# GEOTECHNICAL INVESTIGATION
# OFF-SITE IMPROVEMENTS
# PARADISE HILLS PROJECT
# BADGER CANYON AREA
# TENTATIVE TRACT MAP NO. 18140
# CITY OF SAN BERNARDINO, CALIFORNIA

**PREPARED FOR**

**INLAND COMMUNITIES CORPORATION**

**JOB NO. 06242-3**

C.H.J. Incorporated
1355 E. Cooley Drive, Colton, CA 92324 ◆ Phone (909) 824-7210 ◆ Fax (909) 824-7209
15345 Anacapa Road, Suite D, Victorville, CA 92392 ◆ Phone (760) 243-0506 ◆ Fax (760) 243-1225

June 5, 2006

Inland Communities Corporation
1801 Avenue of the Stars, Suite 1205
Los Angeles, California 90067
Attention: Mr. Jim Ahmad

Job No. 06242-3

Dear Mr. Ahmad:

Attached herewith is the Geotechnical Investigation report, prepared for the off-site improvements, Paradise Hills project, Badger Canyon area, Tentative Tract Map No. 18140, City of San Bernardino, California.

This report was based upon a scope of services generally outlined in our proposal, dated February 21, 2006, and other written and verbal communications.

We appreciate this opportunity to provide geotechnical services for this project. If you have questions or comments concerning this report, please contact this firm at your convenience.

Respectfully submitted,
C.H.J., INCORPORATED

James F. Cooke, Senior Staff Engineer

JFC:dmg

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## INTRODUCTION

During April and May of 2006, a geotechnical investigation for the proposed off-site road and other improvements for the proposed Paradise Hills Project, Badger Canyon Area, Tentative Tract Map No. 18140, City of San Bernardino, California, was performed by this firm. The purpose of this investigation was to explore and evaluate the geotechnical and geologic conditions at the subject alignment and to provide appropriate geotechnical and geologic recommendations for design and construction.

The approximate location of the off-site improvements is shown on the attached Index Map (Enclosure "A-1").

To orient our investigation at the site, an AutoCAD preliminary grading layout, prepared by PBS&J, was provided for our use. The preliminary grading layout included a proposed development scheme with grading contours. The location of the site is shown on the attached Index Map (Enclosure "A-1"). The Preliminary Grading Plan shows existing ground and proposed grades, as well as proposed cut and fill slopes for the road alignments and spreading basin improvements.

The results of our investigation, together with our conclusions and recommendations, are presented in this report.

## SCOPE OF SERVICES

The scope of services provided during this geotechnical investigation included the following:

- Review of published and unpublished literature and maps
- Review and analysis of stereoscopic aerial photographs flown in 1938, 1953, 1963, 1964, 1965, 1971, and 2005
- A geologic field reconnaissance of the alignment and surrounding area

- Geologic mapping of the alignment at a scale of 1 inch equals 200 feet
- Placement of nine exploratory hollow stem auger borings within the road alignment and spreading basin embankment areas
- Laboratory testing on selected samples
- Evaluation of the geotechnical data to develop site-specific recommendations for grading, fill slope stability, and mitigation of potential geotechnical constraints
- Evaluation of the geologic data to develop site-specific recommendations for mitigation of potential geologic hazards and constraints, including cut slope stability and shallow groundwater

## PROJECT CONSIDERATIONS

The proposed road improvements, as currently planned, include an extension of Campus Drive to the west of Tentative Tract Map No. 18140, and an extension of Little Mountain Drive to the east end of Tentative Tract Map No. 18140. These improvements total approximately 9,200 lineal feet of new roadway with approximately six drainage structures. In addition, cut slopes to approximately 25 feet in height and embankments within existing spreading basins are proposed.

Information provided to this office indicates that the subject drainage improvements may include construction of reinforced concrete boxes (RCB), overcrossings, and/or slab bridges. In addition, retention basins are also planned for the area of Exploratory Boring No. 9. The general alignment of the proposed improvements is shown on the attached Geologic Map (Enclosure "A-2").

## SITE DESCRIPTION

The site is located on the southern flank of the western San Bernardino Mountains just north of the California State University campus in the City of San Bernardino, California. The San Andreas Fault Zone (SAFZ) trends through the northern portion of the site along the base of the mountain front. To the west of the site is Devil Canyon Road, and to the east and southeast of the site are residential housing tracts. Flood control/debris basins and access roads characterize the majority of the site. Alluvial fans and active wash channels are present in the northern and eastern portions of the site.

The eastern extension of Campus Drive is proposed in the western portion of the site along the alignment of an existing 20-foot-high flood control embankment. The embankment is comprised of engineered fill material and is flanked on the north by flood control basins. To the south of the embankment is generally undeveloped land. Several campus facility buildings are located just east of Devil Canyon Road.

The northern extension of Little Mountain Drive is proposed in the southeastern portion of the site along the alignment of an existing 20-foot-high flood control embankment and access road. The embankment is comprised of engineered fill material and is flanked on the east by flood control basins. Further to the north, the proposed extension follows an existing access road cut into highly weathered and fractured metamorphic bedrock.

Vegetation on the site consists primarily of a moderate to dense growth of brush and grasses. Several trees exist adjacent to and within the northern and eastern portion of the proposed alignment.

## FIELD INVESTIGATION

The soil conditions underlying the subject alignment were explored by means of nine hollow-stem auger exploratory borings drilled to a maximum depth of 47 1/2 feet below the existing ground surface (bgs). Five of the exploratory borings were drilled with a truck-mounted CME 55 drill rig. Due to access constraints, the remaining four exploratory borings were drilled with a limited access, track-mounted drill rig. Both drill rigs were equipped for soil sampling. The approximate locations of our exploratory borings are indicated on the attached Geologic Map (Enclosure "A-2").

Continuous logs of the subsurface conditions, as encountered within the exploratory borings, were recorded at the time of drilling by a staff geologist from this firm. Relatively undisturbed samples were obtained by driving a split-spoon ring sampler ahead of the borings at selected levels. After the required seating of the sampler, the number of hammer blows required to advance the sampler a total of 12 inches was converted to equivalent SPT data and recorded on the boring logs. The number is the SPT-$N_{60}$ value and has been corrected for hammer type (automatic vs. manual cathead) and sampler size (California sampler vs. SPT sampler). Undisturbed as well as bulk samples of typical soil types obtained were returned to the laboratory in sealed containers for testing and evaluation.

Our exploratory boring logs, together with our equivalent SPT data, are presented in Appendix "B". The stratification lines presented on the boring logs represent approximate boundaries between soil types, which may include gradual transitions.

## LABORATORY INVESTIGATION

Included in our laboratory testing program were field moisture content determinations on all samples returned to the laboratory and field dry densities on all undisturbed samples. The results are included on the boring logs. Optimum moisture content - maximum dry density relationships were established for typical soil types in order that the relative compaction of the subsoils might be evaluated. Remolded direct shear tests were performed on samples representative of the anticipated compacted fill material to provide strength parameters for lateral earth pressure and slope stability calculations. Consolidation tests were performed on selected samples in order to provide consolidation parameters settlement evaluations. Sieve analysis, sand equivalent, and R-value tests were performed on probable street pavement subgrade soils to develop criteria for street pavement design recommendations.

Summaries of the laboratory test results appear in Appendix "C".

## AERIAL PHOTOGRAPH REVIEW

As part of this investigation, aerial photographs dating from 1938 to 2005 were reviewed for past land usage and evidence of geotechnical hazards. The aerial photographs reviewed showed the site as vacant land from 1938 through at least 1953. Several dirt roads were observed to traverse the central portion of the site north of Badger Hill. By 1963, flood-control levees and settling basins were observed in the western and eastern portions of the site. Several dirt roads and disturbed ground associated with access roads were observed to traverse the site and around the base of Badger Hill. In the 2005 aerial photographs, settling basins and flood-control levees were present east-northeast of Badger Hill. No other structures were observed on the site, and no evidence of flooding was observed on the site or adjacent properties in any of the aerial photographs reviewed.

## PREVIOUS INVESTIGATIONS

Prior investigations of Tentative Tract Map No. 18140 were performed during October and December of 2005 (fault hazard investigation, C.H.J., Inc., 2005) and during February and March of 2006 (geotechnical investigation, C.H.J., Inc., 2006). Because some of the on-site soils may be utilized for fill embankment on a portion of the road improvements, these reports were reviewed for pertinent information and, where applicable, utilized to the fullest extent possible.

## SUBSURFACE SOIL CONDITIONS AND GEOLOGIC MATERIALS

As observed during geologic mapping of the site and in our current explorations, the geologic materials at the site included a variety of bedrock and surficial geologic units. The geologic units mapped at the site as part of this investigation (Enclosure "A-2") are discussed below. Additional units are included on the Geologic Map (Enclosure "A-2"), and were discussed in our previous investigation (C.H.J., 2006). Those units, though not identified within the site boundaries of this investigation, were included for completeness of the geologic map. We have adapted the nomenclature of Miller et al. (2001) for the geologic units. A Geologic Index Map is included as Enclosure "A-3".

### FILL (f):

Fill material derived from local alluvial fans and composed of silty sand with gravel was observed in and adjacent to the proposed roadway alignments and within the flood control embankments. Fill was encountered within Exploratory Boring Nos. 3, 4, 5, 7, and 8 at depths ranging from approximately 0.8 foot to 32 feet. Minor amounts of fill may be present in other modified areas of the site and should be addressed at the time of grading.

### VERY YOUNG WASH AND ALLUVIAL-FAN DEPOSITS (Qw, Qf):

Very young deposits of late Holocene age (as designated by Miller et al., 2001) occurred in active drainages, on alluvial-fan surfaces, and on slopes within the site. The very young materials were composed primarily of gray to brown clean sand and silty sand with gravel and cobbles. The colluvial materials tend to be finer-grained and lack cobble-sized clasts relative to the wash deposits that are transported in the higher energy stream beds. Due to rapid emplacement, these materials are typically unconsolidated and may have a potential for settlement.

### YOUNG ALLUVIAL-FAN DEPOSITS (Qyf5, Qyf1):

Young alluvial-fan deposits of late Holocene to late Pleistocene age (as designated by Miller et al., 2001) are derived and transported from the upland areas north of the site along the major canyons (Devil Canyon, Badger Canyon, and Sycamore Canyon) and smaller drainages in the site area. Alluvial-fan materials vary from fine-grained sand to cobble and boulder-sized clasts, are typically rounded, and form interbedded coarse- and fine-grained units of variable lateral extent. Miller et al. (2001) base the relative ages of these units on the degree of consolidation, landscape position, degree of dissection, and grain size (Miller et al., 2001).

**OLD ALLUVIAL-FAN DEPOSITS (Qof3):**

Old alluvial-fan deposits of late Pleistocene age were mapped by Miller et al. (2001) along the base of the mountain front in the Western and Eastern Parcels areas. As observed in our explorations, these materials consisted primarily of consolidated, interbedded gravel and cobble conglomerate with silty sand matrix locally with boulder-sized clasts. Imbricated fluvial and debris flow fabrics occurred locally within the fan deposits. Brown to dark brown color hues are typical. Locally, unconsolidated zones were encountered in some borings based on equivalent blow counts. These less-consolidated zones may be a result of rapid emplacement of materials during debris flow events.

**VERY OLD ALLUVIAL-FAN DEPOSITS (Qvof1):**

Very old alluvial-fan deposits of early Pleistocene age (as designated by Miller et al., 2001) occurred locally as remnants on the uplifted bedrock south of the South Branch SAFZ in the eastern portion of the site.

**BIOTITE MONZOGRANITE (Kmg):**

Monzogranite (herein referred to as granitic) bedrock of Cretaceous age (as designated by Miller et al., 2001) crops out between the Mill Creek and North Branch segments of the SAFZ in the area of the site. These materials are variously sheared and crushed as landslide deposits with pervasive fracture and shear fabric or consist of fresh, intact-appearing rock separated by diffuse shear and fracture surfaces. Straight-trending, slope-normal erosion rills and gullies characterize the drainage patterns formed in these materials. Weathering is intense within the upper few feet of this unit, especially where topography is subdued. Preservation of igneous contacts within the landslide deposits is suggested, in some exposures, by the presence of foliation in a medium-grained, homogeneous-appearing granitic unit near a contact with very fine-grained (possibly hydrothermally altered?), pervasively crushed unit with dark mineral coatings and staining. This contact trends roughly east-west and occurs near the trend of the Mill Creek strand of the SAFZ. It appears that all of the near-surface granitic materials located between the North Branch and Mill Creek strands of the SAFZ are landslide deposits.

**PELONA SCHIST (Mzps):**

The Pelona Schist consists primarily of green, gray, and brown muscovite-chlorite-albite-quartz schist, the age of which is poorly constrained. The Pelona Schist crops out south of the South Branch SAFZ and comprises Badger Hill, a small hill (inselburg) in the southern portion of the site. The schist is typically finely laminated to massive, and is highly fractured and deeply weathered; foliation, jointing, and recumbent folding are pervasive throughout the unit at the site. The unit is highly susceptible to landsliding (Miller and others, 2001). Since significant cut slopes are proposed in this unit along Little Mountain Road, its stability is addressed later in this report.

Groundwater was encountered within Exploratory Boring No. 8 at a depth of approximately 14 feet bgs during this investigation. No other groundwater was encountered.

Bedrock was encountered within Exploratory Boring Nos. 3 and 8 at depths of approximately 0.8 foot and 21 feet bgs, respectively, during this investigation.

Refusal to further advancement of the drilling augers was experienced within Exploratory Boring Nos. 5 and 6 at depths of approximately 41 1/5 feet and 19 feet bgs, respectively, during this investigation.

Slight to moderate caving was experienced within all of the exploratory borings upon removal of the augers.

A more detailed description of the subsurface soil conditions encountered within our exploratory borings is presented on the attached boring logs. (Appendix "B").

## FAULTING

The SAFZ is a major system of faults approximately 800 miles long that forms the tectonic plate boundary between the North American and Pacific tectonic plates. The strands of the SAFZ that traverse the site are considered portions of the "master" fault of this zone that displaces rocks north of the fault northwestward relative to rocks south of the fault at a maximum rate of approximately 2 inches per year. This displacement occurs in an uneven fashion along the various segments of the fault zone producing earthquake events (on average approximately every 140 years for the southern portions) and an accumulated horizontal offset of approximately 350 miles since the inception of faulting along the fault zone.

The northern and eastern portions of the site are located within an Alquist-Priolo Fault Zone (APZ) designated by the State of California to include traces of suspected active faulting within the San Andreas fault zone. The boundaries of the APZ are shown on Enclosure "A-2". The on site geologic concerns associated with the SAFZ were addressed during our previous investigation (C.H.J., Inc., 2005).

## SLOPE STABILITY

### SLOPE STABILITY ANALYSES:

We performed slope stability analyses for the on-site geotechnical investigation of Tentative Tract No. 18140. It is our understanding that the fills for the Campus Drive extension will most likely be constructed from the on-site materials. For the Little Mountain Drive extension, the fills will most likely be constructed from some combination of on-site material and Pelona Schist. The off-site material shear strengths have been compared to the on-site material and, based upon the comparison, it is our opinion that the recommendations provided in that referenced report are valid and should be utilized for the off-site slope design and construction. Those recommendations are provided here for completeness.

Based on our previous exploratory boring data and direct shear results, we generalized the native soil profile to consist of 15 feet of silty sands (SM), underlain by sands (SP-SM, or SW-SM). Two types of fill materials, with higher friction angle and lower cohesion strength and lower friction angle and higher cohesion strength, were selected based on direct shear results of remolded samples. Due to the high value of the seismic coefficient, peak shear strengths were utilized in the calculations of seismic slope stability, while residual shear strengths were utilized for static slope stability. The strength parameters utilized are summarized in Table 1.

**Table 1: Strength Parameters Utilized in Calculation**

| | Static Condition | | Seismic Condition | |
|---|---|---|---|---|
| | $C_{res}$ (psf) | $\phi_{res}$ (°) | $C_{peak}$ (psf) | $\phi_{peak}$ (°) |
| Fill Type 1 | 0 | 38 | 60 | 38 |
| Fill Type 2 | 80 | 35 | 120 | 35 |
| Silty Sand | 60 | 31 | 50 | 33 |
| Sand | 100 | 35 | 150 | 34 |

Due to the high seismic coefficient, the seismic condition controls the slope stability of this site. Therefore, in our previous calculations, we evaluated the maximum stable height of 2(h):1(v) slopes at the seismic condition (Seismic Factor of Safety≥ 1.1) and then confirmed the static stability (Static Factor of Safety≥ 1.5) using residual shear strength.

The results of our previous slope stability analyses are summarized in Table 2.

**Table 2: Summary of Slope Stability Results**

| Slope Type | Fill Material | Maximum Slope Height (ft) | Minimum Bench (ft) |
|---|---|---|---|
| Fill Slope | Type 1 | 55 | 8 |
| | Type 2 | 30 | 0 |
| Fill Over Cut Slope | Type 1 | 40 | 6 |
| | Type 2 | 40 | 6 |

Based on the results of our slope stability calculations, it is our conclusion that special fill reinforcement measures, such as utilization of Geogrid, will be necessary if slopes are planned that will be steeper than 2(h):1(v) or higher than those shown in Table 2.

Because the slope stability depends significantly on the cohesive strength of fill materials, the stability of the fill and fill over cut slopes should be further evaluated during grading by verifying the strength parameters of the fill materials with additional direct shear testing performed by the geotechnical engineer on a regular basis. Fill material having the requisite strength parameters as shown in Table 1 should extend horizontally from the slope face to a distance equal to the proposed slope height or 15 feet, whichever is greater.

## PROPOSED CUT SLOPES:

Northwesterly-facing cut slopes in Pelona Schist (map unit Mzps) up to approximately 25 feet in maximum height are proposed along Little Mountain Road at the southeast end of Badger Hill. In addition, a retaining wall approximately 10 feet in height is proposed along the northwest side of the road in the same area.

The critical factors affecting the stability of the proposed bedrock cut slopes and back cuts are: 1) the presence or absence of existing shallow or deep-seated landslides in the proposed slopes; and 2) the underlying structure of the native materials, particularly the foliation developed in the bedrock.

