POTENTIAL IMPACTS OF THE PELICAN HILL RESORT PROJECT ON THE MARINE ENVIRONMENT OF THE NEWPORT COAST

BY

Richard F. Ford, Ph.D.
Consultant in Marine Ecology
Professor Emeritus of Biology
San Diego State University

PREPARED FOR

The Irvine Company
550 Newport Center Drive
Newport Beach, CA 92658

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1.0 INTRODUCTION

The purpose of this summary report is to provide an evaluation of the potential impacts on the nearshore marine environment that might result from the proposed Pelican Hill Resort Project. The primary information employed in this evaluation is contained in the Pelican Hill Resort Water Quality Technical Report and associated planning documents (GeoSyntec 2004a) and in a series of reports on pertinent marine water quality and ecological studies conducted on the Newport Coast from 1993 through 2003 (see, for example, Ford 1995, Ford et al 2004a-b, GeoSyntec 2004b). The latter study reports are described and cited in subsequent sections of this summary document. While these reports were concerned with both the freshwater watershed and the marine environment, primary emphasis in this summary report was on information concerning potential effects of storm runoff and dry weather low flows on the marine environment of the Newport Coast. Information in these reports is used to characterize whether the Pelican Hill Resort Project will affect natural marine water quality conditions in the Irvine Coast Area of Special Biological Significance, as reflected by water quality data representative of those conditions.

1.1 The Pelican Hill Resort Project and its Watersheds

Brief descriptions of the proposed Pelican Hill Resort Project and its watersheds are important in understanding the marine water quality and marine ecological evaluations of this report. The project site, its watersheds, and their relationships to the Pelican Hill Golf Course, Crystal Cove State Park and the adjacent Pacific Ocean are shown in Figure 1.1. As described by GeoSyntec (2004a), the proposed project includes four elements. They are: 1) a new club house and restaurant within the existing driving range area and relocation of the golf course operations to that existing driving range area; 2) the new Inn at Pelican Hill and associated food service, spa, and other amenities; 3) the new Casitas and Villas time-share condominiums serving tourists; and 4) re-grading and reshaping of the turf practice facility at the northern end of the driving range.

As described by GeoSyntec (2004a), the proposed Pelican Hill Resort Project is situated within three watersheds: Pelican Point, Morning Canyon, and a small part of Los Trancos Canyon . The Pelican Point watershed, approximately 351 acres in size, flows into the Pacific Ocean through unnamed drainages passing through and located approximately 0.5 mile to the northwest of the Crystal Cove State Park (Figure 1.1). The existing parts of the proposed project that will be relocated and or redeveloped (the clubhouse, driving range, existing roads, existing paved parking areas, and some event facilities) lie within the Pelican Point watershed. The new Inn at Pelican Hill, the new clubhouse, most of the remodeled driving range, and approximately 35% of the development of areas for the new Villas and Casitas condominiums (8.9)acres) will be located within the Pelican Point watershed.

1.2 Project Design Features for Water Quality Control and Their Effects

Detailed descriptions of the proposed water quality treatment and control measures for the Pelican Hill Resort Project are provided by GeoSyntec (2004a). The project design features a state-of-the-art "treatment train" of best management practices (BMPs) that include:

Site Planning Strategies
- Minimize Impervious Areas and Directly Connected Impervious Areas
- Proper Selection of Construction Materials and Design Practices
- Conserve Natural Areas
- Protect Slopes and Channels with Vegetative Cover

Source Controls
- Stenciling of Drain Inlets
- Irrigation Controls and Management
- Landscape Designed and Water Quality Manager
- Proper Storage and Application of Fertilizers and Pesticides
- Water Quality Education Program for Community and Resort
- Pavement Sweeping Program
- Litter Control Program

Structural Controls
- Catch Basin Inserts
- Bio-filtration Areas in Swales to Enhance Filtration from the Main Parking Facility and Perimeter Areas
- Water Cisterns Holding 1.2 Million Gallons of Runoff to Capture and Use Storm Water and Nuisance Flows for Irrigation
- Water Quality Detention Basins

The proposed design features incorporate measures to minimize the changes in the water balance, including both surface runoff and infiltration rates, so that they mimic existing watershed conditions (GeoSyntec 2004a). This is a particularly important element to prevent erosion in Morning Canyon, as well as downstream seepage effects in Pelican Point (Figure 1.1). All flow from the Morning Canyon areas of the Project will be routed to cisterns and golf course lakes

As shown in Figure 1.1, the Pelican Hill Resort Project site is located relatively far from the Pacific Ocean. Because of this, there would be no direct discharge from it into the ocean. As described by GeoSyntec (2004a), implementation of the proposed project design features will be quite effective in maintaining infiltration rates and runoff flows to the nearshore ocean at or near their existing levels. Furthermore, given the water quality treatment controls to be employed at the Project site, along with other factors related to flows from the sites (including distances from the shoreline and mixture with runoff waters from other parts of the watershed), the runoff from the Project is not expected to affect the natural water quality in the adjacent marine environment (GeoSyntec 2004a).

1.3 Previous Studies Concerning Effects of Storm and Dry Weather Runoff on the Southern California and Newport Coast Ocean Environments

Potential effects of storm and dry weather runoff on ocean water quality and on marine habitats in southern California and elsewhere have been evaluated fairly extensively. These include studies by Pomeroy, Johnson and Bailey (1972), Shubinski (1974), Makepeace et al (1995), Yoder and Dorsey (1996), Martin et al (1996), Bay and Schiff (1997), Bay et al (1998, 1999), URS Greiner Woodward Clyde (1999), Bergen et al (1999), SCCWRP (1999) and Ogden (2002). In addition, Ford (1995, 1997, 1999a-b, 2001) and Ford et al (2001, 2002, 2003a-b, 2004a-b) conducted a series of monitoring studies to evaluate effects of runoff from the Pelican Hill Golf Course and the Crystal Cove Development Project.

1.4 Importance of the Irvine Coast Marine Life Refuge Area of Special Biological Significance

The evaluation of potential runoff effects in the ocean downstream of the Pelican Hill Resort sites is particularly important because of the nature of the Irvine Coast Marine Life Refuge Area of Special Biological Significance (Brusca and Zimmerman 1974). This and the adjacent Newport Beach Marine Life Refuge, together with others in California, were designated as California Marine Waters Areas of Special Biological Significance (ASBS) in 1979 (Marine Biological Consultants 1970, 1974, Brusca and Winn 1978, SWRCB 1979a-b).

The marine ecological characteristics of the Irvine Coast ASBS have been investigated fairly extensively. Straughan (1982) studied intertidal sand beach habitats and their fauna along the Newport Coast. Pequegnat (1963, 1964, 1968), North (1971, 1976) and North et al (1982) described subtidal habitats and marine environmental conditions of the Irvine Coast ASBS, as well as quantitative ecological studies of these habitats. Littler and co-workers (see Littler 1977, 1978, 1979, 1980, Littler and Littler 1987) conducted studies in rocky intertidal habitats of the area. Broad scale ecological surveys of these intertidal and subtidal habitats also were described by Marine Biological Consultants (1970, 1974), Brusca and Zimmerman (1978) and Valencic (1987). More recent research by Ford (1995, 1997, 1999b, 2000a-b, 2001) and Ford et al (2000a-c, 2001, 2003a-c, 2004 a-b) evaluated the potential effects of storm and dry weather runoff on water quality and marine organisms of the Irvine Coast ASBS.

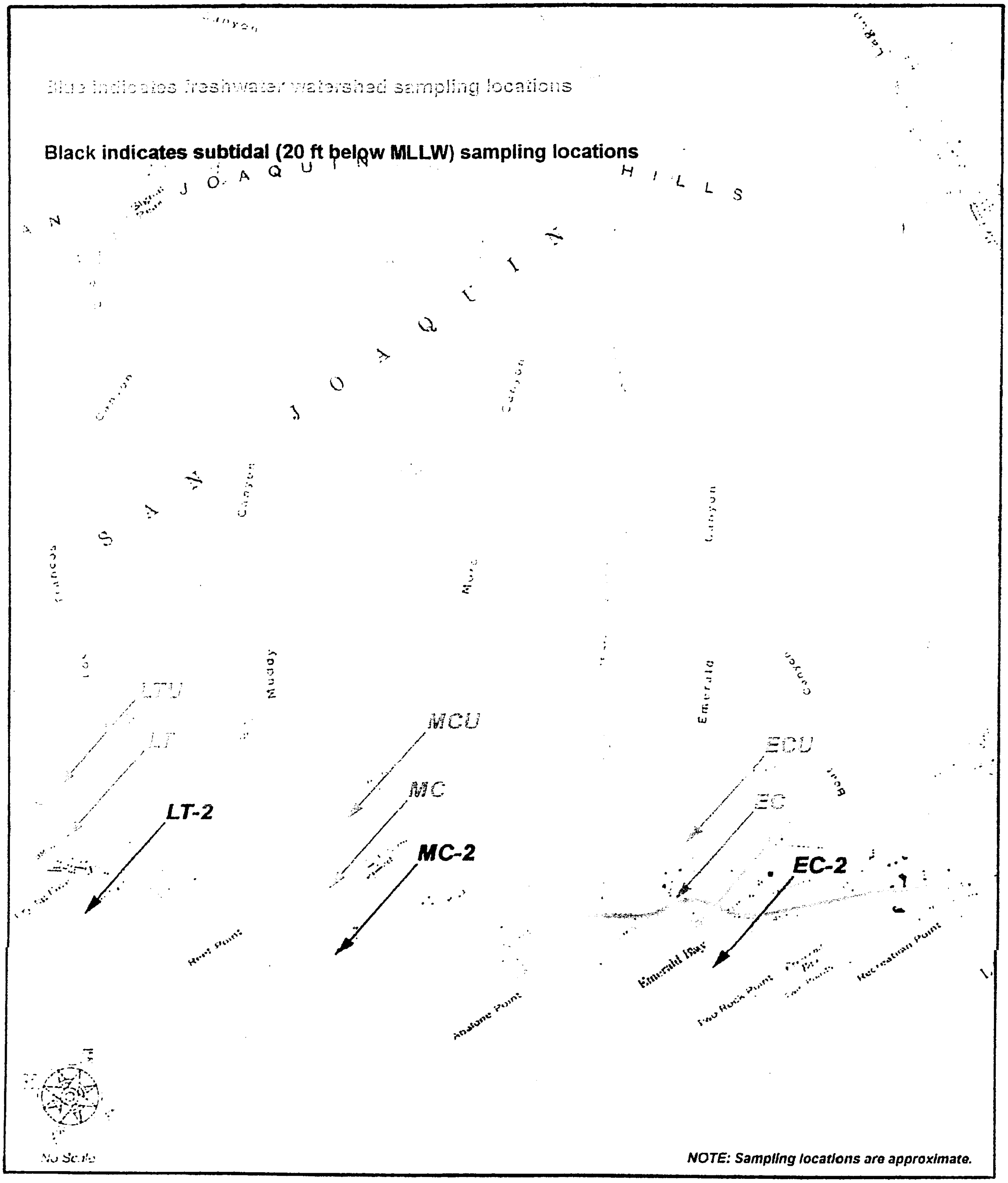
The watershed management systems and the "treatment train" of best management practices (BMPs) to be employed in the Pelican Hill Resort Project are designed to prevent adverse effects on water quality and aquatic life in and adjacent to the Project area. Predictive modeling and evaluations by GeoSyntec (2003a) indicate that use of these runoff management measures will result in no significant adverse effects on water quality and ecological characteristics of the Irvine Coast ASBS. A primary goal of this summary report is to characterize and evaluate these potential effects on the marine environment.

1.5 Natural Water Quality Concentrations of Constituents in the Irvine Coast Area of Special Biological Significance and Other Local Marine Waters

It is particularly important to relate concentrations of seawater constituents measured during storm runoff and dry weather flows to the ranges of their concentrations present under conditions of ;natural water quality. As a basis for these comparisons, ranges of values for natural water quality conditions on the Newport Coast and elsewhere in southern California are shown in Table 1.1.

These concentration values were obtained from several sources. A primary source was the extensive water quality data set obtained at the surf zone and subtidal stations in the Crystal Cove monitoring study (Ford et al 2002, 2003b, 2004b). The only constituent concentrations used in Table 1.1 were those obtained during dry weather conditions at least one week following storm events. In addition, data were employed from inshore water quality and ecological studies conducted either at the Newport Coast or elsewhere in southern California. They include concentrations of nutrient chemicals reported by North et al (1982) for the Newport Cost and adjacent areas and concentrations of nutrients and other constituents from inshore stations reported as part of the California Cooperative Oceanic Fisheries Investigations (CalCOFI) for the years 1995-2002. In addition, data for a variety of seawater constituents were obtained from studies by Pequegnat (1963, 1964), Marine Biological Consultants (1970), Pomeroy et al (1972), Littler (1978, 1979, 1980), Ford (1995, 1997), Bay and Shiff (1997), and Shiff and Kamer (2000). Unpublished data for San DiegoCounty marine study sites from the Ecology Program at San Diego State University also was employed. In addition, values for background concentrations of trace metals reported by CSWRCB (2001) were used.

The ranges of values shown in Table 1.1 were compared to those obtained in sampling during and following storm and dry weather runoff. These comparisons are noted in primarily in Sections 2.0 and 3.0 of this summary report.



NOTE: Sampling locations are approximate.

Source: USGS 7.5' Topographic Series, Newport Beach Quadrangle

STATION LOCATIONS FOR WATER QUALITY AND MARINE ECOLOGICAL MONITORING FOR THE CRYSTAL COVE DEVELOPMENT PROJECT

TABLE 1.1

Ranges of concentrations for seawater constituents under natural water quality conditions on the Newport Coast and in other inshore marine areas of southern California. Sources of these data are cited in Section 1.5. Insufficient data were available for trace metals in dissolved form.

CONSTITUENT	RANGE OF VALUES	UNITS
Total Dissolved Solids	30,000 - 36,000	mg/L
Total Suspended Solids	11 - 50	mg/L
Turbidity	0.21 - 1.8	NTU
Oil and Grease	0 - 0.28	mg/L
TRACE METALS:		
Total Arsenic	0 - 3.0	µg/L
Total Cadmium	0 - 1.0	µg/L
Total Chromium (Non Hexavalent)	0 - 71	µg/L
Total Copper	0 - 8.8	µg/L
Total Mercury	0 - 1.0	µg/L
Total Nickel	0 - 18	µg/L
Total Silver	13 - 60	µg/L
Total Zinc	0 - 66	µg/L
NUTRIENTS:		
Total Phosphorus	0 - 0.63	mg/L
Dissolved Phosphorus	0 - 0.61	mg/L
Total Kjeldahl Nitrogen	0 - 5.0	mg/L
Nitrate + Nitrite	0 - 4.4	mg/L
Ammonium	0 - 2.66	mg/L
ORGANOPHOSPHORUS PESTICIDES:		
Chlorpyrifos	0 - 0.0688	µg/L
Diazinon	0 - 0.0230	µg/L

2.0 MARINE ECOLOGICAL EFFECTS OF NUTRIENT CHEMICALS IN STORM WATER RUNOFF AND DRY WEATHER FLOWS FROM THE PELICAN HILL GOLF COURSE WATERSHEDS AND ADJACENT AREAS

2.1 Nature and Purposes of Studies

During the period 1993-1996, studies were conducted concerning nutrient chemicals entering the Irvine Coast ASBS in storm water runoff and dry weather low flows from the Pelican Hill Golf Course watersheds and adjacent areas. These studies were carried out during the rainfall seasons of 1993-1994 (Ford 1995) and 1995-1996 (Ford 1997). Associated freshwater monitoring was reported by Rivertech (1994, 1995, 1997). The primary purpose of these studies was to evaluate the possible effects of nutrients (nitrogen and phosphorus compounds) and freshwater in storm water runoff and dry weather flows from these watersheds on marine plant indicator species in adjacent, nearshore habitats of the Irvine Coast ASBS. These nutrient chemicals are present in watersheds primarily as the result of controlled fertilizer applications to the golf course and associated, controlled watering, as well as from adjacent residential property. Marine plant species were used as the indicator organisms in this case because they are the ones most responsive and affected by nutrient chemical concentrations.

2.2 Sampling Stations and Methods

2.2.1 Storm Sampling Stations

As shown in Figure 2.1, three primary nearshore ecological study areas were employed at representative, potentially affected (treatment) and control locations along the Newport Coast. It was important to take advantage of the water quality data obtained at the freshwater Principal Monitoring Stations P4 and C of the Pelican Hill Golf Course and its watershed, shown in Figure 2.1 and Rivertech (1995). Therefore, two of these ecological study areas (the two potentially affected or treatment sites) were located directly offshore of the points at which the main water courses passing through the C and P4 locations discharge to the ocean. The remaining ecological study site, established as a best attainable control, was located near the canyon mouth and directly offshore of the point where Muddy Canyon discharges runoff water to the ocean. This was the logical choice as a control location because Muddy Canyon was at that time a relatively natural watershed unaffected by most land uses. Yet the same marine habitats and nearshore physical processes occur offshore of Muddy Canyon as they do offshore of potentially affected (treatment) sites C and P4 (Ford 1995, 1997).

To the extent that they were available, water quality monitoring data obtained at existing Principal Monitoring Stations P4 and C during and following storms were used in conjunction with those obtained in the ocean at the study sites. Water grab samples were taken at a comparable location near the mouth of Muddy Canyon during runoff in order to provide control site data on freshwater quality. Water grab samples also were taken at surf zone stations adjacent to these three locations during runoff. These Surf Zone Stations were designated C-1, P4-1 and MC-1 (Figure 2.1). In addition, water quality samples were taken in the nearshore ocean at each of the six subtidal ecological study sites within 24 hrs after each storm event and again during the course of the biological sampling. These samples were obtained at the same specific locations where the biological samples were taken, so that nutrient levels and salinity could be related directly and specifically to the biological information. Within each of the three subtidal ecological study areas, sampling was conducted in water of two depths, Stations C-2, P4-2 and MC-2 at 15 ft (4.6m) MLLW and C-3, P4-3 and MC-3 at 20 ft (6.1m) MLLW, making a total of six separate subtidal biological sampling stations (Figure 2.1). This allowed an evaluation of biological effects for typical portions of the nearshore zone.

2.2.2 Water Quality Studies

Details concerning the water quality methods are described in Ford (1995-1997). All of the specific sampling was conducted according to a standard time schedule. Sets of water quality and biological samples were taken initially to establish baseline conditions. Then, for the same three major storm runoff events monitored at Stations C, P4 and Muddy Canyon, a time series of water quality and biological samples were taken at standard intervals of time (16-17 days and 30-31 days) following each storm event. This allowed description and assessment of short-term and longer-term effects.

During each of the three storm runoff events per season for which freshwater runoff samples were obtained with the automatic samplers at Stations P4 and C, the staff took water grab samples at Stations MC, MC-1, P4-1, and C-1. They obtained a grab sample at each station as close as possible to the time that substantial runoff to the ocean began. Then, at approximately one hour intervals after taking the first sample, they took a second and a third water grab sample at each station. At the same three times, they took separate water samples for determination of salinity at Surf Zone Stations MC-1, P4-1 and C-1. They then returned to these three sites and took a fourth and fifth salinity sample approximately 12 and 24 hrs after the first set of water samples was obtained. This was to determine the degree to which nearshore seawater salinities returned to non-storm, background levels after stormwater runoff had subsided. All of these salinity measurements also were used in part to estimate the degree of mixing that occurs during freshwater runoff to the nearshore ocean.

