GEOTECHNCIAL EXPLORATION REPORT
PROPOSED KAPOLEI VILLAGE 8
KAPOLEI, OAHU, HAWAII

May 6, 2004

PSC Job No. 24301.10

SUMMARY OF FINDINGS AND RECOMMENDATIONS

The field exploration encountered surface fill materials consisting of very stiff to hard clays and silty clays that range in thickness from about 4 to 20 feet. These fill materials are generally underlain by medium dense to dense, coralline sands and gravels extending down to the maximum boring depth of about 20 feet below the existing ground surface. The depth of clay fill was observed to be greater (approximately 20 feet) at the western end of the property near the boundary with Kapolei High School. Based on a previous geotechnical exploration report (Geolabs-Hawaii report dated August 1996, W.O. 3600-20, for Makai Villages 7 & 8, Ewa, Oahu, Hawaii) performed on and near the property, the clays and silty clay fills were properly compacted and monitored during construction and adequate for foundation support for residential structures if they were designed for expansive soil conditions. Groundwater was not encountered in any of the borings drilled at the residential housing development and borrow site.

Based on the field and laboratory tests, the very stiff to hard, near-surface materials encountered at the site should provide adequate support for the proposed residential housing development. However, laboratory tests show that the near-surface, clayey soils exhibit moderate to high shrink and swell potential when subjected to changes in moisture content. Special attention should therefore be given to the preparation of subgrade and design of slab-on-grade for this project. To limit the adverse effects of ground swelling under the proposed residential structures and pavements, it is recommended that the existing expansive surface soils be removed and or filled such that the finished subgrade and pavement subgrade, respectively are underlain by a 3-foot thick layer of non-expansive, fill material. It is anticipated that 1 to 2 story dwellings will be constructed at the site. These lightly loaded structures may be supported on shallow, conventional spread or continuous footings bearing on the non-expansive, engineered fill. The structures may also be supported with slab-on-grade foundations with thickened edge footings.

Community Planning Inc. (CPI) designates a 64-acre lot east of Kapolei Middle School as a source of borrow material. Based on our field exploration in this area, the southern two-thirds of the designated borrow site will have the adequate borrow material consisting of coralline gravels and sand, while the northern one-third of the borrow site (shown in Boring Nos. B-13 and B-14) consists of clay and silty soils from 16 to 25 feet below the ground surface.

Since there are large quantities of coralline materials in the southern two-thirds of the borrow site, we believe that a grading scheme to strip about 2 feet of the clay soils from the development area and grade the site with select material generated from the excavation of the coralline materials from designated borrow areas is feasible and will provide long-term stability. The

stripped clay soils from the subdivision site may be disposed of in the excavated borrow pits, properly compacted and monitored as engineered fill, and capped with non-expansive capping materials if future development is planned.

The text of this report should be referred to for detailed and special design recommendations.

INTRODUCTION

This report presents the results of our preliminary geotechnical engineering investigation for Kapolei Village 8 and the designated 64-acre borrow area, about 1,500 feet east of the project area. The general location and vicinity of the project site and designated borrow site are shown on the Project Location Map, Plate No. 1.

Our work on the project was performed in general accordance with our December 17, 2003 proposal to Community Planning Inc. This report summarizes our findings and recommendations.

PROJECT CONSIDERATIONS

The project site is located within the existing villages of Kapolei Development in the district of Ewa, Oahu, Hawaii. Kapolei Parkway bound the study area on the north, drainage channel and Historic Railway to the south, and Kapolei High School and Middle School on the west and east, respectively. The site was previously mass graded sometime in the mid 90's as part of the Villages of Kapolei mass grading work. The area, which is generally flat, was raised to its present level with fill materials generally consisting of dark-brown clay with some coral gravel. The proposed Kapolei Village 8 development consists of about 330 individual lots (each with a minimum area of approximately 5,000.00 square feet), housing facilities, paved road network, and a community park and recreation center. At the writing of this report, no grading plans are yet available and the location of the park has not been designed.

A Geotechnical Exploration Report conducted by Geolabs Hawaii in August of 1996 that also covered this site, revealed that the study area was underlain by fill soils consisting of expansive clays ranging from 4 to 7 feet in the majority of the site except at the western end of the property, where the clay fill was encountered at about 20 feet, to the maximum depth of borings drilled. It was concluded in the report that the near-surface clay fills are moderately to highly expansive and adequate for foundation support with expansive soil design. The current grading scheme will

consist of removing the near-surface expansive material and replacing these with 3 feet of non-expansive granular capping material below the finished subgrade which will support the foundation footings and slab-on-grade of the proposed structures. For this current study, twelve borings were drilled by PSC Consultants, LLC within the study area to define the extent of the fill and to obtain samples for index property tests.