Large landslides are common in the Pelona Schist terrain in this area. In fact, many of the small hills comprised of Pelona Schist in the San Bernardino area appear to be comprised largely of previously failed (landslide) material. No evidence of large, deep-seated landslides was observed along the proposed alignment.

As shown on the Geologic Map (Enclosure "A-2"), foliation and jointing in the area of the proposed cut slopes on Little Mountain Road are chaotically oriented. The chaotic orientation of these structures is expected to limit the size of any potential slope failures that could occur as a result of grading. In other words, the potential for deep-seated slope failure is expected to be low. The potential for smaller, pop-out-type failures in finished cut slopes may be significant.

Cut slopes and retaining wall back cuts that expose significant adverse foliation components (components that dip out of slope) may require remedial measures, such as flattening, buttressing, or re-design, due to the potential for triggering a landslide along foliation.

Should significant adverse foliation be exposed in a cut slope or back cut, or adverse jointing results in a large amount of loose rock on the slope face, a buttress/stabilization fill may be recommended. A typical buttress/stabilization fill detail is included in Appendix "D". The need for buttress/stabilization fills in bedrock cut slopes should be determined at the time of grading by the engineering geologist.

## SETTLEMENT

Field density tests and SPT data indicate that the upper younger alluvial soils are in place in a loose to dense state. With the exception of Exploratory Boring No. 7, consolidation testing of these soils indicates they have a low to moderate (0.7 to 1.7 percent) potential for hydroconsolidation. Within Exploratory Boring No. 7, the sample of the native soils obtained from a depth of 10 feet exhibited a high potential for hydroconsolidation (5.4 percent). Because of the hydroconsolidation potential, we recommend that all such soils within the area of Exploratory Boring No. 7 be completely removed and replaced as properly compacted material.

## GROUNDWATER AND LIQUEFACTION

With the exception of surface water flowing in a small creek located in the eastern portion of the site, no evidence of springs or perched groundwater conditions was observed south of the SAFZ on the site during the geologic field reconnaissance, the geologic mapping, or on the aerial photographs reviewed. In contrast, abundant evidence of a significant groundwater barrier formed by the SAFZ was observed in the form of heavy water seepage in trench exposures that crossed the fault zone during our previous investigation (C.H.J., Inc., 2005). During this investigation, perched groundwater was encountered at a depth of approximately 14 feet bgs within Exploratory Boring No. 8 located near the trace of the fault.

According to our review of available groundwater data, water wells representative of the groundwater conditions in the alluvium south of the SAFZ are not present within the site. Wells located south of the Devil Canyon levee and Badger Hill showed groundwater depths of greater than 80 feet bgs for the time period from 1993 to present. These wells are situated at a lower elevation than the site. Though perched groundwater was encountered at a depth of approximately 14 feet bgs within Exploratory Boring No. 8 located near the trace of the fault, the depth to groundwater within the alluvial fan sediments at the site is anticipated to be greater than 52 feet bgs. Based upon the anticipated depth to groundwater and the poorly-sorted, granular character of the materials that underlie the alluvial fans of the site, the hazards posed by shallow groundwater are expected to be low in the site area.

Liquefaction is a process in which strong ground shaking causes saturated soils to lose their strength and behave as a fluid (Matti and Carson, 1991). Ground failure associated with liquefaction can result in severe damage to structures. The geologic conditions for increased susceptibility to liquefaction are: 1) shallow depth to groundwater (i.e., less than 50 feet); 2) the presence of unconsolidated sandy alluvium, typically Holocene in age; and 3) strong ground shaking. All three of these conditions must be present for liquefaction to occur. Based upon available groundwater data and geologic conditions encountered during this investigation, only one of the three geologic conditions for increased liquefaction susceptibility (strong ground shaking) is expected to exist on the site after removal of any loose hydroconsolidatable soils. Therefore, liquefaction is not considered to be a potential hazard to the proposed development.

At exposed interfaces, such as alluvium/bedrock contacts and fill over cut slopes, a potential exists for springs or seeps to develop, especially when considering future landscape irrigation. The seeps may result in minor nuisances or, in extreme cases, may lead to slope failure. Such contacts will need to be evaluated on a case-by-case basis as part of the geologic in-grading observation, and remedial measures may be necessary. Potential mitigation methods for fill over cut slopes include construction of a stabilization fill with a back-drain system. Such stabilization fills could also provide cosmetic improvement of slopes.

Subdrains are expected to be recommended where drainages/canyons are filled. Final subdrain locations and design should be determined by the engineering geologist and geotechnical engineer during grading.

## EXCAVATION POTENTIAL

Bedrock was not exposed on the surface at the site, nor was any bedrock encountered in the exploratory borings conducted as part of this investigation. However, there is a possibility of shallow bedrock existing in the northern portions of the site. Deep cuts performed as part of development may expose bedrock. The bedrock is expected to be generally rippable with conventional grading equipment (D-9 bulldozer or equivalent) to the depths planned, although no geophysical evaluation with respect to rippability has been performed.

## FLOODING AND EROSION

No evidence of recent significant flooding of the site was observed during the geologic field reconnaissance. An evaluation of the hazard of flooding to the site and potential mitigation methods lies outside the purview of this firm.

On-site materials are moderately susceptible to erosion by water and wind. Finish graded areas should be protected from the effects of runoff and wind erosion.

## CONCLUSIONS

On the basis of our field and laboratory investigations, it is the opinion of this firm that the proposed off-site road and spreading basin improvements including storm drainage improvements consisting of RCBs, overcrossings, and/or slab bridges are feasible from a geotechnical standpoint, provided the recommendations contained in this report are implemented during grading and construction.

No large landslides or surficial failures were mapped on or adjacent to the alignment during this investigation. However, evidence of this type of failure in these materials is quickly obscured by erosion and vegetation cover. It is our opinion that all steep slopes (steeper than approximately 2[h]:1[v]) in the Pelona Schist should be considered to have a potential for surficial failure and the generation of debris flows downslope of them.

As shown on the Geologic Map (Enclosure "A-2"), foliation and jointing in the area of the proposed cut slopes on Little Mountain Road are chaotically oriented. The chaotic orientation of these structures is expected to limit the size of any potential slope failures that could occur as a result of grading. In other words, the potential for deep-seated slope failure is expected to be low. The potential for smaller, pop-out type failures in finished cut slopes may be significant.

Within the off-site road alignments, it is our opinion that the upper 36 inches of native soils will not, in their present condition, provide uniform or adequate support for the proposed roadway alignment. Undocumented fill, animal burrows, and heavy vegetation provide unsuitable and highly variable conditions within the upper 36 inches of soil. This condition may cause unacceptable differential settlement. Removals on the order of approximately 36 inches below native ground surface should be sufficient to mitigate this concern. During grading, isolated areas of deeper removal may be encountered. The extent and depth of removal should be confirmed by the engineering geologist. These removals should encompass the entire area to be graded. The removed and cleaned soils may be reused as properly compacted fill.

Within the western portion of the alignment in the area of Exploratory Boring No. 7, it is our opinion that undocumented fill and recent alluvium soils within the drainage channel up to 15 feet below the native ground surface should be removed to dense alluvium soils in order to reduce potential settlement of the roadway and existing embankment. During grading, isolated areas of deeper removal may be encountered. The extent and depth of removal should be confirmed by the engineering geologist. These removals should encompass the entire area of the drainage channel bottom to be graded.

Undocumented fill was encountered in Exploratory Boring Nos. 3, 4, 5, 7 and 8 at depths of 0.8, 15, 32, 7, and 2.5 feet bgs, respectively. Other areas of undocumented fill may be encountered during grading. All such undocumented fill should be completely removed if allowed. Complete removal should be confirmed by the engineering geologist. However, complete removal may not be possible due to issues with removal of flood control structures and berms by the flood control district.

The current depth to groundwater at the site is not known; however, based on the historical groundwater data and the present grade of the site, a minimum depth to groundwater of greater than 50 feet bgs beneath the lower elevations of the alignment during the life of the project does not appear to be unreasonable or overly conservative. Due to the depth to groundwater and age and density of the alluvium and bedrock at the site, liquefaction is not considered to be a potential hazard to the site.

Mixture and moisture treatment of backfill material outside of the excavation prior to lift placement in the RCB or trench backfill excavations would help to prevent overly wet "pumping" conditions during backfill operations.

Cut slopes as high as 30 feet in the Pelona Schist are expected to remain stable at a maximum inclination of 2(h):1(v). Nevertheless, all cut slopes will be subject to surficial raveling. All cut slopes and retaining wall back cuts should be evaluated on a case-by-case basis during grading by the project engineering geologist.

Fill slopes should be constructed no steeper than 2(h):1(v). Based on the results of our slope stability calculations, it is our conclusion that special fill reinforcement measures, such as utilization of Geogrid, will be necessary if slopes are planned that will be steeper than 2(h):1(v) or higher than those shown in Table 2 under the section entitled SLOPE STABILITY ANALYSES. **Because the slope stability depends significantly on the cohesive strength of fill materials, the stability of the fill slopes should be further evaluated during grading by verifying the strength parameters of the fill materials with additional direct shear testing performed by the geotechnical engineer on a regular basis. Fill material having the requisite strength parameters should extend horizontally from the slope face to a distance equal to the proposed slope height.**

No evidence of recent significant flooding of the site or surrounding area was observed. Further evaluation of the flood hazard falls under the purview of others.

## RECOMMENDATIONS

### GENERAL SITE GRADING:

It is imperative that no clearing and/or grading operations be performed without the presence of a representative of the geotechnical engineer. An on-site pre-job meeting with the developer, the contractor and the geotechnical engineer should occur prior to all grading-related operations. Operations undertaken at the site without the geotechnical engineer present may result in exclusions of affected areas from the final compaction report for the project.

Grading of the subject site should be performed, at a minimum, in accordance with these recommendations and with applicable portions of California Building Code (CBC). The following recommendations are presented for your assistance in establishing proper grading criteria.

**INITIAL SITE PREPARATION:**

All areas to be graded should be stripped of significant vegetation and other deleterious materials. These materials should be removed from the site for disposal. Any existing utility lines should be traced, removed, and rerouted.

To assist in undocumented fill and loose/hydroconsolidatable native soil identification, removal, and densification, it is our opinion that a minimum depth of 36 inches of existing soil below the existing ground surface within all areas to be graded should be completely removed and cleaned of significant deleterious materials. The removed and cleaned soils may be reused as properly compacted fill. In areas where the undocumented fill and loose/hydroconsolidatable native soils are not removed by the mandatory 36-inch removal or site grading, additional removals may be necessary. The bottoms of the excavations should be observed by the engineering geologist to verify the complete removal of undocumented fill material and loose/hydroconsolidatable native soils.

It is our recommendation that all existing fills and loose/hydroconsolidatable native soils under any proposed paved and flatwork areas be removed and replaced with properly compacted and controlled fills. If this is not done and any uncontrolled fills are left beneath the pavement, premature structural distress of the paved and flatwork areas can be expected. However, complete removal may not be possible due to issues with removal of flood control structures and berms by the flood control district. It is our opinion that decreased settlement will result from increasing the amount of existing fill and loose/hydroconsolidatable native soils removed, with complete removal of all existing fill and loose/hydroconsolidatable native soils being the upper limit on reasonable efforts to minimize settlement. Because of uncertainties in the composition of undocumented fill and on the preparation of the native soils prior to placement, settlement of any undocumented fill left in place can not be quantified.

Following approval, the excavation bottoms should be scarified to a depth of approximately 12 inches, brought to between optimum moisture content and 3 percent above, and recompacted to at least 90 percent relative compaction (ASTM D 1557) prior to refilling the excavation to grade as properly compacted fill. In addition, all fills placed below a depth of 10 feet below finish grade surface should be compacted to at least 95 percent relative compaction.

Cavities created by removal of subsurface obstructions such as structures, individual effluent disposal systems, and trees, and by the exploratory trenches utilized for the prior subsurface investigation of faulting, should be thoroughly cleaned of loose soil, organic matter and other deleterious materials, shaped to provide access for construction equipment, and backfilled as recommended for site fill.

**PREPARATION OF FILL AREAS:**

Prior to placing fill, the surfaces of all areas to receive fill should be scarified to a depth of 12 inches or more. The scarified soils should be brought to between optimum moisture content and 3 percent above and recompacted to a minimum relative compaction of 90 percent in accordance with ASTM D 1557.

**PREPARATION OF RETAINING WALL FOOTING AREAS:**

All footings should rest upon approved original ground or at least 18 inches of properly compacted fill material . In areas where original ground is unsuitable or the required thickness of compacted fill is not accomplished by site rough grading and mandatory removals, the footing areas should be subexcavated to a depth of 18 inches or more below the proposed footing base grade, with the subexcavation extending at least 5 feet beyond the foundation lines at the bottom of the excavation. This subexcavation operation should include a minimum of the upper 36 inches of existing material within the foundation areas even though planned filling will be sufficient to satisfy compacted fill thickness requirements. The removal of the upper 36 inches of existing material, regardless, is to assist in loose upper alluvial soils and uncontrolled fill identification.

The bottoms of the excavations should then be scarified to a depth of at least 12 inches, brought to between optimum moisture content and 3 percent above, and recompacted to a minimum of 90 percent relative compaction in accordance with ASTM D 1557 prior to refilling the excavation to grade as properly compacted fill.

**PREPARATION OF STRUCTURAL AREAS:**

Structural elements, such as RCBs or overcrossing foundation systems, should rest upon at least 18 inches of properly compacted soil or approved original ground soils. Unsuitable foundation soil conditions, such as encountered in Exploratory Boring No. 7, should be completely removed and replaced with properly compacted fill material. As an alterative, replacement with a lean slurry sand/cement slurry or crushed rock and geotextile may be recommended if necessary for bottom stabilization.

**COMPACTED FILLS:**

The on-site soils should provide adequate quality fill material provided they are free from organic matter and other deleterious materials. Rock or similar irreducible material with a maximum dimension greater than 12 inches should be buried or placed in fills in accordance with recommendations described under the section entitled OVERSIZED MATERIALS.

Import fill should be inorganic, non-expansive granular soils free from rocks or lumps greater than 8 inches in maximum dimension. Sources for import fill should be observed and approved by the geotechnical engineer prior to their use.

Fill should be spread in near-horizontal layers, approximately 8 inches in thickness. Thicker lifts may be approved by the geotechnical engineer if testing indicates that the grading procedures are adequate to achieve the required compaction. Each lift shall be spread evenly, thoroughly mixed during spreading to attain uniformity of the material and moisture in each layer, brought to between optimum moisture content and 3 percent above, and compacted to a minimum relative compaction of 90 percent in accordance with ASTM D 1557. In addition, all fills placed below a depth of 10 feet below finish grade surface should be compacted to at least 95 percent relative compaction.

Based upon the relative compaction of the native soils determined during this investigation, and the relative compaction anticipated for compacted fill soils, we estimate a compaction shrinkage of approximately 7 to 12 percent. Therefore, 1.07 cubic yards to 1.12 cubic yards of in-place soil material would be necessary to yield 1.0 cubic yard of properly compacted fill material. In addition, we would anticipate subsidence of approximately 0.1 foot. These values are exclusive of losses due to stripping, tree removal, or the removal of other subsurface obstructions, if encountered, and may vary due to differing conditions within the project boundaries and the limitations of this investigation.

Values presented for shrinkage and subsidence are estimates only. Final grades should be adjusted, and/or contingency plans to import or export material should be made to accommodate possible variations in actual quantities during site grading.

## OVERSIZED MATERIAL:

It is anticipated that 1 to 5 percent of oversized material (boulders greater than 12 inches) requiring special handling for disposal may be encountered during grading. While site-specific recommendations may be developed during grading plan preparation or in the field during construction, we are providing general methods for disposing of oversized rock on site for preliminary consideration.

Rocks greater than 12 inches in size should not be placed within 10 feet of finish grade. It should be cautioned that large rock below a depth of 10 feet may present difficulties in installing structures or utilities below that depth. Oversized material should not be "nested". Large rocks should be spread out when placed within the fill in a manner that will allow compaction of soil fill around the individual oversized rocks.

## SLOPE CONSTRUCTION:

We have prepared the following general recommendations for slope construction that are typical for projects of this type.

Cut slopes as high as 30 feet in the Pelona Schist are expected to remain stable at a maximum inclination of 2(h):1(v). Nevertheless, all cut slopes will be subject to surficial raveling. All cut slopes and retaining wall back cuts should be evaluated on a case-by-case basis during grading by the project engineering geologist.

Fill slopes should be constructed no steeper than 2(h):1(v). Based on the results of our slope stability calculations, it is our conclusion that special fill reinforcement measures, such as utilization of Geogrid, will be necessary if slopes are planned that will be steeper than 2(h):1(v) or higher than those shown in Table 2 under the section entitled SLOPE STABILITY ANALYSES. **Because the slope stability depends significantly on the cohesive strength of fill materials, the stability of the fill slopes should be further evaluated during grading by verifying the strength parameters of the fill materials with**

**additional direct shear testing performed by the geotechnical engineer on a regular basis. Fill material having the requisite strength parameters should extend horizontally from the slope face to a distance equal to the proposed slope height.**

Fill slopes should be overfilled during construction and then cut back to expose fully compacted soil. Where fills are to be placed against existing slopes steeper than 5(h):1(v), the existing slopes should be benched into competent native materials to provide a series of level benches to seat the fill and to remove the compressive and permeable topsoils. The benches should be a minimum of 8 feet in width, constructed at approximately 4-foot vertical intervals. In addition, a shear key should be constructed across the toe of the slope. The shear key should be a minimum of 15 feet wide and should penetrate a minimum of 2 feet beneath the toe of the slope into firm competent soils (Appendix "D").

Potentially unstable boulders exposed in the slope faces should be removed during construction.

**SLOPE CREEP:**

The outer, upper portions of cut and fill slopes will be subject to potential long-term movements due to creep or erosion forces. All proposed improvements planned near or on the top of slopes, including garden walls, flatwork, and pools, should be designed and constructed to reduce the effects of this movement. Where possible, improvements should be designed as far from the top of the slope as possible. At a minimum, footings should be designed so that there is a least a 5-foot separation from the face of the slope to the face of the footing. This may necessitate deepened footings. The actual design of walls near the tops of slopes will be based on the wall loading conditions and the earth pressure required to resist these loads. This will fall under the purview of the wall designer, who should consult this firm if actual earth pressure information is required.