Water quality sampling at the six subtidal stations included taking Secchi disc (water clarity) readings, surface and bottom water temperatures, and wave height estimates, as well as separate water samples for nutrient analyses and for determination of salinity. These were obtained at each station during the biological sampling. In addition, this same set of observations and water quality samples were taken by the State Parks staff at each of the six stations within 24 hrs after each of the three storm events began. This was to determine conditions at each site during the period closely following storm runoff. Water samples taken at all of the stations were analyzed for:

- Phosphate, PO_4 as P (EPA Method 365.3)
  - Total PO_4 (as P)
  - Dissolved PO_4 (as P) by filtration
- NO_3+ NO_2 as NO_3 (EPA Method 353.3)

Salinity was determined (nearest 0.01ppt) for all ocean samples. Separate PO_4 analyses were run for both filtered and unfiltered freshwater runoff samples from Watershed Stations C, P4 and MC, and the seawater samples taken at all of the surf zone and subtidal stations.

2.2.3 Ecological Studies

Specific ecological methods employed are described by Ford (1995, 1997) . Recent studies have shown that epiphytic algae, species living attached to larger benthic algae or seagrasses, are particularly responsive to increased levels of nutrient chemicals (Dr. Susan Williams, Bodega Marine Laboratory, pers. comm.; Ford 1995). Such responses are generally quite rapid, occurring within 30 days. Changes in these characteristics of the epiphytes may influence or be influenced by the associated animal epibionts attached to and sharing space on the surfaces of the host plant. Therefore, it is important to consider both algal epiphytes and animal epibionts. Sampling was conducted to determine possible differences in the species richness, species composition and dominance or percent cover of epiphytes and animal epibionts present on three important larger marine host plants living in the study areas. The three host species were the southern sea palm (*Eisenia arborea*), the feather boa kelp (*Egregia menziesii*), and the surf grass (*Phyllospadix torreyi*). The latter is a flowering plant species, while the first two are large brown algae.

For a given sample date, the percent cover (dominance) estimates made in the laboratory for each plant and animal epibiont group or species on each of the algal host species were analyzed using two-way nested analyses of variance. These analyses were used to test for differences among sample sites (stations) and between sample site depths.

2.2.4 Sampling of Dry Weather Low Flows

In 1996, water quality grab samples were taken at the five dry weather low flow sites shown in Figure 2.2. In all cases these samples were taken near the base of the bluff where there was flow adjacent to the intertidal sandy beach. These sampling sites were designated C-B, P4-B, P5/P6-B, LT-B and EM-B. At the same time, water grab samples also were taken at surf zone locations immediately opposite each of these five bluff locations (C-S, P4-S, P5/P6-S, LT-S, EM-S in Figure 2.2). The grab samples were obtained and processed using the same methods described for the storm runoff sampling.

2.3 Results and Discussion Concerning Water Quality of Storm Runoff

Total rainfall for both the 1993-1994 and 1995-1996 storm seasons (7.98 and 8.07 inches, respectively) was lower than the long-term average of 11 inches for the area. However, these lower rainfall totals for 1993-1994 and 1995-1996 are typical of many recent years at the study site.

Typical nutrient chemical data for the storm of March 4-5, 1996, are shown in Tables 2.1-2.4. At the six subtidal stations the concentrations of total PO_4, dissolved PO_4 and nitrate + nitrite were not notably higher or lower within 24 hrs after a storm than were those measured on the other eight sampling dates which did not follow closely after storm events. In fact, the concentrations measured for all six of these post-storm samples were all well within the range of variability for the study area. This evidence suggests very strongly that rainfall runoff through the C, P4 (treatment) and Muddy Canyon (control) watersheds (Figure 2.1) had essentially the same effects on concentrations of nutrient chemicals at the six subtidal biological study sites. It also indicates that nutrient concentrations near the bottom at the six subtidal locations were affected minimally, if at all, by the nutrient concentrations in stormwater runoff. Water temperature, water clarity, wave height and salinity conditions were relatively uniform among all six subtidal sites over the course of the study period, and effects of runoff on water clarity and salinity were of short duration. Therefore, it seems very unlikely that these factors had a differential influence on the biological results observed at the Control (MC) and treatment (C and P4) station series.

The most striking differences between the data for the 1993-1994 and 1995-1996 storm seasons were markedly lower concentrations of total PO_4 (as P) measured at Control Station MC during 1996 as compared with 1994. A similar, but less pronounced, change in concentrations of dissolved PO_4 (as P) also was evident between 1994 and 1996. The primary reason for this change appears to be the high levels of particulate and dissolved PO_4 produced from the Laguna Beach fire of Autumn 1993, that were present in the Muddy Canyon watershed during the winter of 1994 (Ford 1995). These concentrations were substantially reduced by the winter of 1996. Concentrations of $NO_3 + NO_2$ (as NO_3) measured at Freshwater Watershed Control Station MC were lower in 1994 than in 1996. Mean concentrations of total and dissolved PO_4 (as P) and $NO_3 + NO_2$ (as NO_3) were variable among storm events in both 1994 and 1996 at Watershed Stations C and P4, but these values were generally similar, with comparable ranges for both years. The values for $NO_3 + NO_2$ were particularly variable. These PO_4 and NO_3 concentrations measured during storm events at Freshwater Watershed Stations C and P4 appeared to be relatively similar between the 1994 and 1996 storms. This is not surprising, considering the similar rainfall totals for these storms and the fact that nutrient chemical applications to the Pelican Hill Golf Course are computer controlled. In contrast to 1994, these levels in the Freshwater Watershed during 1996 storms were considerably lower at Control Station MC than at Freshwater Watershed Stations C and P4. All values were within the ranges of natural water quality for the region.

From an ecological standpoint, one of the most important questions to be considered was whether or not the concentrations of these nutrient chemicals in the freshwater watershed persist once they enter the ocean. The results of this study indicated that during each of the storm events sampled concentrations of total and dissolved PO_4 (as P) and $NO_3 + NO_2$ measured at the three surf zone stations were all below their analytical detection limits. The same was true for all concentrations of total and dissolved PO_4 sampled near the bottom at each of the six subtidal stations within 24 hours of the storm event. Also, concentrations of $NO_3 + NO_2$ measured within 24 hours of each storm event at the six subtidal stations were all well within the normal range for coastal seawater and that reported for the study area by North et al (1982). There was no significant difference in NO_3 concentrations among any of the six subtidal stations. Furthermore, it is clear that these concentrations were essentially the same at both the control and potentially affected (treatment) station series.

These results for the storm events studied in both years indicate four things very clearly. The first is that concentrations of PO_4 and NO_3 nutrients entering from the freshwater watershed were reduced to very low levels once they reached the surf zone. The second is that these concentrations of nutrients had similarly very low levels near the bottom at the six subtidal stations within less than 24 hours following the onset of runoff. Third, the concentrations of these nutrients at the surf zone and subtidal stations were either not measurably or significantly different from one another among control and treatment station locations. Fourth, and most important from an ecological standpoint, the concentrations always were within the known ranges of natural water quality in the area (Table 1.1).

All of the results show that there is very strong containment, mixing and transport of water in nearshore areas of the Irvine Coast. This occurs primarily because of substantial surf action and surge effects present there, the movement offshore of rip currents, as well as the movement produced by strong longshore currents and tidal flow. As a result of these processes, runoff water and its associated chemicals are assimilated, contained, mixed, and transported from the nearshore area very rapidly.

The results reported by Ford (1995, 1997) indicate clearly that stormwater runoff had only a limited effect on the salinity of the receiving water at Surf Zone Stations C-1, P4-1 and MC-1 and at the six nearshore subtidal stations. In addition, the moderate reductions in salinity that apparently occurred at these points in the surf zone during storm runoff were relatively short lived, with salinities returning to non-storm background levels of the coastal ocean in 24 hrs or less.

2.4 Results and Discussion of Runoff Effects on Marine Plant Indicators

Data were obtained and evaluated concerning the species composition and percent cover or dominance of plant and animal epibionts, small species that normally live by attaching themselves to the surfaces of living macroalgae and seagrasses. These data were collected for epiphytes (plant epibionts) and invertebrate animal epibionts living on three dominant marine host plants in the study areas, the brown algae *Eisenia arborea* and *Egregia menziesii*, and the surf grass *Phyllospadix torreyi*.

As in most marine habitats, the red algae (Rhodophyta) were the dominant epiphyte group, represented by 19 species. Of these, *Melobesia mediocris*, *Smithora naiadum*, and *Pterochondria woodii* were dominant species. Among the three green algae (Chlorophyta) species, *Lola lubrica* was the most common. *Leathesia nana* was the only species of brown alga (Phaeophyta) encountered. Among the animal epibionts, the bryozoan or moss animal *Membranipora membranacea* was by far the most dominant species. The bryozoan *Diaperoecia californica* also was an important species.

Typical data for epiphytes and animal epibionts on the feather boa kelp *Egregia menziesii* (sampling of February 16, 1996) are shown in Figure 2.3. Overall, there was almost no evidence to indicate that percent cover of algal epiphytes living attached to *E. menziesii,* was affected differently at Subtidal Stations C-2, C-3, P4-2 and P4-3, located offshore of the Pelican Hill Golf Course watersheds, than they were at Subtidal Control

Stations MC-2 and MC-3. In almost all cases there were no statistically significant differences in percent cover of algal epiphytes among these six stations. Results for algal epiphytes on *E. menziesii* obtained in the 1993-1994 and 1995-1996 studies indicated conclusively that their percent cover was not affected differentially or significantly by runoff from Pelican Hill Golf Course Watersheds through Stations C and P4 (Ford 1995, 1997).

Because of the very small amounts of epiphytic algae present on the southern sea palm *Eisenia arborea* during the 1995-1996 study period, this host plant and its two algal epiphyte species were not very useful as indicators of nutrient conditions (Ford 1997). Percent cover values for algal epiphytes on *E. arborea* were not consistent enough among replicate samples to permit statistical comparisons of these data. These results are in contrast to the samples for 1993-1994, in which epiphytes were more common on *E. arborea* throughout that study period (Ford 1995).The data for 1993-1994 showed that percent cover of epiphytes on *E. arborea* was not significantly different among the subtidal stations.

The surf grass *Phyllospadix torreyi* is known to be an important host plant for many epiphytes and animal epibionts. The dominant algal epiphytes living attached to *P. torreyi* were the red algae *Melobesia mediocris* and *Smithora naiadum*. Two bryozoan or moss animal species, *Diaperoecia californica* and *Membranipora membranacea,* were the dominant animal epibionts on surf grass during the 1994-1996 study. Throughout this study period, the alga *M. mediocris* and the bryozoan *M. membranacea* were by far the most dominant epibiont species on surf grass. Typical summary data for *P. torreyi* (February 16, 1996) are shown in Figure 2.4.

Percent cover (dominance) of algal epiphytes on *P. torreyi* showed declines in April 1994 and 1996. This was accompanied by an increase in dominance of animal epibionts at that time. Such changes in dominance are typical of the interrelationships between different epibiont species. They indicate the dynamic natural seasonal change (annuation), in which one dominant epibiont group is replaced by another.

The results for algal epiphytes living attached to *P. torreyi* were complex, variable and somewhat difficult to summarize in a generalized form. However, it is clear that percent cover (dominance) of algal epiphytes on this host species was unaffected by nutrient chemical concentrations in the nearshore ocean resulting from storm runoff (Ford 1995, 1997).

In order to evaluate the data on algal epiphytes and animal epibionts from a different perspective, Euclidean distance cluster analyses were employed. This technique uses the dissimilarities or Euclidean linkage distances between stations when forming the clusters. The greater the linkage distance between station pairs, the greater is the dissimilarity between those two stations in the epiphyte species and their percent cover present there. It was chosen because of the relatively simple species assemblages formed by the algal epiphytes and animal epibionts living attached to the three larger plant host species. The results indicated that there were no dissimilarities among subtidal stations that could be attributed to nutrient concentrations.

2.5 Results and Discussion Concerning Dry Weather Flows

Measurements were made to determine the concentrations of total PO_4 (as P) and NO_3 + NO_2 for the water grab samples taken at a series dry weather low flow sites (Figure 2.2) in October 1996. However, flow rates of freshwater at all five of the dry weather flow sites were so low at the time of sampling that they could not be measured accurately.

Because of these low flow rates, which appear to be typical of nuisance flow or dry weather flow sites along much of the Newport Coast, it is extremely unlikely that nutrient chemicals entering the ocean from them would have a measurable effect on the nearshore marine environment. All of the concentrations of PO_4 (as P) measured at the dry weather flow sites were quite low. The same was true for concentrations of $NO_3 + NO_2$. Similar values also were reported by Rivertech, Inc. (1995), based on dry weather flow sampling conducted along the Irvine Coast in 1995. These 1995 and 1996 values are all well within concentrations accepted as safe for drinking water (Rivertech 1995). The concentrations of total PO_4 (as P) measured in the surf zone at the five paired sites also were very low. These surf zone values were all well within normal ranges for NO_3 in seawater of the Newport Coast, as reported by North et al (1982) and others (Table 1.1).

To the extent that they are representative of dry weather flow conditions along the Newport Coast, the data reported by (Ford 1997) and by Rivertech (1995) suggest that freshwater and associated nutrient chemicals entering the ocean from these sites would have no measurable or significant ecological effects on the nearshore marine environment. Both the concentrations of these nutrients in the dry weather flows and the rates of flow from these sites were simply too low to produce such effects.

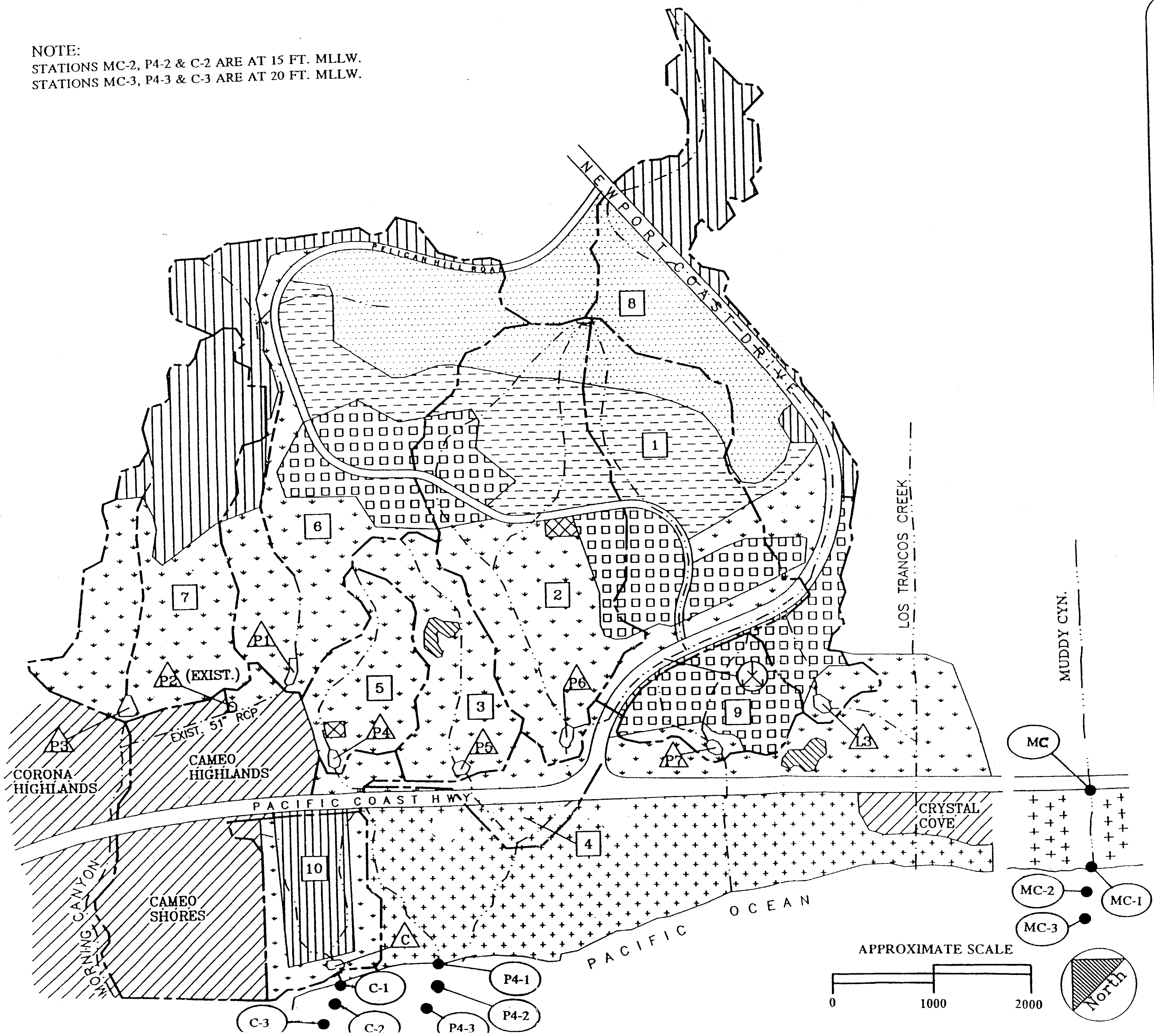
2.6 General Conclusions

The overall conclusion from both the water quality and biological studies is quite clear. The concentrations of nutrient chemicals in the freshwater watershed and in the adjacent ocean were quite low. There were no statistically significant or detectable effects of stormwater runoff from the two golf course watersheds on the algal, surf grass, and epibiont test species considered. The same was true for five dry weather flow sites along the Newport Coast. This conclusion is supported by the results concerning water quality, which indicated that runoff from these watersheds had no detectable effect on the concentrations of nutrient chemicals in the adjacent nearshore ocean. One of the main reasons for this is that nearshore physical processes are very effective in assimilating these chemical constituents as they enter the surf zone.

To the extent that these measurements are representative of storm events as a whole, they provide clear evidence that nutrient chemicals in runoff from the Pelican Hill Golf Course watersheds sampled by Stations C and P4 were reduced to very low concentrations in adjacent surf zone and shallow subtidal locations. They also show clearly that in these surf zone and subtidal locations there were no measurable or significant differences in nutrient concentrations between the control (MC series) and Pelican Hill Golf Course watershed (C and P4 series) locations. Under these conditions, one would also expect to observe no significant differences in biological effects among the subtidal control and potentially affected or treatment locations, and that was the case.

The results indicate that neither current nor planned development at the Pelican Hill Resort have affected, or are expected to affect, natural water quality in the Irvine Coast ASBS. Monitoring of the ASBS to date has not detected concentrations that are discernibly different between the control and treatment stations. All such data are within characteristic natural ranges. The state-of-the-art water quality and hydrologic controls planned for the Pelican Hill Resort Project ensure that the integrity of the Irvine Coast ASBS will continue to be maintained.

