Earth Investigations Consultants

July 1, 2004
Job 1663.01.01

Ms. Mary Bean
Public Affairs Management (PAM)
135 Main Street, Suite 1600
San Francisco, California 94105

RE: GEOTECHNICAL PEER REVIEW
Geotechnical and Hydrology Reports
Proposed Forest Green Estates, Tract 8268
Richmond, California

Dear Ms. Bean:

INTRODUCTION

Pursuant to your authorization, we have completed review of geotechnical and hydrologic reports prepared for the referenced project. The findings and conclusions and recommended action in this summary letter report are based upon the following documents submitted to our office:

- Forest Green Estates, Revision to pending tentative map applications, Subdivision #8268, for General Holdings, Inc. prepared by John Wollman, P.E., 25 pgs. with illustrations dated December 2003;
- Geologic and geotechnical investigation on Forest Green Estates, Tract 8262, Clark Road, Richmond, California for General Holding, Inc., prepared by *TERRASEARCH, inc.* dated March 19, 2003, Project No. 7797.G, 53 pgs. with illustrations and appendices. Geologic site constraints are illustrated on attached Plates 1-3. Proposed geotechnical mitigations are illustrated on Plate 4;
- Hydrology report, Subdivision 8268, Forest Green Estates, Richmond, California, prepared by Wollman Associates, Inc. Project No. 97118.001. Proposed hydrologic mitigations are illustrated on Plate 5;
- Hydrology report, Forest Green Estates, Wetland mitigation and monitoring plan for Forest Green Estates, L.L.C., prepared by Balance Hydrologics, Inc., dated June 2003, 25 pgs. with tables and illustrations;
- Revised mitigation plan, Forest Green Estates (Johnson Ranch), Wesley Way and La Crescenta Road, Richmond, California, supplement to geologic and geotechnical investigation report for Land Research & Management, prepared by *TERRASEARCH, inc.* dated April 6, 2004, Project No. 7797.G, 2 pgs. with illustration.

FINDINGS

Proposed Project

The proposed project is a single-family, residential subdivision (Tract #8268) sited on 81.1 acres hillside parcel. Components of the proposed project include:

- 122 detached homes-42.6 acres;
- Common open space-27.2 acres.
- Park land-4.3 acres;
- An undetermined volume of cut and fill for site development, however it is anticipated that it will removed the shallow (less than 10 feet deep) landslides;
- Streets and emergency vehicle access-7.0 acres;
- 1700 linear feet of earthen buttresses to approximately 60 feet deep by 150 feet wide in the southern half of the site to enhance slope stability
- 500 or more linear feet of subdrainage to a depth of at least 60 feet to enhance slope stability;
- Approximately 1700 linear feet of 3-foot diameter, cast-in-place concrete pier buttressing to a depth of at least 80 feet along the west property line to enhance slope stability;
- Relocation of approximately of the eroded seasonal drainage in the northeast corner of the site draining a watershed of 9.64 acres, including stormwater runoff from Waldorf School;
- Construction of 3 detention basins and 7 water quality basins on the park and open space land designed to reduce flood flows and improve water quality. Reduction of site runoff is proposed by introduction of storm runoff into 12, 60- to 100-foot deep drainage galleries (percolation wells) proposed for each of the 10 basins;
- Development of new seasonal wetlands covering 0.2 acres designed to impound runoff from the upland watershed in the proposed park land at the southwest corner of the site;
- Approximately 2000 linear feet of concrete interceptor ditch to capture runoff from the upland watershed south and west of the site. and direct it to the storm drainage system.

Geologic and Geotechnical Investigation

The site lies in a seismically-active region, and entirely within an ancient landslide that extends from San Pablo Ridge to San Pedro Creek, covering an approximate area of 344 acres (1/2-square mile). The bottom of the landslide, estimated to underlie the site to a depth of 300 feet has not been positively established, and is inferred to occur in weak, late-Tertiary, non-marine sedimentary rocks of the Contra Costa Group that produce highly expansive soils. Active landslides (including disturbed ground) and dormant landslides (potentially active) cover more than 50 percent of the site. Explorations, including small- and large-diameter borings extending to depths of 224.5 feet, and test pits to 19 feet confirmed the presence an ancient landslide containing numerous, random surfaces of weakness along which future landsliding and creep could occur. Two springs have been identified on or adjacent to the site, and dark soil tones identified on historic aerial photographs in the upland area adjacent to the site suggest spring activity within the drainage basin. Seepage was encountered in all of the borings at depths ranging from 14 to 95 feet.

There are no active faults on the property, hence risk is low for primary fault rupture. An array of inactive faults project onto the site, appearing to control the northwest-southeast trending margins of the ancient landslide mass. They present a potential hazard from coseismic movement during a major earthquake, expected to produce violent ground shaking during a nearby major earthquake on the Hayward fault, mapped approximately 1 mile from the site.

Several iterations of computerized (XSTABL, version 5), critical-search (circular), limit slope stability analyses were performed to evaluate potential landslide geometries, including relative stability of the 300-foot thick ancient landslide mass. Relatively conservative shear strengths applied to the analyses were from laboratory testing of landslide debris; *TERRASEARCH,* Inc. desires to eventually obtain representative rupture-surface earth material from a long, deep excavation during project design. Global stability of the overall ancient landslide is based upon the assumption that the ground water table will not rise to within 100 feet of the ground surface. Static and psuedo-static (earthquake conditions) analyses of potential "shallow" landslides (up to 150 feet deep) could occur if the site ground water elevation were to rise to within 30 feet of the ground surface. Factors of safety for static conditions were 1.5 and 1.0 for psuedo-static conditions were deemed satisfactory by *TERRASEARCH,* Inc. They were performed without respect to the proposed hydrologic mitigations described in the following section, however they expressed general concern over introducing water into the ancient landslide from the proposed basins and percolation wells.