A 64-acre vacant lot immediately east of Kapolei Middle School is proposed as a source of borrow material and also serve as disposal area for the expansive soils that will be removed from the project site. Five borings were drilled by PSC to a depth of 25 feet at the proposed borrow area to delineate the depths of the topsoil and to determine the engineering properties of the underlying coral formation intended for borrow material. The stripped, near-surface, clay materials in the subdivision area will be buried in the lower portion of the designated borrow pits, placed in controlled lifts, moisture conditioned, compacted, and capped with a 3 to 5 feet-thick layer of non-expansive soil for future development.

We anticipate that the future residences would be constructed as 1- to 2-story homes, supported by slab-on-grade with thickened edges and/or shallow-spread or continuous footings.

PURPOSE AND SCOPE

The purpose of our geotechnical exploration was to gather information on the nature, distribution, and characteristics of the subsurface earth materials encountered on the proposed project site and borrow area, and to provide specific recommendations pertinent to the proposed residential development. The scope of our exploration consisted of the following tasks and work efforts:

1. Review of the existing available data from published and unpublished sources pertaining to the geology and soil conditions at the site and its vicinity;

2. Schedule the field exploration and coordinate with CPI for the borings and site access;

3. Reconnaissance of the site, locating and staking out drill hole locations, coordination of the field exploration, and logging of the borings and test pits by a field engineer from our firm;

4. Mobilization and demobilization of truck-mounted drill rig and operators;

5. Drilling and sampling of 12 borings at the project site to depths ranging between about 16 and 20 feet below the existing ground surface and drilling of 5 exploratory holes to a depth of 25 feet at the proposed borrow area;

6. Excavation and sampling of 5 test pits, 3 at the project site and 2 at the proposed borrow area to depths of about 5 to 6 feet below the existing ground surface;

7. Laboratory testing of the selected samples obtained during the field exploration to classify the materials encountered and to evaluate their engineering properties, including swell potential and remolded shear strength of soils. Unconfined compressive strength of intact cores obtained at the borrow site were also performed to obtain indicative shear strength of the coral boulders/slabs encountered. This will aid in determining appropriate excavation techniques and excavation equipment to be employed;

8. Analyses of the field and laboratory data for the formulation of preliminary geotechnical engineering recommendations pertinent to the design of site grading, engineered fills, and foundations for the proposed development; and

9. Preparation of this report summarizing our work on the project and presenting our findings and recommendations.

Detailed descriptions of our field exploration and laboratory testing are presented in the appendices of this report.

SITE DESCRIPTION

This project site is located within the existing Villages of Kapolei development in the district of Ewa, on the island of Oahu, Hawaii. Kapolei Parkway bound the study area on the north, to the south is the Kapolei lower channel and Historic Railway and to the east and west are the Kapolei Middle School and Kapolei High School, respectively. The site was previously mass graded as part of the Villages of Kapolei mass grading work. The area, which is generally flat, was raised to its present level by means of fill materials generally consisting of dark brown clay with some coral gravel. Based on the August 1996 report of Geolabs-Hawaii on the project site, the mass grading was completed in early 1996. It involved fill placement from 6 to 15 feet. In addition, 3 borrow pits of about 20 feet deep were excavated within Villages 7 & 8 and backfilled to the present grade with controlled fill. The exact location of the filled borrow areas are not known. At present the site is relatively flat with a thin grass covering. The proposed development consists of about 330 individual lots, each with a minimum area of approximately 5,000 square feet; paved road network; and a community park. At the writing of this report, no grading plans are yet available. The existing ground elevations within the proposed development area range from about +55 to +60 feet, Mean Sea Level (MSL). Several undocumented mounds of dumped fills were also observed within the site in scattered locations.

The designated 64-acre borrow site is located about 1,500 feet east of the subdivision site. At the time of our field exploration, the site is vacant with huge depressions located at the center, southeastern and southwestern corners of the property. These depressions are located within the southern two-thirds of the designated borrow site and were apparently quarried for coral borrow materials.

SUBSURFACE CONDITIONS

Regional Geology

Mainly two basaltic shield volcanoes – Waianae and Koolau, built up the island of Oahu. Waianae, which forms the west side of the island, is the older of the 2 and was built during the Pliocene Epoch by the extrusion of the lavas of the Waianae Volcanic Series. As volcanic activity in Waianae ceased, lava flows from Koolau banked against its eroded slope forming a broad Plateau presently known as Schofield Plateau. Physical and chemical weathering followed by erosion of this plateau generated sediments, which were transported to the coast. In the vicinity of the project site and to the south, these sediments accumulated and interbedded with marine sediments and coral algal reef formation to form a sedimentary wedge. The thickness of the sedimentary wedge ranges from zero in the area of the interstate route H-1 highway to over 1,000 feet at Ewa Beach. This wedge forms the Ewa plain and serves as the confining formation over the artesian basal aquifers of southern Oahu. Deposition of sediments has continued from earlier geologic time through the present. Agricultural developments within the last 100 years and recent mass grading work have brought the Villages of Kapolei area to its present form.