NOTE:
STATIONS MC-2, P4-2 & C-2 ARE AT 15 FT. MLLW.
STATIONS MC-3, P4-3 & C-3 ARE AT 20 FT. MLLW.



LEGEND

- - - - - RIPARIAN CORRIDOR
—— - —— WATERSHED **BOUNDARY**
- · - · - MAIN FLOW PATH (CHANNEL OR PIPE)
5 WATERSHED NO. 5
P6 PRINCIPAL STATION P6 OR DETENTION BASIN NO. P6
▨ LAKE
⊗ BIFURCATION BOX
MC-1 MARINE ECOLOGICAL MONITORING STATIONS

LAND USE CATEGORY

░	RESIDENTIAL HIGH	□□□□	TOURIST/ COMMERCIAL
▥	RESIDENTIAL MEDIUM/LOW	⁘	GOLF COURSE
▩	CLUB & MAINT. FACILITY	▤	RECREATIONAL (NATURAL)
▨	RESIDENTIAL EXIST.	+ + +	RECREATIONAL (STATE PARK)

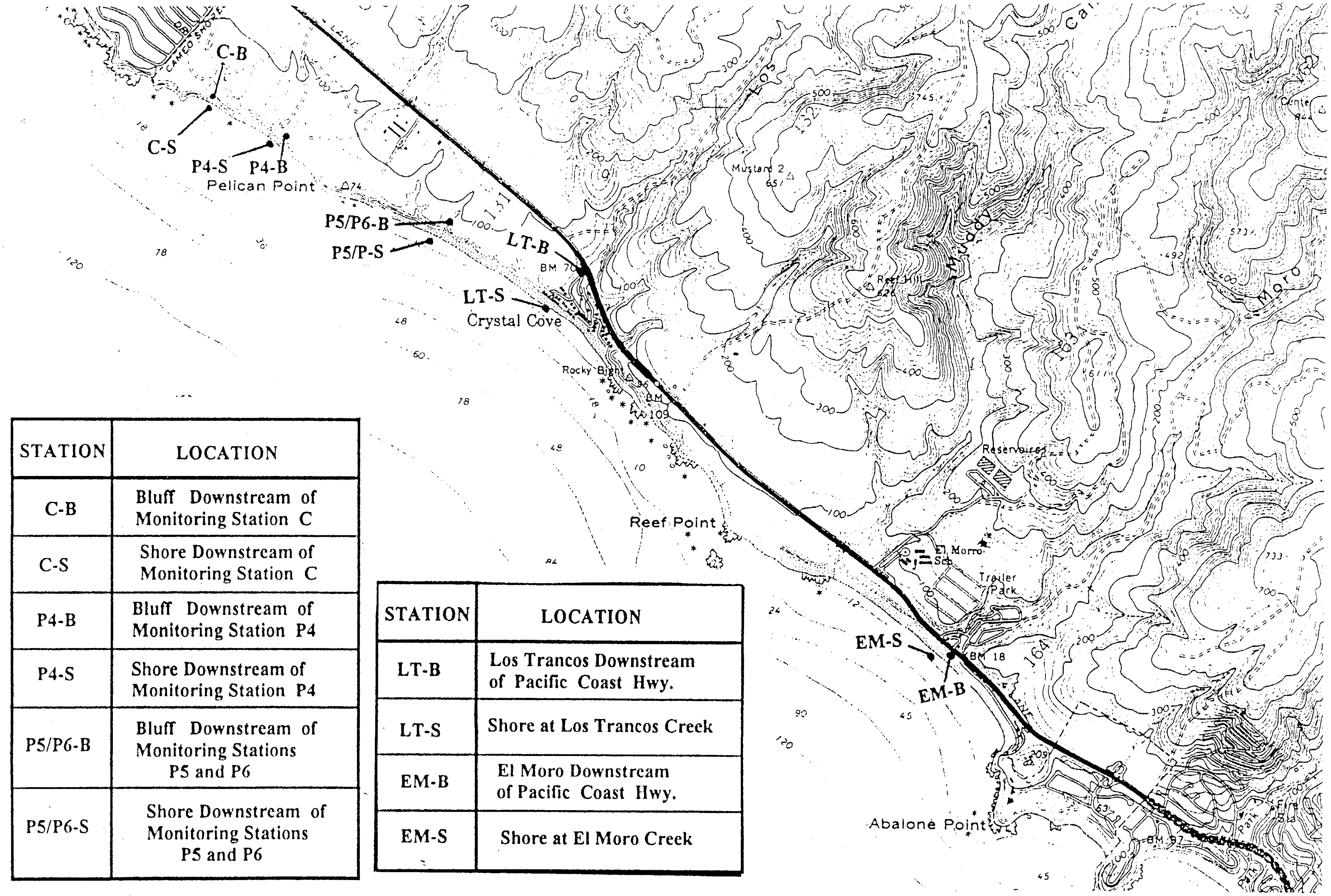
RIVERTECH INC
CONSULTANTS IN WATER RESOURCES ENGINEERING

COASTAL COMMUNITY BUILDERS
A Division of The Irvine Company

FIGURE 2.1

NEWPORT COAST PLANNED COMMUNITY

WATERSHED FEATURES AND STATION SITES EMPLOYED FOR WATER QUALITY AND ECOLOGICAL STUDIES



STATION	LOCATION
C-B	Bluff Downstream of Monitoring Station C
C-S	Shore Downstream of Monitoring Station C
P4-B	Bluff Downstream of Monitoring Station P4
P4-S	Shore Downstream of Monitoring Station P4
P5/P6-B	Bluff Downstream of Monitoring Stations P5 and P6
P5/P6-S	Shore Downstream of Monitoring Stations P5 and P6

STATION	LOCATION
LT-B	Los Trancos Downstream of Pacific Coast Hwy.
LT-S	Shore at Los Trancos Creek
EM-B	El Moro Downstream of Pacific Coast Hwy.
EM-S	Shore at El Moro Creek

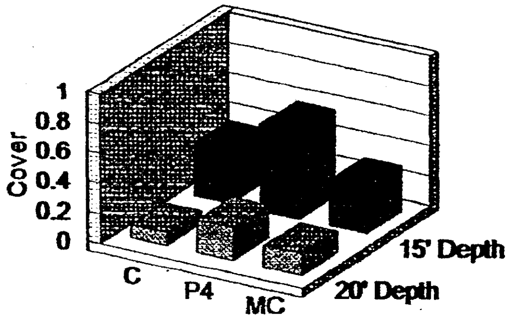
RIVERTECH INC

LOCATIONS OF DRY WEATHER FLOW SAMPLES
ALONG NEWPORT COAST

FIGURE 2.2

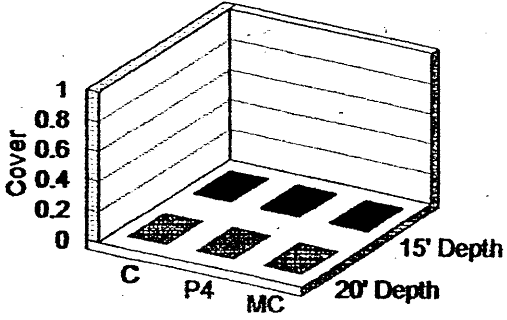
Figure 2.3 Mean percent cover of epiphytes and invertebrate epibionts on *Egregia menziesii* for February 16, 1996 at the six subtidal stations. Shown are separate plots of mean total cover for all epiphytes, mean total cover for all invertebrate animal epibionts and mean total cover of all epiphytes and invertebrates epibionts. Also shown are separate plots of mean percent cover for individual dominant species of epiphytes and invertebrate epibionts. The p values shown represent the results of two-way analyses of variance which tested for significant differences in percent cover among treatment and control stations (site) between depths (depth).

Membranipora membranacea



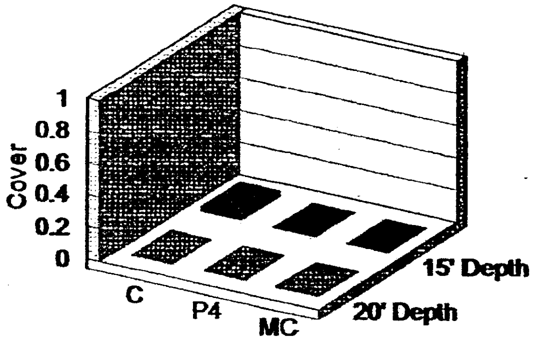
Site p > 0.05
Depth p < 0.05
Inter. p > 0.05

Barentsia benedeni



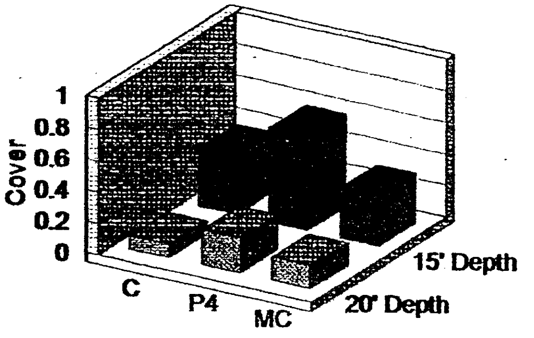
Site p > 0.05
Depth p < 0.05
Inter. p > 0.05

Pterochondria woodii var. woodii



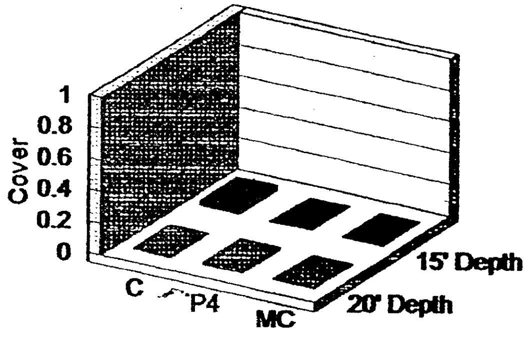
Site p < 0.005
Depth p > 0.05
Inter. p < 0.001

Total Animal Epibionts



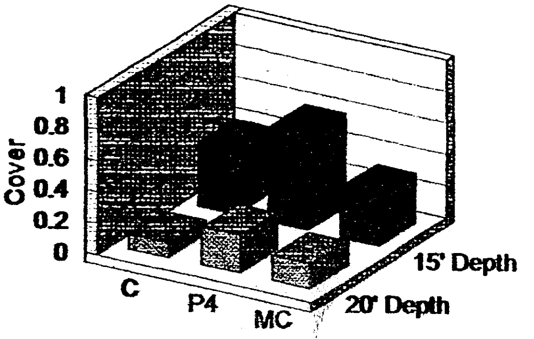
Site p > 0.05
Depth p < 0.05
Inter. p > 0.05

Total Algal Epiphytes



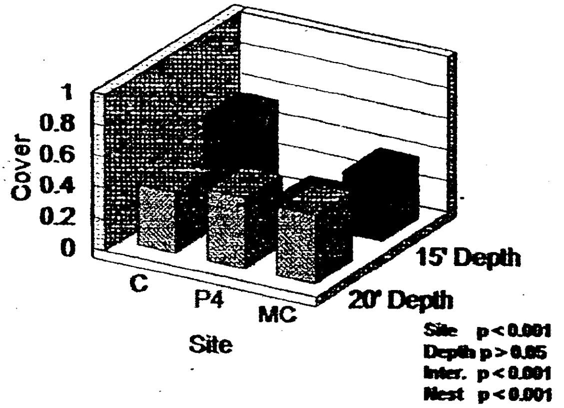
Site p > 0.05
Depth p > 0.05
Inter. p < 0.01

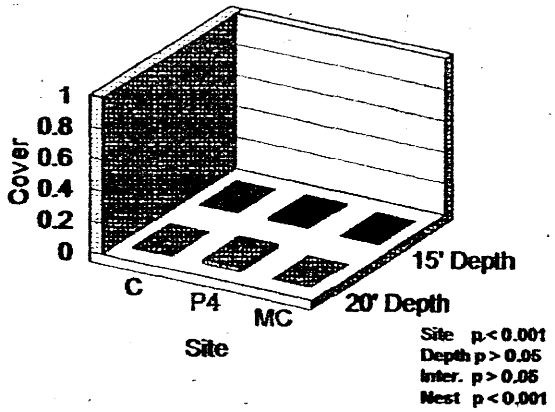
Total Cover

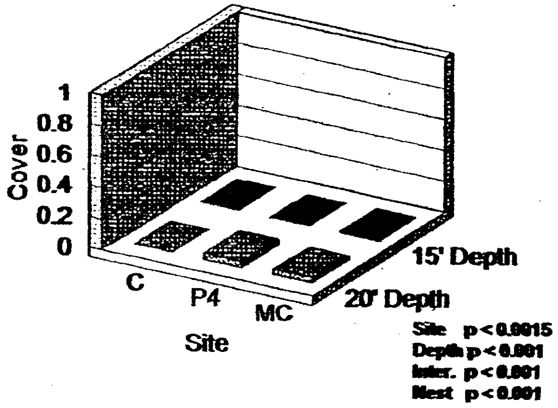


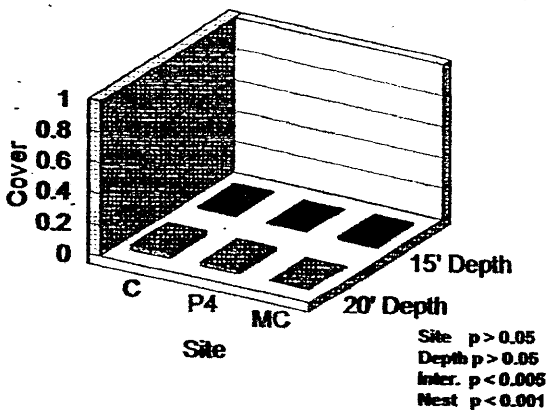
Site p > 0.05
Depth p < 0.05
Inter. p > 0.05

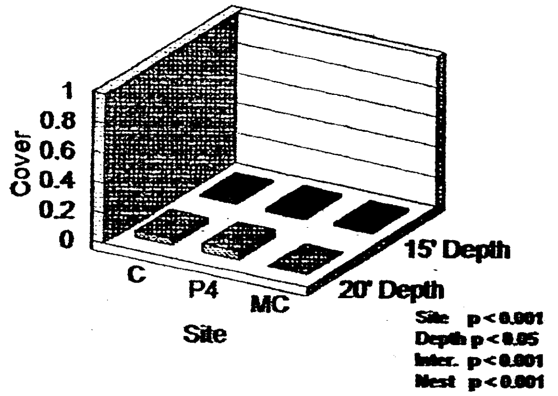
Figure 2.4 Mean percent cover of epiphytes and invertebrate epibionts on *Phyllospacix torreyi* for February 16, 1996 at the six subtidal stations. Shown are separate plots of mean total cover for all epiphytes, mean total cover for all invertebrate animal epibionts and mean total cover of all epiphytes and invertebrates epibionts. Also shown are separate plots of mean percent cover for individual dominant species of epiphytes and invertebrate epibionts. The p values shown represent the results of two-way analyses of variance which tested for significant differences in percent cover among treatment and control stations (site) between depths (depth).


Melobesia mediocris


Diaperoecia californica


Smithora naiadum


Membranipora membranacea


Total Animal Epibionts

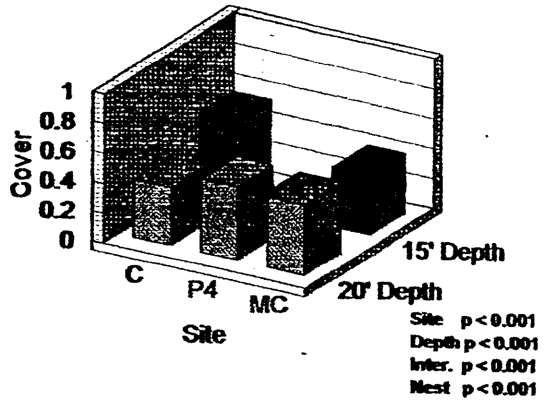

Total Algal Epiphytes

TABLE 2.1 Concentrations of nutrient chemicals (mg/liter) in storm water runoff at Irvine Coast Stations C, and C-1 and Control Stations MC and MC-1 on March 4-5, 1996. COMP indicates measurement of a 24 hour composite of 24 samples.

March 4-5, 1996 **2244 hrs (3/4) - 2245 hrs (3/5)** **C**

	2244	2253	2303	2313	2323		
PARAMETER	**1**	**2**	**3**	**4**	**5**	**COMP**	**MEAN**
UNFILTERED SAMPLE							
Total PO_4 as P	1.2	1.3	1.4	1.5	1.4	1.2	1.33
$NO_3 + NO_2$ as NO_3 (EPA 353.3)	17.2	19.4	18.5	18.0	18.0	14.5	17.6
FILTERED SAMPLE							
Dissolved PO_4 as P (EPA 365.3)	1.2	1.2	1.5	1.4	1.3	1.2	1.3

March 4-5, 1996 **2300 hrs (3/4) - 0100 hrs (3/5)** **C-1**

PARAMETER	**1100 hrs**	**0000 hrs**	**0100 hrs**	**MEAN**
UNFILTERED SAMPLE				
Total PO_4 as P	<0.1	<0.1	<0.1	<0.1
$NO_3 + NO_2$ as NO_3 (EPA 353.3)	3.5	3.9	3.1	3.5
FILTERED SAMPLE				
Dissolved PO_4 as P (EPA 365.3)	<0.1	<0.1	<0.1	<0.1

March 4-5, 1996 **2335 hrs (3/4) - 0115 hrs (3/5)** **MC**

PARAMETER	**2335 hrs**	**0115 hrs**	**MEAN**
UNFILTERED SAMPLE			
Total PO_4 as P	0.1	0.1	0.1
$NO_3 + NO_2$ as NO_3 (EPA 353.3)	12.9	13.2	13.0
FILTERED SAMPLE			
Dissolved PO_4 as P (EPA 365.3)	0.1	0.1	0.1

March 4-5, 1996 **2330 hrs (3/4) - 0135 hrs (3/5)** **MC-1**

PARAMETER	**2220 hrs**	**2300 hrs**	**0010 hrs**	**MEAN**
UNFILTERED SAMPLE				
Total PO_4 as P	<0.1	<0.1	<0.1	<0.1
$NO_3 + NO_2$ as NO_3 (EPA 353.3)	2.6	2.6	2.6	2.6
FILTERED SAMPLE				
Dissolved PO_4 as P (EPA 365.3)	<0.1	<0.1	<0.1	<0.1

TABLE 2.2 Concentrations of nutrient chemicals (mg/liter) in storm water runoff at Irvine Coast Stations P4, and P4-1 and Control Stations MC and MC-1 on March 4-5, 1996. COMP indicates measurement of a 24 hour composite of 24 samples.