Conceptual geotechnical mitigations for potential, on-site, deep-seated landslides included deep, earthen buttresses, and deep subdrainage in the south and west part of the site; and a row of deep piers along the western boundary of the site to

mitigate potential for encroachment by the off-site, deep-seated La Colina Landslide which is nested on a deep creeping landslide mapped beneath a large area of the proposed housing tract and appurtenances. The conceptual mitigation plan is contingent upon acceptable results from supplemental geotechnical investigations, testing and stability analyses.

Hydrologic Reports

The site occupies an area within a Mediterranean climatic zone, typical of central California. Mean annual rainfall of 25 inches is sometimes exceeded by 200 percent during the recorded wettest years. The recorded driest years produce cumulative rainfall approximately 43 percent of the annual average. Temperatures rise sharply in the late spring, and remain elevated through early fall. Evaporation and evapotranspiration rates also rise in response to the warmer weather, typically depleting root zone soil moisture by early May, thus slowing or stopping native vegetation growth until rainfall in early October. Extremes in soil temperature variations result in the pervasive surface cracking present on the site.

The 81-acre site occupies a 213-acre watershed, excluding runoff from approximately 6 acres occupied by the Waldorf School. Existing surface water bodies that contribute to site runoff include a small stock pond in the southeast corner, and two known springs; one just offsite of the southeast property corner, and another in the northwest corner between proposed Lots 49 and 102. When connected by a line, the points of seepage describe a northwest trend subparallel to the regional structural trend. Site runoff begins as excess and/or saturated overland flow when the infiltration capacity of the clayey soils covering the hillside property is exceeded. Overland runoff is carried to the stream channels during rainfall by rills, gullies and swales. An unnamed, main intermittent stream extends diagonally across the site from the southeast to northwest parts, and 5 smaller tributaries drain the site. The main watercourse will remain undisturbed by grading required for the project, with the exception of replacement of the 48-inch diameter culvert beneath Wesley Way with a bottomless arch culvert for a wildlife access corridor. The locally incised and/or actively eroding main and tributary streams drain to San Pablo Creek, approximately ¼-mile to the north, and eventually to the regional base level elevation controlled by San Pablo Bay. According to the FEMA Flood Insurance Rate Map (1987), the site does not occupy the 100-year floodplain. The area of the 100-year floodplain includes the area just north of the site to San Pablo Creek. The existing undeveloped runoff at the northern boundary of the property is 124 cubic feet per second (cfs) for a 10% (10-year) storm event, and 230 cfs for a 1% (100-yr.) event. Runoff from the site and surrounding areas eventually flows beneath San Pablo Dam Road in a 36-inch diameter culvert to discharge into San Pablo Creek.

The maximum difference between existing and unmitigated storm runoff volume from the main channel at the north end of the site for a 1% storm is 1.42 acre-feet (ac-ft). It appears that this calculated volume of water leaving the site in the main channel does not account for considerable reduction in runoff that would be offered by the proposed basins and drainage galleries.

Ground water beneath the central part of the site was encountered in borings at 25 and 42.5 feet deep. Borings in the western part of the site and in the southeast part, near the stock pond, encountered ground water at depths ranging from 14 to 95 feet, and was also interpreted as perched ground water because it occurs as "pinpoint" seepages from shears or other discontinuities, similar to the occurrence of ground water in the active La Colina Landslide west of the site. Evidence of seasonally perched ground water or of past high soil moisture can be inferred on the basis of mottling, blue-grey and blue-green soil color, and the presence of caliche in the upper 30 feet of virtually all of the geotechnical explorations.

Waldorf School contributes uncontrolled, concentrated runoff to the northwestern part of site drainage system. Active erosion by "flashy", peak flows from the school grounds to the tributary of the main stream in the northeast part of the site has undercut and dislocated the culvert system. It is predicted that erosion of the channel and sedimentation into the drainage system on the site will continue given the current state.

Proposed hydrologic modifications in the project area are intended to reduce flows for the site to San Pablo Creek. These mitigations would address Contra Costa Flood Control & Water Conservation District's concern over flooding and bank erosion occurring along developed segments of San Pablo Creek:

- New Seasonal Wetlands (basins) covering an area of 0.2 acres in the southwest part of the site, adjacent to Lots 90-94. The geotechnical consultant will be responsible for specific design details, however conceptual design will include:

    1. Design will be similar to detention basins;
    2. Ponded depth will generally be shallower than detention basins;
    3. Gentle, complex slopes to allow for large changes in wetted area caused by small changes in ponding depth;
    4. Excavation of 1 to 4 feet of soil with a final grade that slopes toward the designated overflow area, which appears to be the proposed, concrete interceptor ditch extending across the southern margin of the site (Figure 6);
    5. Compact the excavated area to reduce infiltration/percolation until a wetland sub-area is developed in approximately 10 years;

