| | 3/15/88 | 4.51 | 24.1 | 6.90 | 555 | 342 | 43 | <1.0 | 0.75 | 0.12 | 0.46 | 35 | <0.05 | <10 |
| | Average | 4.37 | 24.7 | | 598 | 369 | 40 | | 0.73 | 0.18 | 0.33 | 48 | | |
| | Std. Dev | 0.21 | 0.8 | | 60 | 38 | 5 | | 0.04 | 0.08 | 0.19 | 18 | | |
| | Maximum | 4.51 | 25.2 | 6.90 | 640 | 396 | 43 | 1.2 | 0.75 | 0.23 | 0.46 | 60 | 0.05 | <10 |
| | Minimum | 4.22 | 24.1 | 6.40 | 555 | 342 | 36 | <1.0 | 0.70 | 0.12 | 0.19 | 35 | <0.05 | < 1 |
| | No. | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| DC7 | 12/8/87 | 4.17 | 25.2 | 6.95 | 660 | 390 | 34 | <1.0 | 0.62 | 1.90 | 0.05 | 41 | <0.05 | 5 |
| | 3/15/88 | 4.37 | 23.1 | 6.85 | 575 | 352 | 37 | 3.5 | 5.60 | 1.60 | 1.20 | 33 | <0.05 | <10 |
| | Average | 4.27 | 24.2 | | 618 | 371 | 36 | | 3.11 | 1.75 | 0.63 | 37 | | |
| | Std. Dev | 0.14 | 1.5 | | 60 | 27 | 2 | | 3.52 | 0.21 | 0.81 | 6 | | |
| | Maximum | 4.37 | 25.2 | 6.95 | 660 | 390 | 37 | 3.5 | 5.60 | 1.90 | 1.20 | 41 | <0.05 | 5 |
| | Minimum | 4.17 | 23.1 | 6.85 | 575 | 352 | 34 | <1.0 | 0.62 | 1.60 | 0.05 | 33 | <0.05 | <10 |
| | No. | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |

# APPENDIX E

# GROUND WATER VOC DETECTION LIMITS

Table E1. Ground water VOC measurement method detection limits.

| Compound | Units | Method Detection Limit |
|---|---|---|
| Benzene | ug/L | 1.0 |
| Bromodichloromethane | ug/L | 2.2 |
| Bromoform | ug/L | 4.7 |
| Bromomethane | ug/L | 5.8 |
| Carbon Tetrachloride | ug/L | 2.8 |
| Chlorobenzene | ug/L | 6.0 |
| Chloroethane | ug/L | 8.2 |
| 2-Chloroethylvinylether | ug/L | 15.0 |
| Chloroform | ug/L | 1.6 |
| Chloromethane | ug/L | 4.3 |
| Dibromochloromethane | ug/L | 3.1 |
| 1,1-Dichloroethane | ug/L | 4.7 |
| 1,2-Dichloroethane | ug/L | 2.8 |
| 1,1-Dichloroethylene | ug/L | 2.8 |
| Trans-1,2-Dichloroethylene | ug/L | 1.6 |
| 1,2-Dichloropropane | ug/L | 6.0 |
| Cis-1,3-Dichloropropene | ug/L | 5.0 |
| Trans-1,3-Dichloropropene | ug/L | 6.4 |
| Ethylbenzene | ug/L | 7.2 |
| Methylene Chloride | ug/L | 50.0 |
| 1,1,2,2-Tetrachloroethane | ug/L | 4.1 |
| Tetrachloroethylene | ug/L | 3.0 |
| Toluene | ug/L | 6.0 |
| 1,1,1-Trichloroethane | ug/L | 3.8 |
| 1,1,2-Trichloroethane | ug/L | 5.0 |
| Trichloroethylene | ug/L | 1.0 |
| Trichlorofluoromethane | ug/L | 3.2 |
| Vinyl Chloride | ug/L | 1.0 |

# APPENDIX F

# GROUND WATER QUALITY CONTROL SAMPLE RESULTS

Table F1. Ground water quality control duplicate sample results.

| Well | Date | Elev. (ft.) | Temp. (oC) | pH (units) | Cond. (umho/cm) | TDS (mg/L) | Cl (mg/L) | BOD5 (mg/L) | TKN (mg/L) | NO3 (mg/L) | TP (mg/L) | SO4 (mg/L) | MBAS (mg/L) | F.coli. (#/100mL) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PC2 | 9/29/87 | 122.82 | 26.5 | 5.35 | 69 | 120 | | <1.0 | 1.40 | | 4.20 | | | 10 |
| | | | 26.5 | 5.35 | 69 | 118 | | <1.0 | 1.60 | | 5.00 | | | 40 |
| PC5 | 10/15/87 | 122.81 | 24.8 | 5.35 | 82 | 38 | 4 | <1.0 | 0.30 | 0.32 | 0.34 | 12 | <0.05 | <1 |
| | | | 24.8 | 5.35 | 82 | 38 | 4 | <1.0 | 0.48 | 0.36 | 0.50 | 13 | <0.05 | <1 |
| PC4 | 12/15/87 | 123.11 | 24.8 | 5.10 | 165 | 114 | 12 | <1.0 | 0.86 | 2.90 | 3.20 | 27 | <0.05 | <1 |
| | | | 24.8 | 5.10 | 165 | 122 | 12 | <1.0 | 0.78 | 2.50 | 2.60 | 27 | <0.05 | <1 |
| PC5 | 3/8/88 | 122.75 | 21.8 | 5.52 | 47 | 30 | 2 | <1.0 | 0.58 | 0.71 | 3.80 | 9 | <0.05 | <1 |
| | | | 21.8 | 5.52 | 47 | 58 | 2 | <1.0 | 0.48 | 0.68 | 1.10 | 9 | <0.05 | <1 |
| SJC3 | 10/5/87 | 7.19 | 24.0 | | 373 | 248 | 32 | <1.0 | 0.56 | <0.01 | 0.04 | 123 | <0.05 | <1 |
| | | | 24.0 | | 373 | 240 | 33 | <1.0 | 0.31 | 0.21 | 0.03 | 115 | <0.05 | <1 |
| SJC7 | 12/3/87 | 7.31 | 23.4 | 5.85 | 395 | 226 | 13 | <1.0 | 1.00 | 5.60 | 1.40 | 92 | 0.11 | <2 |
| | | | 23.2 | 5.98 | 400 | 260 | 16 | 1.6 | 1.20 | 7.00 | 1.10 | 95 | <0.05 | <2 |
| SJC3 | 3/7/88 | 9.58 | 19.8 | 5.30 | 265 | 216 | 17 | <1.0 | 1.50 | 3.90 | 0.15 | 95 | <0.05 | <10 |
| | | | 19.8 | 5.30 | 265 | 232 | 17 | <1.0 | 1.30 | 4.60 | 0.69 | 95 | <0.5 | <10 |
| BC3 | 10/26/87 | 47.59 | 25.0 | 5.65 | 640 | 630 | 140 | <1.0 | 2.00 | 0.08 | 0.89 | 36 | 0.13 | <10 |
| | | | 25.0 | 5.65 | 640 | 592 | 140 | <1.0 | 2.60 | 0.06 | 0.96 | 33 | 0.11 | <10 |
| BC1 | 11/17/87 | 49.21 | 26.3 | 6.29 | 675 | | | | | | | | | |
| | | | 26.3 | 6.29 | 675 | | | | | | | | | |
| BC6 | 12/8/87 | 48.39 | | | | 534 | 51 | 3.3 | 2.80 | 0.60 | 0.13 | 6 | 0.08 | <10 |
| | | | | | | 544 | 51 | <1 | 2.40 | 0.60 | 0.15 | 7 | 0.08 | <10 |
| BC3 | 3/14/88 | 49.58 | 18.9 | 5.30 | 375 | 288 | 71 | 4.2 | 7.40 | 4.60 | 0.50 | 45 | <0.05 | 150 |
| | | | 18.9 | 7.00 | 375 | 350 | 44 | 4.1 | 5.40 | 0.20 | 1.40 | 13 | 0.08 | 110 |
| DC5 | 12/8/87 | 4.17 | 26.0 | 6.70 | 695 | 378 | 36 | 2.4 | 2.60 | 0.56 | 0.41 | 60 | 0.15 | 270 |
| | | | 26.0 | 6.70 | 695 | 414 | 36 | 1.5 | 2.00 | 0.71 | 0.36 | 55 | 0.13 | 600 |
| DC2 | 3/15/88 | 4.36 | 23.8 | 7.16 | 565 | 330 | 37 | 1.1 | 1.30 | 0.33 | 0.73 | 37 | <0.05 | 170 |
| | | | 23.8 | 7.16 | 565 | 328 | 36 | 1.8 | 1.20 | 0.29 | 0.58 | 37 | <0.05 | <10 |

# APPENDIX G

# SOIL BORINGS AND TESTPIT DESCRIPTIONS

Table G1. Soil profile description for testpit 3 in the subdivision in Polk County.