March 4-5, 1996 **2304 hrs (3/4) - 2300 hrs (3/5)** **P4**

	2304	2313	2322	2332	2343		
PARAMETER	**1**	**2**	**3**	**4**	**5**	**COMP**	**MEAN**
UNFILTERED SAMPLE							
Total PO_4 as P	3.7	3.8	4.3	4.3	3.9	3.8	3.97
$NO_3 + NO_2$ as NO_3 (EPA 353.3)	72.2	56.8	48.4	47.5	46.6	45.3	52.8
FILTERED SAMPLE							
Dissolved PO_4 as P (EPA 365.3)	3.5	3.6	4.0	3.8	4.0	3.7	3.77

March 4-5, 1996 **2310 hrs (3/4) - 0110 hrs (3/5)** **P4-1**

PARAMETER	**2310 hrs**	**0005 hrs**	**0110 hrs**	**MEAN**
UNFILTERED SAMPLE				
Total PO_4 as P	0.2	<0.1	<0.1	0.13
$NO_3 + NO_2$ as NO_3 (EPA 353.3)	4.4	3.5	3.5	3.8
FILTERED SAMPLE				
Dissolved PO_4 as P (EPA 365.3)	<0.1	<0.1	<0.1	<0.1

March 4-5, 1996 **2335 hrs (3/4) - 0115 hrs (3/5)** **MC**

PARAMETER	**2335 hrs**	**0115 hrs**	**MEAN**
UNFILTERED SAMPLE			
Total PO_4 as P	0.1	0.1	0.1
$NO_3 + NO_2$ as NO_3 (EPA 353.3)	12.9	13.2	13.0
FILTERED SAMPLE			
Dissolved PO_4 as P (EPA 365.3)	0.1	0.1	0.1

March 4-5, 1996 **2330 hrs (3/4) - 0135 hrs (3/5)** **MC-1**

PARAMETER	**2330 hrs**	**0040 hrs**	**0135 hrs**	**MEAN**
UNFILTERED SAMPLE				
Total PO_4 as P	<0.1	<0.1	<0.1	<0.1
$NO_3 + NO_2$ as NO_3 (EPA 353.3)	2.6	2.6	2.6	2.6
FILTERED SAMPLE				
Dissolved PO_4 as P (EPA 365.3)	<0.1	<0.1	<0.1	<0.1

TABLE 2.3 Concentrations of nutrient chemicals (mg/liter) in storm water runoff at Irvine Coast Stations C and P4 on March 4-5, 1996. COMP indicates measurement of a 24 hour composite of 24 samples.

March 4-5, 1996 **2244 hrs (3/4) - 2245 hrs (3/5)** **C**

		2244	2253	2303	2313	2323			
PARAMETER		**1**	**2**	**3**	**4**	**5**	**COMP**		**MEAN**
UNFILTERED SAMPLE									
Total PO_4 as P		1.2	1.3	1.4	1.5	1.4	1.2		1.33
$NO_3 + NO_2$ as NO_3 (EPA 353.3)	17.2	19.4	18.5	18.0	18.0	14.5		17.6	
FILTERED SAMPLE									
Dissolved PO_4 as P (EPA 365.3)		1.2	1.2	1.5	1.4	1.3	1.2		1.3

March 4-5, 1996 **2304 hrs (3/4) - 2300 hrs (3/5)** **P4**

		2304	2313	2322	2332	2343			
PARAMETER		**1**	**2**	**3**	**4**	**5**	**COMP**		**MEAN**
UNFILTERED SAMPLE									
Total PO_4 as P		3.7	3.8	4.3	4.3	3.9	3.8		3.97
$NO_3 + NO_2$ as NO_3 (EPA 353.3)	72.2	56.8	48.4	47.5	46.6	45.3		52.8	
FILTERED SAMPLE									
Dissolved PO_4 as P (EPA 365.3)		3.5	3.6	4.0	3.8	4.0	3.7		3.77

TABLE 2.4 Concentrations of nutrient chemicals (mg/liter) near the bottom at Irvine Coast Subtidal Stations C-2. C-3. P4-2, P4-3, MC-2 and MC-3 on March 6, 1996, within 24 hrs after the storm event of March 4-5, 1996.

March 6, 1996	**C-2**	**C-3**
PARAMETER	**1455 hrs**	**1500 hrs**
UNFILTERED SAMPLE		
Total PO_4 as P	<0.1	0.1
$NO_3 + NO_2$ as NO_3 (EPA 353.3)	3.1	3.9
FILTERED SAMPLE		
Dissolved PO_4 as P (EPA 365.3)	<0.1	<0.1

March 6, 1996	**P4-2**	**P4-3**
PARAMETER	**1450 hrs**	**1445 hrs**
UNFILTERED SAMPLE		
Total PO_4 as P	<0.1	<0.1
$NO_3 + NO_2$ as NO_3 (EPA 353.3)	3.1	3.1
FILTERED SAMPLE		
Dissolved PO_4 as P (EPA 365.3)	<0.1	<0.1

March 6, 1996	**MC-2**	**MC-3**
PARAMETER	**1434 hrs**	**1429 hrs**
UNFILTERED SAMPLE		
Total PO_4 as P	<0.1	<0.1
$NO_3 + NO_2$ as NO_3 (EPA 353.3)	2.6	2.6
FILTERED SAMPLE		
Dissolved PO_4 as P (EPA 365.3)	<0.1	<0.1

3.0 WATER QUALITY STUDIES FOR THE CRYSTAL COVE DEVELOPMENT PROJECT DURING 1999 – 2003

3.1 Introduction

Since 1999, water quality monitoring studies have been conducted within and offshore of the watersheds for the Crystal Cove Development Project, Phases IV-3 and IV-4, and nearby at a best attainable control study area in and offshore of Emerald Canyon. All subsequent references in this document to the Crystal Cove Development concern those two phases of the Crystal Cove Development Project. The approaches used in the monitoring studies as a whole are intended to provide accurate and pertinent quantitative evidence about the potential effects of storm water runoff and dry-weather flows from these watersheds on freshwater and ocean water quality and on inshore marine habitats and organisms of the Irvine Coast Marine Life Refuge Area of Special Biological Significance. The specific approaches employed in the monitoring effort are described in the study plan for the work (Ford 2000a), and in a series of reports (see, for example, Ford et al 2000a-c, 2001, 2003a-b, 2004a-b).

From 1999 to 2001, both the freshwater watershed and ocean studies were conducted by Ford et al (2000a-c, 2001, 2002 a-b, 2003a-b). With the exception of freshwater toxicity bioassays, all sampling and evaluation for the freshwater watersheds of Los Trancos, Muddy and Emerald Canyons has been the responsibility of GeoSyntec Consultants since October 2001. The marine water quality monitoring for the 2002-2003 rainfall season (Ford et al 2004b) as described in this summary report was closely coordinated with the freshwater studies by GeoSyntec (2004b).

3.2 Sampling Design

The study design established in 1999 (Ford 2000a) employed a modified version of the Before and After Control Impact (BACI) approach (Schmitt and Osenberg, 1996). Station placement (Figure 3.1) was planned to sample representative conditions in upper and lower portions of the freshwater watershed, in the surf zone and intertidal area, and at subtidal locations sufficiently close to the shore so that the influences of watershed runoff, if any, might be detected. It is important to recognize that sampling at these stations was conducted to provide representative information about conditions existing at the sites where and at the times the samples were taken.

3.3 Sampling Stations

Three station series (study areas) were established in 1999 (Ford 2000a). The locations of these study areas and stations are shown in Figure 3.1. During the 1999–2000 and 2000-2001 rainfall seasons they were employed in the combined water quality and marine ecological field studies within and offshore from the watersheds of Emerald Canyon (EC Station Series), Muddy Creek/Muddy Canyon (MC Series), and Crystal Cove Creek/Los Trancos Canyon (LT Series). The EC stations were selected as the best attainable control or reference locations. For each, one freshwater watershed station was established short distances upstream of where freshwater in storm runoff flows across the beach and into the ocean (Stations EC, MC, and LT). These stations were established just upstream of and adjacent to the arch culverts that carry water under Pacific Coast Highway (PCH). Station LC receives runoff from PCH, the Pelican Hill Golf Course, existing development upstream, and Los Trancos parking lot of Crystal Cove State Park. Station MC receives runoff from PCH, El Morro School, the Crystal Cove State Park Headquarters, and Laguna Beach County Water District facilities. One additional freshwater sampling station was established at an appropriate upstream location in each watershed (Figure 3.1). Those upstream locations were designated Stations ECU, MCU, and LTU.

As of October 2001, the station plan for the freshwater watershed was modified by the deletion of Emerald Canyon Station EC and upper Muddy Canyon Station MCU, as well as the addition of station sites in Los Trancos and Muddy Canyons, as described by GeoSyntec Consultants (2004b: Figure 2-1). All sampling in the freshwater watershed was conducted at this modified station series by GeoSyntec (2004b) during the October 2002-July 2003 rainfall season. Data from these sites are used to evaluate water quality in upstream segments of these watersheds and to consider possible effects of runoff constituents on freshwater organisms present there. They also provide valuable information about the concentrations of runoff constituents entering the ocean.

Water quality and ecological sampling stations also were established in the surf zone directly opposite the mouths of these three canyon watersheds Surf Zone (Stations EC-1, MC-1, and LT-1), and in directly adjacent rocky intertidal habitats (Figure 3.1). Subtidal Stations EC-2, MC-2, and LT-2 were established directly offshore from these intertidal surf zone sites, at depths of approximately 20-27 ft MLLW. These stations (Figure 3.1) were situated in rocky subtidal habitats that were ecologically similar among the three station locations, so that direct and valid comparisons of data could be made between them (Ford et al 2003c).

3.4 Purposes and Approaches of the Studies

The watershed management systems and the series of best management practices (BMPs) employed in the Crystal Cove Development Project were designed to preserve natural water quality (Tabel 1.1) and to prevent adverse effects on aquatic life in and adjacent to the Project area. Predictive evaluations indicate that use of these runoff management measures would result in no significant adverse effects on water quality and ecological characteristics of the adjacent marine environment, which is the Irvine Coast Area of Special Biological Significance. The overall goal of the monitoring studies described here was to characterize and evaluate these potential effects on the freshwater watersheds and on the adjacent marine environment. Emphasis in this summary report is on potential marine environmental effects.

The specific approaches employed in the studies of 1999-2003 were:

- Measure time series data for indicator bacteria, suspended and dissolved solids, oil and grease, and concentrations of important inorganic and organic chemical constituents in the existing freshwater runoff from three major, existing watershed drainage paths (Watershed Stations ECU, EC, MCU, MC, LTU, LT) in Emerald, Muddy and Los Trancos Canyons, respectively.
- Measure the corresponding levels of these same constituents and ocean salinities where storm water runoff enters the marine environment at the surf zone (Stations EC-1, MC-1, and LT-1) adjacent to the mouth of each of these three canyon watersheds.
- Measure ocean salinities and these same constituents in samples taken at the surface and near the bottom at the three subtidal stations (Stations EC-2, MC-2, and LT-2), located a depths of 20-27 ft (MLLW) directly offshore of the surf zone stations. These samples were taken from a boat. They were obtained within approximately 24 hrs after the storm runoff to the ocean began.
- Evaluate the above data to compare levels of constituents among station sites and changes in those levels over the course of storm runoff, employing the Emerald Bay sites as the best attainable control or reference stations.
- Evaluate data for pathogen indicator bacteria taken during dry weather and post-storm conditions by the Orange County Health Care Agency at their coastal station series during each calendar year. Evaluate additional indicator bacteria data for the storm runoff sampled.
- Conduct toxicity tests employing representative freshwater indicator species exposed to initial storm runoff samples from watershed stations.
- Conduct toxicity tests employing representative marine indicator species exposed to initial storm runoff samples from the surf zone stations.
- During the period 1999-2001, measure and evaluate water quality constituents and flow rates of dry weather, low flow runoff in the watersheds and where it enters the surf zone.
- Conduct associated dry weather flow toxicity tests, using representative freshwater and marine indicator species.
- Evaluate the above water quality and toxicity data and their potential influences on aquatic organisms.
- Employ these data to establish existing conditions of freshwater and marine water quality, against which past and future measurements may be compared.
- Conduct quantitative marine ecological studies of benthic invertebrates, algae, and surfgrass epiphytes in rocky intertidal and rocky subtidal habitats located at the test attainable control site (Emerald Bay) and the Muddy and Lost Trancos Canyon sites.
- Compare and evaluate these ecological data, together with the corresponding water quality information, in order to assess similarities and differences among sites and to evaluate possible ecological effects of storm runoff and nuisance flows.

Because of the nature of this short summary report, it is not possible to describe all of the specific methods employed. As an example, the timing of the samples taken at the surf zone stations during each storm event is shown in Table 3.1.The specific constituents evaluated in the marine sampling effort during 2001 – 2003, and the laboratory methods employed to analyze them, are summarized in Table 3.2. For other details regarding specific field and laboratory methods employed, see Ford et al (2000a-c, 2001, 2002, 2003a-c and 2004a-b).

3.5 Results and Discussion of Constituents in Storm Runoff and in the Adjacent Ocean

During the 1999-2000 and 2000-2001 rainfall seasons, runoff from four storm events was sampled each year (Ford et al 2000a-c, 2001, 2002, 2003b). These storm events produced rainfall ranging from 0.7 – 2.3 inches. In contrast, there was no substantial rainfall during the entire 2001-2002 storm season (total rainfall 3.7 inches), with the largest storm events producing only 0.44 inch. There was essentially no runoff and, as a consequence, no sampling was conducted (Ford et al 2004a). In contrast, there was substantial rainfall at the study sites during the 2002-2003 storm season (total rainfall 13.4 inches). The three storm events for which ocean sampling was conducted in 2002-2003 had rainfall ranging from 1.05 – 2.27 inches.

Typical example data for runoff constituents at Station LT during the storm of March 5, 2000, are shown in Table 3.3. Marine water quality data from storm sampling during the 1999-2000 rainfall season were described and evaluated by Ford et al (2002). Typical ocean data for the storm of March 5, 2000, are shown in Tables 3.4 – 3.6. The results for the 2000-2001 and 2002-2003 seasons (Ford et al 2003b, 2004b) were essentially the same for all runoff constituents as those described by Ford et al (2002) for the 1999-2000 rainfall season. Typical marine water quality constituent data for the storm event of December 16, 2002, are shown in Tables 3.7 – 3.9.

3.5.1 Trace Metals and Suspended Solids

During the storms of 1999-2003, there were no instances in which the water quality guidance criteria for trace metals in dissolved form (California Toxics Rule: USEPA 2000a) were exceeded at any of the original freshwater watershed stations in Los Trancos and Muddy Canyons and at two of the three stations in Emerald Canyon. In addition, very few dissolved trace metals were detected at any of the adjacent surf zone and subtidal stations in the marine environment and these were of low concentrations (Tables 3.4 – 3.9). This indicates clearly that potentially toxic dissolved trace metals were not a water quality problem, either in the freshwater watersheds or in the marine environment of the Irvine Coast ASBS.

During all three rainfall seasons sampled, there were occurrences of trace metals in total recoverable form, particularly during peak runoff from the strongest storms. However, there were far fewer of these instances in 2000-2001 and 2002-2003 than in 1999-2000. These concentrations were directly associated with increases in total suspended solids and turbidity in runoff water. Their primary source probably is natural weathering (Dr Kathe Bertine, a Professor and specialist in trace metal geochemistry, Department of Geology, SDSU, pers. com. 2002). In addition, moderate numbers of these total concentrations, including values at Control Stations MC-1 and MC-2, exceeded water quality criteria of the California Ocean Plan (CSWRCB 2001). The lack of dissolved trace metals in almost all ocean samples during all three rainfall seasons indicates that most of the trace metals present were bound to debris, fine sediments and other particulate matter. A combination of evidence discussed by Ford et al (2002, 2004b) shows that these trace metals in particulate-bound form are not an ecological concern and would not affect marine organisms adversely. It is important to note that values exceeding the trace metal criteria of the California Ocean Plan do not necessarily indicate that a water quality problem exists, as these criteria are employed only for guidance in the evaluation process. This is particularly true of values for trace metals in particulate-bound form, because in all cases they are not biologically available and exist in non-toxic form. Dr. Edward Goldberg, an internationally recognized geochemist specializing in trace metals, is a Professor Emeritus at the Scripps Institution of Oceanography. He has stated that water quality criteria for trace metals, other than in dissolved form, must be applied with great caution, because most such trace metals are not toxic to marine or freshwater organisms (pers. comm. 2001).

3.5.2 Pesticide compounds

No concentrations of the 26 organophosphorus pesticides evaluated during 1999-2001 were above laboratory reporting limits at any station in Los Trancos or Muddy Canyon watersheds, at two of the three stations in Emerald Canyon, and at any of the surf zone and subtidal stations. More intensive sampling of the organophosphorus pesticides chloropyrifos and diazinon was conducted starting in the rainfall season of 2002-2003. Typical marine data sets for these two pesticides are shown in Table 3.10 for the storm sampling of December 16-19, 2002. Although the concentrations of chlorpyrifos and diazinon were slightly elevated at these marine station locations during and following all three storms sampled. However, in no case did these levels exceed EPA acute (CMC) water quality to protect aquatic life (USEPA 1986, 1998). The most likely sources of these slightly elevated levels in the marine environment probably are the Santa Ana River, outer Newport Harbor and other nearby coastal areas during storm and dry weather runoff. There is no evidence to indicate that they derived from the Crystal Cove Development sites (see, for example, Ford et al 2002, 2003b: GeoSyntec 2004b).

3.5.3 Nutrient Chemicals

Concentrations of total and dissolved phosphorus, total Kjeldahl nitrogen and $NO_3 + NO_2$ were present either at typical, low concentrations or below laboratory reporting limits at all surf zone and subtidal stations during and following storm runoff. Values of $NO_3 + NO_2$ were all below the water quality guidance objective of 10 mg/L employed in the Santa Ana Region (8) Basin Plan (RWQCB 1995).

All of the concentrations of these phosphorus and nitrogen nutrient chemicals measured at the surf zone and subtidal stations were well within the guidelines established by the California Ocean Plan (CSWRCB 2001). They would not have any adverse effects on plant or animal species inhabiting the Irvine Coast ASBS (Ford et al 2002, 2003b, 2004b). There were relatively few cases in which nutrient chemical concentrations differed significantly among stations. The differences observed probably reflect variations in both the availability of nutrient chemicals in the watersheds and the intensity and timing of the storm events in each canyon.

It is significant that the concentrations of these phosphorus and nitrogen nutrient chemicals were relatively low in the watersheds of Los Trancos and Muddy Canyons during storm runoff. In addition, it is particularly important to note that all of these nutrient chemicals were of low concentrations once they entered the surf zone and the areas of the subtidal stations. In many cases these constituents were reduced to concentrations below the laboratory reporting limits. This same characteristic was reported for runoff from Muddy Canyon and the Pelican Hill watersheds by Ford (1994, 1997). It is clear that the concentrations of nutrient chemicals measured during runoff from storm events of the 1999-2003 rainfall seasons did not introduce elevated nutrient loads into the watersheds or into the adjacent Irvine Coast ASBS or change natural water quality conditions there. Because of this, they would not affect those marine habitats.

3.5.4 Other Runoff Constituents

Concentrations of all other inorganic chemical constituents and physical constituents of storm runoff were within typical ranges during runoff based on comparisons with data from other southern California watershed and coastal ocean areas (Ford et al 2002, 2003b, 2004b). All of these were well within the general water quality guidelines of the California Ocean Plan (CSWRCB 2001). At the surf zone and subtidal stations, the levels of many constituents, including total suspended solids, turbidity, trace metals, and nutrients, tended to decline at least slightly as runoff flow proceeded during a storm event.