6. Place 1 foot of granular material in the bottom of the excavated area, and if necessary, install a drainpipe network to collect seepage from the wetland and direct it to the proposed, concrete interceptor ditch;
7. Compact 1 to 2 feet of clay over the granular material and construct a clay berm, covered with geotextile, on the downslope side to prevent runoff from the wetland;
8. Spread amended fill with wetland seed mix over the clay, with planting of woody vegetation in the adjacent upslope area;
9. Armor the clay berm to prevent erosion and overflows;

Hydrologic functions of the new seasonal wetlands include:

1. Retention and stabilization of sediment generated in the upslope area;
2. Reduction of peak and total flows in the proposed concrete interceptor ditch and its discharge facility;
3. Transformation of excess nitrogen and removal of pollutants derived from the upland watershed;
4. Provide a habitat for aquatic species and water sources for upland wildlife;
5. Provide a more natural setting to local residents.

- Relocation of approximately 360 feet of the 400-foot Ephemeral Channel in the northwest part of the site receiving runoff from Waldorf School, and creation of approximately 0.024 acres of associated seasonal wetlands. The project proposal is to fill the existing channel for building pads, and relocate the channel approximately 50-75 feet to the south. The existing channel measures 14 percent in the lower half and more than 25 percent in the upper half. The new channel will have a minimum slope of 24 percent. Fourteen to nineteen, 2-foot high check dams spaced at regular intervals to create an artificial slope of 14 percent have been recommended to establish a stable channel configuration. This channel inclination appears to reflect stable profiles observed elsewhere in the site watershed, provided flows of runoff exceeding 4 cubic feet per second (cfs) are avoided. Runoff from Waldorf School is not expected to exceed 4 cfs.

  Hydrologic functions of the relocated channel include:

  1. Will be designed to carry storm runoff for a 100-year storm (4 cfs);
  2. The check dam profile will create a stable channel gradient;
  3. Offer the capacity to retain sediment and establish woody riparian vegetation;

4. Side channel seasonal wetlands produced by the check dams will provide areas for discharge of mitigation subdrains, and offer a habitat to encourage growth of riparian vegetation that will improve erosion resistance;
5. Established vegetation will function to remove and transform excess nutrients and remove pollutants derived from the Waldorf School watershed;
6. Reduce volume of sediment generated from the watershed.
7. Provide an aesthetic, health riparian corridor, wildlife and aquatic habitat, and natural hydrologic setting.

- Detention Basins (DB; total of 3) have been designed to detain peak storm flow for a 50-yr. storm (2% event) with freeboard and overflow facilities to accommodate a 100-yr. storm (1% event). They will range in size from 2990 square feet (DB-1) to 5002 square feet (DB-3), with a combined site coverage of 0.3 acres and storage capacity of 129,565 cubic feet (3 acre-ft.). They will be designed for downstream pollution from project storm water by inducing desiltation, and biofiltration before discharging into the proposed drainage gallery system discussed below. They are designed to hold no water except during the storm event, and only for a period of approximately 12 hours afterward. The basins will be constructed in accordance with a 2-stage design: A lower stage, consisting of a micro-pool which would hold 15-25 percent of the runoff volume, filling more often and allowing the basin to be dry and sediment-free most of the time. The forebay would be constructed so that larger particles settle in depressions in the basins inlets, reducing the potential for erosion or resuspension resulting from inflow. The runoff retained in the forebay and silt deposit pools would evaporate over time.

  Hydrologic functions of the detention basins include:

  1. Reduction and control of storm flows into the drainage system;
  2. Desiltation and biofiltration of runoff before entering the drainage system;
  3. Channel erosion reduction.

- Water Quality Basins (WQB; total of 7) will have a combined area of approximately 0.4 acres, constructed in the northern and western parts of the site to remove a wide range of pollutants found in urban runoff. They will offer a combined storage capacity of 35,362 cf (0.81 ac-ft.), and capacity to treat 80-90 percent of average annual runoff for 48 hours prior to release to the drainage galleries (described below). The WQBs will be lined with clay to prevent seepage and/or infiltration. The earthen side slopes will be shaped to a gradient of 3:1. Riprap or similar material will be placed at each basin inlet and outlet to dissipate energy. The

treatment volume will discharge through perforated riser pipes screened to preclude obstruction by debris. The top of the riser will be left open to accommodate larger storm discharge.

Hydrologic functions of the water quality basins include:

1. Provide for small wetlands with a range of hydrophilic and other tolerant vegetation;
2. Provide water treatment using combination of flow-through processes and temporary ponding;
3. Removal of suspended solids by settling and filtration through vegetation;
4. Removal of dissolved pollutants through chemical and biological mechanisms mediated by the plant and soil material.

- Drainage Galleries (DG; total of 12) are designed to temporarily store storm runoff and allow for deep infiltration and/or evaporation. The intent of the galleries is to further reduce site runoff siltation and pollutants. The proposed galleries will be drilled, 40- 100-foot deep, vertical shafts below 6-foot percolation chambers. On the whole, the drainage gallery system will be capable of conveying to the earth by percolation 240-425 cubic feet of water from the subdivision storm drain system, including the discharge from the basins. Each of the detention and water quality basins will be constructed with a gallery. One gallery is proposed in the street storm drain between Lots 49 and 103. Overflow from the galleries will be directed to an erosion-protected segment at the head of the main and tributary channels.

Hydrologic functions of the drainage galleries include:

1. Reduction in storm flow to the drainage system;
2. Additional filtration of storm water derived from the basins and street storm drainage system.

