where sampling and testing was performed, only at the time of our field exploration, and only to the depths penetrated. Our borings cannot be relied upon to accurately reflect the variations that can exist across the site and these variations may not become evident until construction. If variations from the subsurface conditions described in this report do become evident during construction or if the project characteristics described in this report change, GEC should be retained to reevaluate this report's conclusions and recommendations in light of such changes.

6.1 Water Storage Tank Settlement Analyses

Estimates of tank foundation settlements were made using the computer programs SETTLE96 and SAF-I. The tank foundation was modeled with circular dimensions and an inner diameter of 120 feet. An applied contact pressure of 2184 pounds per square foot (psf) under sustained conditions was modeled to estimate settlement. This bearing pressure is produced by 35 feet of sustained water height.

...we estimate a total settlement of about 3 inches...

Based on the results of the settlement analyses, we estimate a total settlement of about 3 inches at the center of the tank and edge settlement of about 1.3 inches, for a differential settlement (from center to outer edge of tank) of about 0.03 in/ft. The majority of tank settlement should occur during the initial filling of the tank. The storage tank vendor should confirm that these settlements are tolerable.

6.2 Staged Loading and Settlement Monitoring

We recommend that the tank be monitored for settlement during the initial filling. Settlement reference points should be placed around the perimeter of the foundation. Settlement measurement should be obtained of each 5 feet of water height in the storage tank. If the settlement data shows an excessive rate of settlement, in excess of about one half an inch per 5 feet of water load, then water loading should cease until the time rate of settlement diminishes. Settlement data should be provided to GEC for review. Additionally, flexible or temporary connections to the tank should be used to minimize the possibility of damage to the connections or the tank's settlement.

6.3 Foundation Design and Construction Recommendations

On the basis of the data obtained for this study, in our opinion the site is suitable for support of the proposed water storage tank and peripheral buildings as described in the preliminary plans. This conclusion is contingent upon the design engineer's and contractor's adherence to the following recommendations:

- Prepare the structure areas in accordance with the recommendations in the

General Site Preparation and **Fill Selection, Placement and Compaction** sections of this report.

- Prepare footing subgrade soils in accordance with the recommendations presented in the **Foundation Subgrade Preparation** section of this report.

- Use a maximum net soil bearing pressure of 3,000 pounds per square foot for peripheral building and tank foundation design.

- Design foundations so that footings bear at least 18 inches below finished exterior grades.

- Support floor slabs constructed on-grade on a compacted sand base.

- Overexcavate excessively loose or disturbed soils encountered in the building and tank areas and replace with sands selected and compacted in accordance with the **Fill Selection, Placement and Compaction** section of this report.

7.0 CONSTRUCTION ISSUES

The following sections of this report include comments on issues related to the geotechnical aspects of the proposed construction. *These recommendations are not intended to dictate construction methods or sequences.* Instead, they are furnished as an aid to design professionals and to identify important construction issues related to foundation and earthwork plans and specifications. These recommendations may also be useful to personnel who observe construction activity.

Prospective contractors for this project should evaluate potential construction problems on the basis of their review of the contract documents, their own knowledge and experience in the local area, and on the basis of similar projects in other localities, taking into account their own proposed means and methods. The presence of cemented sands locally known as "hardpan", will likely make excavation and dewatering more difficult at this site.

7.1 General Site Preparation

Our recommendations regarding routine site preparation of the structure areas can be summarized as follows:

- Remove all vegetation, organic topsoil, major root systems, and other deleterious materials from beneath and to 5 feet beyond the proposed structure limits. Standard clearing, grubbing, and topsoil stripping procedures should be

appropriate for this site.

- Allow a Geotechnical Engineer to inspect the site after it has been stripped to verify adequate topsoil and vegetation removal and also to observe subsequent proofrolling.

- In structure areas where fill is required, proofroll the stripped ground surface using a large vibratory roller (Dynapac CA-25 or equivalent). Proofroll cut areas after excavation to proposed grade to allow adequate compaction of the exposed subsoil.

- *Exercise extreme caution when operating vibratory equipment near existing structures* as they may be adversely affected by vibratory rolling operations. Provisions should be made to monitor the adjacent structures for excessive vibrations. Operate roller in the static mode if excessive vibrations are experienced by any nearby structures.

- Proofroll the structure and pavement areas with a minimum of 10 overlapping passes in each of two perpendicular directions. Allow a Geotechnical Engineer, or his representative, to observe proofrolling operations. The purposes of the proofrolling will be to detect unstable soils that yield when subjected to compaction and to densify the near-surface loose sands for support of shallow foundations, soil supported floor slabs.

- Remove material that yields excessively during proofrolling and replace with fill selected and compacted as described in the next section of this report. The Geotechnical Engineer, based on his observations, should recommend the nature and extent of any remedial work.