**SLOPE PROTECTION:**

Inasmuch as the native materials are susceptible to erosion by running water, it is our recommendation that the slopes at the project be planted as soon as possible after completion. The use of succulent ground covers, such as iceplant or sedum, is not recommended. If watering is necessary to sustain plant growth on slopes, then the watering operation should be monitored to assure proper operation of the water system and to prevent overwatering.

Measures should be provided to prevent surface water from flowing over slope faces.

## SUBDRAINS:

Fill construction may involve placement of relatively permeable fill over less permeable native materials. The result may be conditions conducive to ponding or perching of landscape irrigation water at the fill/native interfaces. Additionally, cuts may also expose perched water, springs, and seeps. Subdrains may be recommended based on conditions observed by the engineering geologist at the time of grading. A typical subdrain design is included in Appendix "D" of this report.

If encountered, springs and seeps in cut areas or areas with a potential for springs and seeps will need evaluation on a case-by-case basis as to the most practical mitigation recommendations. The need for subdrains or alternative mitigation recommendations should be made by the engineering geologist at the time of grading.

## RETAINING WALL FOUNDATION DESIGN (Conventional Spread Foundations):

If the site is prepared as recommended, proposed retaining walls may be safely founded on conventional spread foundations, either individual spread footings and/or continuous wall footings, bearing on approved original ground or at least 18 inches of properly compacted fill material. Footings should be a minimum of 12 inches wide and should be established at a minimum depth of 12 inches below lowest adjacent final subgrade level. For the minimum width and depth, footings may be designed for a maximum safe soil bearing pressure of 2,000 psf for dead plus live loads. This allowable bearing pressure may be increased by 500 psf for each additional foot of width and by 1,000 psf for each additional foot of depth to a maximum safe soil bearing pressure of 3,500 psf for dead plus live loads. These bearing values may be increased by one-third for wind or seismic loading. Toe bearing pressure for walls on soils not bearing on approved original ground or at least 18 inches of properly compacted fill material as described earlier under PREPARATION OF FOOTING AREAS should not exceed CBC values.

## DRAINAGE STRUCTURE FOUNDATION DESIGN:

Although no building structures are proposed, other structures such as RCBs and overcrossing foundation systems may be safely founded on conventional spread foundations, either individual spread footings and/or continuous wall footings or a mat-type foundation system, bearing entirely on a minimum of 18 inches of compacted soil or entirely upon approved original ground soils. Any single individual footing or mat should not span from a cut to fill situation. The engineering geologist should observe and approve the bottom of all excavations, either the foundation placed on original ground soils, or prior to scarification or placement of fill.

Footings should be a minimum of 12 inches wide and should be established at a minimum depth of 12 inches below lowest adjacent final subgrade level. For the minimum width and depth, footings may be designed for a maximum safe soil bearing pressure of 2,000 psf for dead plus live loads. This allowable bearing pressure may be increased by 500 psf for each additional foot of width and by 1,000 psf for each additional foot of depth to a maximum safe soil bearing pressure of 3,500 psf for dead plus live loads. These bearing values may be increased by one-third for wind or seismic loading.

**LATERAL LOADING:**

Resistance to lateral loads will be provided by passive earth pressure and base friction. For footings bearing against compacted fill, passive earth pressure may be considered to be developed at a rate of 400 psf per foot of depth. Base friction may be computed at 0.40 times the normal load. Base friction and passive earth pressure may be combined without reduction.

For preliminary retaining wall design purposes with level, properly drained backfill and no additional surcharge loadings, a lateral active earth pressure developed at a rate of 35 psf per foot of depth should be utilized for unrestrained conditions. For restrained conditions, an at-rest earth pressure of 65 psf per foot of depth should be utilized.

For walls with 2(h):1(v) inclined properly drained backfill with no additional surcharge loadings, a lateral active earth pressure developed at a rate of 55 psf per foot of depth should be utilized for unrestrained conditions. For restrained conditions, an at-rest earth pressure of 95 psf per foot of depth should be utilized.

For walls with 1.5(h):1(v) inclined properly drained backfill as provided for in the section entitled SLOPE CONSTRUCTION, with no additional surcharge loadings, a lateral active earth pressure developed at a rate of 75 psf per foot of depth should be utilized for unrestrained conditions. For restrained conditions, an at-rest earth pressure of 105 psf per foot of depth should be utilized.

The "at-rest" condition applies toward braced walls which are not free to tilt. The "active" condition applies toward unrestrained cantilevered walls where wall movement is anticipated. The structural designer should use judgment in determining the wall fixity and may utilize values interpolated between the "at-rest" and "active" conditions where appropriate. These values do not include a factor of safety other than conservative modeling of the soil strength parameters. If backfills inclined at other than 2(h):1(v) are proposed, this firm should be contacted to develop appropriate earth pressure parameters. If import material is to be utilized for backfill, an engineer from this firm should verify the backfill has equivalent or superior strength values.

These values should be verified prior to construction when the backfill materials and conditions have been determined and are applicable only to properly drained backfills with no additional surcharge loadings. Toe bearing pressure for walls on soils not bearing against compacted fill as described earlier under PREPARATION OF FOOTING AREAS should not exceed CBC values.

Backfill behind retaining walls should consist of a soil of sufficient granularity that the backfill will properly drain. The granular soil should be classified per the USCS as either a GW, GP, SW, SP, SW-SM, or SP-SM. Surface drainage should be provided to prevent ponding of water behind walls. A drainage system should be installed behind all retaining walls consisting of any of the following:

1. A 4-inch diameter perforated PVC (Schedule 40) pipe or equivalent at the base of the stem encased in 2 cubic feet of granular drain material per linear foot of pipe; or
2. Synthetic drains such as Enkadrain, Miradrain, Hydraway 300, or equivalent.

Perforations in the PVC pipe should be 3/8 inch in diameter. Granular drain material should be wrapped with filter cloth to prevent clogging of the drains with fines. Walls should be waterproofed to prevent nuisance seepage. Water should outlet to an approved drain.

Foundation concrete should be placed in neat excavations with vertical sides, or the concrete should be formed and the excavations properly backfilled as recommended for site fill.

**PRELIMINARY FLEXIBLE PAVEMENT DESIGN:**

Representative samples of probable subgrade soils were taken from the subject tract and returned to this laboratory. In the laboratory, sieve analysis and sand equivalent tests were performed on each sample. Upon completion of the sieve analysis and sand equivalent testing, an R-value (RV) test was performed on the sample considered most representative. Based upon the results of these tests (RV = 66) and a range of traffic indices (T.I.s) anticipated for the project, we recommend the following preliminary pavement structural section designs. The actual street T.I. will need to be determined prior to paving in order to allow the appropriate street section to be utilized.

| T.I. of Street | Recommended Section |
|---|---|
| 5.0 | 0.25' AC/0.35' AB Class 2 |
| 5.5 | 0.25' AC/0.35' AB Class 2 |
| 6.0 | 0.30' AC/0.35' AB Class 2 |
| 6.5 | 0.30' AC/0.35' AB Class 2 |
| 7.0 | 0.35' AC/0.35' AB Class 2 |
| 7.5 | 0.35' AC/0.35' AB Class 2 |
| 8.0 | 0.40' AC/0.35' AB Class 2 |

The above structural sections are predicated upon proper compaction of the utility trench backfills and the subgrade soils, with the upper 6 inches of subgrade soils and all aggregate base material brought to a minimum relative compaction of 95 percent in accordance with ASTM D 1557 prior to paving. The aggregate base should meet Caltrans requirements for Class 2 base.

It should be noted that the above pavement designs were based upon the results of preliminary sampling and testing, and should be verified by additional sampling and testing during construction when the actual subgrade soils are exposed.

C.H.J., Incorporated does not practice traffic engineering. The T.I.s used to develop the recommended pavement sections are typical for projects of this type. We recommend that the T.I.s used be reviewed by the project civil engineer or traffic engineer to verify that they are appropriate for this project.

**SOIL CORROSIVITY TESTS:**

Selected samples of material were delivered to Schiff Associates for soil corrosivity tests. Laboratory testing consisted of pH, resistivity, and major soluble salts commonly found in soils. The results of the laboratory tests performed by Schiff Associates are enclosed.

Values from the soils tested are considered mildly corrosive at as-received and mildly to moderately corrosive at saturated moisture conditions to ferrous metals at the site.

Results of the soluble sulfate testing indicate a "negligible" anticipated exposure to sulfate attack, as indicated on the enclosed test results. Based upon the criteria from Table 4.3.1. of the American Concrete Institute (ACI) Manual of Concrete Practice (2000), no special measures, such as specific cement types, water-cement ratios, etc., will be needed for this "negligible" exposure to sulfate attack.

Soluble chloride content of soil was not at levels high enough to be of concern with respect to corrosion of reinforcing steel. The results should be considered in combination with the soluble chloride content of the hardened concrete in determining the effect of chloride on the corrosion of reinforcing steel.

It should be understood that C.H.J., Incorporated does not practice corrosion engineering and that the chemical/corrosivity suite of tests was performed for preliminary screening and possible evaluation by a competent corrosion engineer. If further information concerning the corrosion characteristics, or interpretation of the results submitted herein, are required, then a competent corrosion engineer could be consulted.

**GRADING PLAN REVIEW:**

The final grading plan should be reviewed and approved by the geotechnical engineer and engineering geologist prior to grading.

**CONSTRUCTION OBSERVATION:**

All grading operations, including site clearing and stripping, should be observed by a representative of the geotechnical engineer. The presence of the geotechnical engineer's field representative will be for the purpose of providing observation and field testing, and will not include any supervising or directing of the actual work of the contractor, his employees or agents. Neither the presence of the geotechnical engineer's field representative nor the observations and testing by the geotechnical engineer shall excuse the contractor in any way for defects discovered in his work. It is understood that the geotechnical engineer will not be responsible for job or site safety on this project, which will be the sole responsibility of the contractor.

## LIMITATIONS

C.H.J., Incorporated has striven to perform our services within the limits prescribed by our client, and in a manner consistent with the usual thoroughness and competence of reputable geotechnical engineers and engineering geologists practicing under similar circumstances. No other representation, express or implied, and no warranty or guarantee is included or intended by virtue of the services performed or reports, opinion, documents, or otherwise supplied.

This report reflects the testing conducted on the site as the site existed during the investigation, which is the subject of this report. However, changes in the conditions of a property can occur with the passage of time, due to natural processes or the works of man on this or adjacent properties. Changes in applicable or appropriate standards may also occur whether as a result of legislation, application, or the broadening of knowledge. Therefore, this report is indicative of only those conditions tested at the time of the subject investigation, and the findings of this report may be invalidated fully or partially by changes outside of the control of C.H.J., Incorporated. This report is therefore subject to review and should not be relied upon after a period of one year.

The conclusions and recommendations in this report are based upon observations performed and data collected at separate locations, and interpolation between these locations, carried out for the project and the scope of services described. It is assumed and expected that the conditions between locations observed and/or sampled are similar to those encountered at the individual locations where observation and sampling was performed. However, conditions between these locations may vary significantly. Should conditions be encountered in the field, by the client or any firm performing services for the client or the client's assign, that appear different from those described herein, this firm should be contacted immediately in order that we might evaluate their effect.

If this report or portions thereof are provided to contractors or included in specifications, it should be understood by all parties that they are provided for information only and should be used as such.

The report and its contents resulting from this investigation are not intended or represented to be suitable for reuse on extensions or modifications of the project, or for use on any other project.

## CLOSURE

We appreciate this opportunity to be of service and trust this report provides the information desired at this time. Should questions arise, please do not hesitate to contact this office.

Respectfully submitted,
C.H.J., INCORPORATED

Jan M. Strickland, Staff Geologist

James F. Cooke, Senior Staff Engineer

Jay J. Martin, E.G. 1529
Vice President

REGISTERED GEOLOGIST
JAY J. MARTIN
No. 1529
CERTIFIED ENGINEERING GEOLOGIST
Exp. 3-31-06
STATE OF CALIFORNIA

Allen D. Evans, G.E. 2060
Vice President

REGISTERED PROFESSIONAL ENGINEER
ALLEN D. EVANS
No. 2060
Exp. 3-31-2007
GEOTECHNICAL
STATE OF CALIFORNIA

JMS/JFC/JJM/ADE:dmg

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C.H.J., Inc., 2005, Subsurface Investigation of Faulting, Paradise Hills Project, Badger Canyon area, Tentative Tract Map No. 18140, City of San Bernardino, California, Job No. 05894-3.

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## AERIAL PHOTOGRAPHS REVIEWED

San Bernardino County Flood Control District, November 9, 1963, Black and White Aerial Photographs, Photograph Nos. 5 and 6.

San Bernardino County Flood Control District, May 28, 1964, Black and White Aerial Photographs, Photograph Nos. 54 and 55.

San Bernardino County Flood Control District, December 3, 1965, Black and White Aerial Photographs, Photograph Nos. 118, 119 and 122.

San Bernardino County Flood Control District, October 8, 1971, Black and White Aerial Photographs, Photograph Nos. 18 and 19.

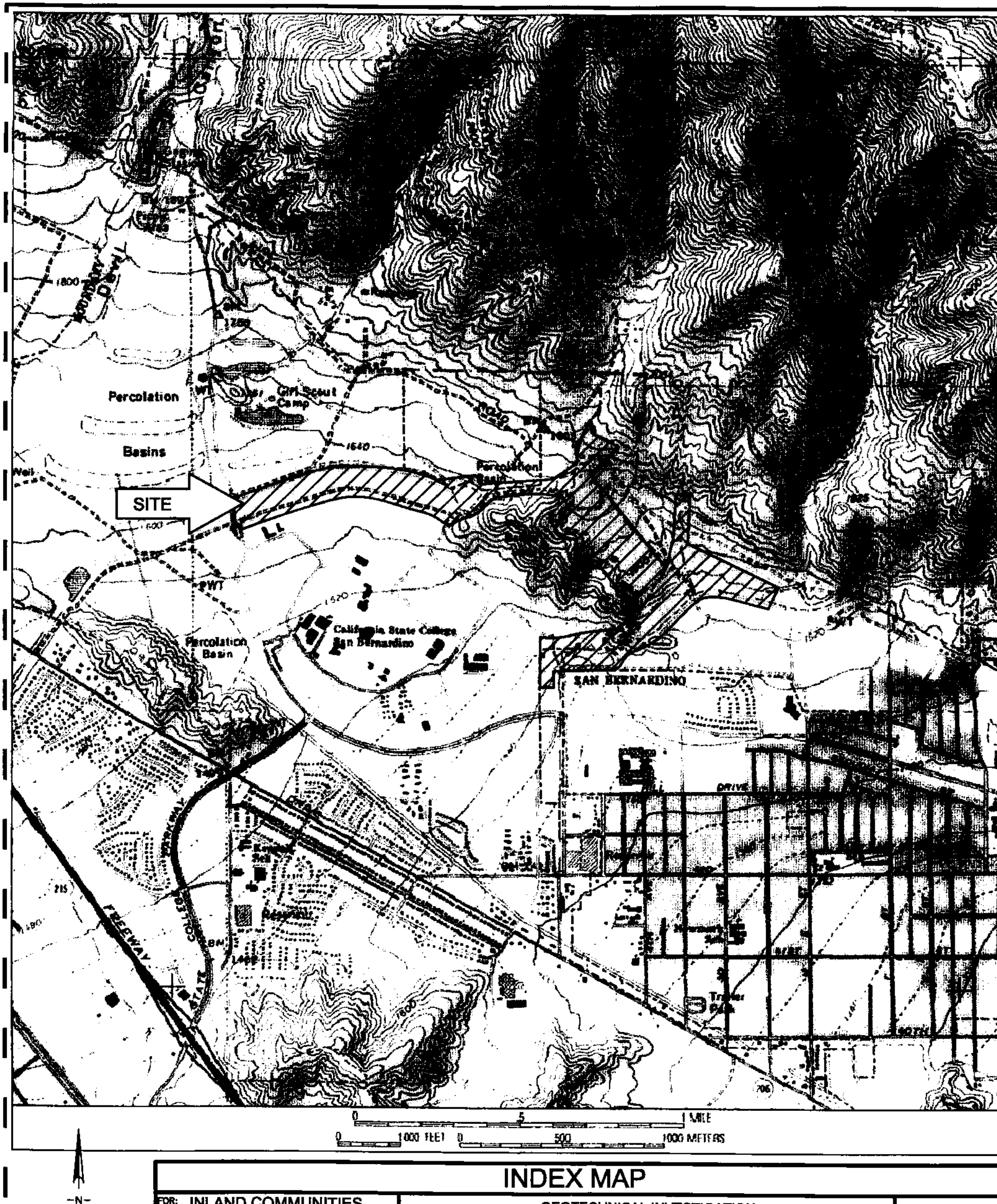
San Bernardino County Flood Control District, January 19, 2005, Color Aerial Photographs, Photograph Nos. 17-37, 17-38, 18-39, and 18-40.

United States Department of Agriculture, September 4, 1938, Black and White Aerial Photographs, Flight No. RE-AXL-83, Photograph Nos. 17 and 18.

United States Department of Agriculture, January 23, 1953, Black and White Aerial Photographs, Flight No. AXL-30K-67, Photograph Nos. 67 and 68.