Subsurface Exploration

The subsurface conditions at the subdivision and designated borrow sites were explored by drilling and sampling 17 borings to depths ranging between 16 and 25 feet below the existing ground surface, and excavating and sampling 5 test pits to depths ranging from 5 to 6 feet below the existing ground surface. Twelve of the borings (B-1 to B-12) were drilled within the proposed subdivision while the other 5 (B-13 to B-17), 25-foot deep borings were drilled at the proposed borrow site. The approximate locations of the borings and test pits are shown in Site Plans, (Plate Nos. 2 & 2A).

Subdivision Area

At the western end of the subdivision, near its boundary with Kapolei High School, the borings (B-1 and B-2) encountered fill materials from ground surface down to the maximum drilling depth of 20 feet. Between Borings B-1 and B-2 and Test Pit TP-1, the fill soils were approximately 10 to 15 feet thick. From here to the eastern end of the project site, the borings encountered approximately 4 to 8 feet thick of clay fills underlain by coralline gravels and coral sand extending down to about 20 feet, the maximum depth of drilling.

Designated Borrow Site

The borings at the northern third of the borrow site (B-13 and B-14) encountered fill materials of silty clay/clayey silt from the surface down to approximately 15 feet in Boring B-13 and 25 feet (end of boring) in Boring B-14. The borings located in the middle and southern portion of the borrow area (B-15 to B-17) encountered coralline deposits of coral gravel, sand, and some coral boulders from the surface down to the maximum depth drilled.

Groundwater was not encountered in the borings during the time of our exploration. All borings and test pits were properly backfilled after completion of our field exploration work. For a detailed description of the materials encountered, please refer to the logs of the borings and test pits presented in Appendix A of this report.

DISCUSSIONS AND RECOMMENDATIONS

Our field exploration indicated that fill materials consisting of expansive clays generally cover the project site. In most areas, the fill thickness range from about 4 to 8 feet. The depth of the clay fill materials are relatively greater in previously excavated borrow areas such as may be the case in Borings B-1 and B-2 where the clay was encountered down to 20 feet, the maximum depth drilled. In the areas west of Boring B-4 and Test Pit TP-1 and in the vicinity of Boring B-12, the clay fill soils were 10 feet to 15 feet thick, based on previous borings by Geolabs Hawaii. These clay soils have low shear strength values and high shrink-swell potential if saturated. Underlying the clay fill are consolidated calcareous marine sediments of coralline gravel and sand, coral slabs and boulders.

From our analyses of data derived from the exploration and laboratory testing, removal and replacement of the upper clay soils would reduce the potential of swelling and shrinking. Since relatively large quantities of coralline materials are available in the proposed borrow site area, and possibly from the deeper portions of the park site, we believe that the grading concept of removing the near surface clay soils and replacing these with borrow coralline material will provide long-term stability for the proposed development. If removal and replacement of the upper clay soils are not preferred, then foundations should be designed for expansive soil

conditions. The expansive soil design is presented in the "Foundation" section of the report. As an alternative, a post-tensioned foundation system can be considered. Post-tensioned foundations typically can resist movement caused by moisture changes.

The removed surface clay soils may be buried in the borrow pits after which it shall be covered with at least 3 to 5 feet of coralline capping material if future developments are planned and if the clay soils are placed under proper compaction and moisture content as outlined below. The capping material may be reduced to 3 feet thick if the thickness of the buried clay soils is less than 10 feet. Similarly, a 1-foot thick capping of non-expansive soils may be used in areas within the subdivision development where no structures are anticipated, such as in open park areas. It is essential that the following site preparation and grading recommendations presented herein be closely followed.

Earthwork and Grading

The following sections present guidelines for the design and construction of the earthwork and grading for the subject development.

Our field exploration indicates that under the clay fill, the site is generally underlain with competent coralline deposits. This material is non-expansive, has good strength characteristics, and if excavated and properly processed, could meet the requirement for borrow and select borrow for subbase course, as stipulated in Sections 16, Borrow and 30 Select Borrow for Subbase Course, respectively of the Standard Specification for Public Works Construction.

Therefore the recommended grading concept would involve utilization of the coralline materials from the designated borrow site as borrow material. The coralline materials could be quarried, processed and stockpiled for use as capping material.

After the coralline material is excavated and stockpiled to generate a sufficient quantity of select fill material, the expansive clay soils in the subdivision site could be stripped to a depth of about 2 feet below the existing grade and disposed of properly and capped with 3 feet of non-expansive soil

We believe the coralline material encountered in the borrow area if properly excavated and processed down to 3- to 6-inch minus sizes, may be a source of fill material. After stripping off the near surface clay, the processed, on-site, coralline material may be used to replace the stripped, clay soils and to construct embankment fills, which are suitable for residential development, installation of utilities, and access roadways.

