Best Management Practices Plan

for

Del Monte Forest Preservation and Development Plan – Golf Course, Equestrian Center, and Driving Range

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Prepared for:

Pebble Beach Company
P.O. Box 1767
Pebble Beach, CA 93953

January 21, 2003

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Del Monte Forest Preservation and Development Plan
Golf Course, Equestrian Center, and Driving Range

Monterey County, California

Prepared for:

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SECTION 1

EXECUTIVE SUMMARY

This report presents a water quality assessment and environmental management plan for the development of a proposed golf course, an equestrian center, and a driving range by Pebble Beach Company. The proposed facilities are part of the Del Monte Forest Preservation and Development Plan. The proposed golf course site (Area MNOUV) is bounded generally by Stevenson Drive and Forest Lake Road to the east, Ondulado Road and Portola Road to the south, and Cypress Point and Spyglass Hill golf courses to the west and north, respectively. In addition to the golf course, the 216-acre site would also include a clubhouse, a maintenance facility, and 11 golf cottages. The existing equestrian center currently located on the site of the proposed golf course would be relocated to an approximately 45-acre site just south of the Congress Road and S.F.B. Morse Drive intersection. The site of the new equestrian center is a former sand mining site in the Gowen Cypress planning area. The new equestrian center will include event rings, a covered arena, staff housing, a camper dormitory, stalls, a hay barn, and parking areas, in addition to a large open space/event area and preservation areas. The proposed driving range will be located near existing Spanish Bay golf course on a 29-acre parcel bounded by Congress Road and Majella Road (Area C). The plan also includes other components not reflected in this report, most notable of which is the permanent preservation of several hundred acres of existing forest within the Del Monte Forest.

The information presented in this report is a combined effort incorporating the results of field studies, engineering, and environmental analysis provided by the following consultants:

- Balance Hydrologics, Inc.
- Environmental & Turf Services, Inc.
- Haro Kasunich
- Nielsen & Associates
- Questa Engineering Corporation
- Wetlands Research Associates, Inc.
- WWD Corporation
- Zander & Associates

This analysis identifies and evaluates both surface and groundwater quality and quantity issues associated with the proposed golf course, equestrian center, and driving range, focusing specifically on the issues described below.

Construction Activities

Construction of the proposed facilities will require general site grading earthwork for roads and parking, pipelines, golf course facilities, and associated structures. Because of the generally sandy soils and wetland resources in the immediate area of portions of the project, construction work and project design must pay careful attention to potential soil erosion hazards. Potential soil erosion and sedimentation problems are always greatest during and immediately following construction, when soil surfaces are bare. However, timely establishment of turfgrass, native grasses, drainage improvements, and other measures can be very successful in controlling erosion such that the resulting annual soil losses associated with the project should be no greater, and possibly significantly less, than under existing conditions. Construction-related erosion and sedimentation will be mitigated by the implementation of an Erosion Control Plan, which will include a monitoring program to ensure that the recommended best management practices are utilized. The plan will be site-specific, and will conform to Monterey County drainage and erosion control standards. The applicant will also obtain applicable permits related to the National Pollutant Discharge Elimination System (NPDES), including the development and implementation of a Storm Water Pollution Prevention Plan for control of construction-related pollutants. After construction is completed, all erosion control elements will be regularly maintained.

Drainage and Runoff

The development of the proposed facilities will change the rainfall-runoff conditions for the project site. Approximately 6.3 acres of impervious surface will be created at the new equestrian center, while a net decrease of 2.2 acres of impervious surface will occur at the proposed golf course. The driving range at Spanish Bay will add 4.23 acres of impervious area. The construction of buildings, roads, parking areas and other impervious surfaces will increase runoff rates. However, the proposed runoff collection and storage facilities will fully mitigate this increased runoff. To manage the increased peak runoff, each development area will utilize various detention-retention systems, including underground pipe storage infiltration facilities and small detention basins. Water from the detention/retention facilities will be released into grassed swales or storm drains, which flow into local drainage courses and eventually into existing outfalls that discharge into the Pacific Ocean. Pebble Beach Company will own, operate, and maintain all drainage facilities. As required by Monterey County, the detention facilities will be designed to store the difference between the peak 100-year post-development runoff volume and the peak 10-year pre-development volume, with release rates no greater than that of the 10-year pre-development peak runoff volume. Application of Best Management Practices (BMPs) as well as the natural topographic and geologic characteristics of the site will limit sediment and nutrient transport off-site. The BMPs will include the use of buffer areas, native grass-lined drainage swales to disperse runoff from paved areas, oil and grease/sediment traps from vehicle parking areas, detention basins, and subsurface infiltration galleries and sediment detention structures in selected well-drained areas.

Irrigation with Reclaimed Water

The golf course will be irrigated principally with reclaimed water supplied by the CAWD/PBSCD Wastewater Reclamation Project owned and operated by the Carmel Area Wastewater District and the Pebble Beach Community Services District, with a small amount of make-up from the potable supply.

Until planned improvements to the Reclamation Project are completed, the recycled water will contain a moderate to high load of salts and sodium (from a landscape irrigation perspective), substantial nutrients (N), but relatively little metals. Turf irrigation will be tightly managed to prevent adverse salt build-up in the surface soils and leaching of the irrigation percolate (potentially containing dissolved constituents inherent in the water supply and applied agrochemicals). Various practices will be employed for salt management, beginning with selection of appropriate turfgrasses, periodic flushing of salts from the root zone with potable water, and possible application of acidifying materials through the irrigation system for pH adjustment. Based on a salt loading analysis, the resultant total dissolved solids (TDS) concentrations in the adjacent wetlands are not expected to vary by more than about 10 percent from existing conditions, with increases of about 5 percent or less likely to occur once the regional plans for reverse osmosis (RO) treatment of the reclaimed water source are implemented.

The nutrient (nitrate) content of the reclaimed water will supply a portion of the turfgrass nitrogen needs; this will reduce the amount of fertilizer used, as well as the potential for nitrate losses to groundwater or site runoff. The irrigation system will employ state-of-the-art control equipment to ensure efficient distribution and conservation of water. It will also include all required design features and operational measures to ensure compliance with State Water Recycling Criteria for public health protection.

Golf Course Fertilizers

Golf course fairways and greens are fertilized regularly, but typically at much lower rates during the rainy season. Nitrogen is the primary fertilizing agent and is of potential water quality concern for the adjacent seasonal wetlands and downstream surface waters. The groundwater in the project area does not have existing or potential uses as a drinking water source because of its limited occurrence and relatively poor mineral quality. The most important aspect of the groundwater is its contribution to the support of several seasonal wetlands. The quality of these wetlands and their associated biological populations could be adversely affected by nutrients from the golf course fertilization practices. BMPs for turf management will be implemented to protect the wetlands against adverse nutrient effects.

