Earth Investigations, Inc.

Geotechnical Analysis January 2005

GEOLOGY, SOILS, SEISMICITY AND HYDROLOGY

The following section summarizes the existing geologic, soils, seismic and hydrologic setting for the revised project, and discusses the impacts that result from the project. Mitigation measures to reduce potential impacts are also provided. The information and analysis provided in this section is based upon a peer review conducted by Earth Investigations Consultants (EIC; EIR geological consultant) of the project applicant's geotechnical studies prepared by TERRASEARCH, Inc. (2003).

1. Setting

a. Regulatory Setting. The Safety Element of the General Plan incorporated public health and safety considerations into Richmond's long-term planning. The Element sets forth the following goals, policies and implementation program:

> ***Policy SF-A.5:*** *continue to investigate the potential for seismic and geologic hazards as a part of the environmental review process and maintain this information for public records.*
>
> ***Policy SF-A.13:*** *Require as a minimum for all hillside construction the recommended guidelines listed in Table OSC-1, Guidelines for Geotechnical Investigations (see Technical Appendix in the Richmond General Plan).*
>
> ***Policy SF-A.14:*** *Conduct site-specific geotechnical studies on a case-by-case basis on projects proposed to be built on or adjacent to inactive bedrock faults. The areas may represent geologic anomalies that could contribute to slope instability and other geologic and geotechnical problems.*
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> ***Policy SF-A.5:*** *City will appraise individual development projects for the potential of significant geologic, soils, seismic and hydrologic problems. Study and reporting will made of seismic safety consideration in all Environmental Impact Reports (EIR). Those sections of an EIR dealing with geology should be reviewed by an engineering geologist prior to being presented to a designated city board or commission.*
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> ***Program SF-A.7:*** *City will require an evaluation of landslide potential by a certified engineering geologist for construction with areas designated as high or medium risk.*
>
> ***Program SF-A.8:*** *City will encourage the use of land in the setback zones along active and potentially active fault traces for open forms of*

land use that could experience displacement without endangering large numbers of people or creating secondary hazards.

Program SF-A.11: *City will incorporate the following measures into either already existing ordinances or proposed ordinances:*

(1) Minimize the removal of the natural vegetation cover and revegetate quickly;
(2) All major drainages should be kept clear of debris;
(3) Where possible, direct drainage away from unstable slopes and at-capacity drainages;
(4) Immediately inspect landslides to mitigate any flooding hazard that might result from blockage of drainages;
(5) Set back structures 75 feet from all mapped landslides or the major break-in-slope, whichever is closer to the proposed development site. (Setbacks are not necessary if structural reinforcements, such as retaining walls, are included in development plans);
(6) The engineering geologist and soil (geotechnical) engineer should be notified at least four (4) working days prior to any site clearing or grading operation on the property in order to observe grading and removal of vegetation;
(7) An engineering geologist or soil engineer should be present during site preparation and construction to evaluate the quality of geotechnical aspects of the work, verify compliance with recommendations, and suggest changes in procedures, if needed;
(8) City will require soil investigations by a soil engineer or an engineering geologist certified in the State of California as part of the site-specific environmental review process for any proposed development on soils with a moderate to high shrink-swell potential as defined by the Contra Costa Soil Survey (Soil Conservation Service, 1977). Review development on the soils with moderate to high shrink-swell potential in terms of site grading, foundation design, and construction in order to avoid site and structural damage resulting from these soil conditions.

b. Geologic Setting*.* The site is located within the central Coast Range at the northern end of the East Bay Hills. It lies within a nearly 50-mile wide zone of crustal deformation formed by interaction between the Pacific and North American Plates. This deformation, occurring over at least the past 5 million years, is reflected in a complex system of fractures, and northwest-trending faults, and folds; the distribution of which has been obscured by complex, regional landsliding (Figure 1).

The East Bay Hills are bordered on the southwest by the Hayward fault and on the northeast by the Calaveras fault (Figure). Crustal movement across these and related faults, including the San Andreas fault, has formed the crustal weaknesses along which erosion has created the steep and dissected slopes of San Pablo Ridge and predominant northwest-trending topographic "grain" that marks the landscape throughout the area.

San Pablo Ridge is underlain primarily by stratified, tightly folded and complexly faulted sedimentary and fewer crystalline rocks. The oldest rocks in the East Bay Hills belong to the Juro-Cretaceous Franciscan Complex within and on the west side of the Hayward fault zone. A northwest trending array of Tertiary sedimentary rocks, ranging from Eocene to Pliocene, dominates the site area. Rocks underlying the area of the site belong to the Pliocene, non-marine Contra Costa Group, which form the east limb of a northwest-trending syncline where strata dips, on average, 35 degrees to the southwest (Bishop and others, 1973; Wagner, 1978; Dibblee, 1980). They are characteristically friable, poorly indurated, conglomerate, sandstone, siltstone and claystone; all with a significant amount of montmorillonitic (highly expansive) clay material. Rocks of the Contra Costa Group and overlying soils they produce are particularly susceptible to creep and landsliding (Bishop and others, 1973; Nilsen, 1973; and 1975; Alan Kropp and Associates, 1991 and 2000). Radbruch (1969) characterizes the physical properties of the Contra Costa Group as follows:

- Depth of weathering irregular, from a few inches to several feet. Weathered rock soft, clayey. Soil generally lacking, but as much as 10 feet thick and clayey in ravines.
- Can be moved (excavated) with power equipment.
- Slope stability poor. Abundant slides in both soil and rock, on natural and cut (artificial) slopes. Slides most abundant on north facing slopes. Earthquakes may trigger soil slips (debris slides and flows) and landslides, particularly if rocks and soils are saturated.
- Expansive soils derived from this unit may cause heaving of structures.
- Properly compacted material suitable for artificial fill.

The moderate to steep, north-facing slope San Pablo Ridge on which the proposed project is sited is characterized by an irregular and locally hummocky landscape covered by annual grasses, locally thick brush and scattered trees. It is typified by a broad, concave upward, east-west profile bordered to the northeast and southwest by strong, northwest trending, strike-controlled ridgelines. Slope gradients of up to 3:1 (horizontal distance:vertical distance; 33%) occur across the arcuate slope breaks, and locally as steep as 1:1 (100%) in the southwest corner of the site. Gradients between slope breaks average 5:1 (20%). The banks of the ephemeral drainage channel average 2 ½:1 (40%) with local segments having gradients greater than 1:1 (100%).

All slopes are judged native, with the exception of grading for a paved access road leading to a private residential property bordering the south side of the property, unimproved vehicular and equestrian trails, and localized filling for equestrian activity in the middle of the site. Photogeologic interpretation suggests that the slope bordering the north side of Waldorf School and containing proposed Lots 1-5 and Water Quality Basin 7 is underlain by undocumented fill.

The property is drained by a relatively disjointed pattern of seasonal swales and structurally-controlled ephemeral channels (Figure 2). The locally incised, main intermittent stream channel (U.S. Geological Survey designation) drains the eastern part of the site as well as property beyond, including runoff derived from Waldorf School. It heads near the southeast corner, where there is an existing stock pond from previous grazing activity, then follows the eastern side of property to approximately the middle where it assumes the northwesterly trend of the regional bedrock structure to near the northwest property corner; eventually draining to San Pablo Creek, approximately ½-mile farther north. Runoff from the majority of the property is conveyed to the main channel by a parallel system of five, structurally-controlled, northerly sloping, seasonal tributary channels that intersect the main channel at nearly regular intervals between the southeast and northwest corners.

Two springs were mapped; one just beyond southeast corner, and another near proposed Lots 23 and 24 (TERRASEARCH, Inc., 1998; Figure). We observed during our site reconnaissance spring discharge on La Colina Road near the intersection with La Crescenta Road. We also interpreted as possible seepage from springs dark soil tones on aerial photographs in the axial and headward part of the swales near the southern property line.

The property lies within the midsection of an approximate 212-acre complex of landslides in bedrock and soil, disturbed ground, and soil and rock creep occurring within Contra Costa Group terrane (Figure 2). From photogeology for this review and previous geologic mapping, landsliding is known to exist between the 800-foot peak on San Pablo Ridge and San Pablo Creek (Bishop and others, 1973; Nilsen and others, 1975; TERRASEARCH, Inc., 1998, 2003; Figure 2). The lateral margins tend to coincide with the regional, predominant northwest-trending geologic structural grain. Geologic mapping and subsurface exploration by TERRASEARCH, Inc. (1998, 2003) for the proposed project revealed that more than 50 percent of the property is affected by *disturbed ground (ds)*, probable deep *active (Qal),* and *dormant (Qld)* landslides nested on a very deep, *ancient or old (Qlo)* bedrock landslide that extends beyond the limits of the property. Disturbed ground on the site appears to be from creep and debris sliding within the drainages, and is therefore considered shallow, active slope movements.