As planned, it will be necessary to establish a borrow pit operation to generate sufficient select fill materials for the required site grading. Based on field observations and unconfined compression tests of intact cores conducted on samples from isolated coral boulders encountered

at the proposed borrow area, it is our opinion that the coral formation at the borrow site can be readily excavated with dozers equipped with a ripping device and bucket type excavators. The resulting excavated area could be utilized as a disposal area for the stripped clay soils. Any clay soils placed in the borrow pits should be laid in controlled lifts and properly compacted and capped with non-expansive material, if future developments are planned. As discussed above, the coralline soils from the borrow site may be considered comparable to select fill material and are suitable for use as the capping fill within the upper 3 feet below the proposed finished subgrade of the subdivision.

If raising the existing elevation of the subdivision site by 3 feet does not adversely affect proposed grading plans, in relation to the Kapolei Villages development as a whole, we recommend that the existing on grade soils remain in place, provided these soils are scarified and compacted and are capped with at least 3 feet of select borrow.

Site Grading

Numerous stockpiles of dump fills are found at various parts of the site, especially in the western part of the site. In addition, two large stockpiles of fills were located at the southeastern portion of the site. These two large stockpiles may be selectively processed for general fill provided they meet the grading specifications and requirements contained in this report. Otherwise, these may be used for landscape purposes, provided it meets the specifications for topsoil, or disposed of in the borrow pits. This can be determined during construction and grading operations.

As mentioned earlier, fill embankments of up to 3 feet in vertical height and cuts of up to -2 feet in depth are planned within the subdivision development. Therefore, proper site preparation and compaction of the new fills and bonding of the new fills to the existing ground surface will be required to provide a stable fill mass. As discussed above, the surface clay soils should be stripped from the planned development. The expansive clays should be disposed of off-site or be placed in the coral borrow pits. The remaining expansive clay material within the subdivision development should be capped with a minimum of 3 feet of non-expansive material. A thicker capping layer may be needed where the footings of the future structure have deeper embedment, as specified in "Foundation" section. The borrow coralline soils may be considered suitable as capping material. Site preparation and grading should be performed in accordance with the following guidelines.

Site grading operation should be observed by a representative of PSC Consultants, LLC. It is important that a representative from our office observe the site grading and to evaluate whether any undesirable materials are encountered during the excavation and scarification process and whether the exposed soil/rock conditions are similar to those anticipated in our engineering analysis.

Site Preparation

At the onset of earthwork, the area within the contract grading limits should be cleared of trees, vegetation, debris, rubbish, boulders and other deleterious materials. These materials should be removed and properly disposed of off-site.

After the clearing and removal of unsuitable near surface materials, the area should be proof rolled to locate soft and yielding spots. Soft or yielding areas encountered should be over-excavated to expose firm soil surface and stabilized by backfilling with select material placed in 8-inch thick, loose, lifts, moisture-conditioned to at least 2 percent above the optimum moisture content and compacted to 90 percent relative compaction. In areas to receive fill, the existing ground should be scarified to a depth of 6 inches, moisture-conditioned to at least 2 percent above the optimum moisture content, and compacted to a minimum of 90 percent relative compaction. Relative compaction refers to the in-place dry density of soil expressed as percentage of the maximum dry density of the same soil established in accordance with ASTM Test designation D 1557-91. The optimum moisture content is the moisture content corresponding to the maximum compacted dry density.

Fill Material Placement

The clay soils to be removed from the subdivision area and placed in the borrow pits are prone to shrinking and swelling when subjected to considerable changes in moisture content, depending on the initial compaction density and molding moisture content prior to wetting. In order to reduce the swelling potential of the soil, the backfill material in the borrow pit should be moisture-conditioned to at least 2 percent above the optimum moisture content and compacted to between 85 to 90 percent relative compaction. The clay soils should be placed at a minimum of 12 inches below the finished subgrade in the borrow pits. To reduce the potential for future settlement and structure distress of possible structures built in this area, the buried clay soils should not exceed 10 feet in thickness.

Special considerations for the foundation construction planned above the buried adobe/expansive clay soil are given in the "Foundation" section of this report.

Except for the open park and recreation area, materials used for general subdivision site embankment filling, and the capping fills placed within the top 3 feet of finished subgrade in the subdivision area should be non-expansive select material, generally less than 3 inches in maximum dimension, should have a plasticity index not exceeding 15, as determined in accordance with ASTM Test Method D 4318-84, and should have maximum 20 percent of particles passing the No. 200 sieve. The borrow coralline materials, if properly processed after excavation, are considered suitable for this purpose.