TERRASEARCH, Inc. conceptually evaluated, but did not rigorously analyze potential adverse site effects on ground water and slope stability by the mitigated storm drainage plan. They concluded that the ponds (detention and water quality basins) should be lined with clay (e.g., chemically-treated expansive site soil) to mitigate cracking and to create an impermeable barrier against infiltration of water. They drilled 2 percolation test holes (PTW 1 and 2) and determined a stabilized percolation rate of 2 inches per hour, but did not relate it to the site storm drainage control/disposal system for a design storm (i.e., 1% event). They indicate that the actual infiltration rate will ultimately be a function of head (height) of water in the wells, and the earth materials encountered at the well locations (e.g., clay will percolate slower than sand). They conclude that

percolation of storm drainage water into the ground through percolation wells would not create instability north of the site (middle and toe region of the ancient landslide) because the land is flat or at low inclination. One detention basin and 2 water quality basins are proposed within the area of the creeping landslide on the west side of the property. They further concluded that percolation wells may be permissible in proposed buttress areas if the anticipated water quantities are minor; a condition *TERRASEARCH*, Inc. recommended be evaluated during the design phase, and that any site for percolation be approved by them.

- Bottomless Arch Culverts will be installed where streets cross three of the tributary streams

- Hydrologic functions of the bottomless arch culverts include:

    1. Allowance for natural flow lines and wildlife access

DISCUSSION AND CONCLUSIONS

According to the *CEQA Guidelines*, exposure of people or structures to major geologic hazards is considered to be a significant adverse impact. More specific examples of this criterion are provided in Appendix I of the *CEQA Guidelines*. A potentially significant impact would result if the project would expose people or structures to the following:

- Fault rupture, seismic ground shaking or ground failure, including liquefaction, seiche, tsunami, or volcanic eruption hazards;
- Landslides or other forms of slope instability;
- Flooding
- Erosion or unstable soil conditions, subsidence; and
- Expansive soils.

Currently identified geologic hazards reflect the project in a high rainfall, seismically active region underlain entirely by unstable and potentially unstable landslide debris. We judge that this site would impose on the project significant geologic hazards, and expose an increased number of people (in this case, the residents and visitors of the proposed development and adjoining developments) to risk of injury or significant loss because of the potential for deep landsliding and landslide creep. In our opinion, the geologic and hydrologic conditions at this site constitute a significant risk to the proposed development, and we judge, from the available body of site-specific geotechnical and hydrologic information that, overall, the risk is so unfavorable that it cannot be overcome by reasonable design, construction and maintenance practices.

The geotechnical report prepared for the proposed project contains important geologic information pertaining to the relative distribution of landslides, and the quality of the earth material underling the site, but is deficient in presenting an understanding of the site ground water regime, mechanism and mode of landsliding, mode of failure, and future risks associated with the proposed project construction/mitigation. It is known that deep landsliding and creep are affecting areas to the west of the site where it has been established that ground water is the principal mechanism for complex translational/rotational failure in a deeper, creeping landslide. Stability analyses for this project do not account for potential creep, and are predicated on assumed ground water conditions. The site lies in a drainage basin that is likely to have perhaps substantial fluctuations in ground water elevation over a year of average rainfall. The stability analyses indicate that global instability to a depth of approximately 300 feet would occur if ground water were to rise within 100 feet of the surface; and that landslides to 150 feet deep could occur if ground water were to rise within 30 feet. This is significant because the proposed hydrologic mitigations recommend recharging the ground water regime to depths of 100 feet. Further, percolation from new seasonal wetlands and water quality basins could exacerbate local stability. Consequently, before project feasibility can be confirmed, it will be necessary to establish through careful monitoring of piezometers and wells, the pre- and post-construction ground water regime. Piezometers readings should be taken regularly over a minimum period of 1 year of average annual rainfall to establish the existing ground water elevation(s) for use in stability analyses. Ground water monitoring wells should be used to establish the impact of recharge to the existing ground water regime by the proposed hydrologic mitigations. Given the site is underlain by thoroughly sheared landslide debris that is expected to receive violent ground shaking during one or more major earthquakes over the project lifetime, conservative psuedo-static slope stability should be evaluated for a minimum factor of safety 1.1, as recommended in California Division of Mines and Geologic, *Special Report 117*.

Another imperative is that depth of creep be evaluated across the site by regular readings of individual slope indicator casing installed in borings at least 200 feet deep, over a period of at least 1 year of average annual rainfall. This measure is intended to empirically establish creep/landslide rupture distribution and depths. Creep monitoring should extend to a minimum depth of 200 feet at points throughout the site. Geologic information gained from this task will be extremely useful in,

1). Judging feasibility of the proposed project; and
2.). Analyses of geotechnical and hydrological mitigations.

RECOMMENDED ACTION

The tentative map application for Subdivision #8268 should be denied until detailed ground water and landslide creep investigations confirm the proposed project will remain stable over the projected lifetime given existing geologic conditions and proposed geotechnical and hydrologic mitigations.