3.5.5 Effects on Ocean Water Clarity and Salinity

The results for all storm events sampled during the period 2002-2003 indicated that runoff had reduced water clarity compared with that observed during non-storm conditions at the surf zone and subtidal stations (Table 1.1). However, these conditions are typical for inshore waters of southern California immediately following winter storms, based on data obtained at several sites along the San Diego County Coast and elsewhere (Ford et al 2002). Such a reduction in water clarity would have no adverse effects on marine plants or animals of these habitats, because it does not persist. Water quality in nearshore areas along the Newport Coast tends to increase markedly within a period of hours to a day after storms (Ford 1997; Ford et al 2004b).

The effects of runoff from all storms on salinity levels at the surf zone and subtidal stations are shown in the time series summarized by Ford et al 2002, 2003b, 2004b). These data were compared to non-storm background levels of salinity, which were determined based on non-storm values. The resulting percent of non-storm estimates provide a convenient and accurate means of evaluating the extent to which entering runoff dilutes and reduces the salinity of seawater in the surf zone (see, for example Tables 3.11 – 3.12). They also provide an indication of the levels of freshwater and associated constituents entering the nearshore ocean at the series of sampling times throughout the runoff period.

The salinity data obtained at the three subtidal stations shortly after each storm of the 11 storm events sampled indicates that there was very little, if any, reduction in salinity. This is consistent with the fact that these inshore subtidal sites are well beyond the surf zone. Even in the surf zone, salinity reductions were relatively small and of short duration (Ford et al 2002, 2004b). Energy in wave action tends to contain and assimilate runoff primarily within the surf zone.

In general, the effects of assimilation and salinity reduction in the surf zone were less pronounced during and following the storms in 2002-2003, than were those measured during the 1999-2000 and 2000-2001 rainfall seasons (Ford et al 2002, 2003b, 2004b). This probably is primarily a reflection of differences in runoff flow among the different storms. The data for Station MC-1 in 2002-2003 indicate that assimilation and salinity reduction effects there were slight and within normal limits for runoff from such small coast watersheds. This suggests that the water quality and flow control installations of the Crystal Cove Development in the Muddy Canyon watershed were working quite effectively during the 2002-2003 rainfall season (Ford et al 2004b).

It is very clear from the marine ecological literature cited and discussed by Ford (2000b) that the reductions in salinity described above would have no adverse or even measurable effects on intertidal or subtidal marine organisms of the Irvine Coast ASBS. As indicated by Ford (1997), Ford et al (2000b, 2003b. 2004b) and oceanographer Dr. Scott Jenkins of the Scripps Institution of Oceanography (pers. comm.), the nearshore oceanographic processes in the study area are very important in this context, because they are a natural control mechanism for freshwater runoff. They include substantial containment, mixing and transport of seawater in the nearshore region of circulation along the entire reach of the Newport Coast and northern Laguna Beach shorelines. This is because of the containing and mixing action on inflowing runoff by the very substantial energy of the storm waves, the heavy surf and surge effects present there, the movement offshore of rip currents, as well as the movement of strong longhsore currents and tidal flow. These are particularly important physical characteristics of this high-energy marine environment, because they assure that freshwater runoff is contained inshore, mixed and transported from the nearshore area quite rapidly, resulting in effective assimilation. The salinity data discussed above provide very convincing evidence of just how effective these assimilation processes are along the Newport Coast, including the area adjacent to the watersheds of the Crystal Cove and Pelican Hill Resort Projects. It is quite evident that they operate well even during more substantial runoff associated with stronger storms (Ford 2000b, Ford et al 2002, 2004b).

3.6 Results and Discussion Concerning Water Quality from Dry Weather Low Flows

Possible water quality effects of nuisance or dry weather low flows were studied in Los Trancos Canyon and at the adjacent surf zone and subtidal sites during 2000-2001.

Such flows were too limited in Muddy and Emerald Canyon to allow sampling. These studies were continued until The Irvine Company began regular diversion of these low flows into the sanitary sewer near Station LT (Figure 3.1). More recently, such diversions of low flows also were established in downstream areas of both Muddy and Emerald Canyons.

Timing of the dry weather flow sampling conducted in 2000-2001 was coordinated directly with the irrigation schedule for the portion of the Pelican Hill Golf Course that contributes runoff to Los Trancos Canyon. In addition, this sampling was coordinated with known watering schedules for residential and roadside landscape areas upstream, from which substantial amounts of runoff enter Los Trancos Canyon. The approach was to take dry weather flow samples in the morning, following irrigation during the previous night and early morning hours. In this way, the possible effects of irrigation on non-storm runoff can be evaluated. Samples for analysis of water quality constituents and salinity were taken once on a given dry weather sampling day at each station where there was flow, using the same methods as for storm water sampling. At locations where there was flowing water of sufficient depth in the runoff channel, the velocity of water movement was determined. Typical data from such sampling on March 21, 2000, are shown in Tables 3.13 – 3.15. Samples also were taken during these dry weather runoff studies at the three surf zone stations (LT-1, MC-1, and EC-1), whether or not there was flow upstream in that watershed.

The results for these studies of dry weather or nuisance flow indicated that the concentrations of runoff constituents were quite low (see, for example Table 3.10), in most cases below laboratory detection limits (Ford et al 2002). None of these dry weather concentrations at the surf zone and subtidal stations exceeded water quality criteria of the California Ocean Plan (CSWRCB 2001). In addition, there was no evidence to indicate that concentrations in the surf zone at Station LT, where most nuisance flow entered the ocean, were significantly or measurably higher than those at Stations MC-1 and EC-1 (Ford et al 2002). They would not change natural water quality there.

Such nuisance or dry weather flows are no longer a concern in downstream Los Trancos, Muddy and Emerald Canyons, as low flow diversion systems are now employed in each watershed. Flow diversion is used except during periods of rainfall.

3.7 Toxicity Bioassays Using Marine Indicator Species

3.7.1 Acute Toxicity Bioassays for Storm Runoff

As described by Ford (2001) and Ford et al (2002, 2003b, 2004b), water samples from the surf zone at Stations LT-1, MC-1, and EC-1 were taken shortly after the start of runoff flow to the ocean during each storm. For the three storm events of 2002-2003, two marine indicator test species, the mysid or opossum shrimp, *Mysidopsis bahia*, and larvae of the California topsmelt, *Atherinops affinis*, were exposed to this water in acute toxicity bioassays to determine possible effects on survival. The same water was analyzed in the laboratory for levels of runoff constituents. Control animals were exposed to clean seawater collected off the Scripps Institution of Oceanography pier. Toxicity bioassays for the 1999-2000 rainfall season employed only *M. bahia*.

The results of these bioassays were considered by Ford et al (2002) for the 1999-2000 storm season. Those for the 2000-2001 storm season were described by Ford (2001). Example results of these toxicity tests for the 2002-2003 rainfall season are shown in Tables 3.16 – 3.17 for samples from the storm events of December 16, 2002 and February 11, 2003. Toxicity bioassays also were conducted using freshwater indicator species (the crustacean *Ceriodaphnia dubia* and larvae of the fathead minnow *Pimephales promelas*) exposed to runoff from Stations LTU, LT and MC, for which data also are shown in Tables 3.16 – 3.17. Discussion of these freshwater bioassays is beyond the scope of this summary report.

The results for all 11 storm events in which marine toxicity bioassays were performed during 2000-2003 were the same. In all cases and for all surf zone sites there were no statistically significant differences in survival of *M. bahia* or larvae of *A. affinis* between animals exposed to the surf zone storm samples and those exposed to uncontaminated control water.

To the extent that these two marine indicators are representative of other nearshore species, the results provide confirmation that storm runoff from the Crystal Cove Development Project had no effects on the marine environment. This conclusion is further supported by the water quality data and the results of the marine ecological studies at the sites (Section 5.0).

3.7.2 Acute and Chronic Toxicity Bioassays for Dry Weather Runoff

Bioassays of the same type were performed at three representative times of year during 2000-1001 to test the potential toxicity of water entering the surf zone in dry weather or nuisance flows. The same methods described for storm runoff bioassays were employed for the acute survival tests. *Mysidopsis bahia* was used as the marine indicator species. Water from all three surf zone stations was sampled when there was dry weather flow from Los Trancos Canyon into the ocean, and the test animals were exposed to these water samples. In addition, chronic bioassays for survival were conducted, using these same water samples of known constituent concentrations.

As for the storm runoff bioassays, there were no statistically significant differences in survival of *M. bahia* between treatment and control groups for any of these acute or chronic tests. To the extent that *M. bahia* is representative of other marine species in the nearshore ocean, these results indicate that dry weather flows into the surf zone at the LT-1 site would not affect them. Given the very low concentrations of runoff constituents present in this water (Section 3.5), this result might be expected.

3.8 General Conclusions Concerning Ocean Water Quality

The evidence presented in this summary document and in the detailed project reports it cites indicates very clearly that storm runoff from Los Trancos and Muddy Canyons during the period January 2000-April 2003 had no evident or measurable adverse effects on the natural water quality of the Irvine Coast Area of Special Biological Significance. Data from three full rainfall seasons support this conclusion.

While a limited number of trace metal concentrations in particulate-bound form exceeded water quality criteria of the California Ocean Plan, these were of no ecological concern because they were not present in biologically active, toxic forms. The concentrations of all other constituents in the ocean water samples were within acceptable limits as defined by expected natural variability for local marine waters.

The same was true for constituent concentrations in the ocean produced by dry weather low flows from Los Trancos Canyon. Such dry weather low flows in Los Trancos, Muddy and Emerald Canyons have now been eliminated because they are diverted into the sanitary sewer.

In toxicity bioassays testing water from the surf zone during initial runoff from storms and during dry weather flows, there was never any indication that survival of two marine indicator species was adversely affected. This suggests that these concentrations of runoff constituents would not be toxic to nearshore species.

Given all the evidence discussed in Section 3.0 concerning water quality of the runoff constituents, it is expected that they would have no evident or measurable adverse ecological effects on marine organisms of intertidal, surf zone, and shallow subtidal habitats in the Irvine Coast ASBS. Substantial evidence that this was the case is provided in the results of the toxicity bioassays and a variety of quantitative marine ecological studies at the station sites, as summarized in Section 5.0.

These extensive studies concerning the Crystal Cove Development during the period 1997-2003 indicate that current development at the Pelican Hill Resort has not affected natural marine water quality in the Irvine Coast ASBS. Given the state-of-the-art water quality and hydrologic controls to be employed as part of the proposed, further development of the Pelican Hill Resort, also is not expected to affect natural water quality in the Irvine Coast ASBS. Monitoring of the ASBS to date has not detected concentrations that are discernibly different between the control and treatment stations. All such concentrations are within characteristic natural ranges.

FIGURE 3.1

Locations of stations in and offshore of Los Trancos, Muddy and Emerald Canyons. These stations were employed for field sampling in the water quality and marine ecological monitoring studies for the Crystal Cove Development Project beginning in 1999. The types of locations sampled are indicated in the color key. Starting in October 2001, the sampling station pattern in the freshwater watershed was modified as described by GeoSyntec (2004b: Figure 2-1). At that time, Stations MCU and EC were eliminated and additional stations were established in Muddy and Los Trancos Canyons.

PREPARED FOR:

THE IRVINE COMPANY
550 NEWPORT CENTER DR,
NEWPORT BEACH, CA.
(949)720-2200

DESCRIPTION:

PELICAN HILL
DRAINAGE
OVERVIEW
EXHIBIT

DATE:
APRIL 4, 2003

FIGURE 1.1

TABLE 3.1

Timing of Sampling at Surf Zone Station LT-1, MC-1, and EC-1 During and Following Runoff from Three Storms on November 8 and December 16, 2002 and February 12, 2003

TIME	LT-1	MC-1	EC-1
Start of Runoff Into Surf Zone	WQ Constituents & Salinity	Same as LT-1	Same as LT-1
+1 Hour After Start of Runoff	WQ Constituents & Salinity	Same as LT-1	Same as LT-1
+2 Hours After Start of Runoff	WQ Constituents & Salinity	Same as LT-1	Same as LT-1
+5 Hours After Start of Runoff	WQ Constituents & Salinity	Same as LT-1	Same as LT-1
+8 Hours After Start of Runoff	WQ Constituents & Salinity	Same as LT-1	Same as LT-1
+24 Hours After Start of Runoff	WQ Constituents & Salinity	Same as LT-1	Same as LT-1

TABLE 3.2

Constituents analyzed for seawater in the water quality monitoring studies for the Crystal Cove Development Project during the period January 2000 – March, 2003. Analytical methods used and typical laboratory reporting limits for those methods are shown. Note that turbidity analyses were added in 2001.

PHYSICAL CONSTITUENTS **CONSTITUENT**	**REPORTING LIMIT**	**METHOD**
Total Dissolved Solids (TDS)	1 mg/L	EPA 160.1
Total Suspended Solids (TSS)	1 mg/L	EPA 160.2
Turbidity	0.05 mg/L	EPA 180.0

CHEMICAL CONSTITUENTS **CONSTITUENT**	**REPORTING LIMIT**	**METHOD**
Salinity (Seawater)	0.01 ppt	Comparison with Standard Seawater
Total Oil and Grease	1.0 mg/L	EPA 1664
Total Phosphorus	0.03 mg/L	EPA 365.3
Dissolved Phosphorus	0.03 mg/L	EPA 365.3
Total Kjeldahl Nitrogen (TKN)	0.1 mg/L	EPA 351
Nitrate + Nitrite (as N)	0.05 mg/L	EPA 353.3
DISSOLVED TRACE METALS		ALL EPA 6020
Cadmium (Cd)	0.1 µg/L	
Chromium, Total (Cr)	1 µg/L	
Copper (Cu)	2 µg/L	
Lead (Pb)	0.5 µg/l	
Nickel (Ni)	1 µg/L	
Silver (Ag)	1 µg/L	
Zinc (Zn)	20 µg/L	
TOTAL RECOVERABLE TRACE METALS		ALL EPA 6020
Cadimium (Cd)	0.1 µg/L	
Chromium, Total (Cr)	1 µg/L	
Copper (Cu)	2 µg/L	
Lead (Pb)	0.5 µg/l	
Nickel (Ni)	1 µg/L	
Silver (Ag)	1 µg/L	
Zinc (Zn)	20 µg/L	

TABLE 3.2 (Cont'd)

Constituents analyzed for seawater in the water quality monitoring studies for the Crystal Cove Development Project during the period January 2000 – March 2003. Analytical methods used and typical laboratory reporting limits for those methods are shown. Note that pesticide determinations by EPA Method 8141A were discontinued in 2002.

CHEMICAL CONSTITUENTS

CONSTITUENT	REPORTING LIMIT	METHOD
ORGANOPHOSPHORUS PESTICIDES		ALL EPA 8141A
Azinphos methyl	1.0 µg/L	
Bolstar	0.500 µg/L	
Chlorpyrifos	0.500 µg/L	
Coumaphos	1.0 µg/L	
Demeton	0.500 µg/L	
Diazinon	0.500 µg/L	
Dichlorvos	0.500 µg/L	
Disulfoton	0.500 µg/L	
Ethion	0.500 µg/L	
Ethoprop	0.500 µg/L	
EPN	0.500 µg/L	
Fensulfothion	0.500 µg/L	
Fenthion	0.500 µg/L	
Malathion	0.500 µg/L	
Merphos	0.500 µg/L	
Mevinphos	0.500 µg/L	
Monocrotophos	0.500 µg/L	
Naled	1.00 µg/L	
Parathion-ethyl	0.500 µg/L	
Parathion-Methyl	0.50 µg/L	
Phorate	0.500 µg/L	
Ronnel	0.500 µg/L	
Stirophos	1.00 µg/L	
Sulfotep	0.500 µg/L	
Tokuthion (Prothiofos)	0.500 µg/L	
Trichloronate	0.500 µg/L	
Chlorpyrifos	50 ng/L	ELISA*
Diazinon	50 ng/L	ELISA*

PATHOGEN INDICATOR BACTERIA

CONSTITUENT	REPORTING LIMIT	METHOD
Total Coliforms (MPN/100ml)	2/100 ml	SM 9221B
Fecal Coliforms (MPN/100ml)	2/100 ml	SM 9221E
Enterococci (MPN/100ml)	2/100 ml	SM 9230B

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* Enzyme-Linked Immunosorbant Assay (Miller et al 1997)

TABLE 3.3 WATER QUALITY DATA FOR STORM OF MARCH 5-6, 2000

SAMPLE SITE	*DATE*	*TIME*	*LAB SAMPLE ID*
LT	3/5/00	9:30 AM	IJC0130-04

ANALYTE	*RESULT*	*RL*	*DL*	*UNITS*
Total Dissolved Solids	2600	10	10	mg/l
Total Suspended Solids	450	10	10	mg/l
Hardness (as CaCO3)	1400	4.0	4.0	mg/l
Cadmium, Total	ND	0.005	0.0010	mg/l
Cadmium, Dissolved	ND	0.005	0.0010	mg/l
Chromium, Total	0.016	0.005	0.0010	mg/l
Chromium, Dissolved	ND	0.005	0.0010	mg/l
Copper, Total	ND	0.010	0.0022	mg/l
Copper, Dissolved	ND	0.010	0.0022	mg/l
Lead, Total	ND	0.005	0.0013	mg/l
Lead, Dissolved	ND	0.005	0.0013	mg/l
Nickel, Total	0.019	0.010	0.0015	mg/l
Nickel, Dissolved	0.019	0.010	0.0015	mg/l
Silver, Total	ND	0.010	0.0010	mg/l
Silver, Dissolved	ND	0.010	0.0010	mg/l
Zinc, Total	0.029	0.020	0.0042	mg/l
Zinc, Dissolved	ND	0.020	0.0042	mg/l
Oil & Grease	ND	1.0	0.35	mg/l
Phosphorus, Total	0.40	0.10	0.020	mg/l
Phosphorus, Dissolved	0.099	0.050	0.0074	mg/l
Total Kjeldahl Nitrogen	1.4	0.50	0.089	mg/l
Nitrate/Nitrite	1.8	0.01		mg/l
Azinphos methyl	ND	1.00	0.330	ug/l
Bolstar	ND	0.500	0.130	ug/l
Chlorpyrifos	ND	0.500	0.280	ug/l
Coumaphos	ND	1.00	0.210	ug/l
Demeton	ND	0.500	0.220	ug/l
Diazinon	ND	0.500	0.160	ug/l
Dichlorvos	ND	0.500	0.110	ug/l
Disulfoton	ND	0.500	0.150	ug/l
EPN	ND	0.500	0.190	ug/l
Ethion	ND	0.500	0.150	ug/l
Ethoprop	ND	0.500	0.130	ug/l
Fensulfothion	ND	0.500	0.320	ug/l
Fenthion	ND	0.500	0.100	ug/l
Malathion	ND	0.500	0.250	ug/l
Merphos	ND	0.500	0.400	ug/l
Mevinphos	ND	0.500	0.330	ug/l
Monocrotophos	ND	0.500	0.0600	ug/l
Naled	ND	1.00	0.220	ug/l
Parathion-ethyl	ND	0.500	0.150	ug/l
Parathion-methyl	ND	0.500	0.130	ug/l
Phorate	ND	0.500	0.140	ug/l
Ronnel	ND	0.500	0.120	ug/l
Stirophos	ND	1.00	0.140	ug/l
Sulfotep	ND	0.500	0.240	ug/l
Tokuthion (Prothiofos)	ND	0.500	0.140	ug/l
Trichloronate	ND	0.500	0.130	ug/l