SUMMARY SOIL PROFILE DESCRIPTION, Subdivision 1.

Project: FL OSDS Site: SUBDIVISION 1 Sample ID: TEST PIT 3 Date: 09-21-87

| DEPTH (ft.) | USDA SOIL TEXTURE (Unified) | STRUCTURE/CONSISTENCY | MUNSELL COLORS Primary | MUNSELL COLORS Secondary | EST. Ksat (cm/day) | REMARKS |
|---|---|---|---|---|---|---|
| 0.0 - 1.2 | Fine Sand (SP-SM) | Weak, fine, granular; very friable | 10yr 2/0 | | 50 - 500 | |
| 1.2 - 2.0 | Fine Sand (SP-SM) | Single grain; loose | 10yr 4/2 | | 25 - 250 | |
| 2.0 - 3.5 | Fine Sand (SP-SM) | Single grain; loose | 10yr 6/2 | | 25 - 250 | |
| 3.5 - 10.0 | Fine Sand (SP-SM) | Single grain; loose | 10yr 7/1 | | 25 - 250 | |

NOTES: Described by David L. Hargett, Ayres Associates, and Richard Ford and Susan Ploetz, USDA-SCS; TP 3 in NE corner of Subdivision 1; ground water observed at 120".

(SPD1TP3.wk1)

Table G2. Soil profile description for testpit 2 in the subdivision in Polk County.

SUMMARY SOIL PROFILE DESCRIPTION, Subdivision 1.

Project: FL OSDS    Site: SUBDIVISION 1    Sample ID: TEST PIT 2    Date: 09-21-87

| DEPTH (ft.) | USDA SOIL TEXTURE (Unified) | STRUCTURE/CONSISTENCY | MUNSELL COLORS | | EST. Ksat (cm/day) | REMARKS |
|---|---|---|---|---|---|---|
| | | | Primary | Secondary | | |
| 0.0 - 0.5 | Fine Sand (SP-SM) | Weak, fine, granular; very friable | 10yr 3/2 | | 50 - 500 | |
| 0.5 - 2.5 | Fine Sand (SP-SM) | Single grain; loose | 10yr 6/4 | | 25 - 250 | |
| 2.5 - 5.3 | Fine Sand (SP-SM) | Single grain; loose | 10yr 6/8 | | 25 - 250 | |
| 5.3 - 7.3 | Fine Sand (SP-SM) | Single grain; loose | 10yr 6/8 | 7.5yr 5/8 | 25 - 250 | Many, medium, prominent high chroma. mottles; few, thin, discontinuous lamallae |
| 7.3 - 8.5 | Sand (SW-SP) | Single grain; loose | 10yr 7/2 | 7.5yr 6/8 | 100 - 1000 | Many, coarse, prominent high chroma mottles; few, thin, scattered lamallae |
| 8.5 - 14.7 | Sandy Clay Loam (SC) | Massive; very firm | 10yr 7/1 | 10yr 7/2 | 0.1 - 1 | Common, medium, high chroma mottles; restriction |
| 14.7 - 15.8 | Loam (SM-ML) | Massive; very firm | 5yr 5/8 | | 0.1 - 1 | iron concretions; cemented; restriction |
| 15.8 - 18.0 | Loam (SM-ML) | Massive; very firm | 5yr 5/8 | | 0.1 - 1 | <15% gravel; variegation; cemented; restriction; phosphatic pebbles |

NOTES: Described by David L. Hargett, Ayres Associates, and Richard Ford and Susan Ploetz, USDA-SCS; TP 2 in SW corner of Subdivision 1; pit bottom at 100"; augered to 216" (18'). No ground water observed.

(SPD1PT2.wk1)

Table G3. Soil profile description for testpit 1 in the subdivision in Polk County.

SUMMARY SOIL PROFILE DESCRIPTION, Subdivision 1.

Project: FL OSDS Site: SUBDIVISION 1 Sample ID: TEST PIT 1 Date: 09-21-87

| DEPTH (ft.) | USDA SOIL TEXTURE (Unified) | STRUCTURE/CONSISTENCY | MUNSELL COLORS Primary | MUNSELL COLORS Secondary | EST. Ksat (cm/day) | REMARKS |
|---|---|---|---|---|---|---|
| 0.0 - 1.8 | Sand (SW-SP) | | 10yr 5/4 | | 5 - 1000 | Fill - Sand to loamy sand |
| 1.8 - 2.7 | Fine Sand (SP-SM) | Weak, fine, granular; very friable | 10yr 3/2 | | 50 - 500 | |
| 2.7 - 3.2 | Fine Sand (SP-SM) | Single grain; loose | 10yr 7/2 | | 25 - 250 | Eluvial zone |
| 3.2 - 4.0 | Fine Sand (SP-SM) | Single grain; loose | 7.5yr 4/3 | | 25 - 250 | Spodic |
| 4.0 - 6.0 | Fine Sand (SP-SM) | Single grain; loose | 10yr 5/6 | | 25 - 250 | |
| 6.0 - 10.0 | Sand (SW-SP) | Single grain; loose | 10yr 6/6 | | 100 - 1000 | No mottles |

NOTES: Described by David L. Hargett, Ayres Associates, and Richard Ford and Susan Ploetz, USDA-SCS; TP 1 in NW corner of Subdivision 1, standing ground water at 10.0'.

(SPD1TP1.wk1)

Table G4. Soil profile description for test boring 1 in the subdivision in St. Johns County.

SUMMARY SOIL PROFILE DESCRIPTION, Subdivision 2.

Project: FL OSDS . Site: SUBDIVISION 2 Sample ID: TEST BORING 1 Date: 09-23-87

| DEPTH (ft.) | USDA SOIL TEXTURE (Unified) | STRUCTURE/CONSISTENCY | MUNSELL COLORS | | EST. Ksat (cm/day) | REMARKS |
|---|---|---|---|---|---|---|
| | | | Primary | Secondary | | |
| 0.0 - 0.3 | Fine Sand (SP-SM) | Weak, fine, granular; very friable | 10yr 4/2 | | 50 - 500 | |
| 0.3 - 1.7 | Fine Sand (SP-SM) | Single grain; loose | 10yr 6/4 | | 25 - 250 | |
| 1.7 - 2.9 | Fine Sand (SP-SM) | Single grain; loose | 7.5yr 7/4 | | 25 - 250 | |
| 2.9 - 3.3 | Fine Sand (SP-SM) | Single grain; loose | 10yr 6/6 | 5yr 6/8 | 25 - 250 | Common, fine, distinct mottles; high chroma mottles |
| 3.3 - 4.2 | Fine Sand (SP-SM) | Single grain; loose | 10yr 7/3 | 10yr 7/1 | 25 - 250 | Common, medium, faint mottles; variegation; low chroma mottles |
| 4.2 - 5.7 | Fine Sand (SP-SM) | Single grain; loose | 10yr 7/3 | 10yr 6/6 | 25 - 250 | Common, coarse, distinct mottles |
| 5.7 - 6.7 | Fine Sand (SP-SM) | Single grain; loose | 10yr 7/2 | 10yr 7/6 | 25 - 250 | Few, fine, faint mottles |

NOTES: Described by David L. Hargett, Ayres Associates, and Jeff Leppo and Robert Baldwin, USDA-SCS; Typical quartzipsamment; Tavares - MWD (borderline Adamsville), Aquic quartzipsamments; FMD 7.5yr5/8 mottles; ground water at 50" BC; seasonal at 35-40"; hole bottom at 80".