The following plates are attached to complete this report:

Plate 1 – Area Geologic Map
Plate 2 – Site Geologic Map
Plate 3 – Geologic Cross Section A-A'
Plate 4 – Geotechnical Mitigation
Plate 5 – Hydrologic Mitigation

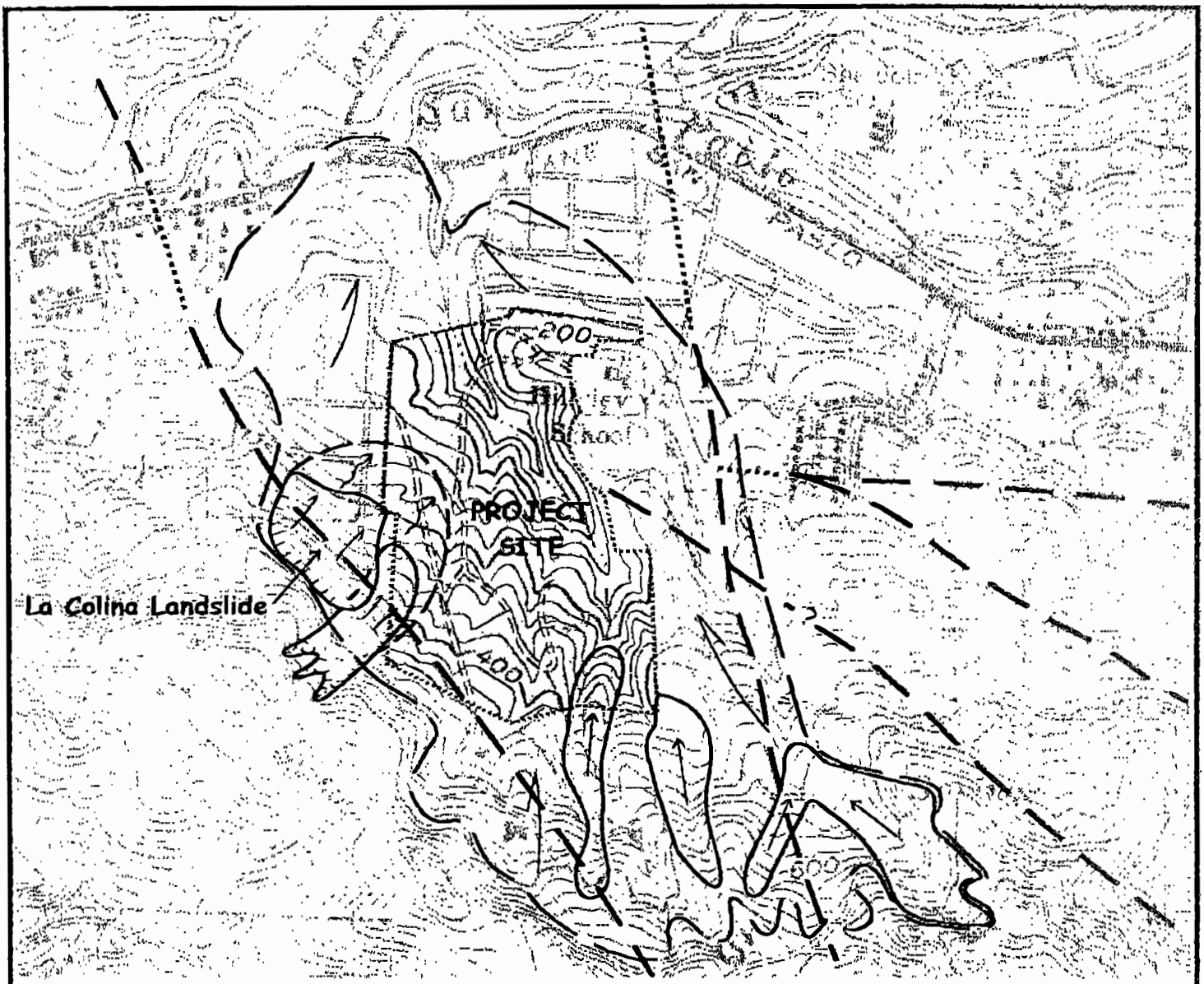
We trust that this provides you with the information you require at this time. Please call if you have any questions or require additional information.

Very truly yours,

Earth Investigations Consultants

Joel E. Baldwin, II
Principal Engineering Geologist

JEB:jb:Eir
Distribution: 5 copies to addressee



EXPLANATION

Approximate Location of Confirmed Landslide Area:
Chiefly active landslides confirmed by geologic or geotechnical investigations which included both a detailed surface reconnaissance and subsurface exploration

Deep actively creeping landslide

Approximate Location of Possible Landslide Area:
Includes active and dormant landslides, as well as areas of disturbed ground that contain a concentration of smaller landslides, mapped from published sources and generally confirmed by serial photo-interpretation