Bishop and others (1973) provide generally-accepted definitions for depth of landsliding (e.g., shallow: 0-10 ft.; intermediate: 10-20 ft.; deep: greater than 20 ft.). Classification of relative landslide activity, also inferring age (i.e., active, dormant, ancient) used by TERRASEARCH, Inc. (1998, 2003) tends to follow Cummings (1976) who developed the following criteria for landslides mapped in Tertiary marine and non-marine sedimentary rocks in Woodside, California, having a similar tectonic and climatic setting as this area of Richmond:

Active Landslides-Als (including Disturbed Ground dg): *"…recognized by angular to slightly smoothed, bare to slightly weathered scarps; open cracks; loose, low density soil materials (in and across ground fissures); undrained depressions; highly irregular broken rubble, actively or recently moving downslope, with bare scarps, undrained depressions, and recently disturbed vegetation. Many of the landslides so classified are known to have moved in recent years where they have affected homes and roadways in the Woodside area. All are judged by the criteria used to have been actively moving downslope within the past 50 years or less;*

Dormant Landslide-Qld: *"…are distinguished by clearly defined but weathered and overgrown scarps, a lack of open cracks, moderately firm soil materials (in and across ground fissures), subdued depressions and hummocky surface features, well rotted, fallen trees, older growing trees, bowed or distorted, and undisturbed younger vegetation. Landslides in this category are judged to have been actively moving downslope 50 to 100 years ago but have relative stability over the past several decades;*

Old Landslide (including ancient) Qlo: *"…are recognized by their overall morphology, lobate in plan, concave-convex in profile, with well rounded and overgrown scarps; very subdued irregular surfaces; firm soils (in and across the surface), and generally undisturbed vegetation. It is presumed that these landslides were actively moving downslope sometime in the past several hundred years but have been relatively stabilized for the past century or so.*

Characterization of landsliding on the property by TERRASEARCH, Inc. (1998, 2003) was from geologic mapping and subsurface exploration, including 6 backhoe test pits (TP1-TP6, Figure 3), ranging in depth from 16 to 18 ½ feet; 3, 8-inch diameter borings (small-diameter borings, C-1 through C-4), ranging in depth from 55 feet to 224.5 feet; down-hole geologic logging of 6, 24-inch diameter borings (large-diameter borings, W-1 through W-4), ranging in depth from 75 to 100 feet, and 2, small diameter percolation test borings (PTW-1 and PTW-2) to a depth of 40 feet (no boring logs prepared). All of the explorations were reportedly terminated in the ancient landslide, estimated to up to 300 feet thick (Figure 4). Earth material encountered in the explorations has been described as sheared and brecciated and generally chaotic, pebbly, silty clay, pebbly clayey silt with some sand and gravel, and minor, fractured siltstone and sandstone, except *possibly* Boring C-4 where they found a polished shear surface at depth of 202.3 feet. However, at a depth of 212 feet, they reported more chaotic texture, possibly of landslide origin. The test pits and large-diameter borings provide the most reliable means of interpreting the subsurface geologic relations by allowing direct observation. All of the explorations encountered landslide shears throughout the depth explored, but primarily in the more clay-rich zones. Ground water was encountered at points throughout the property in Borings C-1 (25'), C-3 (42.5'), W-1 (21'), W-5 (67') and PTW-1 (35'; refer to Figure 4). It should be noted that the C-borings were drilled by rotary-wash methods below the depth where ground water was first encountered. This method relies on water introduced for drilling which obscures a reliable measurement of naturally-occurring ground water. Ground water monitoring (i.e., piezometers) was not undertaken to establish actual ground water conditions.

The ancient landslide underlying the site is interpreted by TERRASEARCH, Inc. (2003) to be a continuous mass across the site, occurring in Contra Costa Group rocks (Figure 4). They initially concluded that the ancient landslide is stable on the basis of stream dissection, and a radiocarbon date of 46,170 years before present (BP) derived from wood fragment retrieved 79 feet deep at the Boring C-3 location in the northwest portion of the site.

The distribution of active and dormant landslides corresponds with the arcuate slope breaks that extend across the property, to breaks in slope on the drainage divides, and areas of uncontrolled grading for the existing network of unimproved trains. Most appear to be a coalescent system of earth slump/flow type features spatially related to the features mentioned above, and to the ephemeral drainages. Debris slides and slumps from the steep banks of the main drainage channel have historically produced relatively high sedimentation near the northeast portion of the site. The northeastern tributary channel bank has retreated into the adjoining land occupied by Waldorf School, and the residential land near the south end of Clark Road. Photogeologic interpretation indicates that 1 or 2 homes at the south end of Wesley Way were removed prior to 1958 due to slide related retreat near the southwest corner of the site. TERRASEARCH, Inc. (2003) recommends grading to mitigate the shallow landslides and erosion, and relocation by grading of the eroded channel below the school. The inflections on the graded slope on the north side of the school (Lots 1-5), appear to represent intermediate to deep, dormant landslides (Figure 3).

Topographic escarpments mapped on the drainage divide underlain by the ancient landslide (near Lots 73-74) were not accounted for in the distribution of actively moving ground in the southern part of the site. A large expanse of land in the western part of the project area is constrained by deep, active landsliding and creep, estimated to be at least 50 feet thick extending several hundred feet west of the site (Figures 2 and 3). TERRASEARCH, Inc. (1998, 2003) extrapolated the active slope movements in that area of the site from previous work by Alan Kropp & Associates (AKA, 2000), who reported damage to private and public property was from the La Cima and La Colina Landslides;

characterized as deep, re-activation on the western margin of the old landslide underlying the entire project site. The La Colina Landslide and a creeping deep landslide are believed by AKA (2000) and TERRASEARCH, Inc. (2003) to encroach well into the western part of Forest Green Estates site. On the basis of exploration (small-diameter hollow stem auger borings), and slope monitoring (slope indicators), AKA established that the La Colina Landslide mode of failure is rotational/translational in the upper 50+ feet of the 80-foot thick creeping landslide (Qla?, Figures 2 and 3). AKA (2000) concludes, on the basis of piezometer ground water monitoring (average depth of 29 ½ feet to ground water in the La Colina Landslide), that the mechanism for movement in the upper 80 feet of an apparently static 150-foot thick, ancient landslide, is from the regional ground water table rising into the zone of movement during periods of heavy rainfall, and from discrete, perched water tables affecting individual planes within the active landslide.

TERRASEARCH, Inc. (2003) performed computer-generated searches for critical, potential landslides occurring within the ancient landslide to a depth of 200 feet. Computerized analyses of relative stability of the ancient landslide was generated for relatively conservative limit equilibrium conditions. The stability analyses yielded acceptable static and psuedo-static factors of safety for the portion of the ancient landslide below 200 feet for an assumed ground water below a depth of 100 feet. Unacceptable factors of safety were calculated when ground water was modeled at the ground surface; a circumstance TERRASEARCH, Inc. (2003) judged unreasonable under current conditions. Using seemingly reasonable strength values, the analyses indicated that critical geometries have unacceptable factors of safety against sliding, given elevated ground water conditions (i.e., within 30 feet of the ground surface). It should be noted that one set of stability analyses is with respect to “shallow critical failures surfaces slide”, which, when scaled from the cross sections, range from approximately 80 to 150 feet in depth. All of the analyses portray a circular failure surfaces, although it has been established that the mode of failure for the La Colina landslide includes a translational component. This mode of slope failure is apparent from interpretation of aerial photographs. Potential Influence by stratification in controlling the geometry of the ancient landslide or the secondary sliding from the east and west flanks. Strike of mapped bedding attitudes (Bishop and others, 1973) is subparallel to the northwesterly direction of ancient landslide movement. Antidip relations are suggested on the west flank. Instability on the east flank could be influenced by a component of dip, however.

Calculated low factor of safety against ground failure uphill of the southern property line, along with an elevated ground water table along Cross Section A-A’ (Figure 3), is judged by TERRASEARCH, Inc.,(2003) to be acceptable because they deemed the potential failure surface far enough from proposed developments. However, this conclusion does not account for runout by potential debris flows in that region and farther upslope.