Fill materials in the subdivision area should be placed in level lifts with maximum loose thickness of 8 inches; moisture conditioned, and compacted to a minimum of 90 percent relative compaction. In roadway areas, the minimum degree of compaction within the upper 2 feet of the finished pavement subgrade level should be 95 percent. Each layer should be spread uniformly and blade-mixed to attain uniformity of the material and water content. Additional fill material should not be placed on any fill layer that has not been properly compacted.

If additional offsite borrow material is required, it should be tested by PSC Consultants, LLC to evaluate its suitability for use as select fill prior to its delivery to the project site.

Slopes

In cases where sloping fills are required, such as at the edge of fill embankments consisting of select material, these may be designed at 2H:1V or flatter. Fill slopes should be constructed by overfilling 2 to 3 feet, then cutting back to the design slope to expose a well-compacted face.

Water should be diverted away from the slopes by diversion ditches at their tops and surface drains on slope surface and sub drains may be used to provide adequate drainage. Slope planting should be utilized to reduce erosion potential.

If sufficient boulders are encountered at the site, the boulders can be either crushed to smaller sizes to be incorporated in the fill or disposed of properly within the non-structural borrow pit areas. No future structures should be planned in these areas. If this scheme is desired, we can provide details of boulder disposal requirements and other details upon request.

Foundations

Detailed information on the proposed residential structures was not available at the time this report was prepared. We anticipate that 1- to 2-story buildings with relatively light loadings will be constructed. It is our opinion that shallow spread and strip footing foundations, or thickened edge slab-on-grade foundations bearing on the proposed engineered coralline capping placed and compacted in accordance with our recommendations may be used to support the proposed houses and other structures.

An allowable bearing pressure of 2,500 psf. for dead plus live loads may be used for footings bearing on the proposed coralline soil capping or engineered fills. The allowable bearing pressure may be increased by 1/3 for transient loadings, such as wind or seismic forces.

Footings should be embedded at least 12-inches below the lowest adjacent finished grade or floor slab whichever is lower. Footings should be supported by at least 2 feet of capping material. We estimate the maximum total footing settlements not to exceed 1 inch with maximum differential settlement of 1/2 inch.

Alternately, if removal of upper 3 feet of onsite soils and replacement of the 3-foot layer by a coralline capping material is not desired, the footings should be deepened to at least 24 inches below the lowest adjacent grade. Two No.4 reinforcing bars should be used on the top and bottom of the footings and the slabs should be designed for expansive soils also. A post-tensioned foundation system (post-tensioned thicken edge and post-tensioned floor slab) may also be considered. We can provide recommendations for a post-tensioned foundation system upon request.

Where structures are built in buried borrow areas, the footings will sit above the buried expansive clay soils, at least 2 feet of coralline materials should be provided below the bottom of the footing level. To limit differential settlement, buildings in borrow areas should be underlain by a uniform thickness of buried clay soil. In addition, we recommend that the buildings should not span the transition between the insitu coralline soils and the buried expansive clay soils in the borrow pits.

The thickness of the clay fill was observed to be relatively thicker (>15 feet) at the western end of the subdivision as shown by the borings B-1 and B-2 in this area (Plate No.2). It is possible, therefore, that this area was once used as a source of borrow materials. The park and recreation center, and several residential lots are proposed to be located within this area. Since no structures are anticipated within the park and recreation areas, it will not be necessary to put a layer of coral capping within this zone. The area south of the park within the vicinity of Boring B-2 however, will be used for housing development and needs to be capped. The thickness of the capping materials in this area where the buried clay soil is more than 15 feet should be increased to five feet to achieve a more uniform foundation support. The 3 feet of capping may be used in all other areas where buried clay is less than 10 feet. The coral capping in the vicinity of Boring B-12 east of the property and in areas west of Boring B-4 and TP-1 where the buried clay is about 15 feet may be increased to 4 feet.

Where footings are located adjacent to or on slopes, the footings should be embedded deep enough to provide a minimum horizontal set-back distance of at least 6 feet measured from the outbound edge of the footing to the face of the slope. Where footings are to be located adjacent to below-grade structures or utilities, the footings should extend to a depth below an imaginary 45-degree plane, projected upward from the bottom of the below-grade structure or utility. This requirement is necessary to avoid surcharging adjacent below-grade structures with additional structural loads and to reduce the potential of foundation settlement.

Lateral loads acting on the structure may be resisted by frictional resistance between the base of the footings and the bearing materials and by passive earth pressure developed against the footings. A coefficient of 0.3 may be used to compute the frictional resistance and the passive pressure may be calculated using an equivalent fluid pressure of 250 pounds per square foot per foot of depth (pcf). These values assume that the concrete for footings is poured directly against the footing excavations. Unless covered by pavements or slabs, the passive resistance in the upper 12 inches below finished grade should be neglected in the computation of the passive pressure.