TABLE 3.4 WATER QUALITY DATA FOR STORM OF MARCH 5-6, 2000

SAMPLE SITE	*DATE*	*TIME*	*LAB SAMPLE ID*
LT-1	**3/5/00**	**11:30 AM**	**IJC0130-08**

ANALYTE	*RESULT*	*RL*	*DL*	*UNITS*
Total Dissolved Solids	20000	10	10	mg/l
Total Suspended Solids	ND	10	10	mg/l
Cadmium, Total	0.015 [c] (d)	0.005	0.0010	mg/l
Cadmium, Dissolved	ND	0.010	0.0020	mg/l
Chromium, Total	0.27 [c] (d)	0.005	0.0010	mg/l
Chromium, Dissolved	ND	0.010	0.0020	mg/l
Copper, Total	0.17 [c] (d)	0.010	0.0022	mg/l
Copper, Dissolved	ND	0.020	0.0044	mg/l
Lead, Total	0.014 (d)	0.005	0.0013	mg/l
Lead, Dissolved	ND	0.010	0.0026	mg/l
Nickel, Total	0.22 [c] (d)	0.010	0.0015	mg/l
Nickel, Dissolved	ND	0.020	0.0030	mg/l
Silver, Total	ND	0.010	0.0010	mg/l
Silver, Dissolved	ND	0.020	0.0020	mg/l
Zinc, Total	0.35 [c] (d)	0.020	0.0042	mg/l
Zinc, Dissolved	ND	0.040	0.0084	mg/l
Oil & Grease	ND	1.0	0.35	mg/l
Phosphorus, Total	8.3	2.5	0.50	mg/l
Phosphorus, Dissolved	0.11	0.050	0.0074	mg/l
Total Kjeldahl Nitrogen	4.5	0.50	0.089	mg/l
Nitrate/Nitrite	1.3	0.01		mg/l
Azinphos methyl	ND	1.00	0.330	ug/l
Bolstar	ND	0.500	0.130	ug/l
Chlorpyrifos	ND	0.500	0.280	ug/l
Coumaphos	ND	1.00	0.210	ug/l
Demeton	ND	0.500	0.220	ug/l
Diazinon	ND	0.500	0.160	ug/l
Dichlorvos	ND	0.500	0.110	ug/l
Disulfoton	ND	0.500	0.150	ug/l
EPN	ND	0.500	0.190	ug/l
Ethion	ND	0.500	0.150	ug/l
Ethoprop	ND	0.500	0.130	ug/l
Fensulfothion	ND	0.500	0.320	ug/l
Fenthion	ND	0.500	0.100	ug/l
Malathion	ND	0.500	0.250	ug/l
Merphos	ND	0.500	0.400	ug/l
Mevinphos	ND	0.500	0.330	ug/l
Monocrotophos	ND	0.500	0.0600	ug/l
Naled	ND	1.00	0.220	ug/l
Parathion-ethyl	ND	0.500	0.150	ug/l
Parathion-methyl	ND	0.500	0.130	ug/l
Phorate	ND	0.500	0.140	ug/l
Ronnel	ND	0.500	0.120	ug/l
Stirophos	ND	1.00	0.140	ug/l
Sulfotep	ND	0.500	0.240	ug/l
Tokuthion (Prothiofos)	ND	0.500	0.140	ug/l
Trichloronate	ND	0.500	0.130	ug/l

TABLE 3.5 WATER QUALITY DATA FOR STORM OF MARCH 5-6, 2000

SAMPLE SITE	*DATE*	*TIME*	*LAB SAMPLE ID*
MC-1	3/5/00	10:30 AM	IJC0132-09

ANALYTE	*RESULT*	*RL*	*DL*	*UNITS*
Total Dissolved Solids	22000	10	10	mg/l
Total Suspended Solids	2300	10	10	mg/l
Cadmium, Total	0.020	0.010	0.0020	mg/l
Cadmium, Dissolved	ND	0.010	0.0020	mg/l
Chromium, Total	0.11 [c] (d)	0.010	0.0020	mg/l
Chromium, Dissolved	ND	0.010	0.0020	mg/l
Copper, Total	0.092 [c] (d)	0.020	0.0044	mg/l
Copper, Dissolved	ND	0.020	0.0044	mg/l
Lead, Total	0.022 [c] (d)	0.010	0.0026	mg/l
Lead, Dissolved	ND	0.010	0.0026	mg/l
Nickel, Total	0.14 [c] (d)	0.020	0.0030	mg/l
Nickel, Dissolved	ND	0.020	0.0030	mg/l
Silver, Total	ND	0.020	0.0020	mg/l
Silver, Dissolved	ND	0.020	0.0020	mg/l
Zinc, Total	0.30 [c] (d)	0.040	0.0084	mg/l
Zinc, Dissolved	ND	0.040	0.0084	mg/l
Oil & Grease	ND	1.0	0.35	mg/l
Phosphorus, Total	7.5	2.5	0.50	mg/l
Phosphorus, Dissolved	ND	0.050	0.0074	mg/l
Total Kjeldahl Nitrogen	2.8	0.50	0.089	mg/l
Nitrate/Nitrite	1.3	0.01		mg/l
Azinphos methyl	ND	1.00	0.330	ug/l
Bolstar	ND	0.500	0.130	ug/l
Chlorpyrifos	ND	0.500	0.280	ug/l
Coumaphos	ND	1.00	0.210	ug/l
Demeton	ND	0.500	0.220	ug/l
Diazinon	ND	0.500	0.160	ug/l
Dichlorvos	ND	0.500	0.110	ug/l
Disulfoton	ND	0.500	0.150	ug/l
EPN	ND	0.500	0.190	ug/l
Ethion	ND	0.500	0.150	ug/l
Ethoprop	ND	0.500	0.130	ug/l
Fensulfothion	ND	0.500	0.320	ug/l
Fenthion	ND	0.500	0.100	ug/l
Malathion	ND	0.500	0.250	ug/l
Merphos	ND	0.500	0.400	ug/l
Mevinphos	ND	0.500	0.330	ug/l
Monocrotophos	ND	0.500	0.0600	ug/l
Naled	ND	1.00	0.220	ug/l
Parathion-ethyl	ND	0.500	0.150	ug/l
Parathion-methyl	ND	0.500	0.130	ug/l
Phorate	ND	0.500	0.140	ug/l
Ronnel	ND	0.500	0.120	ug/l
Stirophos	ND	1.00	0.140	ug/l
Sulfotep	ND	0.500	0.240	ug/l
Tokuthion (Prothiofos)	ND	0.500	0.140	ug/l
Trichloronate	ND	0.500	0.130	ug/l

TABLE 3.6 WATER QUALITY DATA FOR STORM OF MARCH 5-6, 2000

SAMPLE SITE	*DATE*	*TIME*	*LAB SAMPLE ID*
EC-1	3/5/00	10:45 AM	IJC0131-09

ANALYTE	*RESULT*	*RL*	*DL*	*UNITS*
Total Dissolved Solids	34000	10	10	mg/l
Total Suspended Solids	60	10	10	mg/l
Cadmium, Total	ND	0.015	0.0030	mg/l
Cadmium, Dissolved	ND	0.010	0.0020	mg/l
Chromium, Total	ND	0.015	0.0030	mg/l
Chromium, Dissolved	ND	0.010	0.0020	mg/l
Copper, Total	ND	0.030	0.0066	mg/l
Copper, Dissolved	ND	0.020	0.0044	mg/l
Lead, Total	ND	0.015	0.0039	mg/l
Lead, Dissolved	ND	0.010	0.0026	mg/l
Nickel, Total	ND	0.030	0.0045	mg/l
Nickel, Dissolved	ND	0.020	0.0030	mg/l
Silver, Total	ND	0.030	0.0030	mg/l
Silver, Dissolved	ND	0.020	0.0020	mg/l
Zinc, Total	ND	0.060	0.013	mg/l
Zinc, Dissolved	ND	0.040	0.0084	mg/l
Oil & Grease	ND	1.0	0.35	mg/l
Phosphorus, Total	ND	0.10	0.020	mg/l
Phosphorus, Dissolved	ND	0.050	0.0074	mg/l
Total Kjeldahl Nitrogen	1.4	0.50	0.089	mg/l
Nitrate/Nitrite	1.8	0.01		mg/l
Azinphos methyl	ND	1.00	0.330	ug/l
Bolstar	ND	0.500	0.130	ug/l
Chlorpyrifos	ND	0.500	0.280	ug/l
Coumaphos	ND	1.00	0.210	ug/l
Demeton	ND	0.500	0.220	ug/l
Diazinon	ND	0.500	0.160	ug/l
Dichlorvos	ND	0.500	0.110	ug/l
Disulfoton	ND	0.500	0.150	ug/l
EPN	ND	0.500	0.190	ug/l
Ethion	ND	0.500	0.150	ug/l
Ethoprop	ND	0.500	0.130	ug/l
Fensulfothion	ND	0.500	0.320	ug/l
Fenthion	ND	0.500	0.100	ug/l
Malathion	ND	0.500	0.250	ug/l
Merphos	ND	0.500	0.400	ug/l
Mevinphos	ND	0.500	0.330	ug/l
Monocrotophos	ND	0.500	0.0600	ug/l
Naled	ND	1.00	0.220	ug/l
Parathion-ethyl	ND	0.500	0.150	ug/l
Parathion-methyl	ND	0.500	0.130	ug/l
Phorate	ND	0.500	0.140	ug/l
Ronnel	ND	0.500	0.120	ug/l
Stirophos	ND	1.00	0.140	ug/l
Sulfotep	ND	0.500	0.240	ug/l
Tokuthion (Prothiofos)	ND	0.500	0.140	ug/l
Trichloronate	ND	0.500	0.130	ug/l

TABLE 3.7

WATER QUALITY DATA FOR STORM OF DECEMBER 16-17, 2002

SAMPLE SITE	*DATE*	*TIME*	*LAB SAMPLE ID*
LT-1	12/16/2002	6:00 PM	ILL1005-03

ANALYTE	*RESULT*	*RL*	*DL*	*UNITS*
Total Dissolved Solids	30000	10	10	mg/l
Total Suspended Solids	83	10	10	mg/l
Cadmium, Total	ND	100	3.0	ug/l
Cadmium, Dissolved	ND	100	3.0	ug/l
Chromium, Total	ND	100	14	ug/l
Chromium, Dissolved	49	100	14	ug/l
Copper, Total	ND	200	38	ug/l
Copper, Dissolved	ND	200	38	ug/l
Lead, Total	ND	100	13	ug/l
Lead, Dissolved	ND	100	13	ug/l
Nickel, Total	14	100	10	ug/l
Nickel, Dissolved	ND	100	10	ug/l
Silver, Total	ND	100	5.4	ug/l
Silver, Dissolved	ND	100	5.4	ug/l
Zinc, Total	ND	2000	110	ug/l
Zinc, Dissolved	ND	2000	110	ug/l
Oil & Grease	0.39	1.0	0.094	mg/l
Phosphorus, Total	0.12	0.050	0.0087	mg/l
Phosphorus, Dissolved	0.025	0.050	0.0087	mg/l
Total Kjeldahl Nitrogen	0.56	0.50	0.22	mg/l
Nitrate/Nitrite	0.0684	0.00500	0.00250	mg/l
Turbidity	52	2.0	0.40	NTU

TABLE 3.8

WATER QUALITY DATA FOR STORM OF DECEMBER 16-17, 2002

SAMPLE SITE	*DATE*	*TIME*	*LAB SAMPLE ID*
MC-1	**12/16/2002**	**6:00 PM**	**ILL1006-03**

ANALYTE	*RESULT*	*RL*	*DL*	*UNITS*
Total Dissolved Solids	30000	10	10	mg/l
Total Suspended Solids	54	10	10	mg/l
Cadmium, Total	ND	100	3.0	ug/l
Cadmium, Dissolved	ND	100	3.0	ug/l
Chromium, Total	27	100	14	ug/l
Chromium, Dissolved	22	100	14	ug/l
Copper, Total	ND	200	38	ug/l
Copper, Dissolved	ND	200	38	ug/l
Lead, Total	ND	100	13	ug/l
Lead, Dissolved	ND	100	13	ug/l
Nickel, Total	11	100	10	ug/l
Nickel, Dissolved	ND	100	10	ug/l
Silver, Total	ND	100	5.4	ug/l
Silver, Dissolved	ND	100	5.4	ug/l
Zinc, Total	ND	2000	110	ug/l
Zinc, Dissolved	ND	2000	110	ug/l
Oil & Grease	0.16	1.0	0.094	mg/l
Phosphorus, Total	2600	0.050	0.0087	mg/l
Phosphorus, Dissolved	0.045	0.050	0.0087	mg/l
Total Kjeldahl Nitrogen	0.56	0.50	0.22	mg/l
Nitrate/Nitrite	0.598	0.0250	0.0125	mg/l
Turbidity	41	2.0	0.40	NTU

TABLE 3.9

WATER QUALITY DATA FOR STORM OF DECEMBER 16-17, 2002

SAMPLE SITE	*DATE*	*TIME*	*LAB SAMPLE ID*
EC-1	**12/16/2002**	**6:00 PM**	**ILL1004-03**

ANALYTE	*RESULT*	*RL*	*DL*	*UNITS*
Total Dissolved Solids	33000	10	10	mg/l
Total Suspended Solids	ND	10	10	mg/l
Cadmium, Total	ND	100	3.0	ug/l
Cadmium, Dissolved	ND	100	3.0	ug/l
Chromium, Total	ND	100	14	ug/l
Chromium, Dissolved	42	100	14	ug/l
Copper, Total	ND	200	38	ug/l
Copper, Dissolved	ND	200	38	ug/l
Lead, Total	ND	100	13	ug/l
Lead, Dissolved	ND	100	13	ug/l
Nickel, Total	ND	100	10	ug/l
Nickel, Dissolved	13	100	10	ug/l
Silver, Total	ND	100	5.4	ug/l
Silver, Dissolved	ND	100	5.4	ug/l
Zinc, Total	ND	2000	110	ug/l
Zinc, Dissolved	ND	2000	110	ug/l
Oil & Grease	0.098	1.0	0.094	mg/l
Phosphorus, Total	0.023	0.050	0.0087	mg/l
Phosphorus, Dissolved	ND	0.050	0.0087	mg/l
Total Kjeldahl Nitrogen	ND	0.50	0.22	mg/l
Nitrate/Nitrite	1.79	0.0500	0.0250	mg/l
Turbidity	1.2	1.0	0.20	NTU

TABLE 3.10

Concentrations of chlorpyrifos and diazinon (µg/L) measured in nearshore ocean water during and following storm runoff on December 16-19, 2002. All values are below EPA acute (CMC) water quality guidance criteria to protect aquatic life: chlorpyrifos 0.083 µg/L and diazinon 0.09 µg/L.

STATION	TIME (hrs)	DATE	Chlorpyrifos (µg/L)	Diazinon (µg/L)
LT-1	1600	12/16	0.0491	0.0665
LT-1	1700	12/16	0.0428	0.0197
LT-1	1800	12/16	0.0239	0.0258
LT-1	2000	12/16	0.0361	0.0240
LT-1	2300	12/16	0.0537	0.0175
LT-1	1600	12/17	0.0615	0.0174
LT-2 Surf.	1130	12/18	0.0765	0.0131
LT-2 Bott.	1130	12/18	0.0762	0.0161
LT-2 Surf.	1100	12/19	0.0508	0.0110
LT-2 Bott.	1100	12/19	0.0334	0.0082
		MEANS	0.0504	0.0219

STATION	TIME (hrs)	DATE	Chlorpyrifos (µg/L)	Diazinon (µg/L)
MC-1	1600	12/16	0.0427	0.0132
MC-1	1700	12/16	0.0709	0.0157
MC-1	1800	12/16	0.0757	0.0147
MC-1	2000	12/16	0.0694	0.0145
MC-1	2300	12/16	0.0445	0.0145
MC-1	1600	12/17	0.0587	0.0196
MC-2 Surf.	1158	12/18	0.0810	0.0163
MC-2 Bott.	1258	12/18	0.0810	0.0147
MC-2 Surf.	1024	12/19	0.0327	0.0104
MC-2 Bott.	1009	12/19	0.0363	0.0124
		MEANS	0.0594	0.0146

STATION	TIME (hrs)	DATE	Chlorpyrifos (µg/L)	Diazinon (µg/L)
EC-1	1600	12/16	0.0408	0.0146
EC-1	1700	12/16	0.0261	0.0142
EC-1	1800	12/16	0.0296	0.0163
EC-1	2000	12/16	0.0330	0.0169
EC-1	2300	12/16	0.0440	0.0157
EC-1	1600	12/17	0.0685	0.0169
EC-2 Surf.	1230	12/18	0.0767	0.0128
EC-2 Bott.	1247	12/18	0.0600	0.0166
EC-2 Surf.	0930	12/19	0.0218	0.0105
EC-2 Bott.	0855	12/19	0.0237	0.0100
		MEANS	0.0424	0.0144

TABLE 3.11

Salinities (ppt) measured at Surf Zone Stations LT-1, MC-1 and EC-1 and at Subtidal Stations LT-2, MC-2 and EC-2 (2-27 ft MLLW) during and following runoff from a storm of 1.05 inches on December 16-17, 2002. Station locations are shown in Figure 2.1. Samples were taken at the surface (S) and just above the bottom (B) at each subtidal station. Also shown is the percentage of mean normal, dry-weather salinity (33.3 ppt) each value represents, based on non-storm data for the preceding 30 day period.

STATION	DATE	SALINITY (ppt)	TIME (hrs)	PERCENT OF NORMAL
LT-1	12/16	22.56	1600	67.7
LT-1	12/16	29.90	1700	89.8
LT-1	12/16	31.41	1800	94.3
LT-1	12/16	31.34	2000	94.3
LT-1	12/16	33.21	2300	99.7
LT-1	12/17	33.24	1600	99.8
LT-2(S)	12/18	33.36	1130	100
LT-2(B)	11/18	33.43	1130	100
LT-2(S)	12/19	33.26	1110	99.9
LT-2(B)	11/19	33.23	1110	99.8

STATION	DATE	SALINITY (ppt)	TIME (hrs)	PERCENT OF NORMAL
MC-1	12/16	33.24	1600	99.8
MC-1	12/16	31.69	1700	95.2
MC-1	12/16	31.97	1800	96.0
MC-1	12/16	33.20	2000	99.7
MC-1	12/16	33.38	2300	100
MC-1	12/17	32.16	1600	99.6
MC-2(S)	1218	33.36	1158	100
MC-2(B)	12/18	33.41	1158	100
MC-2(S)	12/19	33.25	1009	99.8
MC-2(B)	12/19	33.23	1009	99.8

STATION	DATE	SALINITY (ppt)	TIME (hrs)	PERCENT OF NORMAL
EC-1	12/16	33.21	1600	99.7
EC-1	12/16	33.24	1700	99.8
EC-1	12/16	33.23	1800	99.8
EC-1	12/16	33.37	2000	100
EC-1	12/16	33.37	2300	100
EC-1	12/17	33.43	1600	100
EC-2(S)	1218	33.40	1230	100
EC-2(B)	12/18	33.38	1230	100
EC-2(S)	12/19	33.32	0855	100
EC-2(B)	12/19	33.24	0855	99.8

TABLE 3.12

Salinities (ppt) measured at Surf Zone Stations LT-1, MC-1 and EC-1 and at Subtidal Stations LT-2, MC-2 and EC-2 (20-27 ft MLLW) during and following runoff from a storm of 2.27 inches on February 11-13, 2003. Station locations are shown in Figure 2.1. Samples were taken at the surface (S) and just above the bottom (B) at each subtidal station. Also shown is the percentage of mean normal, dry-weather salinity (33.3 ppt) each value represents, based on non-storm data for the preceding 30 day period.