TERRASEARCH, Inc. (2004) concludes that the if the following mitigation measures (Figure 5) are implemented, development of the proposed subdivision is feasible:

- Some areas of disturbed ground and active landsliding will be remediated as part of the grading, which conceptual sections indicate as much as 30 feet of the central part of the site will be removed. Some areas of disturbed ground require additional investigation in order to determine their extent and mitigation;
- Additional geotechnical investigative work is required to evaluate the geometry of landslide shears (and shear strength) found in the explorations by excavation of (one or more) deep, long excavation(s) to an unknown depth. Further geotechnical investigations are required to monitor ground water levels;
- Mitigate high ground water in the shallower (80-150 feet deep) slides with deep buttress shear keys. Preliminary estimate of the shear key excavations is 40-80 feet deep, 40-50 feet wide, with subdrains that extend to within 5 feet of the surface, and drain by gravity to a nearby reach of the site drainage system. The intent is to maintain ground water 40-60 feet below the ground surface on the upslope side of the property (southern property line). They acknowledge that grading across the swale of the main drainage is not permitted, and revised the mitigation plan by replacing the eastern half of the shear buttress with a subdrainage gallery, and state that it will offer the same level of protection against sliding as shear key buttressing. They indicate that additional (subdrainage) gallery drains may be needed if additional subsurface work shows a high ground water table (TERRASEARCH, Inc., 2004);
- To achieve adequate stability for the slope between the main drainage and Lot 72 will require placement of fill and a geogrid-reinforced buttress. The top and toe of the proposed fill is located between Lot 62 and the E.V.A. road;
- Conceptual mitigation of the creeping landslide on the west property line (affecting Lots 94-107, 42-58, WQB 1, 2 and 3, and approximately 1500 linear feet of roadway) by installation of a row of 3-foot diameter, approximately 80-foot deep, reinforced concrete piers (stitch piers) and perhaps buttressing, and a building setback of 50 feet. They propose to evaluate the final selection of a mitigation scheme for the west part of the site during the design phase after more geotechnical investigations;
- Repair recent, active slide features by removal and replacement with engineered fill. Details will be provided later during the final design phase, however, preliminarily grading is expected to considerable with up to 30 feet of hillside to be removed in the central part, and TERRASEARCH, Inc. (2003) believes most shallow slides will be removed as part of the mass grading operation for the subdivision;

c. Soils. Soils that underlie the site include loam of the Tierra Series in the southern and western parts, and clay loam of the Los Osos Series in the eastern and northern parts (Soil Conservation Service, 1977). The Tierra loam forms on gentle slopes (9-15 percent) underlain by sedimentary rocks. It is described as having high shrink-well potential (highly expansive soil), low (shear) strength, and very slow permeability. Runoff is medium to rapid and erosion hazard is moderate to high on barren slopes. It is a poor source for fill, but is considered to have fair to good compaction characteristics. Soil derived from this deposit may be corrosive to uncoated steel. Because of the potential for high shrink-swell, it is described as posing a severe limitation to shallow, house foundations (footings).

The Los Osos clay loam forms on moderate to steeply sloping (30-50 percent) sedimentary terrane (soft shale and fine-grained sandstone). Soil slips (shallow landslides) are common in this soil type. It has high shrink-swell potential (highly expansive soil), low (shear) strength, and slow permeability. Runoff is medium to rapid, and erosion hazard is low to high on barren slopes. Subsurface erosion (piping) is also a potential hazard. It is considered a poor source for fill because of the high plasticity and low strength, and, for the same reasons, presents severe limitations for support of shallow foundations. It may present a corrosion hazard to uncoated steel.

Highly expansive soils mantling the surface of the site were, during our early summer site observations, pervasively fissured from desiccation, and very commonly burrowed by rodents. Slope gradients as shallow as 5:1 (20 percent) commonly contain irregular surfaces caused by creep. Soil creep is a very active process within expansive soils covering the site, estimated to occur within the upper 3 to 5 feet of the soil profile. This same soil horizon has been found in to also represent the probable depth of seasonal moisture variation. The divide below the graded equestrian facility in the middle of the site typifies the creep deformation from the highly expansive site soils. The irregular, broken ground surface, caused by desiccation cracks and surficial soil creep, has been observed to precede initiation of surficial debris slides and flows from the steeper slopes on the drainage flanks (Baldwin and others, 1984).

d. Seismic Setting. The site area is located in a region of active seismicity dominated by a series of subparallel, strike slip faults within the San Andreas fault system (Figure 1). There is high potential for strong ground shaking at the site from a major earthquake (Borcherdt and others, 1975; Petersen and others, 1999). Potential seismic sources include the Hayward-Rogers Creek, Calaveras, Concord, Green Valley, San Andreas or San Gregorio faults. However, the potential for fault rupture across the site is low because it contains no mapped active faults (State of California, 1982). There is a complex of 5, unnamed, faults mapped in the site vicinity; 4 trend northwesterly and one easterly (Alan Kropp & Associates, 1991). Two of the northwest-trending faults appear to control the local structure as well as the east and west margins the ancient landslide underling the site (Figure 2). These faults are not considered active, and therefore present a low risk of producing a large earthquake. However, close proximity and similar orientation to the Hayward fault make them a potential for sympathetic, coseismic movement in the event of a major earthquake on a nearby segment of the Hayward fault.

According to U.S. Geological Survey records, there have been several major, historic earthquakes in northern California (M6.8, 1836; M6.5, 1865; M7.0, 1868; 6.5, 1892; M6.5, 1898; M8.3, 1906; M7.1, 1989). The southern segment of the Hayward fault produced the 1868 M6.5 event. Lienkaemper (1997) reports that the most recent earthquake on the northern segment of the Hayward fault occurred 200-350 years ago with at least 4 to 7 large earthquakes over the past 2000 years. This fault segment is nearest the site. It, along with other active East Bay faults, including the southern Hayward, and Rodgers Creek, is predicted to have a 25 percent chance of producing one or more major earthquakes by the year 2020 (Borchardt and others, 1992; Working Group, 1996). The maximum probable earthquake on the Hayward fault is 7.1 (California Division of Mines and Geology, 1998). The potential for severe ground shaking at the site is high, with a potential for estimated peak ground acceleration of 0.8g given the maximum probable earthquake on the Hayward fault (Table 1; note: g is the acceleration from Earth's gravitational field). However, it should be understood that the ground shaking hazard is typical and would probably be similar for other East Bay sites with a similar geologic setting.

TABLE 1. SEISMIC INFORMATION FOR NEARBY FAULTS

Seismic Source (fault)	Magnitude	Distance to Site (km)	Mean Peak Horiz. Ground Acceleration (g) (for soft rock)
Hayward	7.1	1.2	0.8
Rogers Creek	7.0	23	0.2
San Andreas	7.9	32	0.2
Calaveras	6.8	30	0.1
Concord	6.5	22	0.2

Source of Data: Idriss (1991); California Division of Mines and Geology (1998); Sadigh and others (1997)

Potential secondary seismic hazards that can affect local and large expanses of the ground surface include liquefaction, lateral spreading, landsliding and ground lurching. Liquefaction occurs when poorly consolidated, granular sediments beneath the ground water table are temporarily transformed during strong ground shaking into a liquid state. Lateral spreading is a form of landslide movement, but commonly occurs during ground shaking and liquefaction on a sub-horizontal rupture surface oriented toward an unsupported bank. The risk of occurrence for liquefaction and lateral spreading is considered low because of the consolidated and clayey nature of the site earth materials. Landsliding can occur in a dry or saturated soil state on steep slopes during strong ground shaking. Ground lurching is a slow lateral movement similar to lateral soil creep during a major earthquake.

e. Hydrologic Setting

The following is based upon review of a hydrology report for the Forest Green Estates property by Balance Hydrologics, Inc. (2003), a report by John Wollman & Associates (2003) to the City of Richmond, and geotechnical evaluation of storm drainage mitigation by TERRASEARCH, Inc. (2003).

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 the Waldorf School. Approximately 38 acres will be developed as a residential subdivision. 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.

An unnamed, main intermittent stream that extends diagonally across the site from the southeast to northwest parts, and 5 smaller tributaries drains 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 (Figure

6). 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.

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. 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.

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 (Figure map).

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) John Wollman & Associates (2003). 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 TERRASEARCH, Inc. (1998, 2003) Borings C-1 and C-3, at 25 and 42.5 feet deep, respectively (Figure 4). Borings in the western part of the site and Boring W-5 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 (Alan Kropp & Associates, 2000). In reviewing their boring logs, evidence of 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 explorations.

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 conceptually 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 (4cfs);
  2. The check dam profile will create a of 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 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 (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; John Wollman, 2003; Figure 6). 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 protection from 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 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 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.

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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 (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. With a combined storage capacity of 35,362 cf (0.81 ac-ft.), and treat 80-90 percent of average annual runoff for 48 hours prior to release to the drainage galleries (described below). They 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 (12)*** are designed to temporarily store storm runoff and allow for deep infiltration and/or evaporation. 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. The intent of the galleries is to further reduce site runoff. Overflow waters will mitigate downstream runoff and siltation and pollutants.

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. (2003) evaluated the concept of directing project area storm drainage to shallow detention basins and drainage galleries (percolation wells), and concluded that further study is necessary to carefully evaluate the impact this concept would have on stability of the sensitive landscape. They concluded that the ponds (detention and water quality basins) should be lined with treated (chemically) site soil to mitigate cracking create and create an impermeable barrier against infiltration of water. They drilled 2 percolation test holes (PTW 1and 2, Figure 3) and determined a stabilized percolation rate of 2 inches per hour. 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 (Figure 6). They further conclude that percolation wells may be permissible in proposed buttress areas if the anticipated water quantities are minor; a condition TERRASEARCH, Inc. (2003) recommended be evaluated during the design phase. They must approve of the location of any percolation well.

- ***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

2. Geology, Soils and Seismicity Impacts and Mitigation Measures

Ted, virtually all of the impacts and mitigations from the previous EIR are applicable with more in the following Hydrology section. Joel

Potential geological impacts associated with the proposed project are related to slope instability, erosion and siltation, expansive soils, bedrock faults, severe ground shaking, earthwork, and storm drainage control measures.

a. Criteria of Significance

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;
- Erosion or unstable soil conditions, subsidence; and
- Expansive soils.