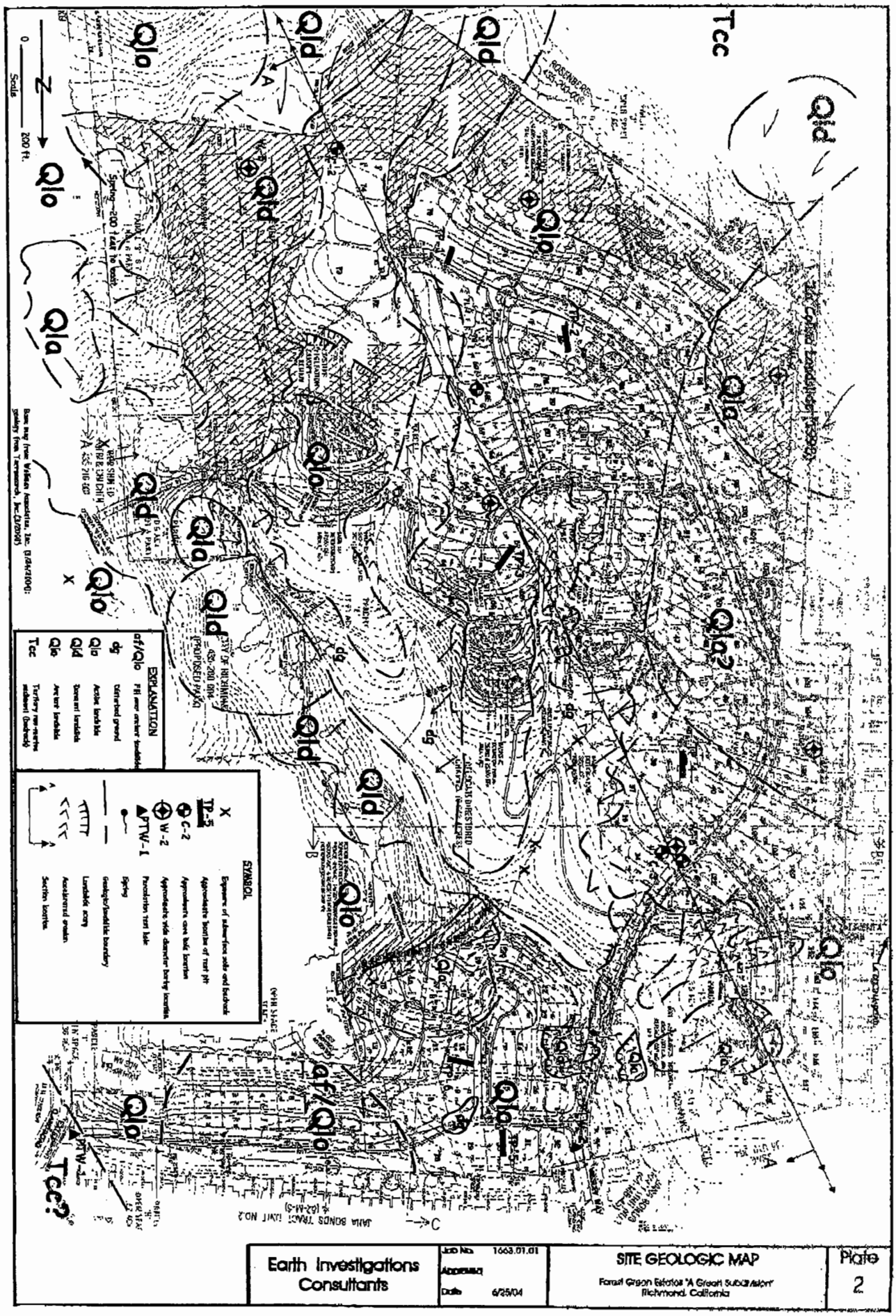
Approximate Location of Inactive, Bedrock Fault (dashed where approximately located, dotted where concealed, queried where location uncertain)

N

0 1000 ft.
Scale

U.S.G.S. Topographic Map, Richmond Quadrangle, 7.5' Series (1959)
Geology from Terrasearch, Inc. (3/2003) and Bishop & others (1973)