STATION	DATE	SALINITY (ppt)	TIME (hrs)	PERCENT OF NORMAL
LT-1	2/12	31.78	0415	95.4
LT-1	2/12	31.73	0515	95.0
LT-1	2/12	32.79	0615	98.5
LT-1	2/12	32.95	0815	98.9
LT-1	2/12	31.87	1115	95.7
LT-1	2/13	33.03	0415	99.2
LT-2(S)	2/13	33.13	1725	99.5
LT-2(B)	2/13	33.27	1725	100

STATION	DATE	SALINITY (ppt)	TIME (hrs)	PERCENT OF NORMAL
MC-1	2/12	33.41	0415	100
MC-1	2/12	32.32	0515	100
MC-1	2/12	31.92	0615	95.8
MC-1	2/12	31.84	0815	95.6
MC-1	2/12	27.03	1115	81.2
MC-1	2/13	33.25	0415	99.8
MC-2(S)	2/13	33.26	1700	99.9
MC-2(B)	2/13	33.25	1700	99.8

STATION	DATE	SALINITY (ppt)	TIME (hrs)	PERCENT OF NORMAL
EC-1	2/12	33.24	0415	99.8
EC-1	2/12	33.25	0515	99.8
EC-1	2/12	33.24	0615	99.8
EC-1	2/12	33.24	0815	99.8
EC-1	2/12	33.19	1115	99.7
EC-1	2/13	33.24	0415	99.8
EC-2(S)	2/13	33.29	1615	100
EC-2(B)	2/13	33.23	1615	99.8

TABLE 3.13

Field data for dry-weather flow sampling on March 21, 2000, at Watershed and Surf Zone Stations, following irrigation during the night and early morning of March 20-21, 2000, in upstream areas of Los Trancos Canyon watershed. There was no dry-weather flow in Muddy canyon or Emerald Canyon.

DATE	TIME (hrs)	STATION	WATER TEMP (°C)	AIR TEMP (°C)	CLOUD COVER (%)	RUNOFF COLOR	WATER TURBIDITY	SURF Ht (ft)
3/21/00	0640	LTU	10.0	7.0	0	Clear	None	
3/21/00	0750	LT	12.0	17.0	0	Clear	None	
3/21/00	0824	LT-1	14.0	20.0	0	Clear	Light	
3/21/00	1000	MCU	NO	RUNOFF	FLOW	AT	STATION	
3/21/00	1010	MC	NO	RUNOFF	FLOW	AT	STATION	
3/21/00	1015	MC-1	14.0	19.0	0	NO	FLOW AT	STATION
3/21/00	1300	ECU	NO	RUNOFF	FLOW	AT	STATION	
3/21/00	1305	EC	NO	RUNOFF	FLOW	AT	STATION	
3/21/00	1330	EC-1	15.0	18.0	0	NO	FLOW AT	STATION

TABLE 3.14

Current velocities of dry-weather flow measured during sampling in Los Trancos Canyon Watershed on March 21, 2000. Mean velocity (ft/sec) is based on three replicate measurements, with range shown. Cross sectional dimensions of water flow are indicated. For description of methods, see text.

Station LTU 0640 hrs
Mean flow velocity at Station = 0.26 ft/sec
Range: 0.25 – 0.26 ft/sec
Dimensions: Mean flow width = 48"
Maximum flow depth = 5"

Station LT 0750 hrs
Mean flow velocity at Station = 1.89 ft/sec
Range: 1.67 – 2.00 ft/sec
Dimensions: Mean flow width = 14"
Maximum flow depth = 0.5"

Station LT-1 0824 hrs
Flow over upper beach to surf zone
Mean flow velocity = 1.19 ft/sec
Range: 1.00 – 1.28 ft/sec
Dimensions: Mean flow width = 19"
Maximum flow depth = 0.75"

TABLE 3.15 WATER QUALITY DATA FOR DRY-WEATHER SAMPLING ON MARCH 21, 2000

SAMPLE SITE	*DATE*	*TIME*	*LAB SAMPLE ID*
LT	3/21/00	7:50 AM	IJC0647-02

ANALYTE	*RESULT*	*RL*	*DL*	*UNITS*
Total Dissolved Solids	4900	10	10	mg/l
Total Suspended Solids	18	10	10	mg/l
Hardness (as CaCO3)	2700	4.0	4.0	mg/l
Cadmium, Total	ND	0.005	0.0010	mg/l
Cadmium, Dissolved	ND	0.005	0.0010	mg/l
Chromium, Total	ND	0.005	0.0010	mg/l
Chromium, Dissolved	ND	0.005	0.0010	mg/l
Copper, Total	ND	0.010	0.0022	mg/l
Copper, Dissolved	ND	0.010	0.0022	mg/l
Lead, Total	ND	0.005	0.0013	mg/l
Lead, Dissolved	ND	0.005	0.0013	mg/l
Nickel, Total	0.012	0.010	0.0015	mg/l
Nickel, Dissolved	0.012	0.010	0.0015	mg/l
Silver, Total	ND	0.010	0.0010	mg/l
Silver, Dissolved	ND	0.010	0.0010	mg/l
Zinc, Total	ND	0.020	0.0042	mg/l
Zinc, Dissolved	ND	0.020	0.0042	mg/l
Oil & Grease	ND	1.0	0.35	mg/l
Phosphorus, Total	ND	0.1		mg/l
Phosphorus, Dissolved	0.068	0.050	0.0074	mg/l
Total Kjeldahl Nitrogen	0.84	0.50	0.089	mg/l
Nitrate/Nitrite	2.5	0.01		mg/l
Azinphos methyl	ND	1.00	0.330	ug/l
Bolstar	ND	0.500	0.130	ug/l
Chlorpyrifos	ND	0.500	0.280	ug/l
Coumaphos	ND	1.00	0.210	ug/l
Demeton	ND	0.500	0.220	ug/l
Diazinon	ND	0.500	0.160	ug/l
Dichlorvos	ND	0.500	0.110	ug/l
Disulfoton	ND	0.500	0.150	ug/l
EPN	ND	0.500	0.190	ug/l
Ethion	ND	0.500	0.150	ug/l
Ethoprop	ND	0.500	0.130	ug/l
Fensulfothion	ND	0.500	0.320	ug/l
Fenthion	ND	0.500	0.100	ug/l
Malathion	ND	0.500	0.250	ug/l
Merphos	ND	0.500	0.400	ug/l
Mevinphos	ND	0.500	0.330	ug/l
Monocrotophos	ND	0.500	0.0600	ug/l
Naled	ND	1.00	0.220	ug/l
Parathion-ethyl	ND	0.500	0.150	ug/l
Parathion-methyl	ND	0.500	0.130	ug/l
Phorate	ND	0.500	0.140	ug/l
Ronnel	ND	0.500	0.120	ug/l
Stirophos	ND	1.00	0.140	ug/l
Sulfotep	ND	0.500	0.240	ug/l
Tokuthion (Prothiofos)	ND	0.500	0.140	ug/l
Trichloronate	ND	0.500	0.130	ug/l

TABLE 3.16

Summary of acute toxicity bioassays testing survival for indicator species exposed to runoff from the storm event of December 16, 2002. Shown are the data for two freshwater indicators, the daphniid crustacean *Ceriodaphnia dubia* and larvae of the fathead minnow *Pimephales promelas*, exposed to runoff water from Watershed Stations LTU, LT and MC. Also shown are the data for two marine indicators, the mysid crustacean *Mysidopsis bahia* and larvae of the California topsmelt *Atherinops affinis*, exposed to the seawater-runoff water mixture at Surf Zone Stations LT-1, MC-1 and EC-1. The treatment groups were exposed to water collected at these stations shortly after substantial runoff first reached each site. Results in which survival of the treatment group was significantly lower than that of the clean water control group are indicated by a triangle. Based on testing of dilution series for the freshwater species, the no observed effect concentration (NOEC) and the concentration producing 50 % mortality of the treatment group (LC_{50}) are shown. These are expressed as percentages of the original, undiluted water sample collected in the field.

Site ID/Test Species	Percent Survival (in 100% sample)	NOEC (% sample)	LC50 (% sample)
LT			
C. dubia	100	100	>100
P. promelas	100	100	>100
MC			
C. dubia	100	100	>100
P. promelas	100	100	>100
ECU			
C. dubia	100	100	>100
P. promelas	95	100	>100
LT-1			
M. bahia	85	NSD[b]	NA[a]
A. affinis	100	NSD[b]	NA[a]
MC-1			
M. bahia	100	NSD[b]	NA[a]
A. affinis	100	NSD[b]	NA[a]
EC-1			
M. bahia	95	NSD[b]	NA[a]
A. affinis	80	NSD[b]	NA[a]

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[a] Statistical derivation of LC50s not possible due to a single concentration exposure.

[b] NSD = No Significant Difference (compared to Lab Control)

NOEC = no observed effect concentration

NA = not applicable

TABLE 3.17

Summary of acute toxicity bioassays testing survival for indicator species exposed to runoff from the storm event of February 11, 2003. Shown are the data for two freshwater indicators, the daphnid crustacean *Ceriodaphnia dubia* and larvae of the fathead minnow *Pimephales promelas*, exposed to runoff water from Watershed Stations LT and MC. Also shown are the data for two marine indicators, the mysid crustacean *Mysidopsis bahia* and larvae of the California topsmelt *Atherinops affinis*, exposed to the seawater-runoff water mixture at Surf Zone Stations LT-1, MC-1 and EC-1. The treatment groups were exposed to water collected at these stations shortly after substantial runoff first reached each site. Results in which survival of the treatment group was significantly lower than that of the clean water control group are indicated by a triangle. Based on testing of dilution series for the freshwater species, the no observed effect concentration (NOEC) and the concentration producing 50 % mortality of the treatment group (LC$_{50}$) are shown. These are expressed as percentages of the original, undiluted water sample collected in the field.

Site ID/Test Species	Percent Survival (in 100% sample)	NOEC (% sample)	LC50 (% sample)
LT			
C. dubia	100	100	>100
P. promelas	100	100	>100
MC			
C. dubia	100	100	>100
P. promelas	100	100	>100
LT-1			
M. bahia	100	NSD[b]	NA[a]
A. affinis	100	NSD[b]	NA[a]
MC-1			
M. bahia	100	NSD[b]	NA[a]
A. affinis	95	NSD[b]	NA[a]
EC-1			
M. bahia	95	NSD[b]	NA[a]
A. affinis	100	NSD[b]	NA[a]

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[a] Statistical derivation of LC50s not possible due to a single concentration exposure.

[b] NSD = No Significant Difference (compared to Lab Control)

NOEC = No Observed Effect Concentration

LC50 = Concentration that produces 50% mortality in test organisms

NA = Not Applicable

4.0 STUDIES OF INDICATOR BACTERIA

4.1 Introduction

For the sampling period 1997-2003, marine microbiologist Dr. Barbara Hemmingsen of San Diego State University evaluated indicator bacteria data from the freshwater and ocean station sites associated with Los Trancos, Muddy and Emerald Canyons, as well as from adjacent locations (Ford et al 2001, 2002, 2003b, 2004a-b).
Historical and current data obtained by the Orange County Environmental Health Monitoring Program (OCEHMP) were used extensively in her evaluations. These entire data sets from Los Trancos, Muddy, and Emerald Canyons were evaluated for the calendar years 1999-2003. The watershed and surf zone stations at which OCEHMP takes weekly samples are shown in Figure 4.1. Dr Hemmingsen also evaluated data for indicator bacteria taken in water quality samples during the regular monitoring of storm runoff and dry weather low flows (Section 3.0). In this summary report, primary emphasis has been placed on her results and conclusions regarding indicator bacteria entering and in the marine environment of the Newport Coast.

4.2 Results and Discussion

The direct detection of pathogenic microorganisms in any water sample is too time-consuming and costly to be practical. Rather, certain "indicator" bacteria are enumerated using a variety of techniques. These indicator bacteria are either coliforms or enterococci, or both. They are not usually pathogens and are shed by all healthy humans and other animals in the feces. They are relatively easy to detect and count. Their presence above certain numbers in water is taken as evidence that the water has been contaminated with feces. Unfortunately, there are several species of soil, freshwater and marine bacteria that mimic the actions of the coliforms, yielding false positives. That is, they behave like coliforms but are not necessarily associated with animal or human feces. Because of this problem, a subset of coliforms-fecal coliforms-are enumerated.

Enterococci are inhabitants of the digestive tract of warm-blooded animals. Their presence in water above certain numbers also indicates contamination by the feces of humans and other animals. Many regulatory agencies prefer to use enterococci as indicator bacteria because they are supposed to live longer in water than do the coliforms.

When all of the data for a particular year are considered, it is clear that the percentages of samples with fecal coliforms or enterococci above the single-sample limit are about the same in the downstream areas of Los Trancos, Muddy, and Emerald Creeks, whether sampled by OCEHMP following storms or during non-storm periods or by the Crystal Cove monitoring program during storms. The surf zone samples taken by OCEHMP rarely show levels of indicator bacteria above the standard, but when storm runoff enters the surf, high percentages of samples exceed the single-sample standard.

In fact, the surf zone water rarely contains more than a minimal number of these indicator bacteria (usually <10/100 ml). In this regard it is particularly important to note that indicator bacteria levels are elevated in the surf zone sites of the study area only for a very short time during storm runoff. When such elevations occur, they never persist in the surf zone. In addition, the levels of indicator bacteria found at the three subtidal stations were always quite low and never exceeded single-sample limits following storm runoff. For both the surf zone and subtidal locations, this is due to the influences of nearshore physical processes that contain, assimilate and transport them away, and also to the very significant fact that these indicator bacteria do not survive well in seawater. Numbers of indicator bacteria were very low in the surf zone and at the inshore subtidal stations under all dry weather conditions. Together, these results are very important evidence that bacteria in watershed runoff would not have an adverse impact on natural water quality of the adjacent ocean or on the marine organisms of the Irvine Coast ASBS.

An analysis of the numbers of indicator bacteria in Muddy Creek water during the years 1997-2003 showed no apparent association between grading, soil stockpiling, and construction activities in Muddy Canyon and numbers of such bacteria in Muddy Creek water at its mouth (Ford et al 2004a-b). There are many other variables affecting these numbers from year to year and within years, such as total rainfall and whether or not water was absent or not flowing, that have little to do with grading or other disturbance of the slopes of Muddy Canyon. The data indicate that the levels of development activity on the slopes of Muddy Canyon have not elevated the numbers of indicator bacteria in the water as compared with past years.

Data for 1997-2003 from six different creeks that drain watersheds of about the same size were evaluated. These are Buck Gully Creek, Crystal Cove Creek, Broadway Creek (Laguna Canyon), Emerald creek, Muddy Creek, and El Morro Creek (Figure 4.1). The first three creeks drain watersheds with approximately the same level of development, whereas the latter three creeks drain watersheds that are less developed. In order to compare the levels of indicator bacteria present in these creeks, arithmetic means of the total fecal coliforms and enterococci were calculated for each quarter and each creek. The means were compared to each other to ascertain if degree of development has an evident influence on the numbers of three different indicator bacteria in the runoff water of a creek. The degree of development of the watersheds does not seem to influence the number of quarters in which the single-sample limits are exceeded.

Inspection of the available data for 1977-2003 for the surf zone areas adjacent to these creeks also shows that rarely do any of the indicator bacteria reach numbers above the single-sample standard. Even when the water flows from the least developed of the watersheds, substantial numbers of quarters have means that are above the single-sample standard. This may be due to the fact that in all watersheds the contribution of indicator bacteria from the feces of natural animal populations is quite substantial. This suggests that further development of the watersheds in this area will not necessarily result in increased input of indicator bacteria into the ocean. The BMPs in use for the Crystal Cove Development may even decrease the numbers of these bacteria now entering the ocean. These are important results concerning the numbers of indicator bacteria in
relation to grading, soil stockpiling and construction, and to levels of development in the watershed. They also are particularly significant as they relate to bacterial input and levels in the adjacent marine environment of the Newport Coast.