The greatest concern is that applied nitrogen fertilizers may be transported by surface runoff before they are absorbed and utilized by the vegetation. Leaching of excess nitrogen into the shallow groundwater is another potential pathway for nutrients to reach the adjacent wetlands. Management factors such as proper application rates, timing, the form of application, and amount of irrigation will be monitored to reduce the likelihood of runoff and seepage losses. The final golf course design and operation will minimize the opportunity for runoff of fertilizer residue by using vegetated buffers along with detention-treatment ponds in selected areas. Measures to minimize fertilizer transport include monitoring of fertilizer application rates (including the contribution from recycled water), use of slow release nitrogen, and computerized sensing to optimize irrigation applications.

A nitrogen loading analysis has been completed for one of the more sensitive sub-basins within the proposed golf course site, where existing wetlands have the greatest potential to be impacted. The results indicate that the combination of proposed management practices and the natural assimilative capacity of the native buffer areas (in terms of soil denitrification and vegetative uptake) is sufficient to maintain nitrogen concentrations at or below background levels. The wetlands water quality near the proposed golf course site is presently impacted in certain areas by nitrogen inputs from the equestrian center and a network of horse trails that will be relocated as part of the project. Water quality conditions in these impacted areas will improve as a result of the conversion from equestrian uses to the proposed golf course. Management practices to protect the wetlands adjacent to the golf course and new equestrian center will also afford a high level of protection against off-site impacts in downstream areas and the Pacific Ocean. The existing conditions at the proposed golf course site are highly impacted and not natural, due to the existing equestrian uses, trails, roads, and driving range located on the site. Management and construction practices to protect the wetlands located on the proposed site will also afford a high level of protection against offsite impacts in downstream areas, the Carmel Bay ASBS, and the Monterey Bay Marine Sanctuary.

Pest Management

Various technologies are typically used by golf courses to control or reduce the adverse effects of pests. Close mowing and poor management favor the occurrence of infectious diseases. These problems will be minimized by use of good cultivation practices (irrigation and mowing) and use of disease-resistant turfgrasses. Pesticides should be applied selectively based on scientific monitoring and will be applied much less frequently than fertilizers. The pesticides tentatively identified for use have been carefully screened and are neither highly mobile nor persistent, to minimize impact to non-target vegetation as well as to surface and groundwater.

Golf course irrigation will be controlled to ensure efficient and minimal watering, to minimize runoff from the site, and to reduce the potential for pesticides, fertilizers, and reclaimed water constituents to be transported to the adjoining wetlands or off-site areas.

Important elements of the proposed golf course operation are the fertilizer and pest management practices incorporated in this overall Best Management Practices (BMP) Plan. These detail the procedures to construct and maintain chemical storage, mixing, and handling areas, as well as information on actual application use and disposal. The document provides technical public disclosure regarding pesticides, fertilizers, and other chemicals to be used on the golf course, as well as methods of application and handling. It includes key water quality protection provisions, such as the use of untreated vegetated buffers and treatment areas, vertical separation between greens and localized, shallow seasonal groundwater, and use of subsurface drainage to collect excess runoff and trap pollutants. Measures to minimize pesticide impacts include application by a licensed Pesticide Applicator in accordance with all applicable laws, use of proper equipment and preparation in a controlled and designated area, selection of less toxic, less mobile, and less persistent pesticides where possible, appropriate timing and scheduling, and buffering to avoid application in identified sensitive areas.

A quantitative Risk Analysis will be completed for all pesticides proposed for use on the golf course at the time of initial construction and will be updated in the future as needed. The Risk Analysis will be submitted to the appropriate agencies for review.

Emerging Technologies

Final project design will consider and, as their effectiveness is demonstrated, employ new and emerging technologies to provide effective and safe environmental and landscape management. These may include, for example, use of a BioJect fermentation unit, which is attached to the irrigation system. The BioJect injects live, naturally occurring soil bacteria (*Pseudomonas aureofaciens, Bacillus thuringensis* and other microbial agents) into the soil, which aids in control of leaf pathogens in turfgrass. The golf course is committed to being at the cutting edge regarding application of new and emerging technologies that minimize the use of broad-spectrum synthetic chemicals in favor of ecologically based management using cultural and biological controls and selective, narrow-spectrum pesticides.

CONCLUSIONS

All of the potential environmental impacts that might be generated by the development of the proposed project can be mitigated by implementation of certain design, construction, and on-going landscape management measures as called for within this report.

Following construction of the golf course, the predicted level of total dissolved solids (TDS) and nitrogen concentration in the shallow groundwater zone and wetlands located downstream of the proposed golf course site will not vary significantly from background conditions. Water quality conditions in portions of the adjacent wetlands that are currently impacted by animal wastes are likely to improve due to the elimination and relocation of the existing equestrian center and horse trails in favor of the proposed golf course, with the planned use of native vegetative buffers and other water quality management practices. The pesticides tentatively identified for use have been selected based generally on their low persistence and mobility in the environment and will not migrate off-site in detectable amounts. With respect to surface water runoff, the project will include detention storage measures designed, in accordance with Monterey County standards, to store the difference between the peak 100-year post development runoff volume and the peak 10-year pre-development volume, with release rates no greater than that of the10-year pre-development peak runoff volume.

SECTION 2

ENVIRONMENTAL MANAGEMENT PRINCIPLES

BEST MANAGEMENT PRACTICES

Golf courses, like many land use activities, represent potential non-point (i.e., diffuse) sources of water pollution. "Non-point" pollution is that primarily associated with rainfall-runoff or percolation into the ground; it is distinguished from "point" sources of pollution, which are the discrete discharges from municipal, or industrial wastewater treatment facilities.

Primary pollution concerns associated with a golf course (or driving range) operation include: (a) soil erosion from grading activities, (b) nutrient (mainly nitrogen) loading from fertilizer applications, (c) leaching or runoff of pesticide residues, and (d) washoff of oil and grease and other residue from roads, parking and maintenance areas. While fertilizer and pesticide use is not a concern at an equestrian center, animal wastes represent potential non-point sources of nitrogen and bacteriological pollution that require careful management and control.

The widely accepted approach to dealing with non-point source pollution is through the implementation of "Best Management Practices (BMP)," which is defined as "... any program, technology, process, siting criteria, operating method, measure or device which controls, prevents, removes, or reduces pollution" (Camp, Dresser, & McKee, *et al*, 1993).