(SPD2TB1.wk1)

Table G5. Soil profile description for test boring 4 in the subdivision in St. Johns County.

SUMMARY SOIL PROFILE DESCRIPTION, Subdivision 2.

Project: FL OSDS Site: SUBDIVISION 2 Sample ID: TEST BORING 4 Date: 09-23-87

| DEPTH (ft.) | USDA SOIL TEXTURE (Unified) | STRUCTURE/CONSISTENCY | MUNSELL COLORS Primary | Secondary | EST. Ksat (cm/day) | REMARKS |
|---|---|---|---|---|---|---|
| 0.0 - 0.4 | Fine Sand (SP-SM) | Single grain; loose | 10yr 4/2 | | 25 - 250 | |
| 0.4 - 2.5 | Fine Sand (SP-SM) | Single grain; loose | 10yr 6/4 | | 25 - 250 | |
| 2.5 - 3.3 | Fine Sand (SP-SM) | Single grain; loose | 10yr 6/4 | 10yr 7/8 | 25 - 250 | Few, coarse, distinct mottles |
| 3.3 - 5.8 | Fine Sand (SP-SM) | Single grain; loose | 10yr 7/4 | 7.5yr 6/8 | 25 - 250 | Many, coarse, distinct mottles |
| 5.8 - 6.7 | Fine Sand (SP-SM) | Single grain; loose | 10yr 7/2 | 5yr 5/8 | 25 - 250 | Many, coarse, distinct mottles |

NOTES: Described by David L. Hargett, Ayres Associates, and Jeff Leppo and Robert Baldwin, USDA-SCS; Tavares; ground water at 55", seasonal at 35-40"; 10yr 5/6 MFD; hole bottom at 80".

(SPD2TB4.wk1)

Table G6. Soil profile description for test boring 2 in the subdivision in St. Johns County.

SUMMARY SOIL PROFILE DESCRIPTION, Subdivision 2.

Project: FL OSDS Site: SUBDIVISION 2 Sample ID: TEST BORING 2 Date: 09-23-87

| DEPTH (ft.) | USDA SOIL TEXTURE (Unified) | STRUCTURE/CONSISTENCY | MUNSELL COLORS Primary | Secondary | EST. Ksat (cm/day) | REMARKS |
|---|---|---|---|---|---|---|
| 0.0 - 0.8 | Fine Sand (SP-SM) | Single grain; loose | 10yr 5/0 | | 25 - 250 | |
| 0.8 - 1.7 | Fine Sand (SP-SM) | Single grain; loose | 10yr 6/2 | | 25 - 250 | |
| 1.7 - 2.9 | Fine Sand (SP-SM) | Single grain; loose | 10yr 7/2 | 10yr 5/8 | 25 - 250 | Few, fine, distinct mottles |
| 2.9 - 3.3 | Fine Sand (SP-SM) | Single grain; loose | 10yr 7/1 | 10yr 7/6 | 25 - 250 | Few, fine, faint mottles |
| 3.3 - 6.7 | Fine Sand (SP-SM) | Single grain; loose | 10yr 7/1 | | 25 - 250 | |

NOTES: Described by David L. Hargett, Ayres Associates, and Jeff Leppo and Robert Baldwin, USDA-SCS; Adamsville; ground water at 40"; seasonally at 30-35"; deep spodic below 80"; hole bottom at 80".

Table G7. Soil profile description for test boring 3 in the subdivision in St. Johns County.

SUMMARY SOIL PROFILE DESCRIPTION, Subdivision 2.

Project: FL OSDS Site: SUBDIVISION 2 Sample. ID: TEST BORING 3 Date: 09-23-87

| DEPTH (ft.) | USDA SOIL TEXTURE (Unified) | STRUCTURE/CONSISTENCY | MUNSELL COLORS Primary | Secondary | EST. Ksat (cm/day) | REMARKS |
|---|---|---|---|---|---|---|
| 0.0 - 0.3 | Fine Sand (SP-SM) | Weak, fine, granular | 10yr 4/2 | | 50 - 500 | |
| 0.3 - 1.7 | Fine Sand (SP-SM) | Single grain; loose | 10yr 5/3 | | 25 - 250 | |
| 1.7 - 3.2 | Fine Sand (SP-SM) | Single grain; loose | 10yr 7/3 | 10yr 5.3 | 25 - 250 | Few, fine, faint mottles |
| 3.2 - 5.0 | Fine Sand (SP-SM) | Single grain; loose | 10yr 6/3 | 10yr 5/4 | 25 - 250 | Few, fine, faint mottles |
| 5.0 - 6.7 | Fine Sand (SP-SM) | Single grain; loose | 10yr 7/2 | | 25 - 250 | |

NOTES: Described by David L. Hargett, Ayres Associates, and Jeff Leppo and Robert Baldwin, USDA-SCS; Adamsville; ground water at 35"; no mottles above ground water; some "sand stripping" above; seasonal ground water at 20-24"; hole bottom at 80".

(SPD2TB3.wk1)

# APPENDIX H

# SEPTIC TANK EFFLUENT WATER QUALITY DATA

Table H1. Septic tank effluent composition at home 11 in the subdivision in Polk County.

| SAMPLE DATE | FIELD MEASUREMENTS | | | ORGANIC | | SOLIDS | | NUTRIENTS | | | MISC. MINERAL/CHEMICAL | | | SURFACTANTS | | MICROBIOLOGICAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TEMP. (°C) | pH | Cond. (uv/cm) | BOD5 (mg/L) | TOC (mg/L) | TDS (mg/L) | TSS (mg/L) | TKN (mg/L) | NO2-NO3 (mg/L) | TP (mg/L) | $Cl^-$ (mg/L) | FOG (mg/L) | | MBAS (mg/L) | | Fec. Coli. (#/100 ml.) |
| 8/20/87 | 33.8 | 7.1 | 760 | 129 | | 472 | 44 | 42 | 0.1 | 12 | 42 | | | 1.1 | | 100,000.0 |
| 9/22/87 | 30.0 | 6.8 | 720 | 176 | | 446 | 106 | 22 | 0.14 | 12 | 51 | 32.2 | | 0.4 | | 280,000.0 |
| 10/14/87 | 27.0 | 6.8 | 870 | 103 | | 502 | 68 | 29 | 0.06 | 11 | 40 | 17.6 | | 1.8 | | 700,000.0 |
| 10/27/87 | 27.5 | 7.2 | 790 | 130 | | 454 | 76 | 68 | 0.01 | 13 | 29 | | | 1.9 | | 470,000.0 |
| 1/06/88 | 23.5 | 7.0 | 770 | | | | | | | | | | | | | |
| 1/27/88 | 21.0 | 6.8 | 880 | | | | | | | | | | | | | |
| 4/11/88 | 26.0 | 7.0 | 840 | | | | | | | | | | | | | |
| AVE. | 26.97 | | 804.29 | 134.50 | | 468.50 | 73.50 | 40.25 | 0.08 | 12.00 | 40.50 | 24.90 | | 1.30 | | |
| STD. DEV. | 4.18 | | 60.24 | 30.36 | | 24.84 | 25.58 | 20.27 | 0.06 | 0.82 | 9.04 | 10.32 | | 0.70 | | |
| n | 7.00 | 7.00 | 7.00 | 4.00 | | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 2.00 | | 4.00 | | 4.0 |
| MIN | 21.00 | 6.80 | 720.00 | 103.00 | | 446.00 | 44.00 | 22.00 | 0.01 | 11.00 | 29.00 | 17.60 | | 0.40 | | 100,000.0 |
| MAX | 33.80 | 7.20 | 880.00 | 176.00 | | 502.00 | 106.00 | 68.00 | 0.14 | 13.00 | 51.00 | 32.20 | | 1.90 | | 700,000.0 |