Geologic hazards that may affect the proposed project during construction and post-construction periods reflect the project in a high rainfall, seismically active region at a site underlain by weak earth materials. For the purposes of this EIR, *significant* geologic hazards pertain to conditions so unfavorable that they cannot be overcome by reasonable design, construction and maintenance practices. In addition, these hazards would have to 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 to constitute a *significant* impact.

<u>Significant Geologic and Hydrologic Impacts and Mitigation Measures</u>

Geotechnical reports prepared for the proposed project (*TERRASEARCH,* Inc. 1998, 2003) contain important geologic information pertaining to the relative distribution of landslides and the quality of the earth material underling the site. However, there remains important, unanswered questions pertaining to current stability (creep and landslide potential) over the entire site, and the impacts on the same that could occur with the proposed grading and storm drainage mitigations. It is known that deep landsliding and creep are affecting areas to the west of the site, and the movements are induced by fluctuations in ground water (Alan Kropp & Associates, 2000), yet, there has been no attempt for the proposed project to quantify by monitoring (inclinometers) potential magnitude and depth(s) of ground movement, even though the area of landslide creep is known to encroach on virtually the entire west site of the project area. Further, there has been no attempt to establish, also through monitoring (piezometers), the ground water regime; the principal mechanism for currently active and potential landsliding (Alan Kropp & Associates, 2000; *TERRASEARCH,* Inc., 2003). Assumptions have been made in the project geotechnical report to address these issues, however, they appear to be inconsistent with known conditions on and adjacent to the site, and are in direct conflict with proposed geotechnical and hydrologic mitigations. For example, stability analyses indicate that elevated ground water will destabilize, potentially over a large area, up to

120 feet of the approximately 300-foot thick ancient landslide, while the proposed site drainage mitigations recommend introducing storm water up to 100 feet into the subsurface through drainage galleries. It has been determined by the project consultant through critical search slope stability analyses that an elevated ground water table (within 30 feet of the ground surface) could cause widespread slope instability over the project area. Other potential points of infiltration having potential of impacting ground water conditions stem from the detention and water quality basins. *TERRASEARCH,* Inc. (2003) acknowledges the potential hazard to stability from infiltration, and recommends that it be analyzed during design. Similarly, they recommend shear key buttresses and subdrainage to mitigate potential instability, but do so without a design depth of slope movement, and recommend that one or more deep, long excavations be made during the design phase to evaluate potential failure surfaces to further the stability analyses. Deep excavations anywhere on the site have potential for possible large-scale destabilization of pervasive sheared ancient landslide debris. Confirmation that the above issues can be properly mitigated must be part of the feasibility studies because too much variability could occur, making the proposed project if not technically, economically unfeasible. Hence, given the available geotechnical information generated for the proposed project, we cannot agree with the assessment by *TERRASEARCH,* Inc, (2003) that the project is feasible given the current body of site geotechnical knowledge. Potentially significant, unavoidable geologic hazards remain until such time that geotechnical consultants undertake further geotechnical feasibility studies, including monitoring for slope movement, and to establish with empirical data the existing ground water regime within the project area.

<u>Impact GEO-1</u>: Areas of known or potential slope instability, including creep and existing fills, could result in significant damage to the proposed development and neighboring developments, and could expose residents to increased levels of risk to injury and loss of property if not properly mitigated.

The entire site is underlain by weak unstable earth. Numerous active and dormant landslides have been identified, and there is available on- and off-site geotechnical data to suggest that the old landslide is susceptible to deep-seated, damaging creep movements. The western margin of the old landslide, off-site, has spawned abundant active landslides that threaten or have damaged existing property west of the site. If not properly characterized by thorough geologic and geotechnical investigations, landslide mitigation measures would likely be inappropriate. If mitigations are not properly engineered, the proposed development would experience significant damage from slope movements.

The applicant's geotechnical consultant has delineated active and dormant and ancient landslides on the basis of remote sensing and field mapping onto a now obsolete version of the project topographic site plan. The site is near the intersection of several inactive bedrock faults that appear to control the limits of the overall ancient landslide the site is on, and past crustal movement across them has probably weakened the bedrock considerably. Explorations by the geotechnical consultant revealed thoroughly sheared and disrupted bedrock materials, but did not extend to the base of the landslide mass. Shears in the rock could control future very deep landsliding and creep. The stability analyses, while applying relatively conservative earth material strength values, did not account for actual or potential structurally-controlled rupture surface geometries or boundary conditions. Further, the project geotechnical consultant wants to apply, after observation and sampling of a deep exploratory excavation, actual rupture surface shear strengths to the stability analysis. Consequently, any one or more of the shears observed in the ancient landslide could produce potential surfaces or zones of movement for landslides and creep to depths of perhaps 200 feet, particularly if ground water becomes elevated by infiltration from the surface water sources associated with the proposed project storm drainage system.

The applicant's geotechnical consultant has recommended the following mitigation measures for landslide mitigation (Figure 5):

- **Deep shear key buttresses** across the southern half of the site excavated to an estimated depth of 40-80 feet, and width of 40-50 feet. However, the preliminary buttress sections indicate that the buttresses terminate above the potentially unstable mass, with only subdrainage extending below the analyzed rupture depth. This makes questionable the intent of the shear keys buttresses, which ordinarily are designed to replace a design segment landslide rupture with strong, well-drained engineering fill. While the buttressing is a common measure of applying grading and subdrainage techniques for development of lateral resistance to unstable slopes, the absence of detailed landslide depth and distribution does not allow for a reasonable understanding of the magnitude of grading, and drainage to implement this technique. Detailed geotechnical data is required for adequate slope stability analyses (static and earthquake conditions) to be performed, which will be the basis for buttress design. Moreover, active and dormant landslides extend off the south, east and west margins of the site, and there is a suspect large area of creep in the west-central and southeast parts of the site that must be considered in the mitigation analysis. In order for the buttress to provide lateral resistance, the buttress foundation earth material must be static. Hence, it is important to assess the buttress foundation areas for deep creep and extend them below any potential creep zone. If findings from Alan Kropp & Associates (2000) mitigations west of the site are valid, buttress excavations for the proposed development could extend deeper than 60 feet. Depending upon the results of subsequent slope and ground water monitoring for slope stability analyses, we anticipate buttress construction can range from 10 feet for shallow (less than 10 feet deep) slides, to as more than 100 feet for deep-seated slides and creep. It should be understood that actual excavation limits for buttress construction will be dictated by relative stability of the sidewalls. The side slopes would need to remain intact until proper subdrainage and properly compacted buttress fill can be placed. Excavations along property boundaries will require special precautions to avoid undermining and collapse of graded slopes and retreat onto adjoining property. It may be necessary to stage buttress excavations in sections to avoid a large expanses of open excavation; and/or properly shore and brace the excavations. The geotechnical consultant and grading contractor, with strict adherence to pertinent guidelines for shoring and bracing of Cal OSHA and City of Richmond, should assess safe slope inclinations. Ultimately, the geotechnical consultant must approve all temporary excavations.

- **Engineered Fill** is proposed to enhance stability of the west flank of the main drainage in the southern part of the site (Figure 5). There was no detail of this mitigation presented in the applicant's geotechnical report, however it routinely requires fill placement onto a keyed and benched, stable surface. Since bedrock is not expected to be encountered in any of the excavations on the site, the fill will be placed on ancient landslide debris. It is doubtful that the highly expansive site soils will be appropriate for fill slope construction.
- **Deep Subdrainage** is proposed in the southeast part of the site where buttress excavation is prohibited across the drainage channel. Subdrainage trenches are expected to be at least 60 feet deep, and must extend at least 5 feet below the depth of potential instability. The geotechnical consultant indicates that subdrainage has the same effect in stabilizing a landslide as a buttress. However, the subdrainage is not constructed to provide lateral resistance to a moving mass, as does the mass of compacted fill in a buttress. Hence, subsequent analyses must address how the proposed subdrains will offer the same support as a buttress in a deep landslide environment.
- **Row of reinforced, cast-in-place concrete piers** (stitch piers) having a minimum diameter of 3 feet, extending to a possible depth of 80 feet or more is proposed to mitigate encroachment of the La Colina Landside and the deep creeping landslide on the west side of the property (Figure 5). The piers must be designed to resist an enormous lateral load from the unstable earth, which seemingly would overwhelm the relatively small diameter stitch piers. Further analysis would probably dictate tie backs to resist the huge forces induced by a deep landslide or creep. However, use of tie backs would be constrained by the distance to the property line, unless permission is granted to extend tie backs beneath adjoining properties. In addition, normally the tops of the stitch piers are connected

to a continuous, reinforced concrete grade beam. This proposed mitigation will underlie the proposed private driveway shown to extend from the entry point at La Crescenta Road to the southwest corner of the site.

- **A 50-foot building setback** is recommended to accompany the stitch pier system to account for potential offsite landslide movement over the stitch pier system.

Mitigation Measure GEO-1: Supplemental site investigations, and particularly monitoring of creep and ground water are required before a conclusion regarding potential landslide distribution and geometries can be established, and project feasibility confirmed. The future studies must incorporate infiltration from the proposed storm drainage facilities, particularly the deep drainage galleries (percolation wells) that are spaced throughout the site. Only then can a reasonable assessment be made as to whether potential impacts from site slope instabilities can be reduced to less than significant. Further, the impacts from off-site landslides and creep must be thoroughly assessed by the project geotechnical consultant to verify that the potential impacts from off-site instability can be reduced to less than significant levels by implementing the proposed mitigations.