Best Management Practices can be implemented at three levels: site design, source control, and treatment control. Site design BMPs are incorporated directly into the design of the golf course, equestrian center, and driving range; these BMPs essentially establish a land use pattern that will complement other BMPs. Source control BMPs focus on managing pollution sources by preventing or limiting constituents of concern from being released into the environment. Treatment control BMPs are used to remove or reduce the constituents once they have been released into the environment. Although source control BMPs are more effective, treatment control BMPs are necessary, since even the most aggressive source control programs cannot guarantee that constituents of concern will not be carried off-site. Best Management Practices at each level will be incorporated into the proposed golf course site, the new equestrian center, and the Spanish Bay Driving Range and will be applied to preserve and maintain the hydrology of existing wetlands.

Following are some of the key BMPs that have been incorporated into the design and operation plan for the proposed facilities to mitigate potential water quality impacts and maintain wetland hydrology.

- **Native Vegetated Buffers.** Native vegetated buffers will separate the maintained golf course and driving range turf areas from the seasonal drainage channels and the adjacent wetland areas. These will utilize grasses and forbs native to the area. The vegetated buffers provide a catchment area for settling, filtering, and uptake of fertilizer or pesticide residue that may be carried from the turf area by runoff.

- **Vegetated Filter Strips and Bioswales.** Site runoff will generally be directed through native grass-lined, permeable drainage swales, and vegetated filter strips in most cases, in lieu of direct piping to one of the existing seasonal drainage channels. The vegetated swales will also retard flow, reducing peaking effects normally associated with development. Any appreciable subsurface drainage intercepted from the golf course may also be discharged into buffer areas for filtration, infiltration, and recycling of this water to vegetated areas of the site.

- **Detention Basins.** Detention basins will be incorporated to attenuate increases in peak flows associated with the development of the project, for protection against flooding, erosion, or other damage to downstream areas, and to provide for treatment of runoff in selected areas. The detention basins will be sized according to Monterey County guidelines to detain the difference between peak 100-year post-project runoff and peak 10-year pre-project runoff, with release rates no greater than the pre-development 10-year peak discharge. Detention basins incorporated into the final plans may include both "dry" and "wet" basins to achieve different treatment design objectives in different areas of the site.

- **Oil and Grease/Silt Traps.** Oil and grease/silt traps will be installed at the parking lots and golf course maintenance facility to intercept and contain oily residue and debris washed from vehicle areas, before dispersal to the grassed swales or other drainage features.

- **Washwater Recycle System.** A wastewater collection, treatment, and recycle system will be installed at the golf course maintenance area to collect and remove pollutants from the washdown of mowers and other equipment; the system will recycle the washwater for continual use.

- **Sub-Surface Drains.** Subsurface drains from beneath tees, greens, and sand traps will be dispersed to the vegetated buffer areas for filtering and absorption of any nitrate or pesticide residue. Additionally, sub-drains will be employed, as needed, to intercept and convey high saline groundwater to appropriate downstream release points in areas where grading activities may affect the natural groundwater flow regimes.

- **Drainage Diversion.** A limited amount of drainage diversion will be employed at the proposed golf course site to reroute (to the north) runoff that currently flows from the Collins Field/equestrian center Areas into the Carmel Bay ASBS (Area of Special Biological Significance), to protect this highly sensitive receiving environment.

- **Animal Waste Management.** Animal wastes at the new equestrian center will be controlled through a combination of design and source control measures aimed at containing, covering, and removing wastes to avoid contact and washoff with rainfall runoff.

- **Fertilizer Control Measures.** The following management practices will be incorporated to minimize the transport of fertilizers from the golf course and driving range into local drainages, seasonal wetlands, and downstream receiving waters, as well as to minimize nitrate additions to groundwater.

    1. Application rates of fertilizers will be monitored closely and adjusted as necessary to not exceed the turfgrass assimilation capacity. This will include testing of the soils and plant tissue under the tees, greens, and fairways periodically (two to three times

per year) to determine proper nitrogen application rates and to monitor any potential excess nitrogen buildup within the soil.

2. The nitrogen fertilizer will be the slow release or less soluble form, whenever possible.

3. Nitrogen content of the reclaimed water will be monitored and accounted for in the development of fertilizer recommendations.

4. The timing of fertilizer application will be planned to coincide with the period of greatest plant uptake and will avoid periods of potential rainfall-runoff events.

- **Pesticide Control Measures.** The following management practices will be incorporated to minimize the use and potential release of pesticides into surface waters or groundwaters.

1. Pesticides will be handled, applied, and disposed of by a licensed spray technician.

2. Only approved and legal chemicals will be used. All county, state, and federal guidelines will be strictly adhered to regarding storage, handling, and application of pesticides.

3. Only proper equipment will be used for application. This equipment will be maintained and in proper calibration.

4. A controlled and designated area/facility will be used for the proper mixing and loading of pesticides into application equipment.

5. Selection of pesticides will be based on the ability to achieve treatment goals and criteria to minimize off-site movement. Selection of less toxic, less mobile, and less persistent pesticides will be a priority management criterion.

6. Pesticide applications will be carefully timed and combined with other pest management practices; pests will be accurately identified and pesticide applications made only when necessary, using the least amount required.

7. Pesticides will not be applied when soil moisture is high during the rainy season. Applications will be restricted prior to any anticipated late or early season storm events to preclude potential impacts from runoff. To avoid drift problems to adjacent natural areas, pesticides will not be applied on windy days.

INTEGRATED PEST MANAGEMENT

Pest management is a very important aspect of golf course operations and water quality protection and has been addressed through Integrated Pest Management (IPM) techniques which have been incorporated into this plan as a BMP. IPM is an ecologically based pest management strategy that provides long-term prevention or suppression of pest problems with minimum impact on human health, the environment, and nontarget organisms. IPM programs use knowledge about the biology of the pest and its relationship to the ecosystem. Chemicals selected for pest management are based on a screening review of pesticides that consider toxicity, persistence, runoff potential, and leachability. IPM practices include the selection of suitable plant species for the site, appropriate cultural and mechanical practices, use of biological controls, and a conservative approach to pesticide application. The aim is to maximize pesticide effectiveness with minimal application, using maintenance and monitoring to anticipate problems before they reach a crisis stage.

IPM programs rely on six basic principles for plant protection and vegetative management. These include the following:

1. **Regulatory** - using certified seed and nursery stock to prevent unwanted weed and disease contamination.

2. **Genetic** - selecting improved or adaptive native species that perform well in specific areas and show a resistance to pest problems.

3. **Cultural** - following recommendations made for primary and secondary cultural practices (i.e., time, height, method of mowing) that will maintain the site in the most healthy condition and influence its susceptibility to and subsequent recovery from pest problems.

4. **Physical** - cleaning equipment to prevent spreading of diseases and weeds from infected areas.