Earth Investigations Consultants	Job No. 1663.01.01 Date 6/25/04	AREA GEOLOGIC MAP Forest Green Estates "A Green Subdivision Richmond, California	Plate 1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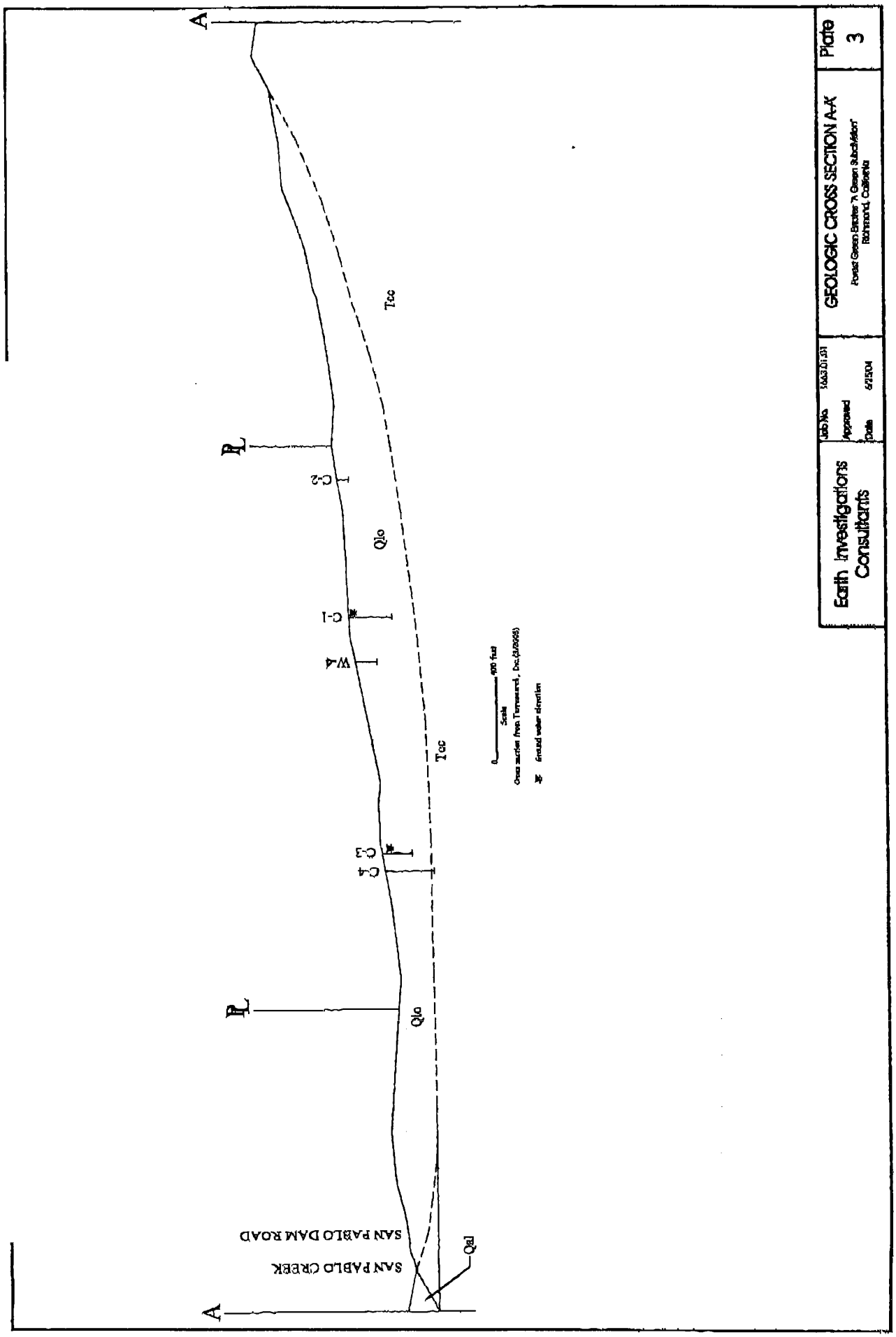
Earth Investigations Consultants
Job No. 1663.01.01
Approved
Date 6/25/04
SITE GEOLOGIC MAP
Forest Green Estates "A Great Subdivision"
Richmond, California
Plate
2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SAN PABLO DAM ROAD
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C-2
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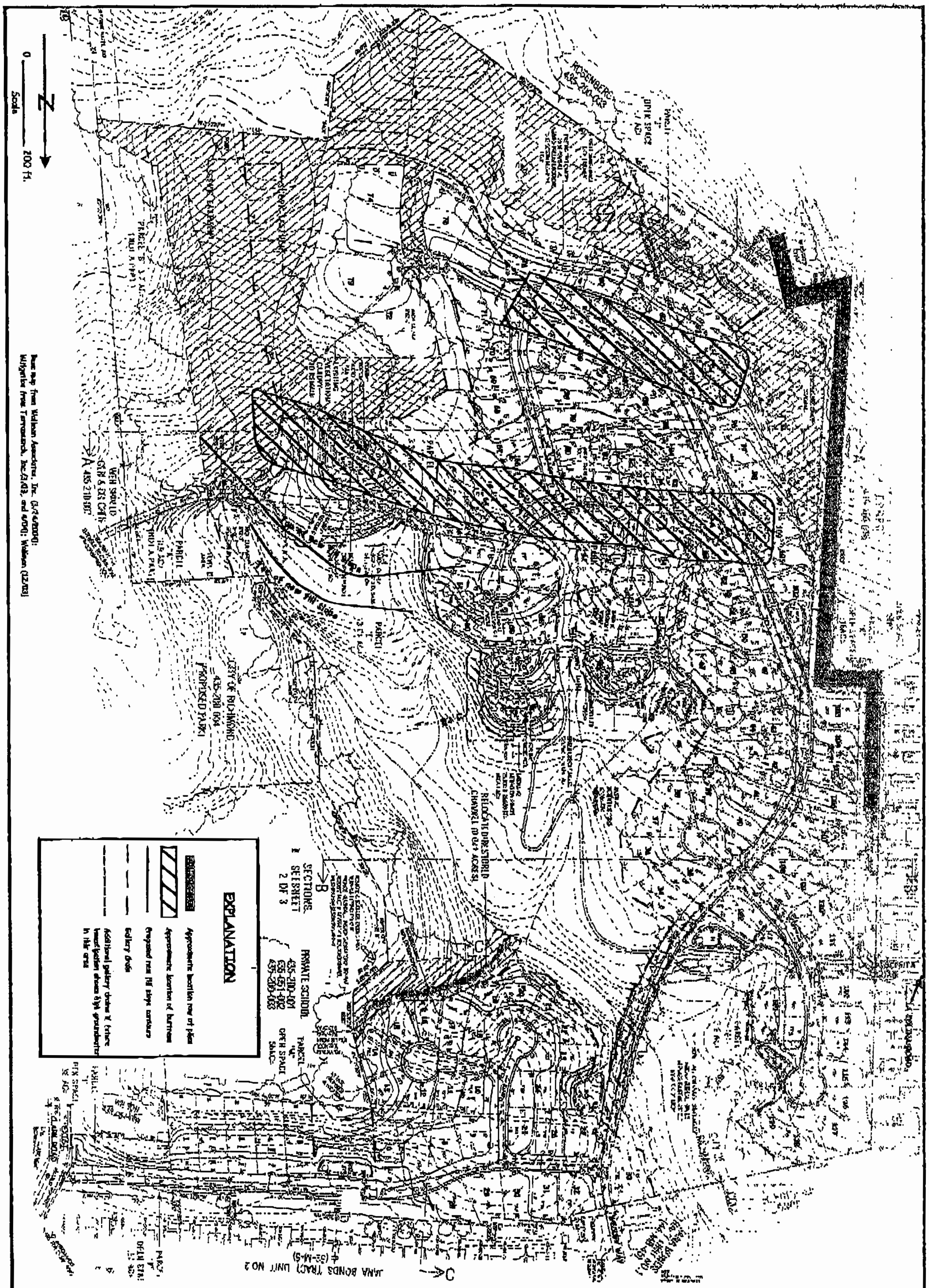