Impact GEO-2: High potential for erosion and siltation exists in the main channel that extends along the eastern boundary of the site to the northwest corner. Proposed arch culverts, runoff velocity control structures and the proposed siltation basin will be adversely affected by this process. (S)

The drainage system has actively eroding segments and erosion of the main channel bank along the east margin of the site has historically produced high sedimentation to the northern property line that will be crossed by proposed roadways supported by arch culverts. Erosion and downstream siltation will be mitigated in part by the proposed channel relocation, but will continue until the new channel is stabilized with vegetation or commercially-available artificial erosion-control materials. The new seasonal wetlands, and proposed detention and water quality basins will tend to reduce silt movement from the site drainage divides, but not within the season channel network. The process of erosion and siltation presents a significant adverse impact to the proposed channel structures by siltation, and would therefore require high maintenance considerations.

Undermining of the bank of the main channel by runoff has produced landslides into the channel, which produces abundant siltation, and secondary erosion of the opposing bank by re-directing channel flow. Diversion of runoff could potentially undermine the proposed arch culvert road crossings.

<u>Mitigation Measure GEO-2</u>: The proposed basin system will reduce sediment derived from the drainage divides. Areas of actively eroding channel banks should be stabilized either mechanically or with appropriate riparian vegetation (e.g., willow or other appropriate woody vegetation). The proposed channel relocation will mitigate sediment derived from the tributary in the northeast part of the site, closest to San Pedro Creek.

Mitigation of gulling in the ephemeral drainages adjoining proposed lots can be mitigated to acceptable levels through prudent grading and surface and subsurface drainage control practices. Details of the procedure for controlling erosion in the gullies are required. Erosion from storm drainage discharge will be reduced by the proposed drainage gallery, provided overflows are well armored and vegetated.

<u>Impact GEO-3:</u> Fills in the northern part of the site are unengineered and subject to settlement and erosion. (S)

Fill placed in the late 1940's to early 1950's appear to be old landslide material side cast during grading for Waldorf School. Undocumented fill also exists along existing unimproved roadways, and the north margin of the equestrian facility in the middle of the site. Unengineered fill material are unsuitable for roadway and building foundation support, and pose a potential adverse impact from settlement, creep and shallow landsliding.

<u>Mitigation Measure GEO-3</u>: Unengineered fills must be removed, or stabilized with stitch piers or retaining walls. If existing fill is highly expansive, it would be unsuitable for replacement as engineered fill unless mixed with non-expansive material, or chemically treated. Such measures, to be carefully evaluated and specified by the applicant’s consultant would reduce potential impacts to roadways, foundations and lifelines from settlement, creep and shallow landsliding to less than significant. In order to mitigate the potential impact satisfactorily, it will necessary for the project geotechnical consultant to thoroughly delineate the distribution of unengineered fill throughout the site, particularly the northeastern part site.

<u>Impact GEO-4</u>: Seismically-induced strong ground motion will probably affect the site over the project lifetime and could result in damage to life and/or property. (S)

Strong ground motion from earthquakes along known, local active faults could cause damage to people and exacerbate landslide movements within the proposed development unless properly mitigated. The site is located approximately 1 mile from the active trace of the Hayward fault, and it is expected that this feature will produce a major earthquake within the project lifetime. Severe ground shaking, although not unique to the site, will likely occur in such an event. The intensity of ground shaking is a function of the magnitude of the earthquake, distance from the site, the quality (relative density) of the earth materials that underlie the site, and the design quality of the buildings, roadways, and lifelines of the project.

The applicant’s geotechnical consultant utilized guidelines in the California Division of Mines and Geology Special Report 117 for seismic slope stability (psuedo-static) analyses. They evaluated seismically-induced sliding potential on the basis of an acceptable factor of safety (FS) of 1.0, which represents the liberal value specified in the special report; FS of 1.15 being the conservative value.

Mitigation Measure GEO-4:

To assure a conservative assessment of potential for instability from severe seismic shaking, it would be prudent to evaluate psuedo-static stability with respect to an FS of 1.15, particularly given the site is underlain by earth material weakened by landsliding. Provided the analyses reflect a FS of 1.15 without any supplemental mitigations derived from GEO-1, potential impacts from seismically-induced landslides would be less than significant.

Potential adverse impacts to structures by severe seismically-induced ground shaking can be reduced to less than significant by implementing current seismic design criteria offered in the 1997 Uniform Building Code (UBC) and City and County guidelines pertaining to seismic design. The applicant’s geotechnical consultant has recommended reasonable earthquake design parameters from the UBC criteria. Design and engineering plans shall be approved by the project geotechnical consultant and City of Richmond prior to issuance of construction permits.

Impact GEO-5: The site is bordered and/or crossed by a bedrock fault(s) that may have potential for coseismic movement in the event of a major earthquake on a nearby segment of the Hayward fault, or may influence occurrence and distribution ground water. (S)

Active faults are not known to cross the site, hence risk of earthquakes from the unnamed bedrock fault mapped across the northern part of the site is nil. However, there is potential for sympathetic offset along the mapped bedrock fault that extends across the northern portion of the site or other bedrock faults mapped in the site vicinity (Alan Kropp & Associates, 1991; Figure 2). This condition poses a potential significant impact to home sites and the roadway network in the northern part of the site.

The occurrence of ground water in the borings and surface seepage tends to follow a northwest orientation across the site. This relation may be associated with bedrock faults that can cause elevated ground water.

Mitigation Measure GEO-5: Anticipated excavations for site grading and landslide abatement will offer opportunities for the project engineering geologist to assess potential for offset by the unnamed bedrock fault that extends across the northern part of the site. Appropriate building setbacks from any zones of potential coseismic fault offset would reduce the potential impact to less than significant. The project engineering geologist to reduce the impact to less than significant shall evaluate all bedrock faults encountered in excavations for appropriate building setbacks.

Similarly, construction excavations may encounter elevated ground water caused by impermeable fault zones. This will enable the project engineering geologist to further evaluate the distribution of elevated ground water across the site and provide appropriate dewatering recommendations to reduce this condition to less than significant.

Impact GEO-6: The proposed development plan will result in unavoidable, significant impacts to topography, and will result in deep artificial cuts and fills, particularly in landslide repair areas. Deep cuts may pose a risk of collapse of the weak landslide deposits. Deep fill may be subject to swelling and differential settlements unless properly constructed. (S)

Extensive grading will be required to prepare the level building pads, roadway alignments and utility trenches. Considerably more grading than indicated on the Vesting Tentative Map is required to install subdrains, and to repair unstable slopes and erosion gullies. Potential cuts and fills to depths up to 100 feet may be required to implement necessary subdrainage and landslide repairs, and for the recommended deep and long excavation to further evaluate landslide shear geometry and rupture surface strength. These conditions will present potential collapse and landslide movements, endangering people and adjoining property by opening a wide expanse of the ancient, dormant and active landslides.

Much of the earth materials underlying the site have high expansive characteristics and may be unsuitable for use in engineered fill.

While there are no unique geologic features that would be impacted, grading will alter and locally bury (at culvert crossing for roadway construction) the existing watercourses and permanently alter the natural landscape. All fills for the proposed project have the potential for settlement if not properly controlled by the project geotechnical consultant who should apply current standards of care for keying, benching, and soil compaction (ASTM D1557 or equivalent soil compaction test procedure). Settlements of 5 to 10 inches could occur in thicker fills that would be placed across the drainage network in the northwestern part of the site and across the main channel to extend the E.V.A. Road into the site and for construction of the entrance road in the northeast part of the site. This condition could result in significant impacts to building and retaining wall foundations, roadway and utility performance and stability.

Cut slopes of 2:1 are proposed. This inclination for cut slopes is probably too steep given the inherent instability of the native earth materials which would result in significant potential impacts to life and property by inducing slope instability that could extend off-site, particularly along the western margin of the site where active landslides and old landslide creep has been reported (Alan Kropp & Associates, 1991 and 2000). Moreover, potentially significant impacts for fill slopes of 2:1 from deep desiccation cracking, accelerated creep, and shallow landsliding could develop if they are constructed with weak and expansive, clayey soils.

<u>Mitigation Measure GEO-6</u>: To reduce unavoidable grading impacts to acceptable levels, the following measures shall be implemented:

(a) A long, continuous, deep excavation to enable further geotechnical analysis of landslide properties is a dangerous proposition on this site. To reduce the risk to potentially significant, it would be prudent to evaluate another method of providing the necessary geotechnical information, such as excavation in sections or by shoring.
(b) Once project feasibility has been confirmed, a design-level geotechnical report should be prepared that contains detailed earthwork recommendations. The recommendations should include measures to protect deep excavations from collapse, and may require sectional excavation techniques. The recommendations should include specifics related to measures to allow usage of highly expansive soils for engineered fill, maximum cut and fill slope inclinations, and comprehensive surface and subsurface drainage measures. A Peer Review geotechnical consultant retained by the City and paid for by the project applicant shall independently verify the project conforms with the geotechnical recommendations.
(c) Structures and improvements developed on deep fills (>20 feet) shall be adequately designed to resist damage related to anticipated differential fill settlements. This is particularly important where house pads and site improvements are constructed on buttress fills. Specially designed, heavily reinforced foundations, and strengthened roadbeds and utility lines may be required. Deep fill lots shall be identified by the project applicant and a list of the same shall be prepared and submitted to the City Building Department and to the project Geologic Hazard Abatement (GHAD)/Homeowner Association (HOA; described

below) prior to issuance of any building permits for individual home development.