5. **Biological** - for a limited number of pest problems, biological control using naturally occurring soil bacteria will be considered as an alternative to chemical control. In biological control, natural enemies are introduced to effectively compete with the pest and reduce the need for chemical controls. The golf course may employ new and emerging technologies to provide effective and safe biological pest control. One such technology under consideration is the "BioJect" fermentation unit, which is attached to the irrigation system. The BioJect injects live, naturally occurring soil bacteria (*Pseudomonas aureofaciens*, *Bacillus thuringensis*, and other common microbial agents) into the soil, which aids in control of leaf pathogens in turfgrass. Other biological controls, including natural insecticides and herbicides derived from plants, are available and may also be used.

6. **Chemical** - the application of synthetic chemical pesticides are sometimes a necessary approach to pest control, but their use can be restricted in many cases to prescriptive rather than preventive applications. This can greatly reduce environmental exposure. Pesticide selection will be based on effectiveness, toxicity to non-target species, solubility, and persistence. Materials will be applied strictly in accordance with label instructions, at labeled rates (or less), under appropriate environmental conditions (i.e., no spraying on windy days or when rain is forecast), and with a low-volume sprayer to reduce the possibility of drift. Different chemicals may be rotated for use

on a particular disease or pest. This may help deter the development of resistant strains of pests, which might otherwise require more frequent and/or higher rates of pesticide applications.

A quantitative Risk Analysis will be completed for all pesticides proposed for use on the golf course at the time of initial construction and will be updated in the future as needed. The Risk Analysis will be submitted to the Agricultural Commissioner as part of the reporting requirements for pesticide use, and at the discretion of the Commissioner, will be subject to peer review by the UC Extension Service, Regional Water Quality Control Board (RWQCB), California Department of Fish and Game (DFG), or other qualified review authority.

SECTION 3

PROJECT SETTING AND SITE CONDITIONS

WATERSHED

Topography and Climate

The new facilities have been proposed by the Pebble Beach Company as part of the Del Monte Forest Preservation and Development Plan. The Del Monte Forest is located on the Monterey Peninsula between the Pacific Ocean and the Santa Lucia Mountains (see **Figure 3-1**) and includes dunes and areas of development (e.g., low-density luxury housing and condominiums, resorts, and golf courses). It generally consists of westward sloping Monterey pine forests with moderate underbrush and heavy duff. The mean annual precipitation on the Monterey Peninsula is about 20 inches, with most of the rainfall occurring from November through April (WRCC, 2002). Temperatures in the area range from an average high of 71.9ºF in September to an average low of 43.3ºF in January (WRCC, 2002).

<u>Proposed Golf Course Site</u>

The proposed golf course site is located on approximately 216 acres, bounded generally by Stevenson Drive and Del Monte Forest Lake Road to the east, Ondulado Road and Portola Road to the south, and Cypress Point and Spyglass Hill golf courses to the west and north, respectively (see **Figure 3-2**). The site has a topography that is moderate to steeply sloped along the east and north; the south, west, and central areas are generally flat to gently sloping.

<u>New Equestrian Center</u>

The proposed new equestrian center is located on a disturbed approximately 45-acre site adjacent to the northwest corner of the Huckleberry Hill Natural Habitat Area (see **Figure 3-3**). The site is topographically divided as a result of past quarrying activities. The upper portion of the site is in the southeast and slopes in a northwesterly direction. The steeper slopes in this area gradually transition into a flat area where small depressions are located. The lower portion of the site is bounded to the north, east, and south by steeper hillsides, and is generally flat to gently sloping.

<u>Spanish Bay Driving Range</u>

The proposed Spanish Bay driving range is located on a 29-acre parcel with flat areas and mostly gentle slopes. The site is bounded by Congress Road to the north and east, and by Majella Road and 17 Mile Drive to the west (see **Figure 3-4**).

Watershed Boundaries

The Del Monte Forest can be divided into five distinct watersheds, with a total of nine drainages (see **Figure 3-1**). The drainages comprise a total area of 4,588 acres, or 7.2 square miles. From north to south, the watersheds within the Del Monte Forest are: Moss Beach Watershed, Sawmill Gulch Watershed, Seal Rock Watershed, Fan Shell Watershed, and Carmel Bay ASBS Watershed. Five of the nine drainages (Pescadero Creek, Del Ciervo Creek, Stillwater East Branch, Stillwater West

Branch, and Pebble Beach Creek) discharge into the Carmel Bay, while the other four drainages (Fan Shell Creek, Seal Rock Creek, Sawmill Gulch, and Moss Beach) discharge directly to the Pacific Ocean. Carmel Bay is an Ecological Reserve encompassed by the Monterey Bay National Marine Sanctuary. The Moss Beach Watershed has no major drainage ways and drains northwest to the ocean. The Sawmill Gulch Watershed empties to Sawmill Gulch through a network of tributaries. The Seal Rock Watershed drains to the ocean through Seal Rock Creek and numerous tributaries. Fan Shell Watershed is relatively flat and drains west to the ocean via Fan Shell Creek, the only well-defined channel within the watershed.

Proposed Golf Course Site

The proposed golf course site is primarily located within the Fan Shell Beach Watershed, although disturbed areas around the existing equestrian center and Collins Field in the south portion of the site drain to the Carmel Bay ASBS Watershed. The majority of the proposed golf course site and upslope contributing areas currently drain through one of five subwatersheds ("Subwatersheds 1-5"), as shown in the *Phase One Hydrology Report* (Mallory *et al*., 2001; see **Figure 3-5**). The runoff is discharged to the existing storm drain system at Cypress Point Golf Course in the Fan Shell Beach Watershed. The rest of the project site drains to either the north or the south. The area that drains to the north (North Drainage) is the upslope area of a subwatershed that drains to Spyglass Hill Golf Course and eventually to Spyglass Beach. The area that drains to the south (South Drainage) comprises the headwaters of a subwatershed ("Subwatershed 4") that eventually discharges to the Carmel Bay ASBS. Under the proposed project, the small amount of runoff from the area of the existing equestrian center that drains to the Carmel Bay ASBS will be redirected into the Fan Shell Beach Watershed.

New Equestrian Center

The new equestrian center is located within the Sawmill Gulch Watershed. This watershed drains to Sawmill Gulch through a network of existing tributaries. The parcel drains via sheet flow to the northwest, through a large, man-made wetland area located on lower portion of the site.

Spanish Bay Driving Range

The Spanish Bay driving range is located in the Moss Beach Watershed. This watershed drains northwest to the ocean, though contains no major drainage ways. The parcel drains to both the southwest and northeast, with water flow occurring during rain events and possibly perennially during wet periods in a northwesterly direction to a drainage ditch along Majella Road.