WQDA11.wk1)

Table H2. Septic tank effluent composition at home 12 in the subdivision in Polk County.

| SAMPLE DATE | FIELD MEASUREMENTS | | | ORGANIC | | SOLIDS | | NUTRIENTS | | | MISC. MINERAL/CHEMICAL | | | SURFACTANTS | | MICROBIOLOGICAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TEMP. (°C) | pH | Cond. (uv/cm) | BOD5 (mg/L) | TOC (mg/L) | TDS (mg/L) | TSS (mg/L) | TKN (mg/L) | NO2-NO3 (mg/L) | TP (mg/L) | $Cl^-$ (mg/L) | FOG (mg/L) | | MBAS (mg/L) | | Fec. Coli. (#/100 ml.) |
| 8/20/87 | 30.9 | 6.8 | 5300 | 125 | | 3160 | 60 | 43 | 0.1 | 13 | 1850 | | | 3.2 | | 480,000.0 |
| 9/22/87 | 31.0 | 7.0 | 4300 | 142 | | 2940 | 84 | 14 | 0.06 | 14 | 1600 | 40.0 | | 3.6 | | 100,000.0 |
| 10/27/87 | 28.0 | 7.3 | 5200 | 151 | | 2900 | 96 | 49 | 0.01 | 20 | 1600 | 16.5 | | 7 | | 630,000.0 |
| 1/6/88 | 22.5 | 7.4 | 4600 | 216 | 79 | 2220 | 220 | 40 | 0.09 | 12 | 1260 | | | 13 | | 170,000.0 |
| 1/27/88 | 19.5 | 7.0 | 8200 | 270 | 87 | 110 | 392 | 55 | 0.44 | 16 | 2360 | 76.0 | | 7.4 | | 280,000.0 |
| 4/11/88 | 26.5 | 6.8 | 4300 | | | | | | | | | | | | | |
| AVE. | 26.40 | | 5316.7 | 180.80 | 83.00 | 2266.0 | 170.40 | 40.20 | 0.14 | 15.00 | 1734.0 | 44.17 | | 6.84 | | |
| STD. DEV. | 4.62 | | 1477.0 | 60.63 | 5.66 | 1255.6 | 138.52 | 15.74 | 0.17 | 3.16 | 408.0 | 29.97 | | 3.94 | | |
| n | 6.00 | 6.00 | 6.0 | 5.00 | 2.00 | 5.0 | 5.00 | 5.00 | 5.00 | 5.00 | 5.0 | 3.00 | | 5.00 | | 5.00 |
| MIN | 19.50 | 6.80 | 4300.0 | 125.00 | 79.00 | 110.0 | 60.00 | 14.00 | 0.01 | 12.00 | 1260.0 | 16.50 | | 3.20 | | 100,000.0 |
| MAX | 31.00 | 7.40 | 8200.0 | 270.00 | 87.00 | 3160.0 | 392.00 | 55.00 | 0.44 | 20.00 | 2360.0 | 76.00 | | 13.00 | | 630,000.0 |

WQDA12.wk1)

Table H3. Septic tank effluent composition at home 13 in the subdivision in Polk County.

| SAMPLE DATE | FIELD MEASUREMENTS | | | ORGANIC | | SOLIDS | | NUTRIENTS | | | MISC. MINERAL/CHEMICAL | | | SURFACTANTS | | MICROBIOLOGICAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TEMP. (°C) | pH | Cond. (uv/cm) | BOD5 (mg/L) | TOC (mg/L) | TDS (mg/L) | TSS (mg/L) | TKN (mg/L) | NO2-NO3 (mg/L) | TP (mg/L) | $Cl^-$ (mg/L) | FOG (mg/L) | | MBAS (mg/L) | | Fec. Coli. (#/100 ml.) |
| 8/20/87 | 30.2 | 7.2 | 850 | 109 | | 628 | 176 | 37 | 0.1 | 5 | 60 | | | 1 | | 3,300,000.0 |
| 9/22/87 | 30.0 | 7.4 | 660 | 197 | | 560 | 576 | 9.5 | 0.14 | 7 | 37 | 8.4 | | 1.4 | | 4,300,000.0 |
| 10/14/87 | 26.5 | 7.0 | 860 | 151 | | 798 | 704 | 20 | 0.02 | 8 | 48 | 88.2 | | 3.3 | | 300,000.0 |
| 10/27/87 | 28.5 | 7.4 | 1000 | 194 | | 686 | 856 | 56 | 0.01 | 14 | 58 | | | 3 | | 3,900,000.0 |
| 1/ 6/88 | 23.5 | 7.5 | 820 | | | | | | | | | | | | | |
| 1/27/88 | 19.0 | 7.0 | 830 | 173 | 56 | 462 | 660 | 63 | 0.4 | 15 | 35 | 51 | | 2.4 | | 1,700,000.0 |
| AVE. | 26.28 | | 836.67 | 164.80 | 56.00 | 626.80 | 594.40 | 37.10 | 0.13 | 9.80 | 47.60 | 49.20 | | 2.22 | | |
| STD. DEV. | 4.36 | | 108.57 | 36.27 | * | 126.92 | 255.02 | 22.82 | 0.16 | 4.44 | 11.55 | 39.93 | | 1.00 | | |
| n | 6.00 | 6.00 | 6.00 | 5.00 | 1.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 3.00 | | 5.00 | | 5.00 |
| MIN | 19.00 | 7.00 | 660.00 | 109.00 | 56.00 | 462.00 | 176.00 | 9.50 | 0.01 | 5.00 | 35.00 | 8.40 | | 1.00 | | 300,000.0 |
| MAX | 30.20 | 7.50 | 1000.0 | 197.00 | 56.00 | 798.00 | 856.00 | 63.00 | 0.40 | 15.00 | 60.00 | 88.20 | | 3.30 | | 4,300,000.0 |

WQDA13.wk1)

Table H4. Septic tank effluent composition at home 14 in the subdivision in Polk County.

| SAMPLE DATE | FIELD MEASUREMENTS | | | ORGANIC | | SOLIDS | | NUTRIENTS | | | MISC. MINERAL/CHEMICAL | | | SURFACTANTS | | MICROBIOLOGICAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TEMP. (°C) | pH | Cond. (uv/cm) | BOD5 (mg/L) | TOC (mg/L) | TDS (mg/L) | TSS (mg/L) | TKN (mg/L) | NO2-NO3 (mg/L) | TP (mg/L) | $Cl^-$ (mg/L) | FOG (mg/L) | | MBAS (mg/L) | | Fec. Coli. (#/100 ml.) |
| 8/20/87 | 33.3 | 7.3 | 1100 | 136 | | 764 | 60 | 57 | 0.1 | 6.5 | 58 | | | 1.8 | | 18,000.0 |
| 9/22/87 | 31.0 | 7.25 | 910 | 131 | | 568 | 60 | 17 | 0.04 | 6 | 47 | 5.6 | | 1.6 | | 13,000.0 |
| 10/14/87 | 28.0 | 7.3 | 1100 | 102 | | 664 | 164 | 28 | 0.02 | 7.5 | 62 | 9.7 | | 2.8 | | 50,000.0 |
| 10/27/87 | 28.0 | 7.2 | 1000 | 145 | | 698 | 104 | 60 | 0.01 | 6.5 | 9 | | | 3.4 | | 220,000.0 |
| 1/6/88 | 22.0 | 7.2 | 1200 | | | | | | | | | | | | | |
| 1/27/88 | 20.0 | 6.8 | 950 | | | | | | | | | | | | | |
| 4/11/88 | 25.5 | 6.9 | 980 | | | | | | | | | | | | | |
| AVE. | 26.83 | | 1034.3 | 128.50 | | 673.50 | 97.00 | 40.50 | 0.04 | 6.63 | 44.00 | 7.65 | | 2.40 | | |
| STD. DEV. | 4.72 | | 102.3 | 18.59 | | 81.67 | 49.25 | 21.30 | 0.04 | 0.63 | 24.18 | 2.90 | | 0.85 | | |
| n | 7.00 | 7.00 | 7.0 | 4.00 | | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 2.00 | | 4.00 | | 4.00 |
| MIN | 20.00 | 6.80 | 910.0 | 102.00 | | 568.00 | 60.00 | 17.00 | 0.01 | 6.00 | 9.00 | 5.60 | | 1.60 | | 13,000.0 |
| MAX | 33.30 | 7.30 | 1200.0 | 145.00 | | 764.00 | 164.00 | 60.00 | 0.10 | 7.50 | 62.00 | 9.70 | | 3.40 | | 220,000.0 |