# APPENDIX "A"

# GEOTECHNICAL MAPS

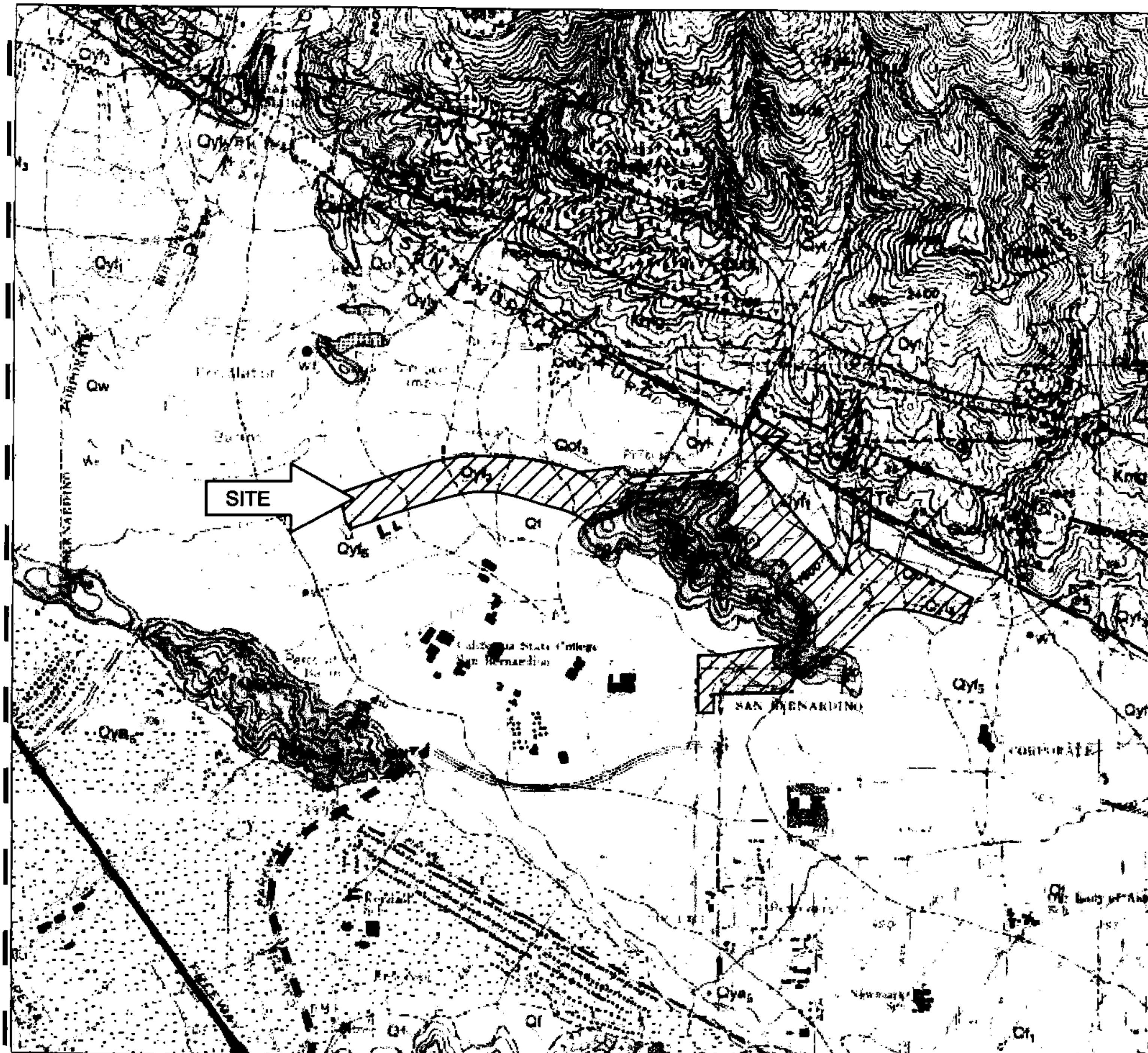



# INDEX MAP

| | | |
|---|---|---|
| FOR: INLAND COMMUNITIES CORPORATION | GEOTECHNICAL INVESTIGATION<br>OFF-SITE ROAD IMPROVEMENTS, PARADISE HILLS PROJECT<br>BADGER CANYON AREA, TENTATIVE TRACT MAP NO. 18140<br>SAN BERNARDINO, CALIFORNIA | ENCLOSURE "A-1" |
| DATE: JUNE 2006 | | JOB NUMBER 06242-3 |

C.H.J. Incorporated


MATCHLINE BELOW
MATCHLINE ABOVE
AP ZONE BOUNDARY
RESTRICTED USE ZONE
B-1
B-2
B-3
B-4
B-5
B-6
B-7
B-8
B-9
Qf (DISTURBED)
Mzps
Kmg
Tc
C.H.J. Incorporated
GEOLOGIC MAP AND SITE PLAN
ENCLOSURE: "A-2"
PROJECT: PARADISE HILLS-OFF SITE
TENTATIVE TRACT MAP NO. 18140
SAN BERNARDINO, CALIFORNIA
PREPARED FOR:
INLAND COMMUNITIES CORPORATION
JOB NO.: 06242-3
DATE: JUNE 2006
GEOLOGIC UNITS
Quaternary
Holocene
Pleistocene
f - fill
Qw - very young wash deposits
Qf - very young alluvial fan deposits
Qc - very young colluvial deposits
Qyf5 - young alluvial fan deposits (late Holocene)
Qyf3 - young alluvial fan deposits (late and middle Holocene)
Qyf2 - young alluvial fan deposits (early Holocene)
Qyf1 - young alluvial fan deposits (early Holocene and late Pleistocene)
Qyls - young landslide deposits (Holocene and late Pleistocene)
Qof3 - old alluvial fan deposits (late Pleistocene)
Qof2 - old alluvial fan deposits (late Pleistocene)
Qols - old landslide deposits (late to middle Pleistocene)
Qvof1 - very old alluvial fan deposits (early Pleistocene)
Qvols - very old landslide deposits (middle to early Pleistocene)
Tertiary
Tc - sandstone - conglomerate and arkose (landslide deposits locally)
Mesozoic
Mzsp - Pelona Schist
Kmg - granitic rock (landslide deposits of variable age)
Mzdc - gneiss
Paleozoic
Pzcu - carbonate rocks
LEGEND
proposed cut and fill slopes
limits and area of recommended restricted use zone to mitigate potential for geologic hazards including surface fault rupture, and landslides
approximate geologic contact, dashed where inferred
limit of zone of deformation southwest of South Branch SAFZ
80
strike and dip of bedding
86
strike and dip of fault
44
strike and dip of foliation
24
stike and dip of joint plane
vertical joint plane
B-35
approximate boring locations
?
fault: dashed where inferred, dotted where concealed, queried where postulated or location uncertain
approximate limit of landslide deposit, arrows indicate direction of movement, locations primarily based on geomorphic evidence
aerial photographic lineament
location of seep or spring based on presence of phreatophtyes
N
SCALE 1"= 200'




(Miller & Others, 2001)

***GEOLOGIC UNITS:***

Qf - Very young alluvial-fan deposits (late Holocene)
Qyf - Young alluvial-fan deposits (Holocene and lates Pleistocene)
Qof - Old alluvial-fan deposits (late to middle Pleistocene)
Mzps - Pelona Schist (Mesozoic)

geologic contact

-N-

SCALE: 1"= 2,000'

# GEOLOGIC INDEX MAP

FOR: INLAND COMMUNITIES CORPORATION

DATE: JUNE 2006

GEOTECHNICAL INVESTIGATION
OFF-SITE ROAD IMPROVEMENTS, PARADISE HILLS PROJECT
BADGER CANYON AREA, TENTATIVE TRACT MAP NO. 18140
SAN BERNARDINO, CALIFORNIA

ENCLOSURE "A-3"

JOB NUMBER 06242-3

C.H.J. Incorporated

# APPENDIX "B"

# EXPLORATORY LOGS

# KEY TO LOGS

SAMPLE TYPE:

| | |
|---|---|
| Ring | Indicates Undisturbed Ring Sample. Undisturbed Ring Samples are obtained with a "California Sampler" (3.00" and 3.25" O.D. and 2.42" I.D.) driven with a 140-pound weight falling 30 inches. The blows per foot are converted to equivalent SPT values.æ |
| Consol. | Consolidation Test (ASTM D 2435)a |
| Dist. | Indicates Disturbed Sample |
| DS | Direct Shear Test (ASTM D 3080) |
| MDC | Maximum Density Optimum Moisture Determination (ASTM D 1557)õ |
| N.R. | No Recovery of Sample |
| Rv | R-value test (Caltrans 301) |
| SA | Sieve Analysis (ASTM C 136) |
| SE | Sand Equivalent Test (ASTM D 2419) |

## ENGINEERING PROPERTIES FROM SPT BLOWS

Relationship of Penetration Resistance to Relative Density for Cohesionless Soils*
(After Mitchell and Katti, 1981)

| No. of SPT Blows ($N_{60}$) | Descriptive Relative Density | Approximate Relative Density (%) |
|---|---|---|
| <4 | Very Loose | 0-15 |
| 4-10 | Loose | 15-35 |
| 10-30 | Medium Dense | 35-65 |
| 30-50 | Dense | 65-85 |
| >50 | Very Dense | 85-100 |

* At an effective overburden pressure of 1 ton per square foot (100 kPa)

# SOIL CLASSIFICATION CHART

| MAJOR DIVISIONS | | | GRAPH SYMBOL | LETTER SYMBOL | TYPICAL DESCRIPTIONS |
|---|---|---|---|---|---|
| COARSE GRAINED SOILS<br><br>MORE THAN 50% OF MATERIAL IS <u>LARGER</u> THAN NO. 200 SIEVE SIZE | GRAVEL AND GRAVELLY SOILS<br><br>MORE THAN 50% OF COARSE FRACTION <u>RETAINED</u> ON NO. 4 SIEVE | CLEAN GRAVELS (LITTLE OR NO FINES) | | GW | WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES |
| | | | | GP | POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES |
| | | GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES) | | GM | SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES |
| | | | | GC | CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES |
| | SAND AND SANDY SOILS<br><br>MORE THAN 50% OF COARSE FRACTION <u>PASSING</u> NO. 4 SIEVE | CLEAN SAND (LITTLE OR NO FINES) | | SW | WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES |
| | | | | SP | POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES |
| | | SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES) | | SM | SITLY SANDS, SAND-SILT MIXTURES |
| | | | | SC | CLAYEY SANDS, SAND-CLAY MIXTURES |
| FINE GRANED SOILS<br><br>MORE THAN 50% OF MATERIAL IS <u>SMALLER</u> THAN NO 200 SIEVE SIZE | SILTS AND CLAYS | LIQUID LIMIT <u>LESS</u> THAN 50 | | ML | INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY |
| | | | | CL | INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS |
| | | | | OL | ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY |
| | SILTS AND CLAYS | LIQUID LIMIT <u>GREATER</u> THAN 50 | | MH | INORGANIC SILTY, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS |
| | | | | CH | INORGANIC CLAYS OF HIGH PLASICITY, FAT CLAYS |
| | | | | OH | ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS |
| HIGHLY ORGANIC SOILS | | | | PT | PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS |

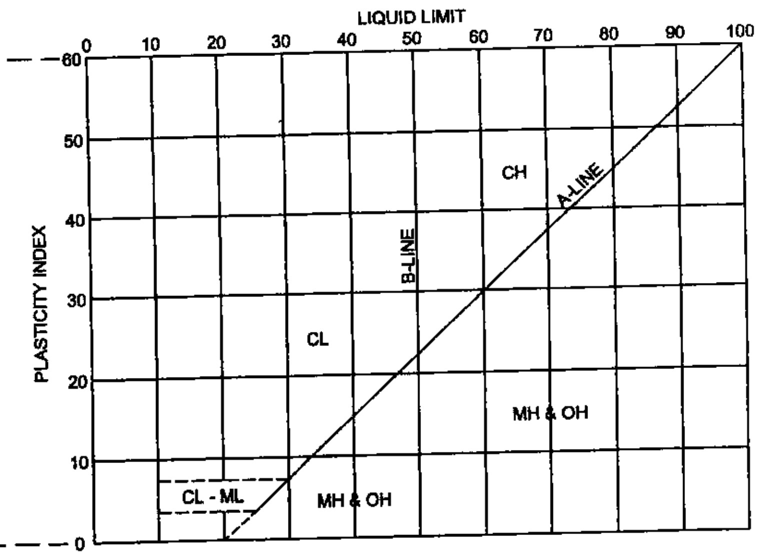
FOR LABROATORY CLASSIFICATION OF FIN-GRAINED SOILS

# GRADATION CHART

| MATERIAL SIZE | | PARTICLE SIZE | | | |
|---|---|---|---|---|---|
| | | LOWER LIMIT | | UPPER LIMIT | |
| | | MILLIMETERS | SIEVE SIZE | MILLIMETERS | SIEVE SIZE |
| SAND | FINE<br>MEDIUM<br>COARSE | .074<br>042<br>200 | #200x<br>#40 x<br>#10 x | 0.42<br>2.00<br>4.76 | #40 x<br>#10 x<br># 4 x |
| GRAVEL | FINE<br>COARSE | 4.76<br>191 | # 4 X<br>3/4"• | 191<br>76 2 | 3/4"•<br>3" • |
| COBBLES | | 76.2 | 3" | 304.8 | 12" |
| BOULDERS | | 304.8 | 12 | 914.4 | 36" |

x US STANDARD • CLEAR SQUARE OPENINGS

# PLASTICITY CHART




# UNIFIED SOIL CLASSIFICATION SYSTEM

C.H.J. Incorporated

# EXPLORATORY BORING NO. 1

Date Drilled: 4/6/06 | Client: Inland Communities Corporation

Equipment: CME 55 Drill Rig | Driving Weight / Drop: 140 lbs / 30 in

Surface Elevation(ft): N/A | Logged by: J.R. | Measured Depth to Water(ft): N/A

| DEPTH (ft) | GRAPHIC LOG | VISUAL CLASSIFICATION | REMARKS | SAMPLES DRIVE | SAMPLES BULK | BLOWS/FOOT (Equiv. SPT) | FIELD MOISTURE (%) | DRY UNIT WT. (pcf) | LAB/FIELD TESTS |
|---|---|---|---|---|---|---|---|---|---|
| | | (SM) Silty Sand, fine to coarse with silt and gravel to 1", dark brown | Native | | X | | 5.1 | | RV, SA, SE |
| | | | | X | | 13 | 6.6 | 113 | Ring |
| 5 | | | | X | | 5 | 8.8 | 111 | Ring, Consol |
| | | (SM) Silty Sand, fine to medium with coarse, brown | | | X | | 8.7 | | |
| 10 | | | | X | | 53/10" | 9.1 | 120 | Ring |
| | | (SP) Sand, fine to medium with coarse and gravel to 2", brown | | | X | | 4.7 | | |
| 15 | | | | X | | 49 | 4.2 | Dist. | Ring |
| 20 | | | | X | | 30/6" | 3.5 | Dist. | Ring |
| 25 | | | | X | | 30/6" | 3.8 | Dist. | Ring |
| 30 | | | | X | | 30/6" | N.R. | N.R. | Ring |
| | | END OF BORING<br>NO BEDROCK, NO REFUSAL, NO FILL<br>SLIGHT CAVING, NO FREE GROUNDWATER | | | | | | | |

# EXPLORATORY BORING NO. 2

Date Drilled: 4/6/06
Client: Inland Communities Corporation
Equipment: CME 55 Drill Rig
Driving Weight / Drop: 140 lbs / 30 in
Surface Elevation(ft): N/A
Logged by: J.R.
Measured Depth to Water(ft): N/A

| DEPTH (ft) | GRAPHIC LOG | VISUAL CLASSIFICATION | REMARKS | SAMPLES DRIVE | SAMPLES BULK | BLOWS/FOOT (Equiv. SPT) | FIELD MOISTURE (%) | DRY UNIT WT. (pcf) | LAB/FIELD TESTS |
|---|---|---|---|---|---|---|---|---|---|
| | | (SM) Silty Sand, fine to medium with coarse and gravel to 3", brown | Native | | X | | 9.9 | | |
| | | | | X | | 32 | 4.5 | 120 | Ring |
| | | (SP) Sand, fine to coarse with silt and gravel to 3", olive brown | | | X | | 3.2 | | |
| 5 | | | | | | | | | |
| | | | | X | | 28 | 1.8 | Dist. | Ring |
| 10 | | | | | | | | | |
| | | | | X | | 30/5" | 1.3 | Dist. | Ring |
| 15 | | | | | | | | | |
| | | (SP) Sand, fine to medium with coarse, silt and gravel to 1", light brown | | | X | | 4.2 | | |
| | | | | X | | 18 | 4.1 | 108 | Ring |
| 20 | | (SP) Sand, fine to coarse with silt and gravel to 3", light brown | | | X | | 2.0 | | |
| | | | | X | | 48 | 3.7 | 128 | Ring |
| 25 | | | | | | | | | |
| | | | | X | | 30/4" | 5.7 | Dist. | Ring |
| | | END OF BORING | | | | | | | |
| 30 | | NO BEDROCK, NO REFUSAL, NO FILL<br>SLIGHT CAVING, NO FREE GROUNDWATER | | | | | | | |

BORING_LOG 06242-3.GPJ CHJ.GDT 5/31/06

C.H.J.