Excavations

Natural soils may be excavated utilizing conventional equipment. Moderately hard Coral Formation and/or Boulder should be excavated using heavy-duty equipment. However, hard and very hard Coral Formation and/or Boulder will require special consideration where they are to be excavated. Contractors, especially those digging utilities, should satisfy themselves as to the hardness of deposits and select the most appropriate type of equipment required.

For temporary un-surcharged construction excavations, the excavations should be sloped or shored. Slopes should not be steeper than 1 H: 1 V in granular soils, and 1/2 H: 1 V in fine-grained soils. If there is insufficient space for sloped excavations, shoring should be used. Traffic and surcharge loads should be kept back at least 10 feet from the top of the excavations. Slopes should be inspected during construction/excavation to determine if they need to be flattened based on exposed conditions. Exposed slopes should be kept moist (but not saturated) during construction.

Slabs-On-Grade

We anticipate that concrete slab-on-grade floors will be used for the proposed residential buildings. We recommend that the concrete slab-on-grade floors be supported by the onsite coralline soils or engineered fills. We recommend that a 4-inch cushion layer of No. 3B fine gravel (ASTM C 33, No. 67 gradation) be used below the slabs. A vapor membrane should be incorporated on top of the gravel cushion layer to reduce potential damage to moisture sensitive floor coverings by infiltration of moisture. It is recommended that a 2-inch layer of moist fine sand be placed above the vapor membrane to aid in concrete curing.

Site Drainage

Subdrains should be provided where there is a possibility that runoff from rainfall or irrigation could saturate the subsurface soils.

Exposed surface soils should be protected from erosive runoff by providing surface drains, diversion berms, and other flood control devices. The finished lot grade should be shaped to shed water away from foundations and to avoid ponding conditions. Also, it is advised that each residence and building be equipped with a gutter and downspout system and the water diverted as far away as possible from the house foundations and driveway. Collected water should be drained into an approved drainage facility, and not allowed to flow freely on the site. Excessive landscape watering near foundations should be avoided.

Pavements

We anticipate that asphaltic concrete pavements will be required for the roadways in the subdivision and while specific traffic loading has not been specified, we anticipate a medium vehicle loading for the project consisting primarily of passenger vehicles and delivery trucks. We have made our preliminary pavement design assuming the pavement subgrade soil will consist of compacted coralline fill materials with a minimum CBR value of 25. The fill material within 2 feet below the pavement subgrade should be compacted to 95 percent relative compaction. Based on the above assumptions, we recommend the following pavement sections be used for preliminary design purposes:

2-Inch	Asphaltic Concrete
6-Inch	Base Course
8-Inch	Total Pavement thickness on a minimum of 3 feet of insitu coralline material and/or properly compacted select material.

The recommended section considers medium subdivision traffic. In areas with heavier traffic, such as main collector roads, the section should be thickened with an additional 1/2-inch asphaltic concrete to provide adequate support for the increased traffic loading.

The base course should be compacted to 95 percent of its maximum dry density as determined in accordance with ASTM Test Method D 1557-91.

CBR and density test and/or field observations should be performed on the actual subgrade used for the roadway subgrade construction to confirm the adequacy of the above pavement sections. The recommended section assumes that adequate drainage will be provided in the paved areas.

Paved areas should be sloped and drainage gradients maintained to carry all surface water off the site. Surface water ponding should not be allowed anywhere on the site during or after construction.

It is anticipated that concrete sidewalks along the subdivision roads will be constructed as part of the road network development. The subgrade for the sidewalk shall be graded to the required cross-section; moisture-conditioned to above optimum moisture content and thoroughly compacted to at least 95% relative compaction.

Utility Trenches

We envision that utility lines will be required for the proposed subdivision project. Granular bedding consisting of 6 inches of No. 3B Fine gravel is recommended under the pipes. Free draining granular materials, such as No. 3B Fine gravel (ASTM C 33, No. 67 gradation), should also be used for the trench backfill, up to about 12 inches above the pipes to provide adequate support around the pipes and to reduce compaction of the backfill, thus reducing the potential for damaging the pipes.

The upper portion of the trench backfill from 1-foot above the pipes to the top of the subgrade or finished grade should consist of select granular material or the onsite coralline borrow fill. The backfill should be moisture conditioned, placed in maximum 8-inch, level, loose lifts, and mechanically compacted to not less than 90 percent relative compaction to reduce the potential for future ground subsidence. Where trenches are below pavement areas, the upper 2 feet of the trench backfill below the pavement subgrade should be compacted to 95 percent relative compaction.