WQDA14.wk1)

Table H5. Septic tank effluent composition at home 21 in the subdivision in St. Johns County.

| SAMPLE DATE | FIELD MEASUREMENT | | | ORGANIC | | SOLIDS | | NUTRIENTS | | | MISC. MINERAL/CHEMICAL | | | SURFACTANTS | | MICROBIOLOGICAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TEMP. (°C) | pH | Cond. (uv/cm) | BOD5 (mg/L) | TOC (mg/L) | TDS (mg/L) | TSS (mg/L) | TKN (mg/L) | NO2-NO3 (mg/L) | TP (mg/L) | Cl⁻ (mg/L) | FOG (mg/L) | | MBAS (mg/L) | | Fec. Coli. (#/100 ml.) |
| 10/15/87 | 26.0 | 6.6 | 520 | 136 | | 380 | 132 | 16 | 0.02 | 6.5 | 26 | 210.0 | | 2.1 | | 200,000.0 |
| 10/29/87 | 25.0 | 7.1 | 550 | 188 | | 300 | 140 | 40 | 0.01 | 7.5 | 30 | 36.6 | | 1.2 | | 320,000.0 |
| 11/10/87 | 25.0 | 7.1 | 540 | 162 | | 314 | 100 | 40 | 0.05 | 6.5 | 26 | 87.0 | | 2.3 | | 240,000.0 |
| 11/16/87 | 25.0 | 6.9 | 550 | 127 | | 446 | 96 | 35 | 0.05 | 7 | 29 | | | 0.65 | | 270,000.0 |
| AVE. | 25.25 | | 540.00 | 153.25 | | 360.00 | 117.00 | 32.75 | 0.03 | 6.88 | 27.75 | 111.20 | | 1.56 | | |
| STD. DEV. | 0.50 | | 14.14 | 27.51 | | 67.11 | 22.24 | 11.41 | 0.02 | 0.48 | 2.06 | 89.20 | | 0.77 | | |
| n | 4.00 | 4.00 | 4.00 | 4.00 | | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 3.00 | | 4.00 | | 4.0 |
| MIN | 25.00 | 6.60 | 520.00 | 127.00 | | 300.00 | 96.00 | 16.00 | 0.01 | 6.50 | 26.00 | 36.60 | | 0.65 | | 200,000.0 |
| MAX | 26.00 | 7.10 | 550.00 | 188.00 | | 446.00 | 140.00 | 40.00 | 0.05 | 7.50 | 30.00 | 210.00 | | 2.30 | | 320,000.0 |

WQDA21.wk1)

Table H6. Septic tank effluent composition at home 22 in the subdivision in St. Johns County.

| SAMPLE DATE | FIELD MEASUREMENTS | | | ORGANIC | | SOLIDS | | NUTRIENTS | | | MISC. MINERAL/CHEMICAL | | | SURFACTANTS | | MICROBIOLOGICAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TEMP. (°C) | pH | Cond. (uv/cm) | BOD5 (mg/L) | TOC (mg/L) | TDS (mg/L) | TSS (mg/L) | TKN (mg/L) | NO2-NO3 (mg/L) | TP (mg/L) | Cl⁻ (mg/L) | FOG (mg/L) | | MBAS (mg/L) | | Fec. Coli. (#/100 ml.) |
| 10/15/87 | 28.0 | 7.0 | 650 | 108 | | 440 | 74 | 16 | 0.02 | 14 | 23 | 14.8 | | 8.2 | | 4,200,000.0 |
| 10/29/87 | 25.5 | 7.1 | 720 | 156 | | 416 | 122 | 47 | 0.01 | 15 | 23 | 24.2 | | 3.0 | | 3,900,000.0 |
| 11/10/87 | 27.0 | 7.0 | 670 | 163 | | 330 | 76 | 38 | 0.05 | 12 | 27 | 36.5 | | 4.3 | | 15,000,000.0 |
| 11/16/87 | 26.5 | 7.1 | 640 | 117 | | 390 | 76 | 28 | 0.05 | 15 | 20 | | | 4.4 | | 5,200,000.0 |
| 1/15/88 | 20.5 | 7.2 | 880 | 149 | 56 | 498 | 116 | 53 | 0.17 | 17 | 29 | 24.0 | | | | 3,700,000.0 |
| AVE. | 25.50 | | 712.00 | 138.60 | 56.00 | 414.80 | 92.80 | 36.40 | 0.06 | 14.60 | 24.40 | 24.88 | | 4.98 | | |
| STD. DEV. | 2.94 | | 98.84 | 24.54 | * | 61.98 | 24.02 | 14.81 | 0.06 | 1.82 | 3.58 | 8.90 | | 2.24 | | |
| n | 5.00 | 5.00 | 5.00 | 5.00 | 1.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 4.00 | | 4.00 | | 5.0 |
| MIN | 20.50 | 7.00 | 640.00 | 108.00 | 56.00 | 330.00 | 74.00 | 16.00 | 0.01 | 12.00 | 20.00 | 14.80 | | 3.00 | | 3,700,000.0 |
| MAX | 28.00 | 7.20 | 880.00 | 163.00 | 56.00 | 498.00 | 122.00 | 53.00 | 0.17 | 17.00 | 29.00 | 36.50 | | 8.20 | | 15,000,000.0 |

(WQDA22.wk1)

Table H7. Septic tank effluent composition at home 23 in the subdivision in St. Johns County.

| SAMPLE DATE | FIELD MEASUREMENTS | | | ORGANIC | | SOLIDS | | NUTRIENTS | | | MISC. MINERAL/CHEMICAL | | | SURFACTANTS | | MICROBIOLOGICAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TEMP. (°C) | pH | Cond. (uv/cm) | BOD5 (mg/L) | TOC (mg/L) | TDS (mg/L) | TSS (mg/L) | TKN (mg/L) | NO2-NO3 (mg/L) | TP (mg/L) | Cl⁻ (mg/L) | FOG (mg/L) | | MBAS (mg/L) | | Fec. Coli. (#/100 ml.) | |
| 10/15/87 | 26.0 | 7.1 | 950 | 83 | | 558 | 40 | 16 | 0.10 | 6.5 | 9 | 5.0 | | 2.1 | | 1,200,000.0 | |
| 10/29/87 | 23.0 | 7.2 | 1000 | 131 | | 646 | 38 | 44 | 0.01 | 11.0 | 8 | 4.4 | | 1.8 | | 340,000.0 | |
| 11/10/87 | 27.5 | 7.3 | 1000 | 125 | | 680 | 80 | 33 | 0.05 | 11.0 | 14 | 18.4 | | 2.8 | | 280,000.0 | |
| 11/16/87 | 25.0 | 7.4 | 1050 | 106 | | 674 | 100 | 40 | 0.10 | 14.0 | 10 | | | 1.8 | | 510,000.0 | |
| AVE. | 25.38 | | 1000.0 | 111.25 | | 639.50 | 64.50 | 33.25 | 0.07 | 10.63 | 10.25 | 9.27 | | 2.13 | | | |
| STD. DEV. | 1.89 | | 40.82 | 21.64 | | 56.32 | 30.57 | 12.37 | 0.04 | 3.09 | 2.63 | 7.92 | | 0.47 | | | |
| n | 4.00 | 4.00 | 4.00 | 4.00 | | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 3.00 | | 4.00 | | 4.0 | |
| MIN | 23.00 | 7.10 | 950.00 | 83.00 | | 558.00 | 38.00 | 16.00 | 0.01 | 6.50 | 8.00 | 4.40 | | 1.80 | | 280,000.0 | |
| MAX | 27.50 | 7.40 | 1050.0 | 131.00 | | 680.00 | 100.00 | 44.00 | 0.10 | 14.00 | 14.00 | 18.40 | | 2.80 | | 1,200,000.0 | |