- Silty sand may be exposed during site preparation. This soil type can be unstable during proofrolling if it contains excess moisture. The contractor should be prepared to manipulate the moisture content of unstable subgrade soils as necessary to achieve stability and compaction requirements.

- Continue proofrolling until the soil at a depth of 12 inches below the compaction surface has attained a minimum of 95% of the soil's modified Proctor maximum dry density as determined by ASTM Standard D-1557.

- Allow an Engineering Technician, working under the direction of a Geotechnical Engineer registered in the State of Florida, to perform in-place density tests to verify that the required degree of compaction has been achieved.

7.2 Fill Selection, Placement and Compaction

After the contractor prepares the site in accordance with the above recommendations, the contractor should place and compact fill required to bring the site to final grade. We recommend that all fill be selected, placed and compacted as follows:

- Use fill material comprised of non-plastic sands with less than about 12% fines content. The fill should not contain any significant amount of organic soils (less than 3% by weight) and should be substantially free from roots or other organic or deleterious materials.

- Place fill in level lifts no thicker than 12 inches. Thinner lifts may be needed to achieve compaction in the silty sands.

- Compact fill to a minimum of 95% of the soil's modified Proctor maximum dry density as determined by ASTM Standard D-1557 for each lift of fill placed.

- Allow an Engineering Technician, working under the direction of a registered Geotechnical Engineer, to perform in-place density tests to verify that the recommended degree of compaction has been achieved.

- Extend fill a minimum of 5 feet beyond structure limits to prevent possible erosion or undermining of footing bearing soils.

- Provide fill slopes no steeper than 2 horizontal to 1 vertical.

- Compact fill placed in utility trenches to the specifications stated above. However, in restricted working areas, where use of a large vibratory roller is not feasible, compact fill with lightweight, hand-guided compaction equipment and limit lift thicknesses to a maximum of 6 inches.

- All excavations including utility trenches, should comply with the recommendations included in the **Temporary Excavations** section of this report.

7.3 Foundation Subgrade Preparation

We recommend the following steps be taken during foundation excavation and subgrade preparation:

- Excavate foundations in accordance with the recommendations presented in the **Temporary Excavations** section of this report.

- Compact subgrade soils to a depth of 12 inches below bearing elevations to a minimum of 95% of the soil's modified Proctor maximum dry density as determined by ASTM Standard D-1557.

- Perform in-place density tests to verify subgrade compaction.

- Allow a Geotechnical Engineer, or his representative, to observe excavation conditions prior to placement of reinforcing steel or concrete.

- On the basis of the Geotechnical Engineer's observations, remove any unsuitable material encountered in the footing excavations and replace with sand selected and compacted in accordance with the **Fill Selection, Placement and Compaction** section of this report.

7.4 Temporary Dewatering

Temporary dewatering will likely be required to facilitate stable excavations and placement and compaction of fill.

Temporary dewatering may be required to facilitate stable excavations and placement and compaction of fill. The contractor should be required to provide a dewatering system which maintains groundwater levels at least 2 feet below compaction surfaces, including the bottom of excavations. A system of ditches and sumps may be sufficient in some instances to achieve adequate dewatering for excavations extending slightly below groundwater levels. However, deep excavations will require an extensive dewatering system, designed by a licensed professional, which should be designed to accommodate the specific soil and groundwater conditions expected based on the construction plans and site conditions. The contractor should be aware that cemented soil (hardpan) was encountered on site and excavations will likely be more difficult.

7.5 Temporary Excavations

The owner and the contractor should be familiar with local, state and federal safety regulations, including current Occupational Safety and Health Administration (OSHA) excavation and trench safety standards. Construction site safety is the responsibility of the contractor. The contractor should also be responsible for the means, methods, techniques, sequences, and operations of the construction. The contractor should be aware that slope height, slope inclination, and excavation depths (including utility trench excavations) should not exceed those specified in local, state, or federal safety regulations; e.g., OSHA Health and Safety Standards for

Excavations, 29 CFR Part 1926. *OSHA regulations are strictly enforced and, if not followed, the owner, contractor, earthwork subcontractor or utility subcontractor could be liable for substantial penalties.*

8.0 USE OF THIS REPORT

GEC has prepared this report for the exclusive use of our client, Boyle Engineering, and for specific application to our client's project. GEC will not be held responsible for any third party's interpretation or use of this report's subsurface data or engineering analysis without our written authorization.

GEC has not evaluated the site for the potential presence of contaminated soil or groundwater, nor have we subjected any soil samples to analysis for contaminants.