Wetlands

Wetlands Research Associates (WRA) conducted an analysis of wetland habitats found within the Del Monte Forest for the Pebble Beach Company in July 2001 (Josselyn & Levine, 2001). According to this report, approximately 20 acres of natural and man-made wetlands are located within the Del Monte Forest watersheds. Three types of natural and man-made wetlands occur within the Del Monte Forest: (1) Palustrine Emergent/Forested, Seasonally Saturated, (2) Palustrine Emergent, Semi-Permanently Flooded, and (3) Palustrine Emergent, Semi-Permanently Saturated. The first type is found in drainage swales within the Del Monte Forest, and is primarily dominated by Pacific reedgrass (*Calamagrostis nutkaensis*), a facultative wetland grass. The second type of wetland is a freshwater marsh wetland that is ponded for a significant period of the winter; this type is dominated by various obligate rush species (*Juncus effuses*, *J. balticus*, and *J. xiphioides*), Pacific reedgrass, velvet grass (*Holcus lanatus*), tufted hairgrass (*Deschampsia caespitosa*), annual rabbitfoot grass (*Polypogon monspeliensis*), and European plantains (*Plantago coronopus* and *P. major*). The third type is located in groundwater discharge areas on hillslopes; this type of wetland does not have areas inundated by surface water. The dominant plant species of the third type of wetland include obligate rushes, slough sedge (*Carex obnupta*), Pacific reedgrass, and tufted hairgrass. Most of the wetlands are seasonal, with rainfall events creating localized seasonally wet soil that support herbaceous wetland plants. However, some perennial wetlands, supported by groundwater seeps, are also located within the watersheds.

According to the WRA report (Joselyn & Levine, 2001), environmentally sensitive habitat areas (ESHAs) are those in which plant or animal life or their habitats are rare or especially valuable due to their special role in an ecosystem[1]. A description of ESHAs, and their significance, is further discussed in the referenced WRA report.

<u>Proposed Golf Course Site</u>

Of the approximate 20 acres of wetlands within the Del Monte Forest, the proposed golf course site contains 4.3 acres of wetlands. These wetlands are mostly natural and man-made Palustrine Emergent/Forested Seasonally Saturated wetlands, though a small, man-made Palustrine Emergent, Semi-Permanently Flooded wetland is also evident on the site. The Palustrine Emergent, Semi-Permanently Flooded wetland is formed by the blockage of downslope drainage by an elevated equestrian trail. Water to this wetland is augmented by a drainage ditch that borders the equestrian trail, diverting natural runoff to the wetland. Without the adjacent equestrian trail, this wetland would most likely still be present, but would not maintain a semi-permanently flooded condition. In an unaltered, natural state, this wetland would still receive downslope drainage; however, it would probably function as a Palustrine Emergent/Forested, Seasonally Saturated wetland. Palustrine Emergent/Forested, Seasonally Saturated wetlands are not designated as ESHA wetlands by the Del Monte Forest Area Land Use Plan.

<u>New Equestrian Center</u>

The wetlands of the new equestrian center area are primarily recent man-made Palustrine Emergent/Forested Seasonally Saturated wetlands; however, a man-made Palustrine Emergent Semi-Permanently Saturated wetland also occurs on the lower part of the site. The large wetland on the lower terrace of the site derives its water primarily from groundwater, rather than surface water runoff. However, the wetland located on the upper terrace likely receives significant surface runoff (Mallory, *et al*., 2001). The wetlands on the new equestrian center site total 1.4 acres.

<u>Spanish Bay Driving Range</u>

Approximately 0.8 acres of natural wetlands are located on the Spanish Bay driving range site. Moderate slopes drain the site to the southwest and northeast, with the wetlands located in the southwest corner, adjacent to a drainage. The wetland is assumed to be a natural Palustrine Emergent, Semi-Permanently Saturated wetland, although it is located adjacent to and immediately north of existing homes, from which it may receive nuisance runoff water from landscape irrigation.

[1] As defined by the Del Monte Forest Area Land Use Plan.

Coastal Dunes and Monterey Pine Forest

In addition to wetlands, two other types of habitat are found in the Del Monte Forest Preservation and Development Plan Area: coastal dunes and Monterey pine forest. Coastal dune habitat is found on the northern area of the proposed golf course site; the Monterey pine forest habitat is found at the proposed golf course site, the new equestrian center, and the Spanish Bay driving range, and is dominant in most areas of the Del Monte Forest.

Special Status Plants and Animals

Special status plants and animals, and associated habitats that may be affected by water quality considerations are discussed in the WRA 2001 wetland report (Joselyn & Levine, 2001), and in other studies referenced in **Section 10** of this report.

GEOLOGY, SOILS, AND GROUNDWATER

Geology

The main geologic formations or bedrock units mapped in the Del Monte Forest are: (1) Porphyritic Granodiorite of the Mesozoic age; (2) Unnamed Sandstone of the mid-Miocene age; (3) the Carmelo formation; and (4) the Monterey formation. The Porphyritic Granodiorite are medium to coarse grained and contain feldspar crystals with some quartz and other common granitic material. This unit generally yields water of low salinity (dominated by calcium and bicarbonate ions), and is relatively resistant to erosion and weathering processes. The Unnamed Sandstone is usually a very tightly cemented, partially weathered, fine- to medium-grained, massively bedded sandstone, and contains a considerable portion of clay and silt, particularly where it has weathered. Groundwater that passes through the Unnamed Sandstone often has a relatively high salinity as compared with other near-surface consolidated units along the Central Coast and Monterey Peninsula area. The Carmelo formation is a very dense, hard gray sandy siltstone and shale containing highly-cemented sandstones and conglomerates (locally). This unit has sufficient clay or weathered silt content to form restrictive clay horizons in the soil, and is slightly less resistant to erosion than the other mapped units; groundwater passing through this formation has a salinity similar to that of the Unnamed Sandstone previously described. The Monterey formation is composed of mudstones and shales that include several diatomaceous or phosphatic members; the Unnamed Sandstone overlies the Monterey formation in addition to the Carmelo and granodiorite. Salinities of groundwater or springs passing through the Monterey formation are generally lower than those passing through the Unnamed Sandstone or Carmelo formation, though higher than waters passing through the granitic unit.