WQDA23.wk1)

Table H8. Septic tank effluent composition at home 24 in the subdivision in St. Johns County.

| SAMPLE DATE | FIELD MEASUREMENTS | | | ORGANIC | | SOLIDS | | NUTRIENTS | | | MISC. MINERAL/CHEMICAL | | | SURFACTANTS | | MICROBIOLOGICAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TEMP. (°C) | pH | Cond. (uv/cm) | BOD5 (mg/L) | TOC (mg/L) | TDS (mg/L) | TSS (mg/L) | TKN (mg/L) | NO2-NO3 (mg/L) | TP (mg/L) | Cl⁻ (mg/L) | FOG (mg/L) | | MBAS (mg/L) | | Fec. Coli. (#/100 ml.) | |
| 10/15/87 | 25.0 | 8.0 | 1000 | 110 | | 600 | 66 | 34 | 0.02 | 13 | 20 | 13.2 | | 3.4 | | 2,200,000.0 | |
| 10/29/87 | 23.0 | 8.0 | 900 | 126 | | 492 | 72 | 65 | 0.01 | 10 | 16 | 16.6 | | 2.7 | | 340,000.0 | |
| 11/10/87 | 25.5 | 8.9 | 1000 | 137 | | 606 | 52 | 57 | 0.05 | 12 | 36 | 25.9 | | 6.2 | | 680,000.0 | |
| 11/16/87 | 24.5 | 8.8 | 870 | 103 | | 548 | 72 | 35 | 0.05 | 9 | 27 | | | 1.4 | | 600,000.0 | |
| 1/15/88 | 18.0 | 8.2 | 1025 | 107 | 42 | 504 | 152 | 78 | 0.11 | 15 | 44 | 8.9 | | | | 320,000.0 | |
| AVE. | 23.20 | | 959.00 | 116.60 | 42.00 | 550.00 | 82.80 | 53.80 | 0.05 | 11.80 | 28.60 | 16.15 | | 3.43 | | | |
| STD. DEV. | 3.05 | | 69.14 | 14.36 | * | 52.73 | 39.54 | 19.15 | 0.04 | 2.39 | 11.48 | 7.22 | | 2.03 | | | |
| n | 5.00 | 5.00 | 5.00 | 5.00 | 1.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 4.00 | | 4.00 | | 5.0 | |
| MIN | 18.00 | 8.00 | 870.00 | 103.00 | 42.00 | 492.00 | 52.00 | 34.00 | 0.01 | 9.00 | 16.00 | 8.90 | | 1.40 | | 320,000.0 | |
| MAX | 25.50 | 8.90 | 1025.0 | 137.00 | 42.00 | 606.00 | 152.00 | 78.00 | 0.11 | 15.00 | 44.00 | 25.90 | | 6.20 | | 2,200,000.0 | |

WQDA24.wk1)

# APPENDIX I

# SEPTIC TANK EFFLUENT VOC DATA

Table 11. Volatile organic compounds detected in septic tank effluent by U.S. EPA Method 624.

| | METHOD DET. LIMITS 624 (ug/L) | LAB. DET. LIMITS ug/L | STATIONS DETECTED |
|---|---|---|---|
| Benzene + | 4.4 | 1.0 | ALL STATIONS BDL |
| Bromodichloromethane | 2.2 | 1.1 | 11T* |
| Bromoform | 4.7 | 2.4 | ALL STATIONS BDL |
| Bromomethane | nd | 10.0 | ALL STATIONS BDL |
| Carbon Tet. + | 2.8 | 1.4 | ALL STATIONS BDL |
| Chlorobenz | 6.0 | 3.0 | ALL STATIONS BDL |
| Chloroethane | nd | 10.0 | ALL STATIONS BDL |
| 2-Chloroethyl vinyl ether | nd | 1.0 | ALL STATIONS BDL |
| Chloroform | 1.6 | 1.6 | 11, 11T*, 12, 13, 14, 24 |
| Chloromethane | nd | 10.0 | ALL STATIONS BDL |
| Dibromochloromethane | 3.1 | 1.6 | ALL STATIONS BDL |
| 1,2 Dichlorobenzene | nd | 10.0 | ALL STATIONS BDL |
| 1,3 Dichlorobenzene | nd | 10.0 | ALL STATIONS BDL |
| 1,4 Dichlorobenzene + | nd | 10.0 | 22 |
| 1,1 Dichloroethane + | 4.7 | 2.4 | ALL STATIONS BDL |
| 1,2 Dichloroethane + | 2.8 | 1.4 | ALL STATIONS BDL |
| 1,1 Dichloroethylene | 2.8 | 1.4 | ALL STATIONS BDL |
| trans 1,2 Dichloroethene | 1.6 | 1.0 | ALL STATIONS BDL |
| 1,2 Dichloropropane | 6.0 | 3.0 | ALL STATIONS BDL |
| Cis 1,3 Dichloropropene | 5.0 | 1.0 | ALL STATIONS BDL |
| trans 1,3 Dichloropropene | nd | 2.5 | ALL STATIONS BDL |
| Ethylbenzene | 7.2 | 3.6 | ALL STATIONS BDL |
| Methylene Chloride | 2.8 | 1.4 | 12, 13, 14, 24 |
| 1,1,2,2 Tetrachloroethane | 6.9 | 3.5 | ALL STATIONS BDL |
| Tetrachloroethene | 4.1 | 2.1 | ALL STATIONS BDL |
| Toluene | 6.0 | 3.0 | 11, 12, 13, 14, 21, 22, 23, 24 |
| 1,1,1 Trichloroethane + | 3.8 | 1.9 | ALL STATIONS BDL |
| 1,1,2 Trichloroethane + | 5.0 | 2.5 | ALL STATIONS BDL |
| Trichloroethene | 1.9 | 1.0 | ALL STATIONS BDL |
| Trichlorofluoromethane | nd | 1.0 | ALL STATIONS BDL |
| Vinyl Chloride + | nd | 1.0 | ALL STATIONS BDL |

* Detected in tapwater supply to Station 11
\+ VOC's currently regulated under SDWA Amendments
BDL - Below Detection Limits

VOC.TBL

# APPENDIX J

# SEPTIC TANK EFFLUENT QUALITY CONTROL DATA

Table J1. Septic tank effluent quality control sample results.