(d) Grading operations must be appropriately sequenced to balance the cuts and fills. It will be necessary to temporarily stockpile excavated soil on site. If expansive soils are unusable, then considerable soil off-haul and non-expansive import will be required. A plan showing the location and safety measures to be employed for this procedure should be approved by the geotechnical consultant and City Peer Review consultant should be submitted. Detailed grading plans clearly describing and illustrating the proposed approach to balance grading shall be submitted and approved by the City prior to issuance of a grading permit.

<u>Impact Geo-7</u>: Increased erosion and sedimentation during and following the construction would result from earthwork operations, drainage pattern alterations and general disruption to terrain by general construction operations. (S)

Significant erosion to cut and fill slopes, road-crossing channel works, and house pads could result if unprotected from rainfall over the course of and following construction. Short- and long-term erosion and sedimentation can be significantly reduced by careful implementation of a detailed erosion and sediment control plan. Implementing and maintaining an appropriate landscape and drainage control plan can positively effect long-term erosion. Removal of vegetation will expose highly expansive soil to extremes temperature variations, thereby exacerbating pervasive soil cracking, creep and surficial landsliding.

<u>Mitigation GEO-7</u>:

Reduction of potential impacts from erosion and sedimentation to less than significant can be achieved by implementing the following measures:

(a) Prepare and implement comprehensive erosion and sediment control plans by applying guidelines contained in the Association of Bay Area Governments *Manual for Standards for Erosion and Sedimentation Control.* Typical measures include installation of temporary drainage control measures such as water bars, basins to trap sediment and re-direct runoff in properly-sized pipes to positively sloped surfaces protected with hay bales, jute netting, hydro-mulching, or application of one or more of the commercially available erosion-control geotextiles materials. The final erosion and sediment control plan should be reviewed and approved by the project geotechnical consultant and the City prior to issuance of a grading permit.

(b) Topsoil removed during rough grading should be stockpiled to re-use in landscape areas. Landscape areas and other common areas made barren during grading should be planted with an appropriate vegetation material as soon as practical after the earthwork and drainage provisions are installed.

(c) Careful grading and soil handling is required at the arch culvert crossing to avoid placement of loose soil in the drainages. Following construction, the disturbed soil surfaces should be covered with erosion-protection matting and planted with hearty ground cover to mitigate downstream siltation.

(d) Exposure of expansive soils to undue direct sunlight (extreme temperature variations) can be mitigated by comprehensive planting of hearty vegetation.

Impact Geo-8: Drainage improvements, graded and native slopes will require on-going maintenance over the project lifetime. If neglected, likely adverse impacts to site stability and performance. (S)

Although lacking specificity at this time, the proposed project will incorporate involve an integrated system of engineered improvements that must coexist with the natural geologic setting. From the time construction begins and through time over the project life, there will be a need to improve or repair drainage provisions, including diversion ditches, arch culverts, detention and water quality basins, new seasonal wetlands, and storm drainage outlets to maintain original design capacity and performance for the design 100-year storm event. Given the geologic setting and the earth materials available to establish the proposed grading plan, it is likely that shallow erosion and landslides will develop on sloping land, particularly at storm drain discharge points underlain by weak old landslide deposits, and along the eastern property boundary where limited control of off-site drainage exists, and where adverse drainage may develop because of individual homeowner activity, and common area "wear and tear". Moreover, much of the earth materials available for roadway and embankment construction are expansive. It will be necessary to create a mechanism to assure periodic maintenance.

Mitigation Measure GEO-8: It is important to create a financially stable organizational structure able to provide the necessary resources for periodic maintenance over the project lifetime to reduce potential short- and long-term maintenance and future geologic hazard impacts within the proposed project area to less than significant. This can be achieved by implementing the following:

(a) Establish and implement a Geologic Hazard Abatement District (GHAD) or Homeowners Association (HOA) that is organized to monitor potential for on-site geologic hazards and provide for mitigation of the same should they develop over the project lifetime. This would require that the organization provide preventative and repair services to the development. The project applicant should develop a Slope Management Program (SMP) under the direction of a certified engineering geologist. The program shall be prepared by the applicant prior to occupancy and submitted to the City for review by the City-retained Peer Review consultant. The SMP should allow for at least annual inspections of slopes and drainage systems, and should include provisions for timely hazard mitigations reported by the certified engineering geologist. The GHAD or HOA should have the authority to require property owners within the development to maintain appropriate landscaping and drainage controls. Upon completion of the project, and creation of the GHAD/HOA, the financial responsibility of maintaining the SMP shall be shifted from the project applicant to the GHAD/HOA.

(b) To limit the financial responsibility of the GHAD/HOA, the project developer shall provide appropriate security, in an amount and form acceptable to the City, to guarantee continual and timely maintenance of any and all future geologic hazards that may develop over a 10-year period following project completion. A separate security may be required if the project is phased. The details of posting of the security and provisions allowing the GHAD/HOA to draw upon security in the event a geologic hazard repair shall be detailed in the SMP.

Impact GEO-9: Springs on the site can induce ground failure and surface erosion and interfere with performance of structures. (S)

Springs mapped in the southeast part of the site by the applicant's consultant and evidence of seepage observed on aerial photographs in the headward part of the tributary drainages in the southeast part of the site can result in landslides, erosion and affect performance of building foundations, and roadway and slab pavement subgrades.

Mitigation GEO-9: Strategically locating and installing shallow subdrains, including individual foundation subdrainage to intercept near-surface seepage would reduce the potential impact from spring discharge to less than significant. Subdrains typically consist of a continuous trench, at least 12 inches wide that slopes at least 2 percent to discharge. The trench is normally backfilled with drainrock wrapped in filter fabric (Mirafi 140N or equal) after a properly-sized, high crush strength, smooth-walled perforated pipe is placed at the bottom of the trench with a minimum 2 percent slope to outfall. Depending upon the occurrence of the encountered seepage, and location of the mitigation, the upper part of the subdrain trench, to be determined by the applicants' consultant, should be backfilled with compacted soil and covered with erosion control material. The subdrain should be connected to a similar solid pipe that drains to an erosion-protected outfall location. Regular spacing of cleanouts is mandatory.

3. Site Hydrology Impacts and Mitigation Measures

TED: Restate pertinent aspects of the previous hydro impacts mitigations not included here from the previous EIR, which have no copy of-JOEL

The revised project was evaluated for potentially significant hydrologic and water-quality impacts that could result from construction activities and/or the eventual completion of the proposed development.

a. Significance Criteria. For this EIR and in accordance with *CEQA Guidelines,* hydrologic and water quality impacts would be considered significant if the revised project would:

- Cause substantial flooding, erosion or siltation;
- Substantially degrade water quality;
- Substantially degrade or deplete ground water resources;
- Interfere substantially with ground water recharge;
- Contaminate a public water supply; or
- Conflict with relevant City and County general plan policies addressing this topic.

b. Less-than-significant Hydrology Impacts. Potential impacts associated with flooding, erosion, siltation, ground water resources, and water quality are discussed below. Impacts associated with public water supply are not relevant since the site is not located with a drinking water watershed. In addition, the site has only limited surface and ground water resources, and is not considered a potential source for public water supply. Therefore, implementation of the revised project would not substantially affect the quality of any public water supply. This topic is not discussed further.

c. Significant Potential Flooding and Drainage Impacts and Mitigation Measures. Flooding and drainage impacts resulting from implementation of the revised project could be potentially significant, depending on the design of the proposed facilities.

<u>Impact HYD-1:</u> Development of the currently undeveloped site will create impervious surfaces on the site that would result in increased volume of stormwater runoff that could contribute to downstream flooding. (S)

Approximately 38 acres of the 81-acre site will be developed as a residential subdivision. Runoff from the area is directed to the unnamed, main seasonal watercourse along the east side. At the northern boundary, the existing undeveloped runoff is 124 cubic feet per second (cfs) for a 10% (10-yr. storm) event, and 230 cfs for a 1% (100-yr. storm) event. Total discharge from the site post-development conditions, including impervious surfaces without any mitigation, would be 136 cfs, or an increase of 12 cfs (approximately 10 percent increase). This increase would be totally offset by the proposed storm water collection system, including detention basins, enhanced wetland areas, and a series of 12 infiltration chambers of galleries designed to reduce peak discharge to the existing, pre-development level.