Terrace deposits, sand dunes, and stream deposits (alluvium) are the main surficial deposits found within the Del Monte Forest. The terrace deposits form thin and discontinuous units on the flatter-lying areas, such as the southern portions of the Del Monte Forest. Where the terrace deposits are very thin or not present, weathered bedrock outcrops are found. Terrace deposit sediments are often slightly weathered, erodible, and permeable, unless clays have accumulated within them. Sand dunes of at least three distinguishable ages are found in the urbanized portions of the Monterey Peninsula. The dunes are formed when sand from beaches and other dunes is transported by wind and deposited on top of older surfaces. All dunes are younger than the terraces or bedrock on which they have been deposited. Older and intermediate-aged dunes occur within some of the areas proposed for development of the proposed golf course site. They usually have a very low runoff rate and yield a low-salinity groundwater. Younger dunes lie just outside the proposed golf course site, near proposed holes 15, 16, and 17, in an area disturbed by existing trails. The stream deposits (alluvium) found within the project area are generally the youngest of the sediments. They are derived from eroded material from the watersheds of each channel, and, therefore, vary considerably according to location. The quality of the water found in the alluvium is usually similar to that of the overlying stream or seasonal drainage. Other surficial deposits include slope deposits (colluvium) and artificial fill, which are found at most sites within the project boundaries.

Information regarding the subsurface geology and groundwater at the proposed facilities was obtained from geotechnical studies performed by Haro, Kasunich, and Associates (2001), Nielsen and Associates (2002), and the *Phase One Hydrology Report* by Balance Hydrologics (2001).

Proposed Golf Course Site

Bedrock at the proposed golf course site occurs at very shallow depths, typically 2 to 5 feet below ground surface. Where the bedrock is at a greater depth, it is dense and unweathered, making drilling extremely difficult. A large portion of the southern half of the proposed golf course site is mantled by a thin layer of soil or terrace deposits a few feet thick, underlain by Carmelo siltstones or granitic bedrock. North of Drake Road, Unnamed Sandstone is found locally overlain by terrace deposits and older dune deposits.

New Equestrian Center

Granodiorite bedrock was mapped beneath the lower Sawmill Gulch borrow site, and it is possible that the Unnamed Sandstone occurs in some places in the northern portion of the site. Prior to quarrying activities at the site, older sandy deposits covered the bedrock. The past quarrying activities have left the original wave-planated granitic rocks of two different terraces exposed in the borrow pit.

Spanish Bay Driving Range

Subsurface drilling of the proposed driving range site indicates that it is underlain by a loose to dense dune sand, which is then underlain by granodiorite bedrock, at a depth of 17 to 23 feet.

Slope Stability and Landslides

Information on slope stability, landslides, and other geologic hazards is discussed in the geotechnical investigations by Haro, Kasunich and Associates, and Nielsen and Associates.

Proposed Golf Course Site

Slope instability problems are unlikely over most of the proposed golf course site. The southern part of the site has gentle slopes and few irregular surface features. Neither active nor inactive landslides are evident within this area. The gentle slopes within the area are not steep enough for slope failure to occur, so the potential for slumping, sliding, or debris flow is nonexistent. The northern side of the proposed golf course site contains some areas of steep, potentially unstable, man-made fill slopes. Also, there are natural sand dunes that have been incised by drainage courses or wind activity, and thus, have a potential for small failures; however, extensive failures are extremely unlikely. The potential for ground rupture from earthquakes (the primary seismic hazard) is very low since no known fault crosses the site.

New Equestrian Center

The investigations by Haro, Kasunich and Associates, and Nielsen and Associates concluded that existing native and graded slopes at the site are stable, and that slope instability and land sliding problems are not evident at the new equestrian center site. However, erosion and gullying are evident on the site, despite revegetation efforts. The formation of the gullies does not preclude the development of the site, although good drainage control and erosion controls measures will be needed to maintain slope stability. As with the proposed golf course site, the potential for ground rupture from earthquakes (the primary seismic hazard) is very low since no known fault crosses the site.

Spanish Bay Driving Range

Investigations by Haro, Kasunich and Associates, and Nielsen and Associates did not reveal any adverse geologic or geotechnical hazards, such as slope instability or landslide problems, that would preclude the development of the Spanish Bay driving range.

Soils

Thirteen soil types are mapped within the Del Monte Forest Preservation and Development Plan Area: Baywood sand, Coastal beaches, Dune land, Elder very fine sandy loam, Elkhorn fine sandy loam, Los Osos-Millsholm complex, Narlon loamy fine sand, Oceano loamy sand, pits and dumps, rock outcrop-Xerorthents association, Santa Lucia shaly clay loam, Sheridan coarse sandy loam, and Tangair fine sand (Cook, 1978). The Narlon loamy fine sand is the most predominant soil type mapped in the Del Monte Forest; however, Tangair fine sand and Sheridan coarse sandy loam are also common.

Proposed Golf Course Site

The proposed golf course site is dominated by Narlon loamy fine sand with 2- to 9-percent slopes. This soil has a slow to medium runoff rate, and a moderate erosion hazard. The upper 8 to 36 inches of this soil is permeable, silty sand, which will allow the infiltration of most rainfall. A 1-foot-thick discontinuous layer of very dense clay is found at a depth 8 to 36 inches below the silty sand. The clay layer restricts water from moving downward and, therefore, influences the amount of water stored in the upper silty sand layer. Wetlands can be formed in low, flat catchment areas when this layer becomes saturated with water. A second silty sand layer is found beneath the clay layer. Bedrock follows this layer and is located at a depth of approximately 3 to 10 feet. Sheridan coarse sandy loam with 15 to 30 percent slopes is also mapped within the proposed golf course site; this soil has a rapid runoff rate and a high erosion hazard. Dune land soils are mapped in the northern portion of the project site; these soils are very permeable, and have a slow to very slow runoff rate.

New Equestrian Center

Like the proposed golf course site, the predominant soil type at the new equestrian center is Narlon loamy fine sand with 2- to 9-percent slopes. Past quarrying activities included the removal of the top layer of soil from much of the site. Wetlands have formed in some of these disturbed areas. In addition to Narlon loamy fine sand, the site also contains “pit and dump” soils, which, in this case, is sandy fill of surficial soil and other heterogeneous debris from clearing at the Spanish Bay site.

Spanish Bay Driving Range

The Baywood sands with 2- to 15-percent slopes are located in the area of the proposed Spanish Bay driving range. This series also has a slow to medium runoff rate and moderate erosion hazard. This series, formed of dune deposits, is highly permeable, relatively thick, and has the capacity to store a large amount of water.

Groundwater

Groundwater sources in the area are mainly influenced by granitic bedrock and the Unnamed Sandstone. Areas underlain by the Unnamed Sandstone tend to have more saline groundwater than do areas underlain by granitic bedrock.