OFF-SITE ROAD IMPROVEMENTS
PARADISE HILLS, SAN BERNARDINO

Job No. 06242-5

Enclosure B-2

# EXPLORATORY BORING NO. 3

Date Drilled: 4/6/06
Client: Inland Communities Corporation
Equipment: CME 55 Drill Rig
Driving Weight / Drop: 140 lbs / 30 in
Surface Elevation(ft): N/A
Logged by: J.R.
Measured Depth to Water(ft): N/A

| DEPTH (ft) | GRAPHIC LOG | VISUAL CLASSIFICATION | REMARKS | SAMPLES: DRIVE | SAMPLES: BULK | BLOWS/FOOT (Equiv. SPT) | FIELD MOISTURE (%) | DRY UNIT WT. (pcf) | LAB/FIELD TESTS |
|---|---|---|---|---|---|---|---|---|---|
| | | (SM) Silty Sand, fine to coarse and gravel to 1/2", olive gray | Fill | | | | | | |
| | | (SM) Weathered Bedrock, recovered as Silty Sand, fine to medium with coarse and gravel to 1", light gray | Bedrock | X | X | 30/4" | 8.6<br>2.7 | N.R. | Ring |
| 5 | | | | X | | 30/5" | 7.7 | Dist. | Ring |
| | | END OF BORING<br><br>BEDROCK AT 0.8'<br>NO REFUSAL<br>FILL TO 0.8'<br>SLIGHT CAVING<br>NO FREE GROUNDWATER | | | | | | | |
| 10 | | | | | | | | | |
| 15 | | | | | | | | | |
| 20 | | | | | | | | | |
| 25 | | | | | | | | | |
| 30 | | | | | | | | | |

BORING_LOG 06242-3.GPJ CHJ.GDT 5/31/06

# EXPLORATORY BORING NO. 4

Date Drilled: 4/6/06 | Client: Inland Communities Corporation

Equipment: CME 55 Drill Rig | Driving Weight / Drop: 140 lbs / 30 in

Surface Elevation(ft): N/A | Logged by: J.R. | Measured Depth to Water(ft): N/A

| DEPTH (ft) | GRAPHIC LOG | VISUAL CLASSIFICATION | REMARKS | SAMPLES DRIVE | SAMPLES BULK | BLOWS/FOOT (Equiv. SPT) | FIELD MOISTURE (%) | DRY UNIT WT. (pcf) | LAB/FIELD TESTS |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | (SM) Silty Sand, fine to coarse with gravel to 1/2", brown | Fill | | X | | 6.1 | | RV, SA, SE |
| | | | | X | | 25 | 7.2 | 128 | Ring |
| 5 | | | | | | | | | |
| | | | | X | | 25 | 8.4 | 118 | Ring |
| 10 | | | | | | | | | |
| | | | | X | | 8 | 5.3 | 110 | Ring, Consol |
| 15 | | (SP) Sand, fine to medium with coarse, silt and gravel to 1 1/2", olive brown | Native | | X | | 4.7 | | |
| | | | | X | | 11 | 2.8 | 117 | Ring |
| 20 | | | | | | | | | |
| | | | | X | | 13 | 4.2 | 110 | Ring, Consol |
| 25 | | | | | | | | | |
| | | | | X | | 28 | 5.3 | 118 | Ring |
| 30 | | | | | | | | | |
| | | | | X | | 30/6" | 2.7 | 117 | Ring |

BORING_LOG 06242-3.GPJ CHJ.GDT 5/31/06

# EXPLORATORY BORING NO. 4

Date Drilled: 4/6/06 Client: Inland Communities Corporation

Equipment: CME 55 Drill Rig Driving Weight / Drop: 140 lbs / 30 in

Surface Elevation(ft): N/A Logged by: J.R. Measured Depth to Water(ft): N/A

| DEPTH (ft) | GRAPHIC LOG | VISUAL CLASSIFICATION | REMARKS | SAMPLES DRIVE | SAMPLES BULK | BLOWS/FOOT (Equiv. SPT) | FIELD MOISTURE (%) | DRY UNIT WT. (pcf) | LAB/FIELD TESTS |
|---|---|---|---|---|---|---|---|---|---|
| | | (SP) Sand, fine to medium with coarse, silt and gravel to 1 1/2", olive brown | | | | | | | |
| | | | | X | | 25 | 3.6 | 117 | Ring |
| 40 | | (SM) Silty Sand, fine to medium with coarse and gravel to 1", olive brown | | | X | | 8.7 | | |
| | | | | X | | 26 | 6.1 | 115 | Ring |
| 45 | | | | | | | | | |
| | | | | X | | 30/4" | N.R. | N.R. | Ring |
| | | END OF BORING<br>NO BEDROCK<br>NO REFUSAL<br>FILL TO 15'<br>SLIGHT CAVING<br>NO FREE GROUNDWATER | | | | | | | |
| 50 | | | | | | | | | |
| 55 | | | | | | | | | |
| 60 | | | | | | | | | |
| 65 | | | | | | | | | |

BORING_LOG 06242-3.GPJ CHJ.GDT 5/31/06

# EXPLORATORY BORING NO. 5

Date Drilled: 4/6/06
Client: Inland Communities Corporation
Equipment: CME 55 Drill Rig
Driving Weight / Drop: 140 lbs / 30 in
Surface Elevation(ft): N/A
Logged by: J.R.
Measured Depth to Water(ft): N/A

| DEPTH (ft) | GRAPHIC LOG | VISUAL CLASSIFICATION | REMARKS | SAMPLES DRIVE | SAMPLES BULK | BLOWS/FOOT (Equiv. SPT) | FIELD MOISTURE (%) | DRY UNIT WT. (pcf) | LAB/FIELD TESTS |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | (SM) Silty Sand, fine to medium with gravel to 3/8", brown | Fill | | X | | 6.3 | | DS, MDC, SA, SE |
| | | | | X | | 55 | 5.6 | 125 | Ring |
| 5 | | | | X | | 38 | 5.3 | 129 | Ring |
| 10 | | | | X | | 35 | 8.0 | 127 | Ring |
| 15 | | | | X | | 30/5" | 4.7 | 118 | Ring |
| 20 | | | | X | | 54/11" | 6.1 | 123 | Ring |
| 25 | | | | X | | 51 | 5.9 | 116 | Ring |
| 30 | | | | X | | 10 | 5.5 | 107 | Ring |
| | | (SM) Silty Sand, fine to medium with coarse and gravel to 2", brown | Native | | | | | | |

BORING_LOG 06242-3.GPJ CHJ.GDT 5/31/06

# EXPLORATORY BORING NO. 5

Date Drilled: 4/6/06 | Client: Inland Communities Corporation

Equipment: CME 55 Drill Rig | Driving Weight / Drop: 140 lbs / 30 in

Surface Elevation(ft): N/A | Logged by: J.R. | Measured Depth to Water(ft): N/A

| DEPTH (ft) | GRAPHIC LOG | VISUAL CLASSIFICATION | REMARKS | SAMPLES DRIVE | SAMPLES BULK | BLOWS/FOOT (Equiv. SPT) | FIELD MOISTURE (%) | DRY UNIT WT. (pcf) | LAB/FIELD TESTS |
|---|---|---|---|---|---|---|---|---|---|
| | | (SM) Silty Sand, fine to medium with coarse and gravel to 2", brown | | X | | 29 | 5.8 | 113 | Ring |
| | | (SP-SM) Sand, fine to medium with coarse and gravel to 2", olive brown | | | X | | 5.3 | | |
| 40 | | | | X | | 17 | 5.0 | 115 | Ring |
| | | END OF BORING<br>NO BEDROCK<br>REFUSAL AT 41.5'<br>FILL TO 32.0'<br>SLIGHT CAVING<br>NO FREE GROUNDWATER | Refusal | | | | | | |
| 45 | | | | | | | | | |
| 50 | | | | | | | | | |
| 55 | | | | | | | | | |
| 60 | | | | | | | | | |
| 65 | | | | | | | | | |

BORING_LOG 06242-3.GPJ CHJ.GDT 5/31/06

# EXPLORATORY BORING NO. 6

Date Drilled: 4/12/06 | Client: Inland Communities Corporation

Equipment: Limited Access Drill Rig | Driving Weight / Drop: 140 lbs / 30 in

Surface Elevation(ft): N/A | Logged by: T.D. | Measured Depth to Water(ft): N/A

| DEPTH (ft) | GRAPHIC LOG | VISUAL CLASSIFICATION | REMARKS | SAMPLES DRIVE | SAMPLES BULK | BLOWS/FOOT (Equiv. SPT) | FIELD MOISTURE (%) | DRY UNIT WT. (pcf) | LAB/FIELD TESTS |
|---|---|---|---|---|---|---|---|---|---|
| | | (SM) Silty Sand, fine to medium with coarse, gravel and cobbles to 6", dark brown | Native | | | | | | |
| | | (SP-SM) Sand, fine to coarse with silt, gravel and cobbles to 6", dark brown | | | X | | 5.3 | | SA, SE |
| | | | | X | | 32 | 3.1 | 116 | Ring |
| 5 | | | | | | | | | |
| | | (GP) Sandy Gravel with silt, fine to coarse with gravel and cobbles to 6", dark brown | | | X | | 5.4 | | |
| | | | | X | | 40/1" | N.R. | N.R. | Ring |
| 10 | | | | | | | | | |
| | | | | X | | 44/6" | N.R. | N.R. | Ring |
| 15 | | | | | | | | | |
| | | | | X | | 40/1" | 9.6 | Dist. | Ring |
| | | END OF BORING | Refusal | | | | | | |
| 20 | | | | | | | | | |
| 25 | | | | | | | | | |
| 30 | | | | | | | | | |

END OF BORING

NO BEDROCK
REFUSAL AT 19.0'
NO FILL
HEAVY CAVING
NO FREE GROUNDWATER

# EXPLORATORY BORING NO. 7

Date Drilled: 4/12/06 Client: Inland Communities Corporation

Equipment: Limited Access Drill Rig Driving Weight / Drop: 140 lbs / 30 in

Surface Elevation(ft): N/A Logged by: T.D. Measured Depth to Water(ft): N/A

| DEPTH (ft) | GRAPHIC LOG | VISUAL CLASSIFICATION | REMARKS | SAMPLES: DRIVE | SAMPLES: BULK | BLOWS/FOOT (Equiv. SPT) | FIELD MOISTURE (%) | DRY UNIT WT. (pcf) | LAB/FIELD TESTS |
|---|---|---|---|---|---|---|---|---|---|
| | | (SM) Silty Sand, fine to medium with coarse and gravel to 2", brown | Fill | | X | | 8.0 | | |
| | | | | X | | 6 | 7 7 | 110 | Ring |
| 5 | | | | X | | 4 | 9.4 | 106 | Ring |
| | | (SP-SM) Sand, fine to medium with coarse, silt and gravel to 2 1/2", yellow brown | Native | | X | | 4.0 | | |
| 10 | | | | X | | 22 | 3.3 | 104 | Ring, Consol |
| 15 | | | | X | | 56/11" | N.R. | N.R. | Ring |
| 20 | | | | X | | 42 | 5.0 | 118 | Ring |
| 25 | | | | X | | 34 | 3.5 | 119 | Ring |
| 30 | | | | X | | 58 | 3.1 | 123 | Ring |
| | | END OF BORING<br><br>NO BEDROCK, NO REFUSAL, FILL TO 7.0'<br>MODERATE CAVING, NO FREE GROUNDWATER | | | | | | | |

BORING LOG 06242-3.GPJ CHJ.GDT 5/31/06

# EXPLORATORY BORING NO. 8

Date Drilled: 4/12/06 | Client: Inland Communities Corporation

Equipment: Limited Access Drill Rig | Driving Weight / Drop: 140 lbs / 30 in

Surface Elevation(ft): N/A | Logged by: T.D. | Measured Depth to Water(ft): 14.0

| DEPTH (ft) | GRAPHIC LOG | VISUAL CLASSIFICATION | REMARKS | SAMPLES: DRIVE | SAMPLES: BULK | BLOWS/FOOT (Equiv. SPT) | FIELD MOISTURE (%) | DRY UNIT WT. (pcf) | LAB/FIELD TESTS |
|---|---|---|---|---|---|---|---|---|---|
| | | (SM) Silty Sand, fine to coarse with gravel and cobbles to 6", dark brown | Fill | | X | | 4.6 | | SA, SE |
| | | (SM) Silty Sand, fine with medium, yellow brown | Native | X | X | 14 | 5.1<br>5.0 | 115 | Ring |
| 5 | | | | | | | | | |
| | | (SM) Silty Sand, fine to medium with gravel to 1", dark gray brown | | | X | | 14.6 | | |
| | | | | X | | 16 | 9.9 | 114 | Ring |
| 10 | | | | | | | | | |
| | | | | X | | 16 | 11.5 | 123 | Ring |
| | | | ▼ Groundwater | | | | | | |
| 15 | | (SM) Silty Sand, fine to medium with coarse and gravel to 2", dark brown | | | X | | 15.4 | | |
| | | | | X | | 17 | 14.1 | 122 | Ring |
| 20 | | | | | | | | | |
| | | (SM) Granitic Bedrock, recovered as Silty Sand, fine with clay, red brown | | X | | 30/5" | 11.0 | 127 | Ring |
| 25 | | | | | | | | | |
| | | | | X | | 30/3" | 12.8 | 125 | Ring |
| | | END OF BORING<br><br>BEDROCK AT 21.0<br>NO REFUSAL<br>FILL TO 2.5'<br>MODERATE CAVING<br>GROUNDWATER AT 14.0' | | | | | | | |
| 30 | | | | | | | | | |

BORING_LOG 06242-3.GPJ CHJ.GDT 5/31/06

# EXPLORATORY BORING NO. 9

Date Drilled: 4/12/06 Client: Inland Communities Corporation

Equipment: Limited Access Drill Rig Driving Weight / Drop: 140 lbs / 30 in

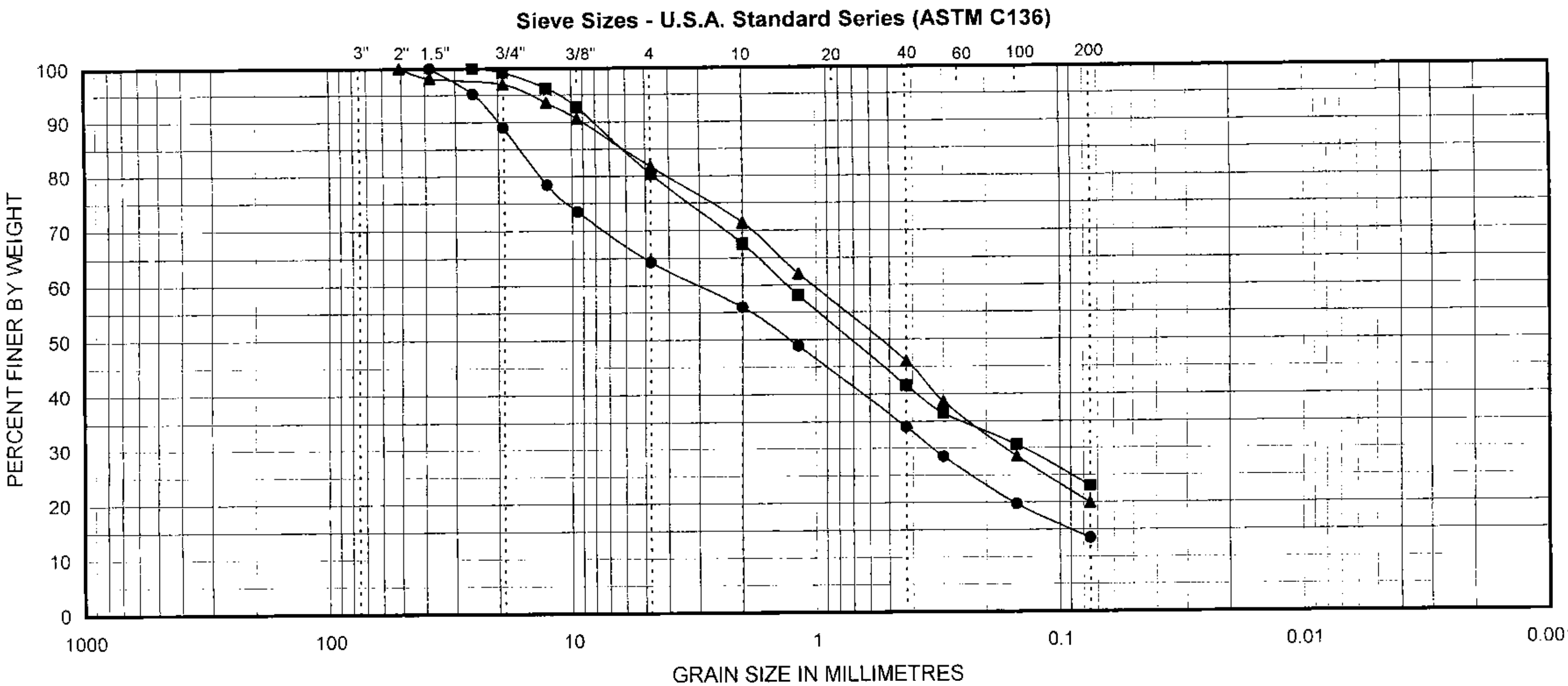
Surface Elevation(ft): N/A Logged by: T.D. Measured Depth to Water(ft): N/A

| DEPTH (ft) | GRAPHIC LOG | VISUAL CLASSIFICATION | REMARKS | SAMPLES DRIVE | SAMPLES BULK | BLOWS/FOOT (Equiv. SPT) | FIELD MOISTURE (%) | DRY UNIT WT. (pcf) | LAB/FIELD TESTS |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | (SP-SM) Sand, fine to coarse with silt and gravel to 1 1/2", dark brown | Native | | X | | 6.8 | | SA, SE |
| | | | | X | | 10 | 5.5 | 108 | Ring |
| 5 | | | | X | | 15 | 4.3 | 110 | Ring |
| | | (SP-SM) Sand, fine to medium with coarse, silt and gravel to 3", brown | | | X | | 5.8 | | |
| 10 | | | | X | | 13 | 9.1 | 113 | Ring, Consol |
| 15 | | | | X | | 46 | 4.8 | 125 | Ring |
| 20 | | | | X | | 41/11" | 4.6 | 118 | Ring |
| 25 | | | | X | | 38 | 4.7 | 124 | Ring |
| 30 | | | | X | | 34 | 3.9 | 118 | Ring |
| | | END OF BORING<br>NO BEDROCK. NO REFUSAL. NO FILL, MODERATE CAVING, NO FREE GROUNDWATER | | | | | | | |

BORING_LOG 06242-3.GPJ CHJ.GDT 5/31/06

# APPENDIX "C"

# LABORATORY TESTING




| Cobbles & Boulders | Gravel | | Sand | | | Silt | Clay |
|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | | |

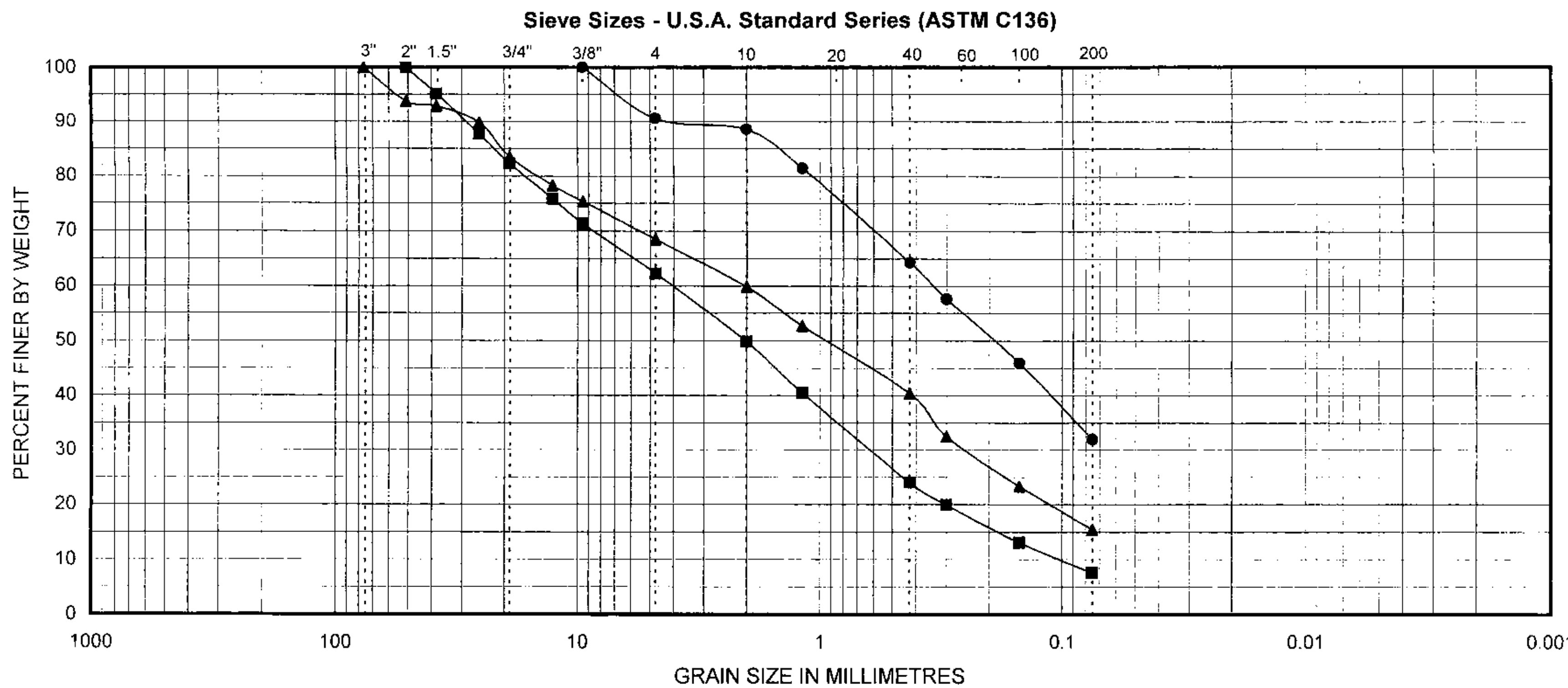
| Symbol | Boring No. | Depth (ft) | Classification | $D_{10}$ (mm) | $D_{30}$ (mm) | $D_{50}$ (mm) | $D_{60}$ (mm) | $C_u$ | $C_c$ | SE |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 1A | 0 | (SM) Silty Sand, fine to coarse with gravel to 1" | | 0.330 | 1.285 | 3.049 | | | 22 |
| ■ | 3B | 0.8 | (SM) Silty Sand, fine to coarse with gravel to 1/2" | | 0.141 | 0.715 | 1.311 | | | 23 |
| ▲ | 4A | 0 | (SM) Silty Sand, fine to coarse with gravel to 1/2" | | 0.166 | 0.547 | 1.031 | | | 23 |
| | | | | | | | | | | |

C.H.J. Incorporated

## GRADATION CURVES

| | | | |
|---|---|---|---|
| Project: | Inland Communities, Paradise Hills | | |
| Location: | Tentative Tract Map No. 18140, Off-Site Road Improvements | | |
| Job Number: | 06242-3 | Enclosure: | C-1 |

CHJ® LabSuite ver2.11. Programmed by Dr. Fred Yi




| Cobbles & Boulders | Gravel | | Sand | | | Silt | Clay |
|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | | |

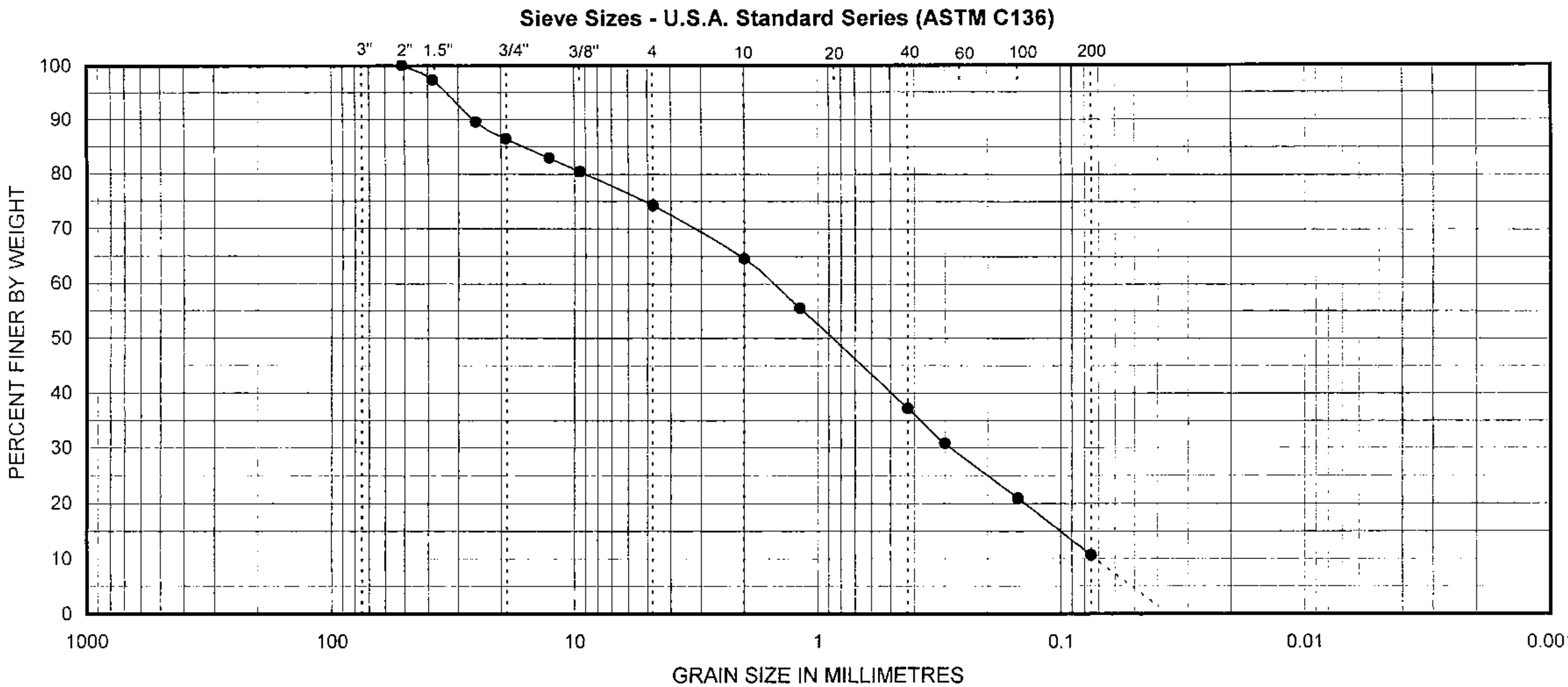
| Symbol | Boring No. | Depth (ft) | Classification | $D_{10}$ (mm) | $D_{30}$ (mm) | $D_{50}$ (mm) | $D_{60}$ (mm) | $C_u$ | $C_c$ | SE |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 5A | 0 | (SM) Silty Sand, fine to medium | | | 0.191 | 0.340 | | | 18 |
| ■ | 6A | 0 | (SP-SM) Sand, fine to coarse with silt and gravel to 1 1/2" | 0.1013 | 0.616 | 2.029 | 4.074 | 40.205 | 0.921 | 43 |
| ▲ | 8A | 0 | (SM) Silty Sand, fine to coarse with gravel to 1" | | 0.249 | 0.943 | 2.031 | | | 32 |
| | | | | | | | | | | |

C.H.J. Incorporated

## GRADATION CURVES

| | | | |
|---|---|---|---|
| Project: | Inland Communities, Paradise Hills | | |
| Location: | Tentative Tract Map No. 18140, Off-Site Road Improvements | | |
| Job Number: | 06242-3 | Enclosure: | C-2 |

CHJ® LabSuite ver2.11. Programmed by Dr. Fred Yi



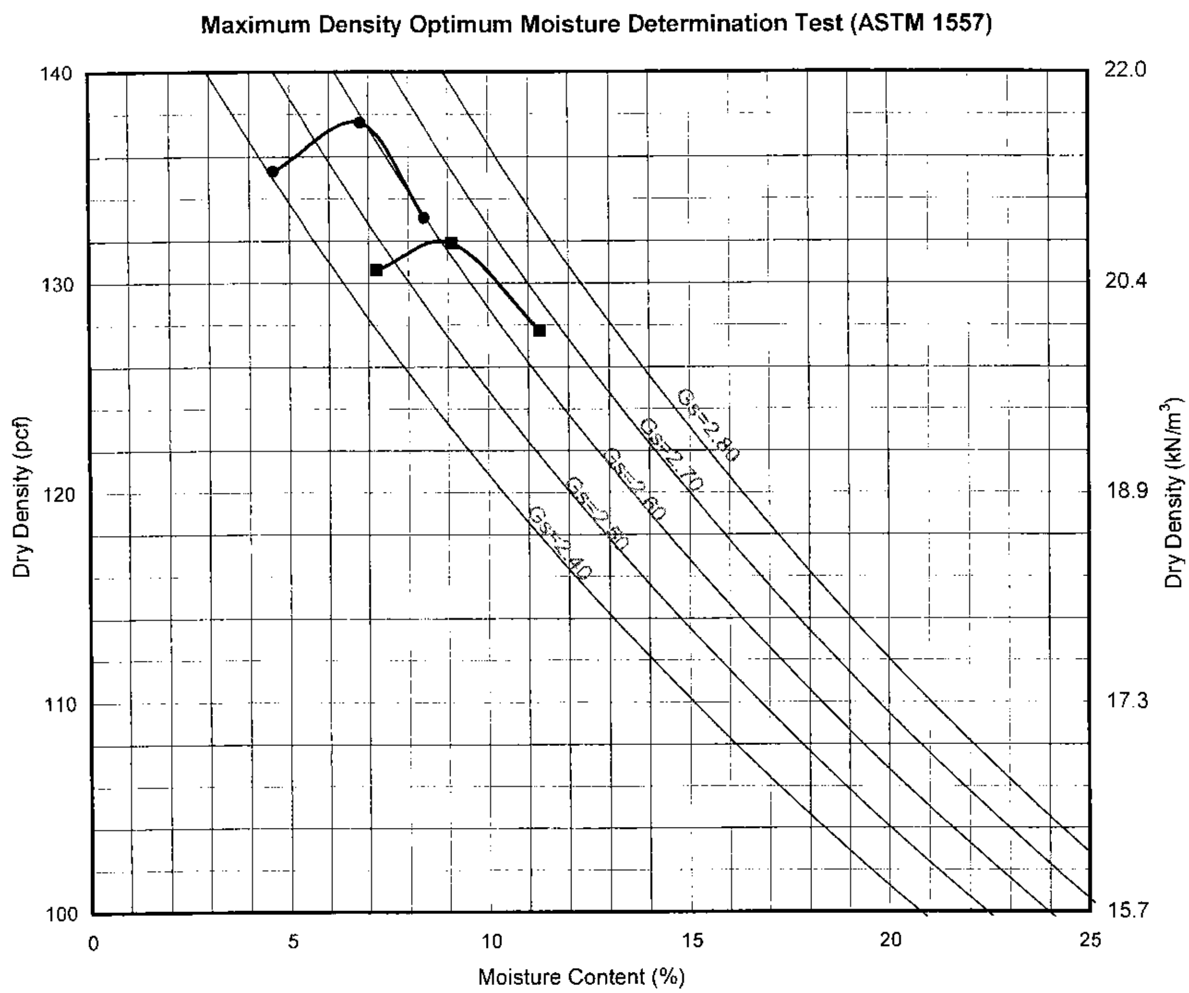

| Cobbles & Boulders | Gravel | | Sand | | | Silt | Clay |
|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | | |

| Symbol | Boring No. | Depth (ft) | Classification | $D_{10}$ (mm) | $D_{30}$ (mm) | $D_{50}$ (mm) | $D_{60}$ (mm) | $C_u$ | $C_c$ | SE |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 9A | 0 | (SP-SM) Sand, fine to coarse with silt and gravel to 1 1/2" | 0.0716 | 0.284 | 0.868 | 1.537 | 21.460 | 0.731 | 38 |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

C.H.J. Incorporated

## GRADATION CURVES

| | | | |
|---|---|---|---|
| Project: | Inland Communities, Paradise Hills | | |
| Location: | Tentative Tract Map No. 18140, Off-Site Road Improvements | | |
| Job Number: | 06242-3 | Enclosure: | C-3 |

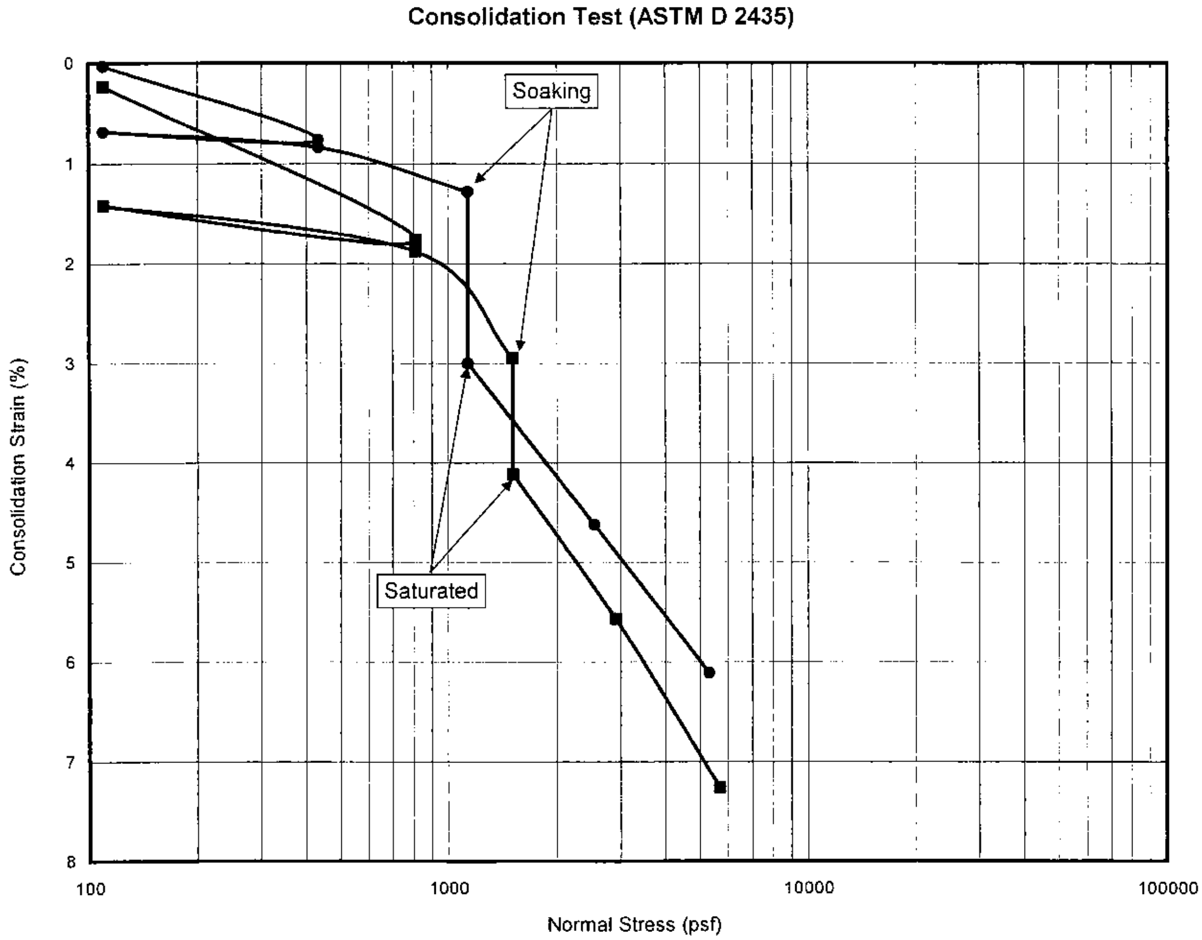



| | Boring # | Depth(ft) | Soil Type | $\gamma_{max}$ (pcf) | $w_{opt}$ (%) |
|---|---|---|---|---|---|
| ● | 3B | 0.8 | (SM) Silty Sand, fine to coarse with gravel to 1/2" | 138.0 | 7.0 |
| ■ | 5A | 0 | (SM) Silty Sand, fine to medium | 132.0 | 10.0 |
| | | | | | |
| | | | | | |
| | | | | | |

C.H.J. Incorporated

## MOISTURE DENSITY TESTS

| | | | |
|---|---|---|---|
| Project: | Inland Communities, Paradise Hills | | |
| Location: | Tentative Tract Map No. 18140, Off-Site Road Improvements | | |
| Job No.: | 06242-3 | Enclosure: | C-4 |




| | Boring # | Depth(ft) | Soil/Sample Type | $\gamma_d$ (pcf) | MC(%) | HCS(%) |
|---|---|---|---|---|---|---|
| ● | 1 | 5 | (SM) Silty sand, fine to coarse with gravel to 1" / undisturbed | 8.8 | 111.0 | 1.72 |
| ■ | 4 | 12 | (SM) Silty sand, fine to coarse with gravel to 1/2" / undisturbed | 5.3 | 110.0 | 1.17 |
| | | | | | | |
| | | | | | | |
| | | | | | | |