4.3 General Conclusions

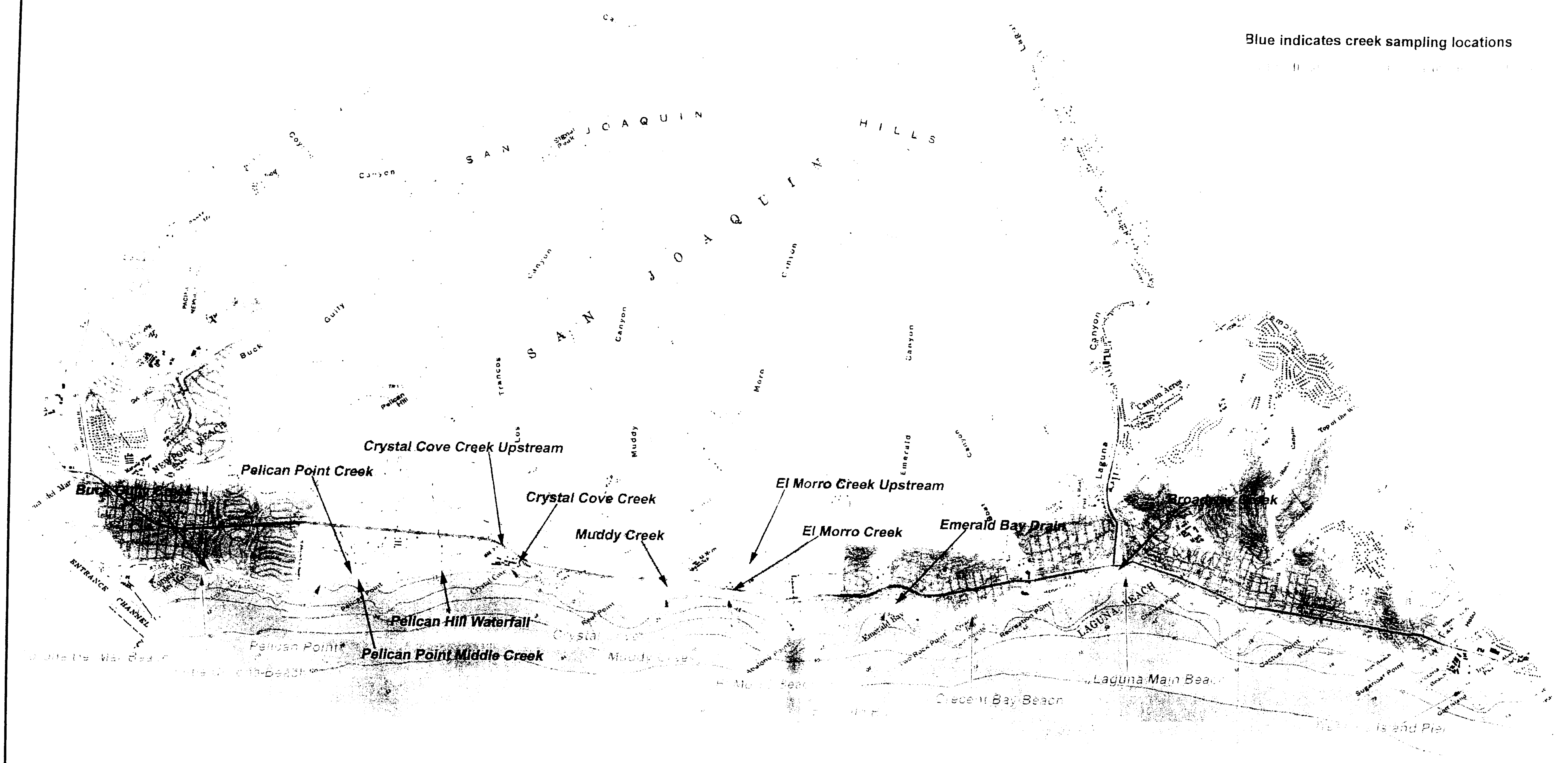
The percentages of samples containing numbers of fecal coliforms and enterococci above the single-sample standard were approximately the same at downstream locations in Los Trancos, Muddy, and Emerald Creeks. Seawater in the surf zone at all three sites rarely had levels of indicator bacteria above the single-sample limits, and those numbers were predominantly <10/1000ml at all surf zone locations sampled. Numbers of these indicator bacteria became elevated in the surf zone for a very short time during storm runoff, but returned to low levels soon afterward. In addition, levels of these bacteria at the inshore, subtidal stations were always low. These effects are produced in part through the action of nearshore physical processes and also are due to the poor survival of enteric bacteria in seawater. All of this evidence indicates that bacterial levels in storm runoff would have no adverse effects on natural marine water quality or marine organisms of the Irvine Coast ASBS.

An evaluation of historical data indicated that there was no apparent relationship between grading, soil stockpiling and construction activities and numbers of indicator bacteria near the mouth of Muddy Creek. Another comparison of historical data for six watersheds of approximately the same size, including Los Trancos, Muddy and Emerald Canyons, indicated that their degree of development had no discernible effect on the number of quarters in which single-sample limits for number of indicator bacteria were exceeded. These also are significant results as they relate to bacterial levels in the watersheds and in the adjacent marine environment.

FIGURE 4.1

Sampling stations employed in the Bacteriological Monitoring Program of the Orange County Health Care Agency. Freshwater and surf zone sampling locations employed in this dry weather monitoring are indicated by the color key.

Blue indicates creek sampling locations



Source: USGS 7.5' Topographic Series, Newport Beach Quadrangle

NOTE: Sampling locations are approximate.

COUNTY OF ORANGE SAMPLING STATIONS FOR BACTERIOLOGICAL INDICATORS

No Scale

5.0 INTERTIDAL AND SUBTIDAL MARINE ECOLOGICAL STUDIES

5.1 Introduction

As part of the monitoring project during the period 2000-2003, extensive, quantitative marine ecological studies were conducted before and after storms. These studies were performed in order to evaluate possible effects of storm and dry weather runoff on intertidal and shallow subtidal marine invertebrate animals and plants. The results of the associated water quality studies were employed in the evaluation process. The results for 2000 were described and evaluated by Ford et al (2003a-c). The marine ecological data for 2001 and 2002-2003 are currently being processed and will be produced in final report form during 2004. Some of the data from the 2002-2003 study are considered in this section for the purpose of long-term comparisons.

Two separate approaches were employed. The first involved quadrat sampling of the rocky intertidal and subtidal reefs to obtain quantitative data per unit are on species composition, percent of the rock surface occupied by each species or taxon, and the number (density) of individuals for most non-colonial species. The second involved quantitative studies of epiphytes and animal epiobionts living on blades of the surf grass, *Phyllospadix torreyi*. The methods used in the latter study were essentially the same as those described for the earlier epiphyte studies (see Sections 2.2 – 2.4 of this summary report and Ford 1995, 1997).

5.2 Results and Discussion Concerning Intertidal and Subtidal Quadrat Sampling Studies

Quantitative ecological field studies were conducted by taking photographic quadrat samples in the rocky intertidal reef habitats adjacent to the mouths of the three watersheds (Stations LT-l, MC-1, and EC-1). The primary purpose of this work was to compare specific ecological characteristics before and at a series of time periods after rainfall at each site, in order to evaluate possible impacts of storm water runoff. These comparisons were made among the three sites. This sampling was conducted prior to the beginning of the rainfall season. It was then repeated at two intervals of approximately 30 and 60 days after each major storm event sampled for evaluation of water quality (Ford et al 2003a-c). This allowed shorter and longer-term evaluations of possible runoff effects.

Four different, important species groups and habitats of rocky intertidal invertebrates and algae were sampled, using a 0.1 sq m stainless steel ring quadrat. They were the aggregating sea anemone (*Anthopleura elegantissima*) and associated species, the California mussel (*Mytilus californianus*) and associated species, small tide pools containing the solitary sea anemone (*Anthopleura sola*) and associated species, and algal turf species. In addition, the barnacle species *Balanus glandula*, *Chthamalus dalli* and *C. fissus* were sampled by using a smaller square quadrat of 100 sq cm. Eight or more replicate samples of each species group described above were taken at each of the three intertidal stations on a given sampling date. The species evaluated in these intertidal studies are listed in Table 5.1.

Template quadrat samples were employed for groups of aggregating sea anemones (*Anthopleura elegantissima*) and California musssels (*Mytilus californianus*). Five or more replicate sample sites for each species were established at each of the three intertidal reef stations by setting marker pins in the rock surface. These same specific template quadrat sites were sampled photographically each time ecological sampling was conducted at the station, usually 6-8 times per season. This produced a record of pre-and post-storm samples showing the same groups of individuals over the course of each storm season and also over a four-year period.

The results of all of these studies for 2000-2003 indicated clearly that there were no significant or even evident ecological effects on these species that could be related to runoff from the storm events of 2000-2003 or from dry weather flows of 2000-2001 (Ford et al 2003c). Because of very low rainfall during the season of 2001-2002, no water quality or marine ecological studies were conducted.

For example, template quadrat data from the 2000-2001 and 2002-2003 rainfall seasons were evaluated for the aggregating sea anemone and the California mussel. The results indicate very clearly that there were no major changes in percent cover of these two indicator species from pre-storm conditions through the different post-storm periods of the rainfall season. This is the same result described for 2000 by Ford et al (2003c). In addition, the percent cover values were very similar for both species in all three years. This indicates that both indicator species remained relatively constant in dominance and abundance at the template quadrat sites, and provides direct evidence that there were no effects on them from storm runoff.

Similarly, there was little change in the mean abundance of California mussels at each site sampled randomly in 1999-2000 (Ford et al 2003c), and again in 2000-2001 and 2002-2003. Comparisons of the mean percent cover values of other indicator species, including barnacles, aggregating sea anemones, solitary anemones and algal turf components, indicated that they were not significantly different at a given site between 1999-2000, 2000-2001, and 2002-2003. This high degree of ecological stability is another significant indication that there were no adverse effects of storm runoff on the Irvine Coast ASBS.

Ecological field sampling was conducted on rocky reefs at Subtidal Stations LT-2, MC-2, and EC-2 (Ford et al 2003c). The timing of these pre-and post-storm samples was essentially the same as that for the intertidal samples. The primary indicator species employed in these subtidal studies were the gold sea fan *Muricea californica*, the red sea fan *Muricea fruticosa* and the erect coralline algae *Corralina vancouverensis*, *Jania crassa*, and *Lithothrix aspergillum*. The species evaluated in the subtidal studies are listed in Table 5.2.

The evidence from these studies of subtidal invertebrate and algal indicator species shows very clearly that runoff from storms and dry weather flows had no evident or significant effects on them during the period 2000-2003. It also seems unlikely that other species in this shallow subtidal habitat would be affected. This might be expected, because the nearshore physical processes acting on freshwater runoff entering the ocean contain, mix and disperse the low salinity water and runoff constituents very rapidly

Comparable data for sea fans and coralline algae from subtidal samples taken in 2002-2003 showed essentially the same results. As for the intertidal data, there was a relatively high degree of consistency in results from one year to another. It is further, substantial evidence that there were no adverse ecological effects of storm runoff on nearshore subtidal habitats of the Irvine Coast ASBS.

5.3 Results and Discussion Concerning Studies of Algal Epiphytes and Animal Epibionts Living on Surf Grass

The surf grass *Phyllospadix torreyi* is known to be an important feature of lower rocky intertidal and shallow subtidal habitats in southern California. In addition, it is an important host plant for many algal epiphytes and for some animal epibiont species. This was confirmed for surf grass along the Newport Coast in studies reported by Ford 1995, 1997.

The expectation is that if nutrient chemical concentrations in the nearshore ocean increase as the result of storm runoff, or from other sources, then the presence and percent cover of algal ephiphytes on *P. torreyi* would increase in response, in essentially the same way that lawn grass grows and spreads faster after fertilizer applications. To the extent that this response is not observed, it is an indication that excess nutrient concentration were not present or did not persist sufficiently to change natural conditions. It is important to note that animal epibionts do not show this response to nutrients. This was tested by obtaining quantitative percent cover data for epiphyte and animal epibiont species living on samples of surf grass taken at the six intertidal and subtidal reef stations. The laboratory methods were the same as those described by Ford (1995).

As for the 1995-1997 studies on the Newport Coast (Ford 1995, 1997), *Melobesia mediocris* and *Smithora naiadum* were the dominant red algal epiphytes on surf grass. *Laurenceia* spp and the brown alga *Leathesia nana* also were present on the blades. The dominant animal epibionts were the bryozoans *Diaperoecia californica* and *Membranipora tuberculata*, as in the previous studies. In general, the percent cover values also were lower than those reported by Ford (1995, 1997). These results may reflect differences in site characteristics or year-to-year differences in epiphyte abundance.

The data for algal epiphytes on intertidal and subtidal *Phyllospadix torreyi* were difficult to interpret because of low and variable mean percent cover estimates. However, there is no evidence to indicate that nutrient chemicals in runoff from storms or dry weather flows affected these percent cover values. Furthermore, there is no evidence to suggest that water quality conditions associated with storm water runoff had any direct effect on the animal epibionts of *Phyllospadix torreyi*. The changes in percent cover of both the algal epiphytes and animal epibionts likely were the result of natural conditions in combination with sampling variability. They would be expected, considering the relatively low concentrations of nutrient chemicals measured for all storm and dry weather samples during the period 2000-2003 (Ford et al 2002, 2003b, 2004b).

5.4 General Conclusions Concerning Ecological Studies

All of the evidence discussed in this section concerning data from quadrat sampling indicates that there were no evident or significant adverse effects of runoff from storms or dry weather flows on intertidal invertebrate species during the period 1999-2003. This result is not surprising, given the low concentrations of chemical constituents reported for these intertidal and subtidal stations during and following storm runoff of 1999-2003 and from nuisance flows that occurred in 2000-2001.

Similarly, evidence for subtidal invertebrate and algal species used as representative indicators shows very clearly that runoff had no evident or significant effects on them. It also seems unlikely that other species in this shallow subtidal habitat would be affected. This might be expected, because the nearshore physical processes acting on freshwater runoff entering the ocean contain it within the surf zone and mix and disperse the low salinity water and runoff constituents very rapidly.

The results of the ecological studies suggest that there have been no discernible changes in natural marine environmental conditions due to development. Water quality in the Irvine Coast Marine Life Refuge Area of Special Biological Significance clearly is sufficient to support natural communities of marine organisms.

All of the data obtained from intertidal template quadrat sampling of aggregating sea anemones, California mussels, and associated sessile organisms indicate very clearly that there were no evident or significant effects on them caused by runoff from storms or dry weather flows. This result would be expected, considering the results of the water quality studies concerning this runoff reported for the 1999-2003 period.

The data for algal epiphytes on *Phyllospadix torreyi* in intertidal and subtidal habitats were difficult to interpret because of low and variable mean percent cover estimates. However, there is no evidence to indicate that nutrient chemicals in runoff from storms or dry weather flows affected these percent cover values. In addition, there is no evidence to suggest that water quality conditions associated with storm water runoff had any direct effect on the animal epibionts. The changes in percent cover of both the algal epiphytes and animal epibionts likely were the result of natural conditions in combination with sampling variability.

TABLE 5.1

Intertidal Master Species List

Invertebrates:

CNIDARIA
- ANTHOZOA
  - *Anthopleura elegantissima* (aggregating anemone)
  - *Anthopleura sola* (solitary anemone)

ANNELIDA
- POLYCHAETA
  - *Dodecaceria fewkesi* (clustered calcareous tube worm)
  - *Phragmatopoma californica* (sand tube worm)
  - *Serpula vermicularis* (white calcareous tube worm)

MOLLUSCA
- GASTROPODA
  - *Acanthina spp.* (unicorn/driller snail)
  - *Collisella spp.* (smaller limpet; mostly *C. scabra*)
  - *Littorina spp.* (periwinkle)
  - *Lottia gigantea* (owl limpet)
- POLYPLACOPHORA
  - *Nutallina californica* (chiton)
- BIVALVIA
  - *Mytilus californianus* (California mussel)

ARTHROPODA
- CRUSTACEA
  - *Balanus glandula* (gray barnacle)
  - *Cthamalus dalli & C. fissus* (little barnacle)
  - *Pollicipes polymerus* (leaf barnacle)
  - *Pachygrapsus crassipes* (lined shore crab)

ECHINODERMATA
- STELEROIDEA
  - *Pisaster brevispinus* (pink sea star)
- ECHINOIDEA
  - *Strongylocentrotus purpuratus* (purple urchin)

Algae:

CHLOROPHYTA (green algae)
- *Cladophora spp.*
- *Codium fragile*
- *Enteromorpha spp.*
- *Ulva spp.*

PHAEOPHYTA (brown algae)
- *Colpomenia sinuosa*
- *Dictyota spp.*
- *Sargassum spp.*
- *Cylindrocarpus rugosus*
- *Laminaria spp.*
- *Egregia menziesii*
- *Ralfsia spp.*

RHODOPHYTA (red algae)

Erect Corallines
- *Corallina spp.* (mostly *C. vancouveriensis*)
- *Lithothamnion spp.*
- *Jania crassa*
- *Lithothrix aspergillum*

Erect Non-coralline
- *Centroceras clavulatum*
- *Ceramium spp.*
- *Coelosiera compressa*
- *Gelidium spp.*
- *Laurencia spp.*
- *Pterocladia capillacea*

Filamentous
- *Endocladia muricata*

TABLE 5.2

Subtidal Master Species List

Invertebrates:

CNIDARIA
  ANTHOZOA
    Anthopleura sola (solitary anemone)
    Muricea californica (gold sea fan)
    Muricea fruticosa (red sea fan)

ANNELIDA
  POLYCHAETA
    Serpula vermicularis (white calcareous tube worm)

MOLLUSCA
  GASTROPODA
    Tegula spp. (subtidal snail)
    Kelletia kelletii (Kellet's whelk)

ARTHROPODA
  CRUSTACEA
    Pachygrapsus crassipes (lined shore crab)

ECHINODERMATA
  STELEROIDEA
    Patiria miniata (bat star)
    Pisaster brevispinus (pink sea star)
    Pisaster giganteus (giant sea star)
  ECHINOIDEA
    Strongylocentrotus purpuratus (purple urchin)
    Strongylocentrotus franciscanus (red urchin)
  HOLOTHUROIDEA
    Parastichopus californicus (sea cucumber)
    Parastichopus parvimensis (sea cucumber)

Algae:

RHODOPHYTA (red algae)
Erect Corallines
  Corallina vancouveriensis
  Jania crassa
  Lithothrix aspergillum

PHAEOPHYTA (brown algae)
  Dictyota spp.
  Sargassum aghardianum
  Laminaria farlowii
  Egregia menziesii
  Macrosystis pyrifera

6.0 CONCLUSIONS REGARDING POTENTIAL IMPACTS OF THE PROPOSED PELICAN HILL RESORT PROJECT ON THE MARINE ENVIORNMENT OF THE NEWPORT COAST

The studies described in this summary report show quite clearly that storm runoff and earlier dry weather low flows from both the Pelican Hill Golf Course and the Crystal Cove Development have had no significant or measurable adverse effects on water quality or marine organisms in the adjacent marine environment of the Newport Coast. The results suggest that the extensive complement of BMPs employed as part of the golf course operations and of the Crystal Cove Development have been very effective in preventing such adverse effects by controlling water quality and flows of runoff water before they reach the ocean.

Review of the state-of-the-art "treatment train" of BMPs proposed for the Pelican Hill Resort Project indicates that these design features will be even more effective in containing and controlling storm and dry weather runoff from those Project sites. Particularly significant are the proposed on-site containment of runoff from rainfall of less than 1.4 inch, and capture and re-use of storm water runoff and nuisance flows by employing cisterns and golf course water bodies. These methods, described in Section 1.2 and by GeoSyntec (2004a), will be quite effective in controlling runoff flows to the ocean and infiltration rates at or near their existing levels. In addition, the use of catch basin inserts, bio-filtration areas and other proposed water quality design features will prevent runoff constituents from reaching the nearshore ocean in concentrations that would affect natural water quality or be of ecological concern.

The natural nearshore processes that act on runoff water entering the surf zone are an important back-up element in the process. To the extent that runoff constituents from the Project sites or from adjacent areas might reach the surf zone, they would be substantially contained, assimilated, and carried away from points of runoff entry quite rapidly. This is because of the containing action on inflowing runoff within the surf zone by the very substantial energy of the storm waves, the heavy surf and surge effects present there, the movement offshore of rip currents, as well as the movement of strong longshore currents and tidal flow. These are particularly important physical characteristics, because they assure that freshwater runoff and all of its constituents are assimilated without change in natural water quality. These beneficial, natural effects are quite obvious in the results of the studies conducted on the Newport Coast during the rainfall seasons as monitored from 1993-2003.

All of this evidence indicates very clearly that storm runoff and nuisance flows from the proposed Pelican Hill Resort Project sites would not change the ocean water quality of the Newport Coast. Nor would natural water quality conditions in the ASBS be changed or adversely affected, as water quality constituents would remain well within the characteristic ranges for these constituents. Because of this, there would be no measurable effects on the marine organisms and habitats of the Irvine Coast Marine Life Refuge Area of Special Biological Significance.

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