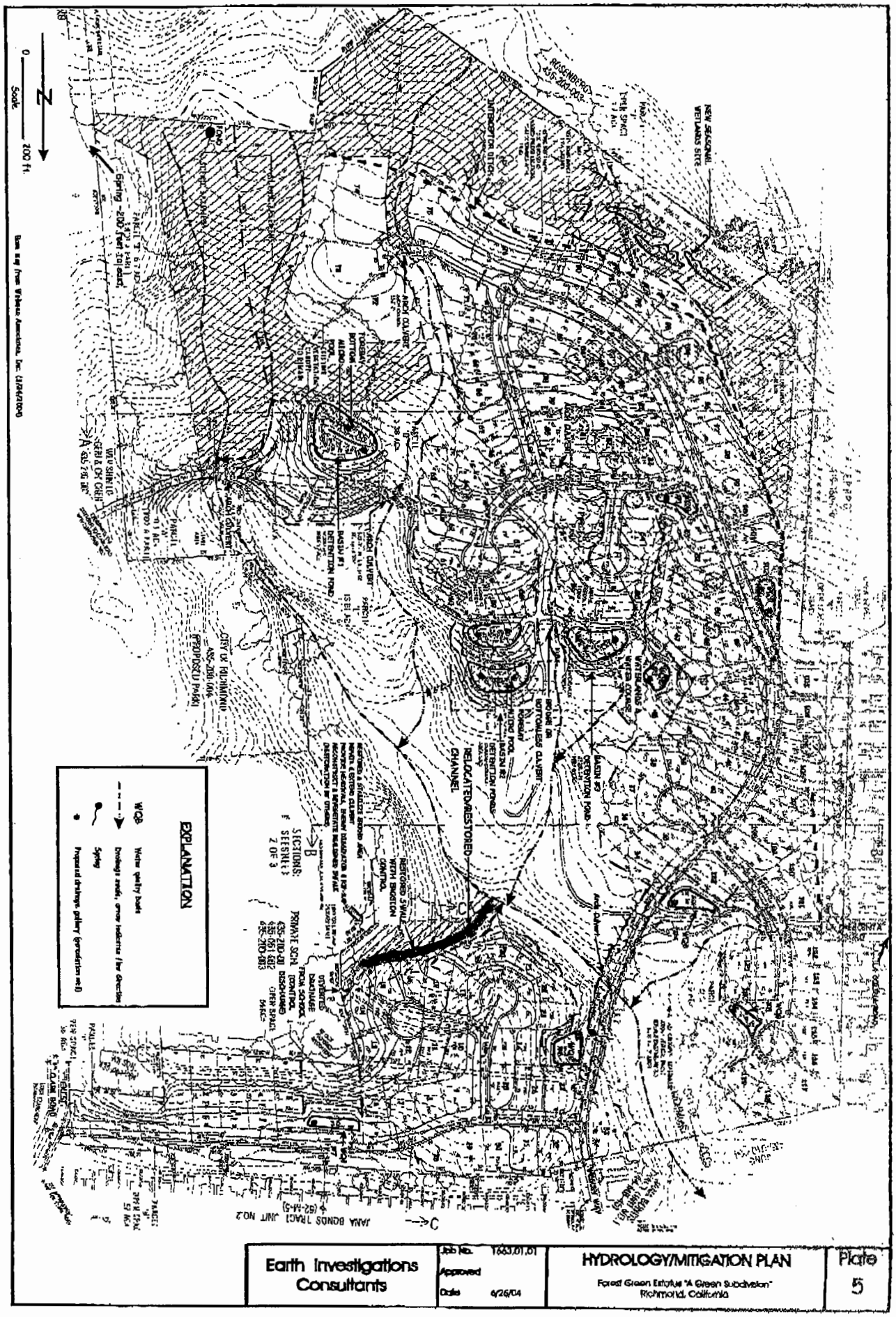
C-3
C-4
Scale
Cross section from Thomasand, Inc.(3/2005)
Ground water elevation
Earth Investigations Consultants
Job No. 1003.001.001
Approved
Date 6/15/04
GEOLOGIC CROSS SECTION A-A'
Forest Green Estates 'N Green Subdivision
Richmond, California
Plate 3



Earth Investigations Consultants	Job No. 1663.01.01 Approved Date 6/26/04	**GEOTECHNICAL MITIGATION PLAN** Forest Green Estates "A Green Subdivision" Richmond, California

Plate 4



Earth Investigations Consultants	Job No. 1663.01.01 Approved Date 6/26/04	HYDROLOGY/MITIGATION PLAN Forest Green Estates "A Green Subdivision" Richmond, California	Plate 5