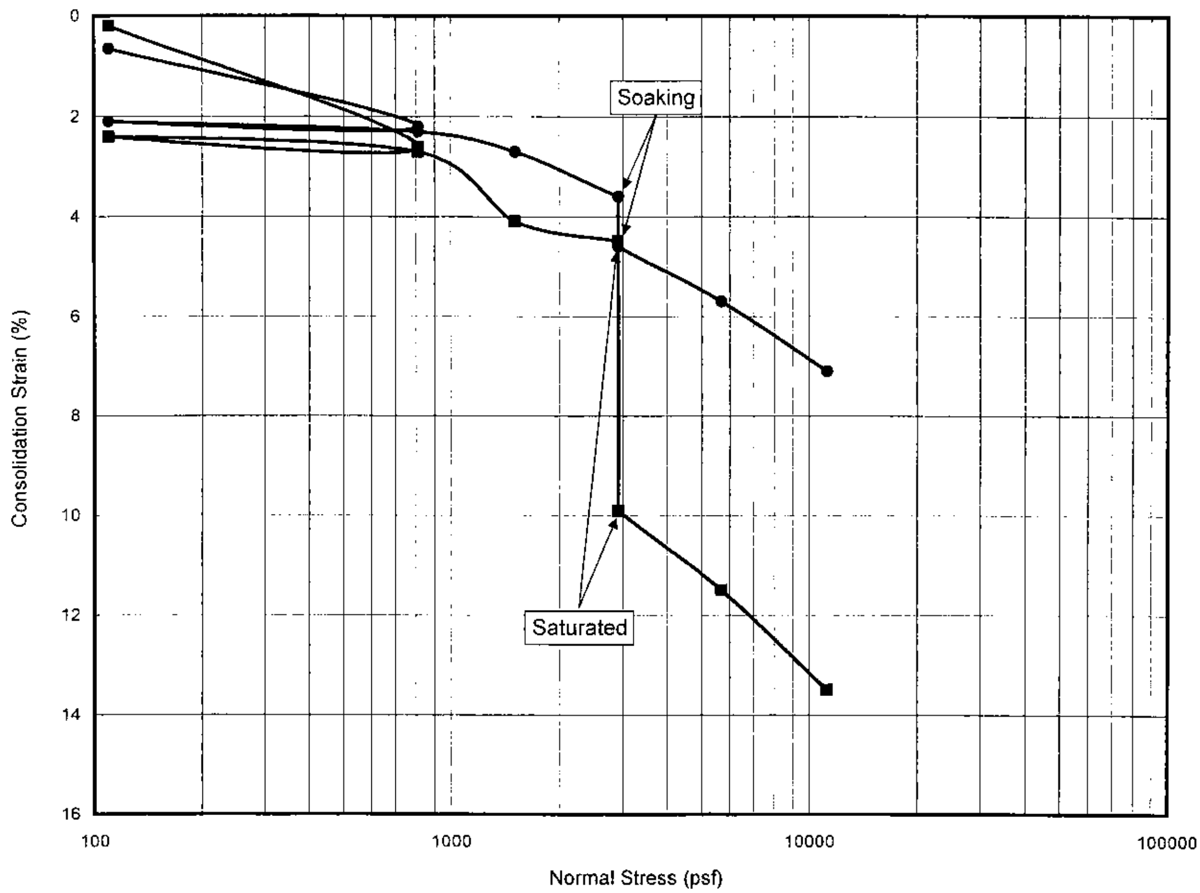
* HCS - Hydroconsolidation strain in percent.

C.H.J. Incorporated

**CONSOLIDATION TESTS**

| | | | |
|---|---|---|---|
| Project: | Inland Communities, Paradise Hills | | |
| Location: | Tentative Tract Map No. 18140, Off-Site Road Improvements | | |
| Job No.: | 06242-3 | Enclosure: | C-5 |

## Consolidation Test (ASTM D 2435)



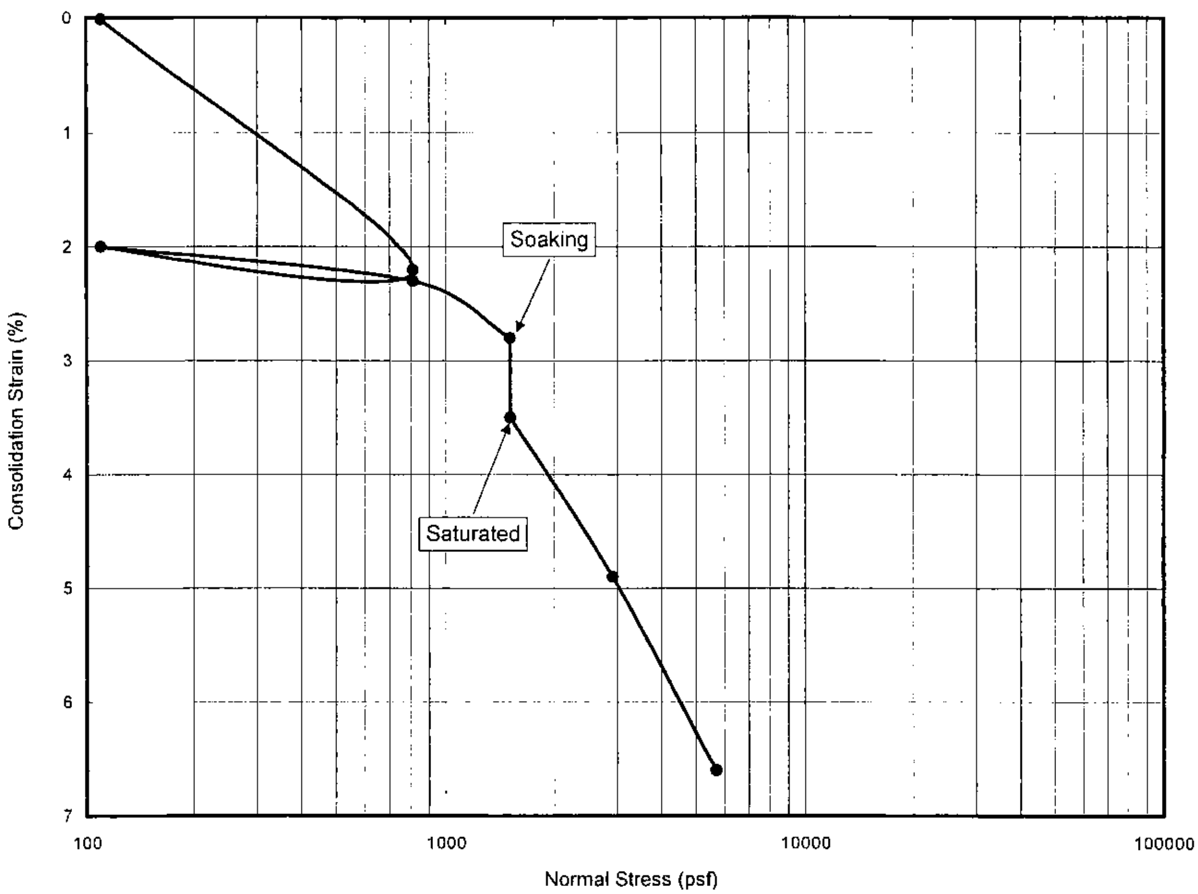

| Boring # | | Depth(ft) | Soil/Sample Type | $\gamma_d$ (pcf) | MC(%) | HCS(%) |
|---|---|---|---|---|---|---|
| ● | 4 | 22 | (SP) Sand, fine to medium with coarse, silt, and gravel to 1 1/2" / undisturbed | 4.2 | 110.0 | 1.00 |
| ■ | 7 | 10 | (SP-SM) Sand, fine to medium with coarse, silt and gravle to 1 1/2" / undisturbed | 3.3 | 104.0 | 5.40 |
| | | | | | | |
| | | | | | | |
| | | | | | | |

* HCS - Hydroconsolidation strain in percent.

C.H.J. Incorporated

| CONSOLIDATION TESTS | | | |
|---|---|---|---|
| Project: | Inland Communities, Paradise Hills | | |
| Location: | Tentative Tract Map No. 18140, Off-Site Road Improvements | | |
| Job No.: | 06242-3 | Enclosure: | C-6 |

## Consolidation Test (ASTM D 2435)



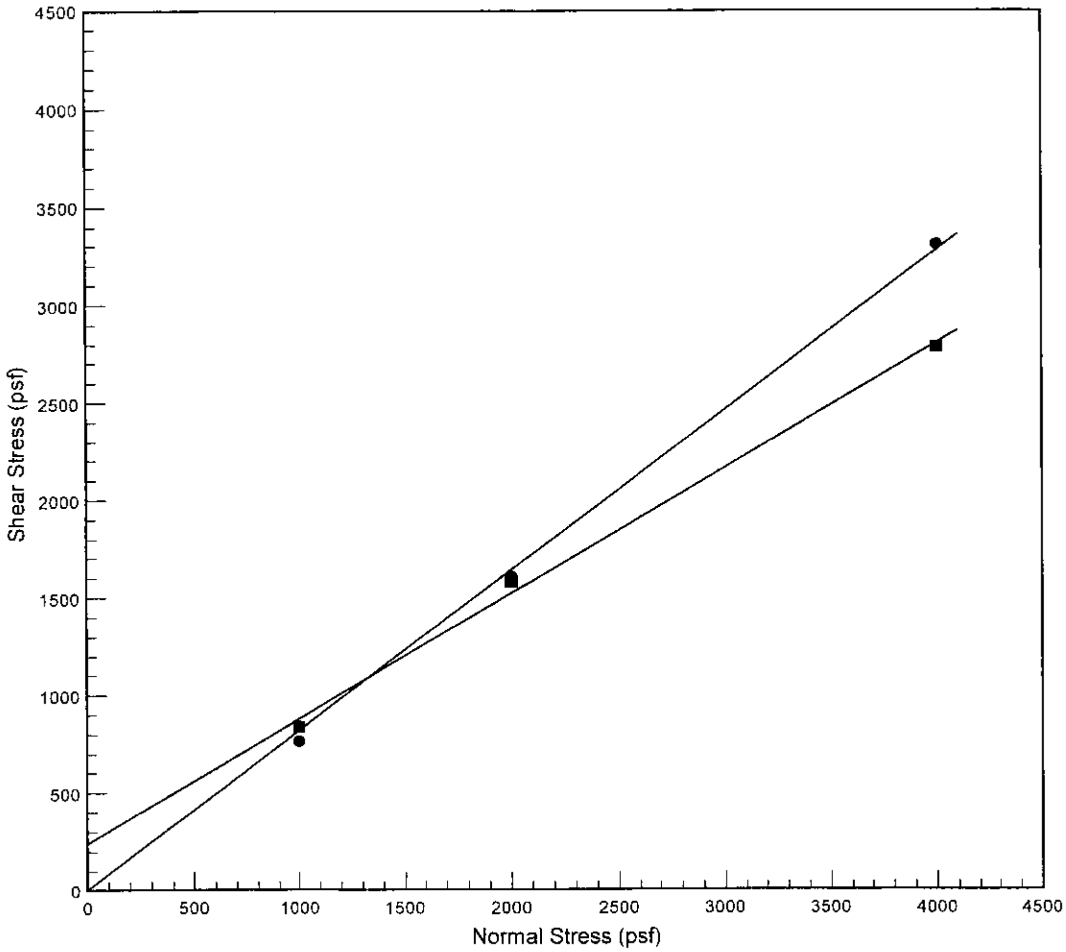

| Boring # | | Depth(ft) | Soil/Sample Type | $\gamma_d$ (pcf) | MC(%) | HCS(%) |
|---|---|---|---|---|---|---|
| ● | 9 | 10 | (SP-SM) Sand, fine to medium with coarse, silt and gravel to 3" / undisturbed | 9.1 | 113.0 | 0.70 |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

* HCS - Hydroconsolidation strain in percent.

C.H.J. Incorporated

| CONSOLIDATION TESTS | | | |
|---|---|---|---|
| Project: | Inland Communities, Paradise Hills | | |
| Location: | Tentative Tract Map No. 18140, Off-Site Road Improvements | | |
| Job No.: | 06242-3 | Enclosure: | C-7 |

## Direct Shear Test (ASTM D 3080)




| | Boring # | Depth(ft) | Soil Type | $\gamma_d$ (pcf) | MC(%) | C (psf) | φ(°) |
|---|---|---|---|---|---|---|---|
| ● | 3B | 0.8 | (SM) Silty Sand, fine to coarse with gravel to 1/2" | 131 | 7.0 | 0 | 39.4 |
| ■ | 5A | 0 | (SM) Silty Sand, fine to medium | 125 | 10.0 | 240 | 32.7 |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

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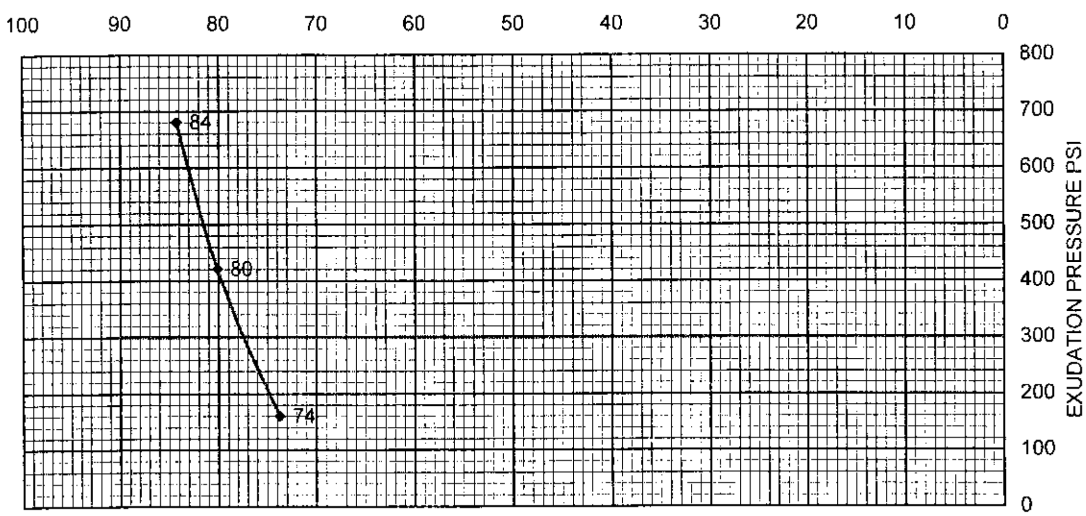
### REMOLDED DIRECT SHEAR TESTS

| Project: | Inland Communities, Paradise Hills | | |
|---|---|---|---|
| Location: | Tentative Tract Map No. 18140, Off-Site Road Improvements | | |
| Job No.: | 06242-3 | Enclosure: | C-8 |

| Traffic Index (T.I.) 5.0 | A | B | C | D |
|---|---|---|---|---|
| COMPACTOR AIR PRESSURE P.S.I. | 350 | 350 | 300 | |
| INITIAL MOISTURE % | 7.1 | 7.1 | 7.1 | |
| WATER ADDED, ML | 15 | 20 | 25 | |
| WATER ADDED % | 1.3 | 1.8 | 2.2 | |
| MOISTURE AT COMPACTION % | 8.4 | 8.9 | 9.3 | |
| HEIGHT OF BRIQUETTE | 2.51 | 2.45 | 2.48 | |
| WET WEIGHT OF BRIQUETTE | 1160 | 1140 | 1160 | |
| DENSITY LB. PER CU.FT. | 129.1 | 129.5 | 129.6 | |
| STABILOMETER PH AT 1000 LBS. | 20 | 12 | 15 | |
| 2000 LBS. | 18 | 22 | 28 | |
| DISPLACEMENT | 3.70 | 3.90 | 4.20 | |
| R-VALUE | 84 | 80 | 74 | |
| EXUDATION PRESSURE | 680 | 420 | 160 | |
| THICK. INDICATED BY STAB. | 0.25 | 0.32 | 0.42 | |
| EXPANSION PRESSURE | 2 | 1 | 0 | |
| THICK. INDICATED BY E.P. | 0.07 | 0.03 | 0.00 | |

EXUDATION CHART




R-Value: 77

| Boring No. | Depth (ft) | Soil/Sample Type | SE | $w_0$(%) |
|---|---|---|---|---|
| 1 | 0 | (SM) Silty Sand, fine to coarse with gravel to 1" | 15 | 7.1 |

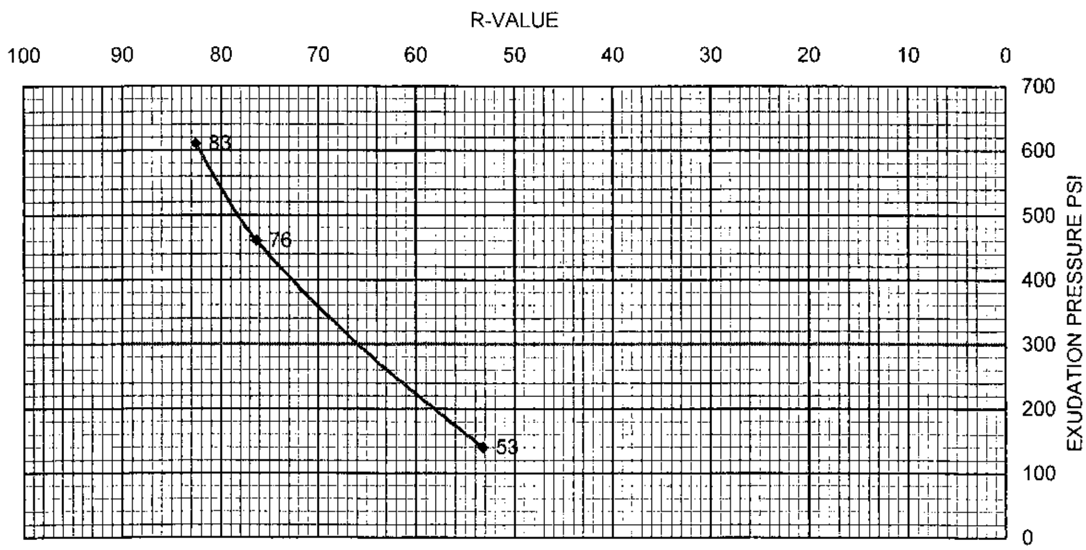
C.H.J. Incorporated

**R-VALUE TEST**

| | | | |
|---|---|---|---|
| Project: | Inland Communities, Paradise Hills | | |
| Location: | Tentative Tract Map No. 18140, Off-Site Road Improvements | | |
| Job No.: | 06242-3 | Enclosure: | C-9 |

| Traffic Index (T.I.) 5.0 | A | B | C | D |
|---|---|---|---|---|
| COMPACTOR AIR PRESSURE P.S.I. | 350 | 300 | 300 | |
| INITIAL MOISTURE % | 5.6 | 5.6 | 5.6 | |
| WATER ADDED, ML | 10 | 20 | 30 | |
| WATER ADDED % | 0.9 | 1.8 | 2.6 | |
| MOISTURE AT COMPACTION % | 6.5 | 7.4 | 8.2 | |
| HEIGHT OF BRIQUETTE | 2.51 | 2.52 | 2.45 | |
| WET WEIGHT OF BRIQUETTE | 1180 | 1180 | 1160 | |
| DENSITY LB. PER CU.FT. | 133.8 | 132.2 | 132.5 | |
| STABILOMETER PH AT 1000 LBS. | 10 | 16 | 29 | |
| 2000 LBS. | 21 | 26 | 55 | |
| DISPLACEMENT | 3.50 | 4.00 | 4.20 | |
| R-VALUE | 83 | 76 | 53 | |
| EXUDATION PRESSURE | 610 | 460 | 140 | |
| THICK. INDICATED BY STAB. | 0.28 | 0.38 | 0.75 | |
| EXPANSION PRESSURE | 2 | 1 | 0 | |
| THICK. INDICATED BY E.P. | 0.07 | 0.03 | 0.00 | |