Proposed Golf Course Site

At the proposed golf course site, recent borings encountered two distinct groundwater units: a perched unit that lies above a shallow clay layer and a groundwater unit that is above the bedrock. The upper groundwater unit is very shallow and perched above the previously described 1-foot-thick clay layer. This groundwater unit was not encountered in previous borings (from the 1990s), and is probably the result of increased rainfall over the past several years. The lower groundwater unit is contained within the silty sand layer beneath the clay layer. This groundwater unit is under slightly artesian conditions where the clay layer was intact above it. In addition, deeper groundwater in the granodiorite was encountered in borings completed by Haro, Kasunich, and Associates (2001).

New Equestrian Center

The lower wetland at the new equestrian center appears to be associated with a shallow groundwater zone that was exposed as a result of excavations and quarrying activities. The low to moderate salinity of the groundwater emanating from seeps is typical of granitic influences. Groundwater levels are at the surface, and perched groundwater is at a depth of 12 to 14 feet in the lower portion of the project site.

Spanish Bay Driving Range

Groundwater levels approach the surface in the southern portion of the driving range during the rainy season, near the site of the proposed teaching facility. Perched groundwater is located on the top of the granodiorite bedrock and the dense sand layers (at a depth of approximately 1.3 to 21.5 feet). The groundwater levels are influenced by rainfall, and can be expected to vary seasonally.

SECTION 4

CONSTRUCTION ACTIVITIES

Construction of the proposed facilities will require earthwork for golf tees, greens and fairways, roads, pipelines, and general site grading. Large portions of the proposed golf course site are characterized by nearly level or gently sloping meadows, but there are areas of moderately to steeply sloping terrain and several seasonal drainages. Earthwork and grading will be required for the development of the golf course on the project site. Grading will be required to form the tees and greens, and cut and fill will be required to contour the fairways in the more hilly portions of the site. The golf course has been designed to take advantage of existing topography so that grading is minimized, and existing terrain and vegetation is used to accentuate play.

Although the steeper portions of the site will not be graded, construction work and project design must pay careful attention to potential erosion hazards and slope instability. The new equestrian center site has been disturbed as a result of past quarrying activity. The development of the equestrian center will help stabilize the site against further erosion problems; however, the sandy soils are susceptible to erosion during construction. The new driving range at Spanish Bay is a gently sloping wooded site that will entail significant removal of vegetation, but a relatively small amount of grading.

ENVIRONMENTAL ASSESSMENT

Soil erosion can cause numerous impacts. Eroded soil contains nitrogen, phosphorus, and other nutrients which, when carried into water bodies, can stimulate algae growth that reduce water clarity, deplete oxygen, and create odors. Eroded sediments can also accumulate in downstream drainage channels and structures, potentially contributing to flooding, accelerated stream erosion and associated damage to property and the aquatic environment. The greatest soil erosion hazard exists during and immediately following construction. The completed project will not cause erosion and sediment discharges to downstream water bodies, due to the addition and maintenance of turfgrass and other re-vegetation measures in areas of soil disturbance. New storm water detention facilities will also reduce the risk of erosion problems and sediment discharges.

Erosion Control Plan

Erosion and sedimentation impacts from the construction of the golf course and other facilities are expected to be confined predominantly to the construction phases of the project. Construction-related erosion and sedimentation will be mitigated by the implementation of an Erosion Control Plan. This plan should be prepared by a Certified Professional Erosion Control Specialist (CPECS) or Registered Civil Engineer (RCE), and incorporate effective, up-to-date technologies to reduce erosion and sedimentation, as well as a comprehensive site supervision and monitoring program to ensure that Best Management Practices are utilized and that the Erosion Control Plan is followed.

The overall plan for erosion control will include the following components:

- A specific plan, prepared by an RCE and/or CPECS, that defines specific types and locations of erosion control measures to be utilized, including such measures as silt fencing, temporary diversion structures, sodded turf buffers, native grass and tree-lined drainage ways, soil stabilization areas, sediment detention basins, staging areas, seeding specifications, limits of disturbance, etc. The plan will also include a schedule for completion of grading activities and implementation of site stabilization components.

- Grading plans and construction activities will conform to all drainage and erosion control standards adopted by Monterey County. These standards include:

  a. Requiring the installation of erosion and drainage control measures, and generally limiting grading to the time of year when intensive rainfall is unlikely.

  b. Protecting all finished graded slopes from erosion through use of erosion control blankets on steep slopes, re-vegetation, drainage diversion, and/or other appropriate methods.

  c. Slope stabilization design including toe buttressing when needed, drainage, and compaction standards for areas of cut and fill on dormant landslides and dip slopes. This aspect will be coordinated with the project geotechnical engineer.

  d. Salvaging and reapplying topsoil (surface four to six inches) with select soil amendments in areas of final grading to insure success in protective vegetation establishment.

  e. Protecting any downstream storm drainage inlets from sedimentation.

  f. Use of silt fencing, straw bales, and temporary sedimentation basins to retain sediment on the project site.

After construction is completed, all drainage culverts and other structures will be inspected, maintained, and repaired, as needed, on a regular basis to ensure their continued effectiveness. These drainage structures should be cleared of debris and sediment whenever significant accumulation is noted. Typically, inspection/maintenance will occur in late September, prior to the onset of fall rains, after the first two rainfall-runoff events of the year, and after every large storm event. Pebble Beach Company maintenance crews will carry this out.

NPDES Permit and SWPPP

Since portions of the project will involve the grading of more than five (5) acres, the project applicant will be required to apply to the State Water Resources Control Board (SWRCB) for a construction-activities permit under the National Pollutant Discharge Elimination System (NPDES). Prior to beginning construction, the project applicant must submit a Notice of Intent (NOI) to the SWRCB and prepare a Storm water Pollution Prevention Plan (SWPPP). The SWPPP is subject to review and approval by the Regional Water Quality Control Board.

The SWPPP, typically prepared by the project civil engineer, is intended to be a guidance document for construction managers and workers concerning water quality-related matters. It is required to be kept on site for the duration of the construction phase, and to be updated from time-to-time, as required. In general, it identifies potential sources of pollutants and details management practices and water quality control measures to be implemented during and following construction.

The Erosion Control Plan, previously referenced, will be a critical component of the SWPPP, since one of the greatest potential risks to water quality during construction is likely to be from sediment discharges in runoff from graded and unprotected surfaces. A unique aspect of the SWPPP for this project will address the need and intended methods to limit activities that could breach the shallow clay layer found at approximately 1.5 to 2 feet below ground surface at the proposed golf course site. The clay layer lies above groundwater found to have high salinity, with a specific conductance in the range of 10,000 μmhos/cm. When the clay layer is breached, such as when a tree has fallen, this allows the deeper saline groundwater to rise near ground surface. This water is of a higher salinity than the upper groundwater zone (which is perched on the clay layer). The presence of the higher saline groundwater is also evident in the wetlands at the proposed golf course site, which receive some water from shallow groundwater inflow. However, unlike when a tree falls and creates a localized pothole of higher salinity groundwater, the concern with the construction of the trenches and grading for the proposed golf course site is that the trenches could allow for the conveyance of the higher saline groundwater onto turfgrass and native vegetation over a larger area. Therefore, golf course construction will minimize penetration into the clay zone to minimize the effects of the higher salinity water.