Where the sewer line trench bottom is on expansive clay soils, the trench should be over-excavated below invert elevation by at least 18 inches and replaced with No. 3B Fine gravel wrapped with geofabric comparable to Mirafi 140N or equivalent. The aggregate fill shall be placed in 6-inch layers, compacted and brought to within 6 inches of the invert grade as specified in Section 11.4-B of the Standard Specifications for Public Works Construction. Alternatively, the coralline borrow materials may be used for backfilling the sewer line trench after over excavating below the invert by 24 inches and recompacted as specified above. Excavation and backfill for manholes shall likewise be in accordance with section 11 of the Standard Specifications for Public Works Construction "Trench Excavation and Backfill". These over excavation with granular backfill are measures to limit the effects of possible differential settlements or heave in the utility pipes resulting from changes in moisture content of the surrounding clay soils.

Design Review

Drawings and specifications for the proposed construction should be submitted to PSC Consultants, LLC, as geotechnical consultant, for review and written comments prior to construction. This review is needed to evaluate adherence of the plans to the recommendations provided herein. If this review is not made, PSC cannot assume responsibility for the interpretations made by others, or errors resulting there from.

Construction Observation and Testing

The recommendations provided in this report are based on subsurface conditions disclosed by widely spaced exploratory borings and excavations. The geotechnical consultant should check the interpolated subsurface conditions during construction. The geotechnical consultant should attend the pre-construction meeting between the contractors and owners/designers.

During grading, the geotechnical consultant should:

- Observe excavation, placement, and compaction of engineered fill for new structures and pavements;
- Observe preparation and compaction of aggregate base for asphalt/concrete pavement and flatwork subgrade;
- Check and test any imported materials prior to their use as fill;
- Perform field tests to evaluate fill compaction;
- Observe subgrade conditions at the bottom of pipeline trenches;
- Observe fill placement and compaction around the pipes in the utility trenches; and
- Observe the fine-grading and exterior drainage improvements constructed around the finished structures.

The recommendations provided in this report assume that PSC will be retained as the geotechnical consultant during the construction phase of the project. If another geotechnical consultant is selected, we request that the selected consultant provide a letter to the architect/designer and owner/client (with a copy to PSC) indicating that they fully understand our recommendations and that they are in full agreement with the recommendations contained in this report. If deviations from soil conditions and recommendations presented in this report occur, they should provide amended recommendations as new geotechnical consultants of record for the project.

LIMITATIONS

The analyses and recommendations submitted in this report are based, in part, upon information obtained from field borings. Variations of subsoil conditions between the borings may occur, and the nature and extent of these variations may not become evident until construction is underway. If variations then appear evident, it will be necessary to reevaluate the recommendations provided in this report.

The test pits and boring locations in this report were selected by PSC Consultants LLC, based on the previous boring information done by others and our scope of work. The field locations for the borings and test pits were located by taping from existing features and structures shown on the plans. The physical locations and elevations of the borings should be considered accurate only to the degree implied by the methods used.

The stratification lines shown on graphic representations of the borings depict the approximate boundaries between soil/rock types and, as such, may denote a gradual transition.

This report has been prepared for the exclusive use of Community Planning, Inc., their client, and their consultants for specific application to the proposed 333-lot Kapolei Village 8 development in accordance with generally accepted geotechnical engineering principles and practices. No warranty is expressed or implied.

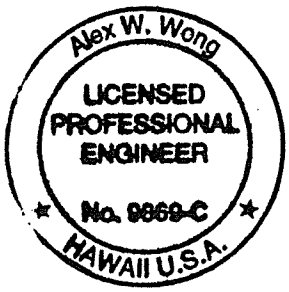
This report has been prepared solely for the purpose of assisting the architect/engineer in the design evaluation of the proposed project. Therefore, it may not contain sufficient data, or proper information to serve as the basis for preparation of construction cost estimates. A contractor wishing to bid on this project is urged to retain a competent geotechnical engineer to assist in the interpretation of this report and/or in the performance of additional site-specific exploration for bid estimating purposes.

The owner/client should be aware that unanticipated soil/rock conditions are commonly encountered. Unforeseen soil/rock conditions, such as perched ground water, soft deposits, hard layers, or cavities, may occur in localized areas and may require probing or corrections in the field (which may result in construction delays) to attain a properly constructed project. Therefore, a sufficient contingency fund is recommended to accommodate these extra costs.

The findings in this report are valid as of the present date. However, changes in the soil conditions can occur with the passage of time, whether they may be due to natural processes, or to the works of man, on this or adjacent properties. In addition, changes in applicable or appropriate standards occur, whether they result from legislation, or from the broadening of knowledge. Accordingly, the findings in this report might be invalidated, wholly or partially, by changes outside of our control. Therefore, this report is subject to review by the controlling agencies and is valid for a period of two years.