Implementation of the following mitigation measures would reduce Impact HYD-1 to less than significant:

Mitigation HYD-1a: Implementation of the proposed storm drainage is strictly contingent upon acceptance by the geotechnical consultant who must confirm that infiltration of storm runoff does not impact stability and ground water elevations on the site and adjoining properties. Geotechnical considerations for the drainage and subdrainage systems shall be carefully coordinated with the hydrologic design and planning of the storm drainage system. As recommended in the Geology section, the geotechnical consultant shall establish pre-development ground water levels throughout the site, carefully evaluating the relationship to geologic discontinuities that appear to control the site drainage pattern and distribution of springs. Where ground water elevations are determined elevated by the geotechnical consultant, measures to mitigate infiltration of storm water to acceptable levels for slope stability must be integrated with the proposed drainage systems. This may preclude the opportunity to use drainage galleries in the proposed mitigation. If they are deemed appropriate for the design use, then long-term ground water monitoring must be accomplished under the auspices of the GHAD or HOA.

Mitigation HYD-1b: The proposed drainage system, including stormwater detention ponds, shall be designed to comply with the storm drain design requirements of the City of Richmond, Contra Costa County Department of Public works, and the Contra Costa County Flood & Water Conservation district. The design shall conform with the design recommendations presented in the Contra Costa County Flood Control & Water Conservation District's *Detention Basin Guidelines.* Design details of storm drain facilities (particularly the detention ponds) shall be coordinated, reviewed, and approved by representatives of all three jurisdictions and project geotechnical consultant. The storm drain system shall be designed to reduce stormwater discharges from the project site so that during rainstorms, downstream flows to San Pedro Creek would remain at existing or less flow levels when combined with flow from other tributaries. The design shall account for not only volume of runoff, but also for rate of discharge and trimming of peak flows relative to upstream and downstream peak flow conditions. The review shall include evaluation of hydrographs and other assumptions used to design storm drain facilities. In addition, all ponds shall be designed to detain low flow runoff events (up to 2-yr, 12-hr. storm flow) in order to provide treatment of "first rush" flows.

Mitigation HYD-1c: To assure satisfactory, long-term operation of the storm drain system, the GHAD or HOA shall be responsible for hiring a licensed and qualified contractor to complete regular maintenance activities, such as desilting culverts and basins, and removing vegetation and debris from stream channels to assure that the facilities operate at their design capacities and to prevent downstream flooding problems. If the percolation galleries are deemed acceptable, there must be provisions to evaluate, monitor, and confirm long-term functionality and maintenance. A perpetual maintenance funding source shall be established for these services.

Mitigation HYD-1d.: The storm water detention basins and other water quality best management practice (BMP) structures shall be designed to ensure public safety during low and high water conditions in order to minimize nuisance and vectors (e.g., mosquitoes, rodents, excess algae, etc.), and to be compatible with biological habitat considerations along stream corridors and open space areas. The geotechnical consultant shall review and approve the design of all surface water storage basins with particular attention to basin stability and there long-term erosion resistance. To achieve these long-term performance of the proposed surface water detention systems, the GHAD/HOA shall maintain adequate funds for regular maintenance by a qualified, licensed contractor having specific experience with earthen basins and wetland maintenance.

Impact HYD-2: Development of the currently undeveloped project site will alter surface and subsurface drainage patterns on the site due to relocation and recontouring of on-site streams, and influence ground water movement and elevations beneath the site. These hydrological modifications will affect seasonal wetlands and other natural communities dependent upon the presence of water. (S)

The proposed project will alter the site drainage patterns, although, overall, the unnamed main channel will not sustain modification from grading or other construction activities except in the north end of the site for replacement of the culvert at Wesley Way with an arch culvert. Within the proposed lots, surface drainage will be diverted from overland flow to the seasonal main and tributary channels to the developed street storm drainage system. The detention basins would provide for temporary storage of runoff generated from the site, and the drainage galleries would offer long-term storage and percolation of storm water. The severely eroded, unstable seasonal tributary that receives runoff from Waldorf School will be relocated to allow for building pad development and reduce sedimentation into the main channel and ultimately San Pablo Creek. It has been determined that the relocated channel will convey 100-yr. stormwater runoff up to and including the natural watershed conditions (4 cfs), including the school property. Check dams (14-19 riprap structures) will be installed in the channel to reduce the reconstructed channel gradient to 14 percent; a gradient that conforms with other stable channels within the watershed. The check dams will provide for an additional seasonal wetlands totaling approximately 0.024 acres designed to retain and stabilize sediment. Prior to abandonment of the eroded channel, all unstable soil, vegetation, and construction material will be removed. Remedial grading to abandon the existing channel will conform with adjacent main channel banks. Specifications for engineering fill and subdrainage for this work will be provided the project geotechnical consultant.

Arch culverts will be installed at roadway crossings. The culverts are designed to allow for more natural flow patterns and to offer unimpeded wildlife access along the drainage courses. Engineered fill and subdrainage will be required for these features. Armor with riprap for erosion control on the up and down stream sides of the culvert crossings will modify local channel gradients and have the potential for inducing downstream erosion/siltation if constructed with abrupt, steeper transitions to the unconsolidated alluvial deposits forming the natural channel bottoms.

Surface waters directed to the basins and drainage galleries will directly influence ground water between the surface and up to 100 feet deep. Subdrainage necessary for buttress, retaining wall and other subdrainage works will redirect ground water occurring between the surface and up to 100 feet below.

Mitigation Measure HYD-2a: The project applicant shall comply with requirements of the California Fish and Game Streambed Alteration Permit as well as Corps of engineers and California Regional Water Quality Control Board (RWQCB). A qualified civil engineer having experience in hillside development shall prepare detailed grading and drainage plans. Such plans shall be submitted to the City of Richmond and Contra Costa County Flood Control & Water Conservation District for review and approval. The geotechnical consultants shall carefully review and approve in writing the proposed grading and drainage plan, and submit the letter to the City of Richmond Public Works Department.

Mitigation Measure HYD-2b: Plans and specifications for the proposed channel relocation and associated reclamation of the eroded channel draining Waldorf School shall be carefully evaluated and approved by the applicant’s geotechnical consultant to assure that appropriate grading and subdrainage measures are accomplished according to the approved plans and geotechnical recommendations. The geotechnical consultant shall provide any necessary recommendations for reinforcement of the engineered fill to rebuild the abandoned channel segment conformable with adjacent channel bank segemtns. Similarly, guide specifications for placement of the check dam riprap, and erosion control measures will be prepared by the geotechnical consultant to assure a stable bank configuration for the relocated channel.

For period of at least 10 years, or as determined and funded by the GHAD or HOA, the civil engineer and geotechnical consultant shall make annual inspections of potential erosion and siltation associated with the channel relocation mitigation, and produce their findings in a letter report. The GHAD or HOA shall hire a qualified, licensed contractor to implement recommendations by the civil engineer and geotechnical consultant for a stable environment.

Mitigation HYD-2c: A detailed and specific erosion and sediment control plan will be prepared by the project civil engineer in accordance with recommendations by the geotechnical consultant to mitigate surface erosion and siltation and watershed erosion. The plan should include short-term artificial measures, and long-term measures including deep-rooted plant materials that conform to acceptable biological considerations. The plan shall be submitted to the City of Richmond and Contra County Flood Control & Water Conservation District for approval. The geotechnical consultant shall approve the plan in writing and oversee the installation and approve in writing the as-built construction.

Mitigation HYD-2d. Prior to proceeding with the plans for final plans for the proposed basin and drainage gallery system, the geotechnical consultant shall establish the existing ground water regime through monitoring of piezometers or wells, and determine through careful analysis that anticipated infiltration of surface water will not create elevated ground water and global instability of the site. Specific mitigation measures to avoid elevated ground water shall be presented in writing.

d. Significant Water Quality Impacts. The following water quality impacts could result from the stormwater runoff during construction and long-term operation of the revised project:

Impact HYD-3: Project construction could result in increased erosion and sedimentation, could potentially result in release in chemicals to stormwater, and could temporarily increase turbidity and decrease water quality in surface waterways. (S)

Construction of the revised project would require extensive cut and fill operations. Construction activities involving soil disturbance, such as excavation, stockpiling, and grading, could result in increased instability and erosion of hillsides and sedimentation in surface waters, especially if construction occurs during the rainy season. Due to the extent and proximity of streams and drainages on the project site, construction activities could result in soil erosion and decreased water quality to adjacent streams and downstream waterways unless proper erosion control and sedimentation precautions are employed. Sedimentation of streams would not only degrade water quality but also could also increase channel siltation, reduce the flood-carrying capacity of waterways, and affect associated aquatic and riparian habitats.

In addition to increasing the potential for sedimentation of streams, construction activities would introduce construction vehicles, machinery and equipment to the project site throughout the duration of project construction. Use and storage of motor-powered vehicles and equipment on-site would increase the potential for spills and leaks of petroleum products and other chemicals that, in turn, could be carried via stormwater runoff to on-site and downstream waterways and affect water quality. Construction activities such as refueling, or chemical and fuel storage, could result in accidental releases of chemicals to surface water, unless proper precautions are employed.