| SAMPLE DATE | SAMPLE DESCRIPTION | PARAMETER | | | | | | | | | | | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOD5 (mg/L) | TDS (mg/L) | TSS (mg/L) | TKN (mg/L) | NO2-NO3 (mg/L) | TP (mg/L) | Cl (mg/L) | FOG (mg/L) | MBAS (mg/L) | Fec. Coli. (#/100 ml.) | VOC's(a) (ug/L) | |
| 08/20/87 | Sta 11 Duplicates | | 468 | | 41 | | | 42 | | | | | Check ok |
| | Sta 14 Duplicates | | | 60 | 57 | <0.10 | 6.5 | | | | | | Check ok |
| 09/22/87 | Sta 11 Duplicates | | | | 22 | | | | | 1.6 | 10,000 | | Check ok |
| | Sta 14 Duplicates | | 578 | 56 | | | 6.0 | | | | | | Check ok |
| 10/14/87 | Sta 11 Duplicates | | 500 | | 31 | | | | | | | | Check ok |
| | Sta 14 laboratory split | | | | | | | | | | | 29 | Check compd. & conc. |
| | Subdiv. 1 Field Blank | | | | | | | | | | | BDL(b) | |
| 10/15/87 | Sta 24 laboratory split | | | | | | | | | | | 29 | Check compd. & conc. |
| | Sta 21 Duplicates | | 372 | | | | | | | | | | Check ok |
| | Sta 22 Duplicates | | | 70 | | | | | | | | | Check ok |
| | Sta 24 Priv. Well | | 134 | | | <0.02 | 0.14 | | | <0.05 | <1 | | Hard: 120; Alk.: 120; |
| 10/27/87 | Sta 11 Duplicates | | | 80 | | | | | | | 230,000 | | Check ok |
| | Sta 14 Duplicates | | | | | | | | | | | | Check ok |
| 10/29/87 | Sta 21 Duplicates | 178 | | 144 | | | | | | 2.6 | 350,000 | | Check ok |
| | Sta 24 Duplicates | | 504 | | | <0.01 | 10 | | | | | | |
| | Subdiv. 2 Field Blank | | | | | | | | | | | BDL(b) | |
| 11/10/87 | Sta 24 Duplicates | | 608 | | 41 | <0.05 | 12 | 42 | | 6.3 | 440,000 | | Check ok |
| 11/16/87 | Sta 21 Duplicates | | 466 | 100 | 34 | | 7.0 | | | | | | Check ok |
| | Sta 24 Duplicates | 109 | | | | <0.05 | 9.0 | 27 | | 1.5 | 320,000 | | Check ok |
| 01/06/88 | Subdiv. 1 Field Blank | | | | | | | | | | | 7.8 | Toluene only |
| | Sta 11 tapwater sample | | 180 | <1 | | 0.05 | 0.12 | 11 | | | <1/<1 | 48(c) | Hdness: 160; Alk.: 13 |
| | Sta 12 Duplicates | | | | | | | 1260 | | | | | Check ok |
| | Sta 12 laboratory split | 198 | 2440 | 196 | 53 | 2.6(d) | 2.2(d) | 1296 | | | >2400 | | Check except (d) |
| 01/12/88 | Sub.1 Soil Samp Field Blk | | | | | | | | | | | BDL | |
| 01/14/88 | Sub.2 Soil Samp Field Blk | | 8 | | 0.05 | 0.01 | <0.05 | <1 | | | <1 | BDL | |
| 01/15/88 | Sta 22 Duplicates | | | | 55 | 0.17 | 17 | | | | | | Check ok |
| | Sta 22 Tapwater | | 172 | | | <0.01 | | 10 | | | | | Check ok |
| | Sta 24 Duplicates | 104 | | | | | | | | | 330,000 | | Check ok |
| 01/27/87 | Sta 12 Duplicates | | | | | 0.44 | | | | | 210,000 | | Check ok |
| | Sta 13 Internal split | 208 | 504 | 708 | 58 | 0.31 | 14 | 42 | | 2.5 | | | Check ok |
| | Sta 14 laboratory split | | | | | | | | | | | 30.1 | Check compd. & conc. |
| | Subdiv.1 Field Blank | | | | | | | | | | | BDL | |
| All dates | Trip Blanks | | | | | | | | | | | BDL (b) | |

(a) Concentration value represents total VOC's by EPA Method 624. Individual compounds also checked.
(b) Results for trip blanks and all field blanks prior to 11/01/87 were verbally reported as BDL by laboratory due to misunderstanding.
Laboratory policy was to only include blanks on written laboratory report if VOC's were detected.
(c) Chloroform and Bromodichloromethane detected on EPA 624 Scan.
(d) Split lab results assumed in error based on concentrations and past experience.
BDL = Below detection limits.

wqdqcs.wk1

# APPENDIX K

## SUB-INFILTRATION SYSTEM SOIL SAMPLING DATA

Table K1. Results of sub-infiltration system soil sampling at home 12.

| SAMPLE LOCATION | GRD. LEVEL ELEV. (ft.) | SOIL SAMPLE MID-CORE DEPTH(1) (ft.) | INF. SURF. TO MID-CORE DEPTH (ft.) | SOIL TEMP (°C) | SOIL MOIST % | COLOR/TEXTURE (2) | PH | CEC (meq) 100 gm | TOC (mg/kg) | Cl (mg/kg) | TKN (mg/kg) | NO3-N (mg/kg) | TP (mg/kg) | OP (4) Leach. (mg/kg) | Fecal Coli #/gm | VOC's (ug/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12-C1A | 140.4 | 1.9 | NA | 21 | 4.98 | 10yr 3/3-1fs | 5.9 | 1.60 | 3800 | 3.2 | 190 | 0.06 | 520 | 0.06 | <100 | BDL |
| 12-C1B | | 3.6 | NA | 21 | 3.98 | 10yr 5/4-fs | 5.5 | 1.00 | 1700 | <3.2 | 87 | <0.02 | 450 | <0.02 | <100 | BDL |
| 12-C1C | | 5.7 | NA | 23 | 3.01 | 10yr 6/3-fs | 5.3 | 0.77 | 670 | <1.5 | 57 | 0.02 | 360 | <0.02 | <100 | BDL |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| 12-D2A | 140.4 | 2.6 | 0.2 | 20 | 3.96 | 10yr 6/4-fs | 6.5 | 0.75 | 2400 | 62 | 91 | 0.06 | 440 | 0.06 | <100 | BDL |
| 12-D2B | | 4.8 | 2.4 | 21 | 3.88 | 10yr 6/4-fs | 6.6 | 0.64 | 790 | 150 | 55 | 0.02 | 510 | 0.36 | <100 | BDL |
| 12-D2C | | 6.7 | 4.3 | NA | 3.66 | 10yr 6/3-fs | 5.7 | 0.76 | 460 | 150 | 39 | 0.78 | 520 | 0.02 | <100 | BDL |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| 12-D1A | 141 | 2.8 | 0.3 | 21 | 9.23 | 10yr 5/6-1fs | 6.9 | 2.10 | 5200 | 110 | 380 | 12.00 | 880 | 2.60 | 200 | BDL |
| 12-D1B | | 4.7 | 2.3 | 21 | 6.89 | 10yr 5/6-fs | 6,4 | 1.10 | 690 | 90 | 78 | 0.18 | 780 | 6.90 | <100 | BDL |
| 12-D1C | | 6.7 | 4.2 | 20 | 7.41 | 10yr 6/3-fs | 6.5 | 0.58 | 520 | 120 | 47 | 1.60 | 620 | 4.20 | <100 | BDL |
| | | | | | | | | | | | | | | | | |

(1) Soil core sampled extended above and below mid-core point by approximately 0.25 feet.
(2) Munsell colors and soil textures as determined manually on field-moist samples.
(3) Units on TOC, Cl-, TKN, NO3-N, TP, and OP are mg/kg dry soil.
(4) Orthophosphate analyses run on water extracts of the soil (Olson and Sommers, 1982).