Respectfully submitted,

PSC CONSULTANTS, LLC



Joseph Angelo G. Nolasco
Project Engineer

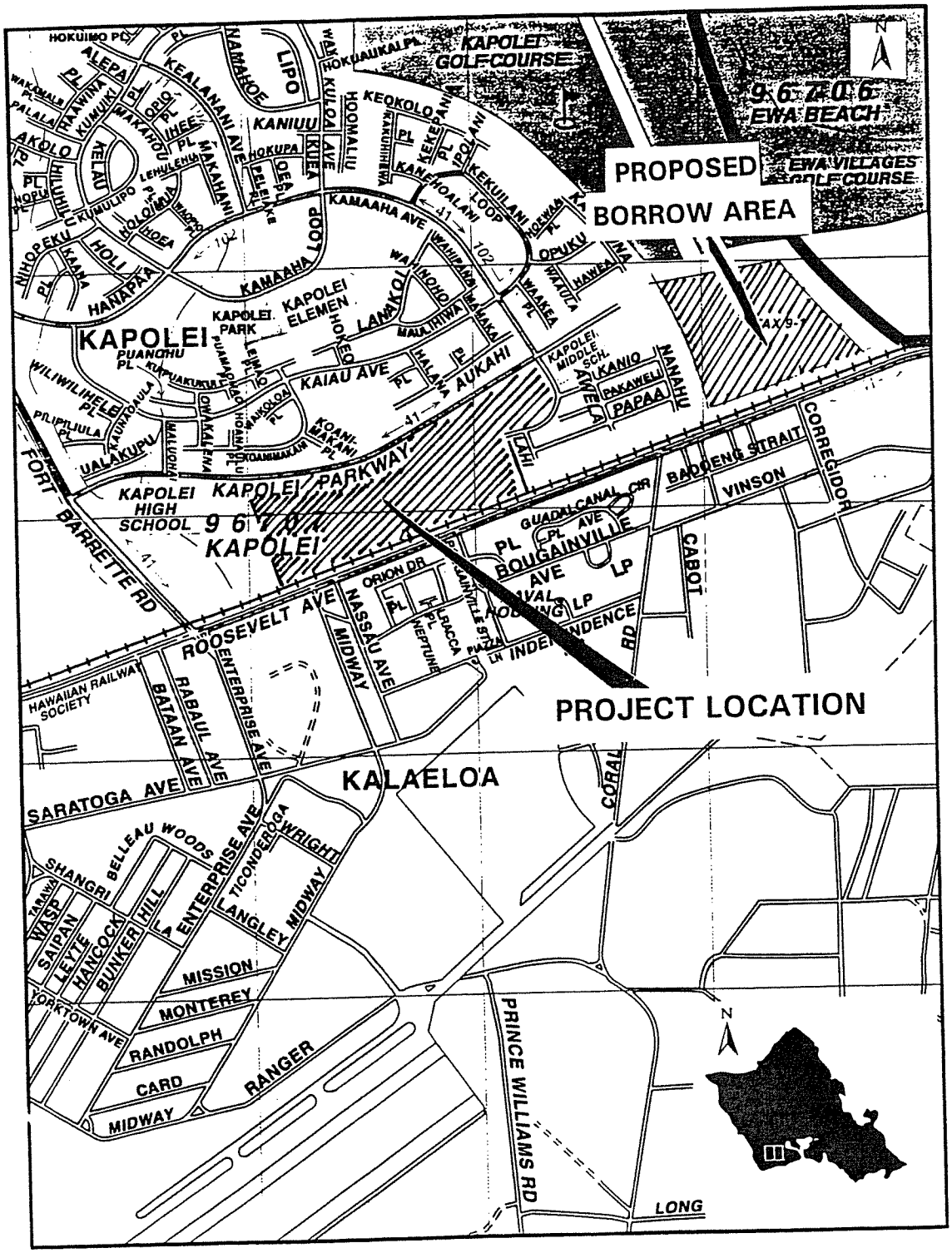
This work was prepared by
me or under my supervision
(License Expires April 30, 2006)

Alex W. Wong, P.E.
Senior Engineer

JGN/ASW/PSC:ch

Enc.:

Plate No. 1	Project Location Map
Plate No. 2 and 2A	Site Plans
Plate No. 3 through 24	Logs of Borings and Test Pits
Plate No. 25	Soil/Rock Classification Chart
Plate No. 26	Rock Classification System
Plate No. 27 through 28	Atterberg Limits Data
Plate No. 29 through 31	Compaction Test Results
Plate Nos. 32 & 33	California Bearing Ratio Data
Plate Nos. 34 through 36	Unconfined Compression Test Data



MAP SCALE: 1" = 1500'

Reference: "The O'AHU MAPBOOK" 2003 Edition, Map 25

PROJECT LOCATION MAP

PSC CONSULTANTS, LLC
SOILS, FOUNDATION, AND GEOLOGICAL ENGINEERS

Proposed Kapolei Village 8
Kapolei Parkway, Kapolei, Oahu, Hawaii

DATE: April 2004 | PROJECT NO. 24301.10

PLATE NO. 1

HHL 02579