EXUDATION CHART




R-Value: 66

| Boring No. | Depth (ft) | Soil/Sample Type | SE | $w_0$(%) |
|---|---|---|---|---|
| 4 | 0 | (SM) Silty Sand, fine to coarse with gravel to 1/2" | 15 | 5.6 |

C.H.J. Incorporated

**R-VALUE TEST**

| | |
|---|---|
| Project: | Inland Communities, Paradise Hills |
| Location: | Tentative Tract Map No. 18140, Off-Site Road Improvements |
| Job No.: | 06242-3 |
| Enclosure: | C-10 |

SCHIFF ASSOCIATES

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# Table 1 - Laboratory Tests on Soil Samples

*C.H.J., Inc.*
*Inland Comm., Paradise Hills, CA*
*Your #06242-3, MJS&A #06-0891LAB*
*23-May-06*

**Sample ID**

| | | | 3A | 5A | 6A |
|---|---|---|---|---|---|
| **Resistivity** | | **Units** | | | |
| as-received | | ohm-cm | 12,000 | 16,000 | 39,000 |
| minimum | | ohm-cm | 7,200 | 10,000 | 11,000 |
| **pH** | | | 7.9 | 7.8 | 7.9 |
| **Electrical Conductivity** | | mS/cm | 0.12 | 0.13 | 0.21 |
| **Chemical Analyses** | | | | | |
| **Cations** | | | | | |
| calcium | $Ca^{2+}$ | mg/kg | 100 | 107 | 229 |
| magnesium | $Mg^{2+}$ | mg/kg | 7.5 | 6.8 | 14 |
| sodium | $Na^{1+}$ | mg/kg | 11 | 23 | 6.9 |
| **Anions** | | | | | |
| carbonate | $CO_3^{2-}$ | mg/kg | ND | ND | ND |
| bicarbonate | $HCO_3^{1-}$ | mg/kg | 259 | 177 | 290 |
| chloride | $Cl^{1-}$ | mg/kg | 1.7 | 10 | 1.8 |
| sulfate | $SO_4^{2-}$ | mg/kg | 16 | 37 | 67 |
| **Other Tests** | | | | | |
| ammonium | $NH_4^{1+}$ | mg/kg | na | na | na |
| nitrate | $NO_3^{1-}$ | mg/kg | na | na | na |
| sulfide | $S^{2-}$ | qual | na | na | na |
| Redox | | mV | na | na | na |

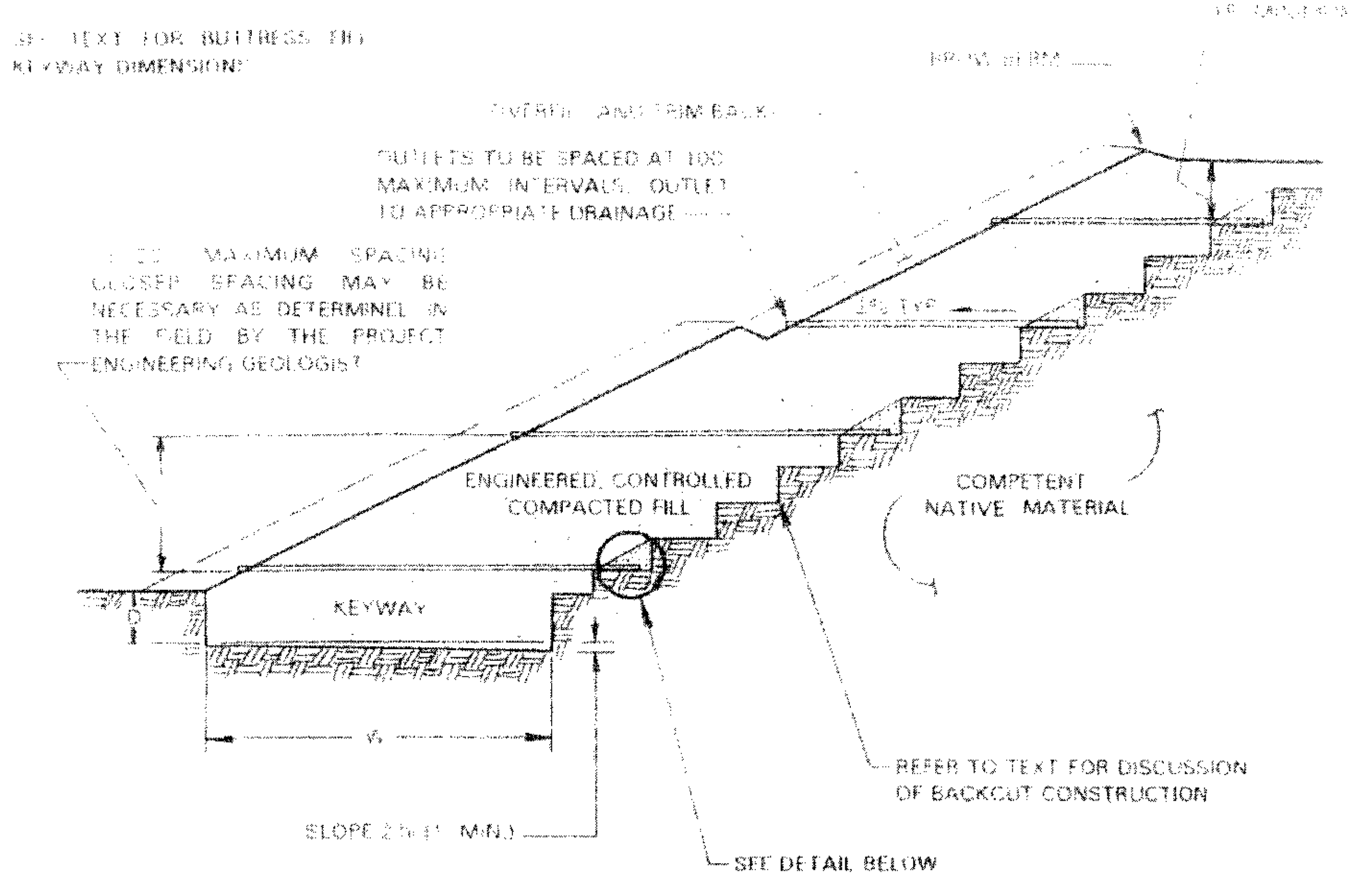
Minimum resistivity per CTM 643, sulfate per CTM 417, and chloride per CTM 422

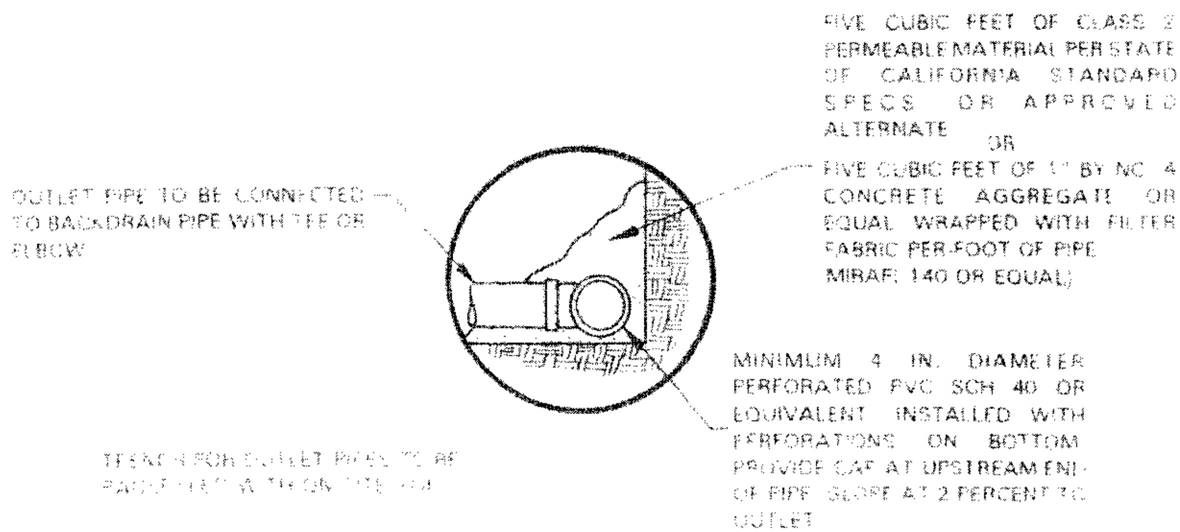
Electrical conductivity in millisiemens/cm and chemical analysis were made on a 1:5 soil-to-water extract.
mg/kg = milligrams per kilogram (parts per million) of dry soil.
Redox = oxidation-reduction potential in millivolts
ND = not detected
na = not analyzed

431 West Baseline Road Claremont, CA 91711
Phone: 909.626.0967 Fax: 909.626.3316

# APPENDIX "D"

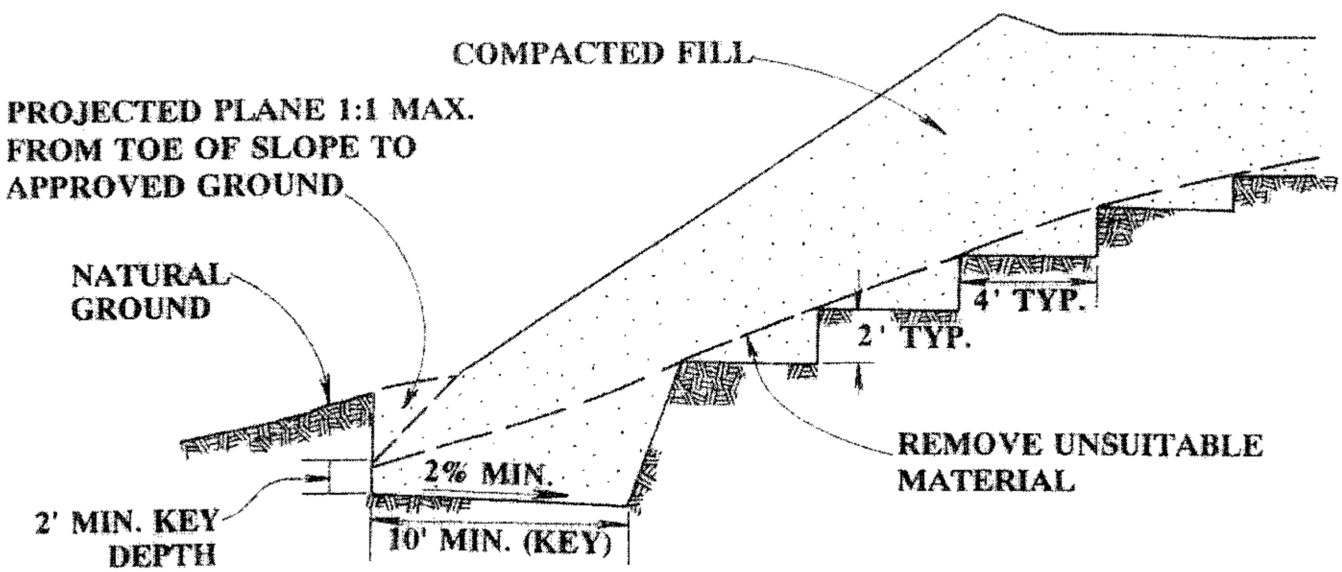
# GEOTECHNICAL DETAILS




| BUTTRESS/ STABILIZATION FILL DETAIL | | |
|---|---|---|
| FOR: INLAND COMMUNITIES CORPORATION | GEOTECHNICAL INVESTIGATION<br>OFF-SITE ROAD IMPROVEMENTS, PARADISE HILLS PROJECT<br>BADGER CANYON AREA<br>TENTATIVE TRACT MAP NO. 18140<br>SAN BERNARDINO, CALIFORNIA | ENCLOSURE "D-1" |
| DATE: JUNE 2006 | | JOB NUMBER 06242-3 |

C.H.J. Incorporated




FILL SLOPE

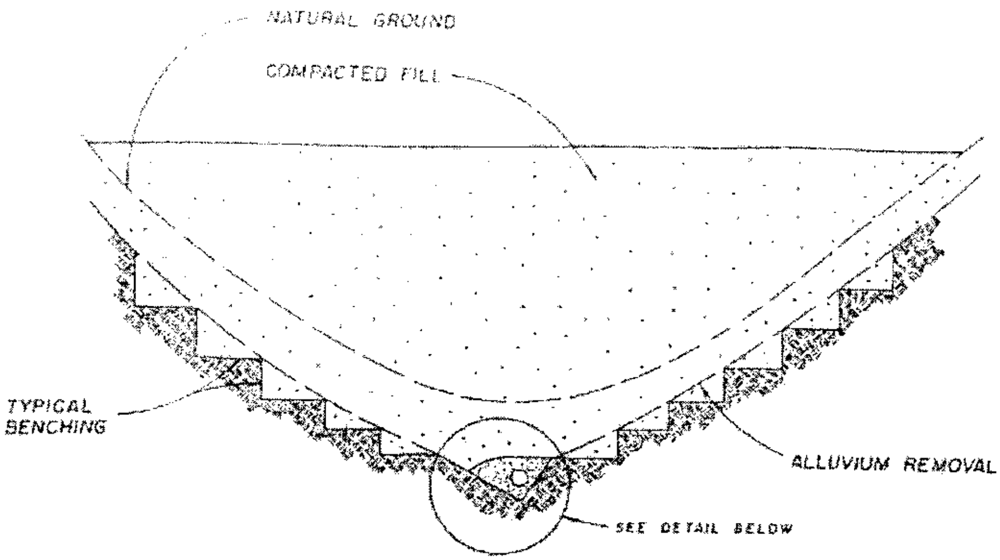
NOTES: (1) - DIMENSIONS SHOWN SUBJECT TO FIELD CHANGE BASED ON ENGINEER'S JUDGEMENT

(2) - BENCHING REQUIRED WHEN FILLING OVER NATURAL GROUND STEEPER THAN 5H : 1V

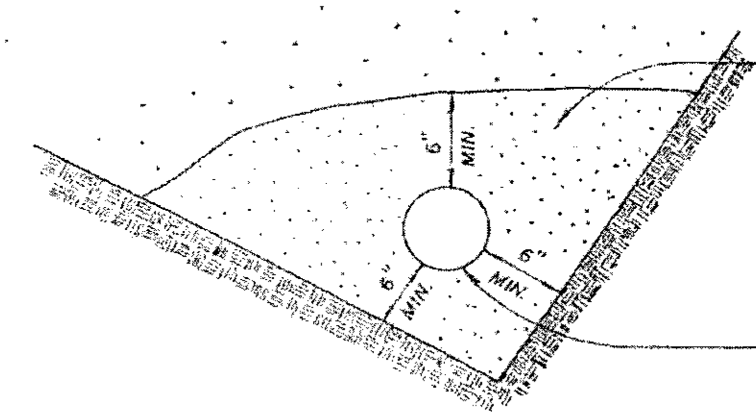
# KEYING AND BENCHING DETAIL

| | | |
|---|---|---|
| FOR: INLAND COMMUNITIES CORPORATION | GEOTECHNICAL INVESTIGATION<br>OFF-SITE ROAD IMPROVEMENTS, PARADISE HILLS PROJECT<br>BADGER CANYON AREA<br>TENTATIVE TRACT MAP NO. 18140<br>SAN BERNARDINO, CALIFORNIA | ENCLOSURE "D-2" |
| DATE: JUNE 2006 | | JOB NUMBER 06242-3 |

C.H.J. Incorporated




NOTE: DOWNSTREAM 20' OF PIPE AT OUTLET SHALL BE NON-PERFORATED AND BACKFILLED WITH FINE GRAINED MATERIAL. OUTLET SHALL BE TO NON-NUISANCE AREA.




FILTER: USE GRAVEL, (1" BY # 4 CONC. AGGREGATE) MINIMUM OF NINE CUBIC FEET PER FOOT OF PIPE, ENCASED IN FILTER FABRIC. (MIRAFI 140 OR EQUAL). FILTER MATERIAL SHALL BE LAPPED PER THE MANUFACTURERS SPECIFICATIONS.

VARIABLE TO 8" DIA. SCH. 40 OR EQUIVALENT WITH CRUSHING STRENGTH OF AT LEAST 1000 LBS. WITH 8 UNIFORMLY SPACED PERFORATIONS PER FOOT OF PIPE INSTALLED WITH PERFORATION ON BOTTOM OF PIPE. CONSTRUCT SO AS TO DRAIN.

NOTE: PVC DIAMETER SIZE DEPENDS ON SURFACE GRADE AND CANYON SIZE, SUBJECT TO REVIEW BY GEOTECHNICAL ENGINEER.

# SUBDRAIN DETAIL

| | | |
|---|---|---|
| FOR: INLAND COMMUNITIES CORPORATION | GEOTECHNICAL INVESTIGATION<br>OFF-SITE ROAD IMPROVEMENTS, PARADISE HILLS PROJECT<br>BADGER CANYON AREA<br>TENTATIVE TRACT MAP NO. 18140<br>SAN BERNARDINO, CALIFORNIA | ENCLOSURE "D-3" |
| DATE: JUNE 2006 | | JOB NUMBER 06242-3 |

C.H.J. Incorporated