(SSR12.WK1)

## Table K2. Results of sub-infiltration system soil sampling at home 13.

| SAMPLE LOCATION | GRD. LEVEL ELEV. (ft.) | SOIL SAMPLE MID-CORE DEPTH(1) (ft.) | INF. SURF. TO MID-CORE DEPTH (ft.) | SOIL TEMP (°C) | SOIL MOIST % | COLOR/TEXTURE (2) | pH | CEC (meq) 100 gm | TOC (mg/kg) | Cl (mg/kg) | TKN (mg/kg) | NO3-N (mg/kg) | TP (mg/kg) | OP (4) Leach. (mg/kg) | Fecal Coli #/gm | VOC's ug/kg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13-C1A | 143.2 | 5.1 | NA | 24 | 1.91 | 10yr 6/6-fs | 6.5 | 0.76 | 860 | <3.1 | 49 | <0.02 | 420 | <0.02 | <100 | BDL |
| 13-C1B | | 7.1 | NA | 24 | 2.30 | 10yr 7/4-fs | 5.5 | 0.56 | 370 | 1.5 | 31 | <0.02 | 310 | <0.02 | <100 | BDL |
| 13-C1C | | 9.2 | NA | 25 | 3.76 | 10yr 6/2-lfs | 5.2 | 0.29 | 300 | <1.6 | 25 | <0.02 | 500 | 0.05 | <100 | BDL |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| 13-D2A | 142.9 | 3.7 | 0.4 | 24 | 7.25 | 10yr 3/2-lfs | 7.0 | 0.78 | 3200 | 8.1 | 220 | 6.00 | 470 | 0.47 | 900 | BDL |
| 13-D2B | | 5.8 | 2.5 | 23 | 8.79 | 10yr 6/8-fs | 6.3 | 0.33 | 430 | 6.6 | 56 | 0.44 | 480 | <0.02 | <100 | BDL |
| 13-D2C | | 7.9 | 4.6 | 23 | 7.86 | 10yr 6/6-fs | 5.3 | 0.65 | 180 | <3.3 | 29 | 0.20 | 360 | 0.02 | <100 | BDL |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| 13-D1A | 143 | 3.4 | 0.4 | 22 | 14.84 | 10yr 3/2-lfs | 7.6 | 1.40 | 3000 | <8.8 | 300 | 0.81 | 680 | 5.1 | <100 | BDL |
| 13-D1B | | 5.5 | 2.5 | 21 | 5.78 | 10yr 5/6-fs | 7.9 | 0.67 | 440 | 8.0 | 72 | 0.05 | 470 | 4.8 | <100 | BDL |
| 13-D1C | | 7.6 | 4.6 | 21 | 5.64 | 10yr 6/6-fs | 7.9 | 0.3 | 200 | 19.0 | 35 | <0.02 | 380 | 0.78 | <100 | BDL |
| | | | | | | | | | | | | | | | | |

(1) Soil core sampled extended above and below mid-core point by approximately 0.25 feet.
(2) Munsell colors and soil textures as determined manually on field-moist samples.
(3) Units on TOC, Cl-, TKN, NO3-N, TP, and OP are mg/kg dry soil.
(4) Orthophosphate analyses run on water extracts of the soil (Olson and Sommers, 1982).

(SSR13.wk1)

Table K3. Results of sub-infiltration system soil sampling at home 22.

| SAMPLE LOCATION | GRD. LEVEL ELEV. (ft.) | SOIL SAMPLE MID-CORE DEPTH(1) (ft.) | INF. SURF. TO MID-CORE DEPTH (ft.) | SOIL TEMP (°C) | SOIL MOIST % | COLOR/TEXTURE (2) | pH | CEC (meq) 100 gm | TOC (mg/kg) | Cl (mg/kg) | TKN (mg/kg) | NO3N (mg/kg) | TP (mg/kg) | OP (4) Leach. (mg/kg) | Fecal Coli #/gm | VOC's ug/kg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 22-C1A | 14.9 | 2.7 | NA | 15 | 5.41 | 10yr 6/3-fs | 6.9 | 0.71 | 750 | 16.00 | 79 | 0.03 | 93 | 0.13 | <10 | BDL |
| 22-C1B | | 4.6 | NA | 18 | 21.52 | 10yr 6/2-vfs | 7.4 | 0.24 | 150 | 11.00 | 20 | <0.02 | 21 | 0.29 | <10 | BDL |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| 22-D2A | 14.9 | 2.4 | 0.3 | 15 | 6.96 | 10yr 6/3-fs | 6.6 | 1.10 | 1300 | 3.2 | 170 | 3.40 | 350 | 4.20 | 370 | BDL |
| 22-D2B | | 4.6 | 2.5 | 17 | 22.04 | 10yr 6/2-vfs | 7.1 | 0.28 | 170 | 9.6 | 23 | 0.04 | 70 | 1.20 | 10 | BDL |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| 22-D1A | 15 | 2.6 | 0.4 | 17 | 13.10 | 10yr 6/3-fs | 5.2 | 1.60 | 3300 | <8.6 | 520 | 1.30 | 540 | 14.00 | 2000 | 17 * |
| 22-D1B | | 4.6 | 2.4 | 18 | 21.08 | 10yr 6/2-vfs | 6.5 | 0.51 | 250 | 9.5 | 49 | 6.10 | 110 | 2.90 | 10 | BDL |
| | | | | | | | | | | | | | | | | |

(1) Soil core sampled extended above and below mid-core point by approximately 0.25 feet.
(2) Munsell colors and soil textures as determined manually on field-moist samples.
(3) Units on TOC, CL-, TKN, NO3-N, TP, and OP are mg/kg dry soil.
(4) Orthophosphate analyses run on water extracts of the soil (Olson and Sommers, 1982).

* 1,4 Dichlorobenzene

(SSR22.wk1)

SAD22.WK1
(05-25-88)

Table K4. Results of sub-infiltration system soil sampling at home 24.

| SAMPLE LOCATION | GRD. LEVEL ELEV. (ft.) | SOIL SAMPLE MID-CORE DEPTH(1) (ft.) | INF. SURF. TO MID-CORE DEPTH (ft.) | SOIL TEMP (°C) | SOIL MOIST % | COLOR/TEXTURE (2) | pH | CEC (meq/100 gm) | TOC (mg/kg) | Cl (mg/kg) | TKN (mg/kg) | NO3-N (mg/kg) | TP (mg/kg) | OP (4) Leach. (mg/kg) | Fecal Coli #/gm | VOC ug/k |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24-C1A | 15.6 | 2.8 | NA | 13 | 4.89 | 10yr 6/6-fs | 6.5 | 0.94 | 640 | 3.2 | 54 | 0.06 | 33 | 0.09 | <10 | BDL |
| 24-C1B | | 4.6 | NA | 16 | 12.59 | 10yr 6/6-fs | 7.4 | 0.48 | 300 | 6.9 | 55 | 0.01 | 31 | <0.02 | <10 | BD |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| 24-D2A | 15.7 | 3.1 | .3 | 16 | 14.00 | 10yr 5/2-1fs | 6.2 | 1.60 | 3400 | 7.0 | 520 | 6.60 | 350 | 0.87 | 70 | BDL |
| 24-D2B | | 5.0 | 2.2 | 16 | 14.13 | 10yr 6/3-fs | 6.9 | 0.63 | 260 | 14.0 | 41 | 9.40 | 89 | 1.70 | <10 | BDL |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| 24-D1A | 15.7 | 3.0 | .4 | NA | 16.99 | 10yr 4/3-1fs | 5.5 | 2.30 | 5100 | 14.0 | 870 | 6.50 | 550 | 8.10 | 380 | BDL |
| 24-D1B | | 5.0 | 2.4 | 18 | 15.25 | 10yr 7/2-fs | 6.7 | 0.52 | 210 | 14.0 | 43 | 9.30 | 90 | 1.10 | <10 | BDL |
| | | | | | | | | | | | | | | | | |

(1) Soil core sampled extended above and below mid-core point by approximately 0.25 feet.
(2) Munsell colors and soil textures as determined manually on field-moist samples.
(3) Units on TOC, CL-, TKN, NO3-N. TP and OP are mg/kg dry soil.
(4) Orthophosphate analyses run on water extracts of the soil (Olson and Sommers, 1982).

SSR24.wk1