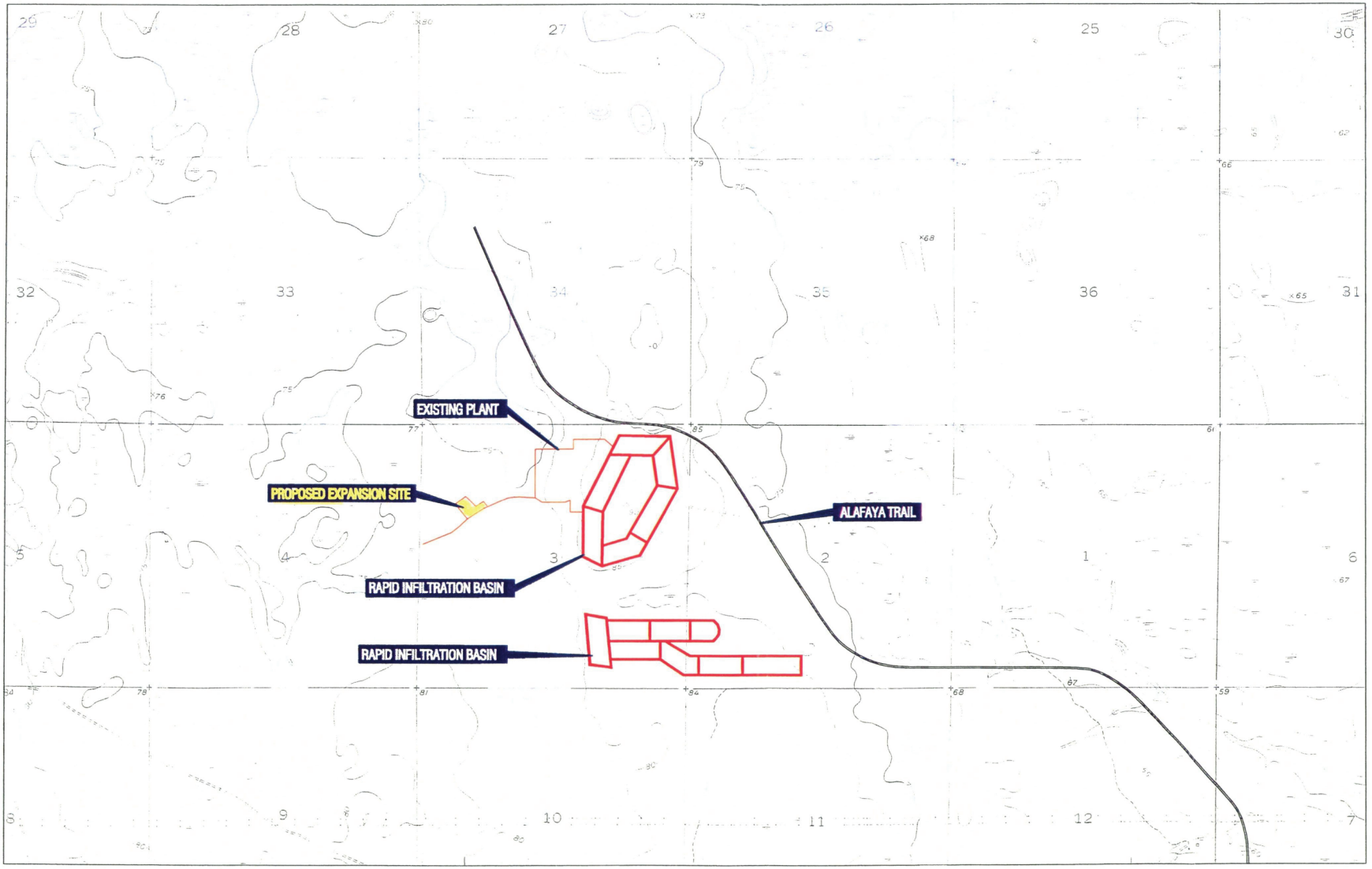
The sole purpose of the borings performed by GEC at this site was to obtain indications of subsurface conditions as part of a geotechnical exploration program. GEC has not evaluated the site for the potential presence of contaminated soil or groundwater, nor have we subjected any soil samples to analysis for contaminants.

GEC has strived to provide the services described in this report in a manner consistent with that level of care and skill ordinarily exercised by members of our profession currently practicing in Central Florida. No other representation is made or implied in this document.

The conclusions or recommendations of this report should be disregarded if the nature, design, or location of the facilities is changed. If such changes are contemplated, GEC should be retained to review the new plans to assess the applicability of this report in light of proposed changes.

APPENDIX

USGS QUADRANGLE MAP



PREPARED FROM:
USGS OVIEDO SW, FLA. QUADRANGLE MAP
ISSUED 1953
PHOTOREVISED 1980
SECTION: 3
TOWNSHIP: 23 SOUTH
RANGE: 31 EAST

Geotechnical and Environmental Consultants, Inc.