Potential impacts to water quality during construction would be mitigated to a less-than-significant level provided that the project complies with the requirements of the State NPDES General Permit for Discharges of Storm Water Associated with Construction Activity. This permit is required for construction disturbing more than 1 acre of land. The revised project would involve disturbance of about 38 acres. Therefore, depending on the timing and sequencing of the project development phases, a separate construction stormwater permit may be required for each phase of project construction.

Potential control measures include submitting a Notice of Intent and site map to the Regional Water Quality Control Board (RWQCB), developing a stormwater pollution prevention plan (SWPPP), and implementing site-specific BMPs to prevent sedimentation to surface waters. The control measures must also be consistent with the Contra Costa County Clean Water Program (CCCCWP) guidelines for stormwater control.

Implementation of the following two-part mitigation measure would reduce water quality-related impacts to a less-than-significant level:

> Mitigation Measure HYD-3a: The project applicant shall comply with requirements of the RWQCB construction stormwater permit. As part of the permit requirements, the project applicant shall be required to develop and implement a SWPPP for the project site. The SWPPP shall be consistent with the terms of the State Construction Storm Water General Permit, the manual of Standards for Erosion & Sedimentation Control Measures by the Association of Bay Area Governments, policies and recommendations of the City of Richmond and Contra Costa County, and the recommendations of the RWQCB. The SWPPP shall be a condition of project approval. Implementation of the SWPPP shall be enforced during the construction period by the City, through the use of citations, or stop work orders, if necessary. An independent certified Engineering Geologist, retained by the City and funded by the project applicant, shall monitor on-site

implementation of the SWPPP throughout the duration of construction activity.

The SWPPP shall implement an erosion-control plan during and after construction. The erosion-control plan should be prepared by a registered civil engineer and reviewed by the City for conformance to geotechnical recommendations. The following specific measures shall be considered in developing the erosion control plan and shall be implemented as determined necessary by the SWRCB, the RWQCB, and the City:

(1) Phase construction to limit areas of exposed soil and to minimize length of time the site is cleared and graded.

(2) Stabilize denuded areas as soon as possible with seeding, mulching, or other effective methods. The replanting of these areas shall be consistent with the requirements of Chapter 12.44 of Article XII of the Municipal Code. In addition, the planting scheme shall be designed and maintained to minimize fire hazards and preserve the aesthetic quality of the area.

(3) Coordinate the implementation of the erosion control plan with on-going maintenance practices of the City's Department of Public Works for cleaning, inspection and maintenance of the storm drain system, including cleaning of detention ponds, catch basins and culverts and clearing of stream channels.

(4) Design and engineer use of the velocity control dikes, hay bales, filter fabrics, and silt fencing and other erosion-control practices for strategic placement, especially with respect to longer-term stockpiles, to maximize effectiveness of erosion control and to prevent sediment discharge to streams and waterways. Incorporate program for cleaning, repair and replacement of these facilities as necessary.

(5) Coordinate implementation of the erosion-control measures with the phasing of the construction of the new storm drain system, so that erosion control measures are in place for whichever system(s) or portions thereof are operating for the duration of construction activities at the project site.

(6) Schedule excavation and grading activities during the dry season, between April 15 and October 15, to the extent feasible.

<u>Mitigation Measure HYD-3b</u>: The construction contractors shall enforce strict on-site handling rules to keep construction and maintenance materials out of receiving waters. The rules typically include measures to:

(1) Store all reserve fuel supplies only within the confines of a designated construction staging area.

(2) Refuel equipment only within designated areas within the designated construction staging area.

(3) Regularly inspect all construction vehicles for leaks.

(4) Require the preparation of a Emergency Response Plan to be implemented in the event of an accidental spill.

(5) Require that the construction staging areas be designed to contain surface runoff so that contaminants such as oil, grease, and fuel products do not drain towards receiving waters. If heavy-duty construction equipment is stored overnight adjacent to potential receiving water, drip pans shall be placed beneath the machinery engine block and hydraulic systems. (LTS)

<u>Impact HYD-4</u>: Stormwater runoff from the proposed development could potentially contribute to long-term pollutant discharges to surface waters, including on-site streams and downstream to San Pablo Creek~ (S)

Runoff from residential developments typically contains pollutants such as sediment, oil, grease, heavy metals, pesticides and fertilizers. With the exception of sediment, these substances are not expected to be present in existing runoff discharged from the project site, since the site is currently undeveloped. During long-term use and occupancy of the revised project, stormwater runoff from the site would likely contain pollutants typical of other residential development. While these pollutants are currently present elsewhere within the watershed, additional pollutants in the stormwater runoff from the project site would contribute to adverse downstream water quality in the San Pablo Creek watershed. Discharge of varying levels of pollutants would occur year-round, through irrigation runoff in the summer months and through stormwater runoff in the rainy season.
The relocated channel in the northeast part of the site and grading for the proposed project would reduce the potential for continued sediment production as the result of erosion and landsliding.

As described previously in this section, the project proposes construction of basins (detention and water quality basins) and drainage galleries for management of stormwater runoff generated by the proposed residential development. These features constitute a common "best management practice" (BMP) for protection of water quality. The basins and galleries offer opportunities for removal of pollutants primarily through gravitational settling of suspended solids. The drainage galleries can offer filtering for dissolved pollutants. Moderate to high removal of sediment and heavy metals can be achieved by these systems. The basins are appropriate water quality mitigation measures for large (i.e., 10 acres or more) developments and in areas of low permeability soils. Discharge into the detention ponds would remove floatable materials and associated pollutants. Discharge from the basins to the galleries would offer the opportunity for additional filtering. Further reduction in offsite transport of pollutants could occur with overflow into "grassy swales”. These measures would provide another common water quality BMP. The GHAD/HOA would be responsible for maintenance of these structures.

Discharges would be subject to the water quality requirements of the RWQCB under the NPDES permit for stormwater discharge. In addition, the City of Richmond requires the preparation of Final and Interim Erosion and Sedimentation Control Measures for grading operations proposed by a project. The plans are required to comply with guidance for temporary and permanent erosion control measures presented in the Association of Bay Area Government (ABAG) "Manual of Standards for Erosion and Sediment Control Measures" and/or the "California Storm Water Best Management Practices Hand Books." These guidance documents present performance standards for the design and maintenance of construction-period BMPs and post-construction period BMPs, including extended detention ponds and vegetated channels.

The runoff from the project site would be subject to the requirements of the Contra Costa County Clean Water Program (CCCCWP) for runoff control as part of NPDES permit requirements. The City, as a participant in the program, is required to implement BMPs, public education and outreach, inspection activities and special studies to reduce loading of urban pollutants to stormwater runoff.

Implementation of the following mitigation measures would reduce surface water pollution impacts to a less-than-significant level:

> Mitigation Measure HYD-4a*:* The City, in consultation with the Contra Costa County Clean Water Program, shall implement its stormwater management program at the project site and proposed residences. The developer shall develop and implement a Stormwater Plan, including a SWPPP as required in Mitigation Measure HYD-3a (including provisions for erosion and sediment control), which provides Best Management Practices for both construction and post-construction periods. The City shall review to ensure compliance with the provisions of Article XII of the Municipal Code. Approval of this Plan shall be a condition of approval of the Final Development Plan.
>
> Mitigation Measure HYD-4b: The GHAD/HOA shall be required to fund all maintenance of basins and all other on-site drainage facilities, including drainage galleries and underground arch culverts. Vegetation shall be managed to minimize fire hazards. Mosquito abatement shall be performed in compliance with guidance from the Contra Costa County Mosquito and Vector Control District.
>
> Mitigation Measure HYD-4c*:* The applicant shall include detention basin maintenance provisions in the Stormwater Plan. Provisions for regular inspections and maintenance shall be included. In addition, a methodology for characterization of sediment removed from detention basins, new seasonal wetlands and drainage galleries shall be provided. Chemical characterization of the sediment shall be conducted by a qualified professional and shall, at a minimum, include analyses for heavy metals

(cadmium, chromium, nickel lead, and zinc). Based on results of the characterization, the professional shall determine whether soils can be reused on-site or must be disposed of at an appropriate landfill. The disposal option shall be determined by comparing analytical results to EPA's Preliminary Remediation Goals (PRGs) for residential land uses for each constituent analyzed. If analyzed levels exceed the PRGs, sediments shall be properly disposed of off-site. If levels are below PRGs, the sediment can be disposed of on-site or at a local landfill. The City of Richmond Department of Public Works shall review the Stormwater Plan to ensure that the requirements listed above are included in the plan.

Mitigation Measure HYD-4c: The GHAD/HOA shall minimally conduct annual water quality sampling during the "first flush" storm event at the furthest downstream point (northeast corner of the project site) of the seasonal main stream. The samples shall be analyzed at a State-certified laboratory for pH, total organic carbon, nitrate, total suspended solids, metals, and organo-phosphate pesticides. The analytical results of the water quality sampling shall be evaluated by a licensed engineer or certified hydrogeologist to determine if water quality objectives have been maintained. If water quality objectives have been violated, a corrective action plan shall be developed. A report of the results of the analysis and recommendations for any necessary corrective actions shall be submitted for approval to the City of Richmond Planning Department. (LTS)

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