EASTERN WATER RECLAMATION FACILITY

PROJECT NO.:	1904G
DATE:	8-4-03
PROJECT ENGINEER:	SDB
SENIOR ENGINEER:	BPM
DRAWN:	SKR
REVISION:	
REVISION:	

0 1000 2000
SCALE (feet)

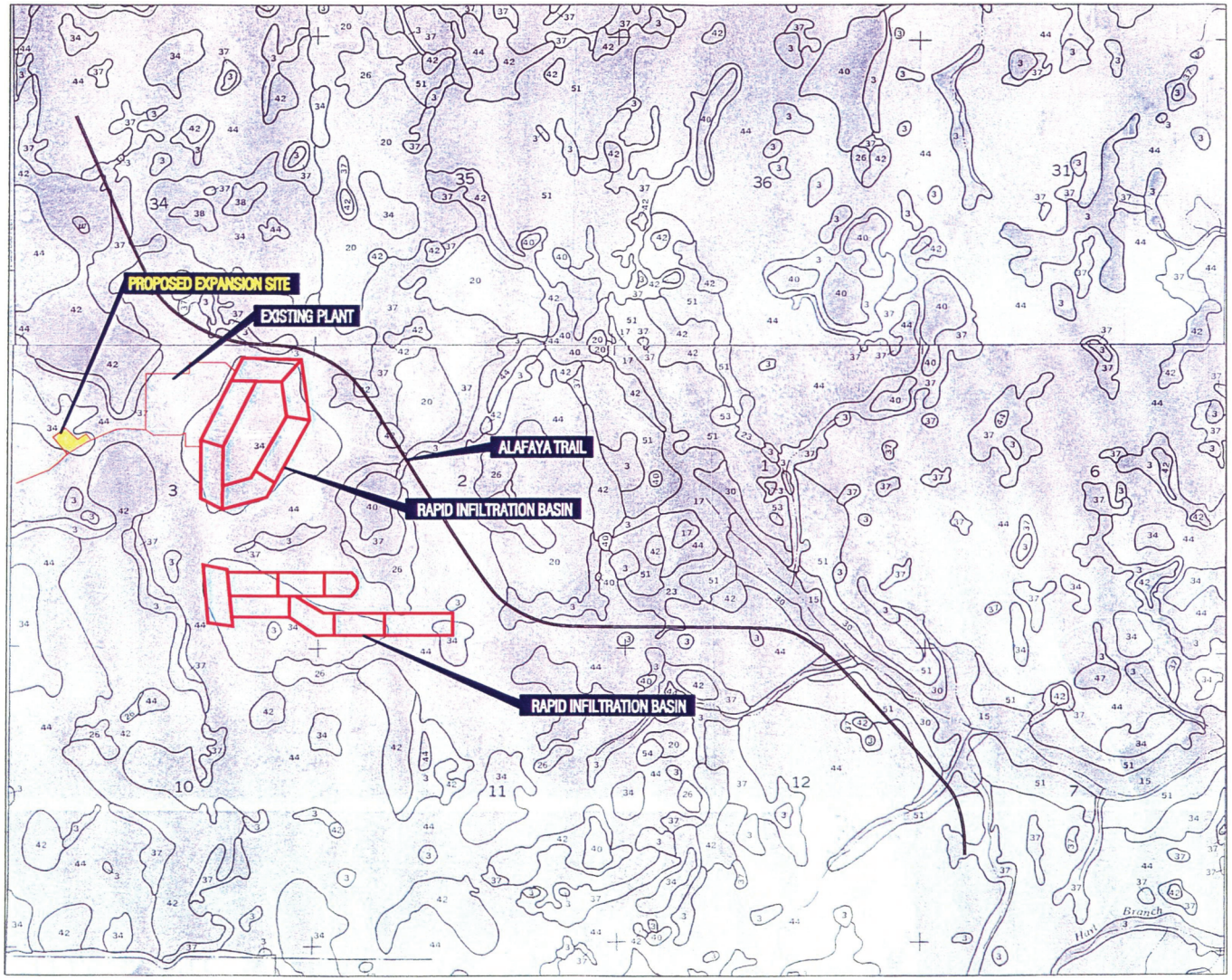
N
W E
S

USGS QUADRANGLE MAP

FIGURE 1

D21 1904G

SCS SOIL SURVEY MAP



PREPARED FROM:
SCS SOIL SURVEY OF ORANGE CO., FLORIDA
AERIAL PHOTOBASE DATED 1981

ORANGE COUNTY MAP UNIT LEGEND

34 – POMELLO FINE SAND, 0 TO 5 PERCENT SLOPES
44 – SMYRNA FINE SAND

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REVISION:	
REVISION:	

0 1000 2000
SCALE (feet)

N
W E
S

SCS SOIL SURVEY MAP

FIGURE 2