The SWPPP for the project will also include a variety of "housekeeping" measures to prevent pollution from building materials, chemicals, and maintenance during construction of the development and infrastructure. Examples of typical "housekeeping" measures to be incorporated in the SWPPP may include the following:

- Performing major vehicle maintenance, repair jobs, and equipment washing at appropriate locations.
- Maintaining all vehicles and heavy equipment and frequently inspecting for leaks.
- Designating one area of the construction site, well away from streams or storm drain inlets, for auto and equipment parking and routine vehicle and equipment maintenance.
- Cleaning-up spilled dry materials immediately. Spills are not to be "washed away" with water or buried.
- Using minimum amount of water[1] for dust control.
- Cleaning-up liquid spills on paved or impermeable surfaces using "dry" cleanup methods (i.e., absorbent materials, cat litter, and/or rags).
- Cleaning-up spills on dirt areas by removing and properly disposing the contaminated soil.

[1] Disinfected secondary-23 reclaimed water can be used for dust control under Title 22 of the California Code of Regulations. "Disinfected secondary-23 reclaimed water" means reclaimed water that has been oxidized and disinfected so that the median concentration of the total coliform bacteria in the disinfected effluent does not exceed a most probable number (MPN) of 23 per 100 milliliters using bacteriological results as defined in Title 22 of the California Code of Regulations. The reclaimed water to be purveyed from the Carmel Area Water District (CAWD) and Pebble Beach Company Sanitary District (PBCSD) meets or exceeds this level of treatment, as discussed in **Section 6** of this report.

- Reporting significant spills to the appropriate spill response agencies.

- Properly storing containers of paints, chemicals, solvents, and other hazardous materials in garages or sheds with double containment during rainy periods.

- Washing-out concrete mixers only in designated wash-out areas where the water will flow into settling ponds or onto stockpiles of aggregate or sand. Whenever possible, the wash-out will be recycled by pumping back into mixers for reuse. The wash-out is not to be disposed of into the street, storm drains, drainage ditches, or streams.

- Applying concrete, asphalt, and seal coat during dry weather. Keeping contaminants from fresh concrete and asphalt out of the storm drains and creeks, by scheduling paving jobs during periods of dry weather, allowing new pavement to cure before storm water flows across it.

- Covering catch basins and manholes when applying seal coat, slurry seal and, fog seal.

- Parking paving equipment over drip pans or absorbent materials, to capture dripping oil and/or other possible pollutants.

SECTION 5

DRAINAGE AND RUNOFF

The development of the proposed facilities will change the rainfall-runoff rates for the project site from the existing conditions. Approximately 6.3 acres of impervious surface will be created at the new equestrian center, while the proposed driving range at Spanish Bay includes approximately 4.23 acres of impervious surfaces primarily for the parking area. A net decrease of 2.2 acres of impervious surface will occur at the proposed golf course. The decrease in impervious surface area at the golf course site is due to the removal of several paved roads and buildings on the site; the amount of new impervious surface area from the construction of new roads, buildings, and parking areas is less than that which currently exists. In addition to decreasing the total amount of impervious surface, the removal of the regularly traveled streets will both reduce storm water runoff pollutants and allow a greater opportunity to treat surface flows before they enter wetlands. Currently, the existing roadways, buildings, and other impervious surfaces at the proposed golf course site do not include any water quality improvement features and drain directly into wetlands. New construction will include water quality improvement features, such as those discussed in this section. The construction of buildings, roads, parking areas and other impervious surfaces will increase runoff rates, while the proposed runoff detention and storage facilities will fully mitigate this increase and maintain pre-development wetland hydrology.

ENVIRONMENTAL ASSESSMENT

Physical Setting Conditions

<u>Proposed Golf Course Site</u>

The majority of the golf course and upslope contributing areas currently drains through one of five subwatersheds ("Subwatersheds 1-5"), as delineated in the *Phase One Hydrology Report* (Mallory *et al.*, 2001). Figures showing the boundaries of these subwatersheds are presented in that report. The runoff is discharged to the storm drain system at Cypress Point Golf Course in the Fan Shell Beach Watershed. The rest of the project site drains to either the north or the south. The area that drains to the north (North Drainage) is the upslope area of a subwatershed that drains to Spyglass Hill Golf Course and eventually to Spyglass Beach. The area that drains to the south (South Drainage) comprises a small component of a subwatershed that eventually discharges to the Carmel Bay ASBS. Runoff from this area is proposed to be rerouted to "Subwatershed 4" to eliminate the potential for nonpoint source pollutant discharge to the Carmel Bay ASBS.

Four distinct physical settings are recognized within the proposed golf course site project area. The four conditions are: (1) highly permeable sandy soils comprising most of the North Drainage, (2) less permeable soils with steep terrain in the central area and part of the southern area of the property, (3) less permeable soils with gentle terrain in part of the southern area of the property, and (4) impermeable areas where buildings, parking facilities, roads, or other impervious surfaces are existing or are proposed to be constructed.

New Equestrian Center

The new equestrian center is part of the Sawmill Gulch Watershed. Past quarrying activities have left the area topographically divided into two areas, roughly equal in size. Generally, the site drains to the northwest, with the drainage from the upper area flowing down the steep slopes dividing the two areas, and through drainage to the man-made wetlands in the lower area. Most of the upper terrace drains north to a Sawmill Gulch tributary.

Spanish Bay Driving Range

The Spanish Bay driving range parcel, located in the Moss Beach Watershed, drains to both the southwest and northeast, with water flow occurring during rain events and possibly perennially during wet periods in a northwesterly direction to a drainage ditch along Majella Road. All runoff discharges northwest to an existing 24-inch storm drain crossing 17 Mile Drive.

Peak Runoff Rate

To manage the increased peak runoff, each development area will utilize various detention-retention systems, including underground pipe storage-infiltration and small detention basins. The outflow will be directed to existing storm drains, drainage ways and, in some cases, dispersed as overland flow. Pebble Beach Company will own, operate, and maintain all drainage facilities. As required by Monterey County, the detention facilities will be designed to store the difference between the peak 100-year post development runoff volume and the peak 10-year pre-development volume, with release rates no greater than that of the10-year pre-development peak runoff volume.

Proposed Golf Course Site

Since the construction of the proposed golf course will result in a net decrease in impervious area on the site, no retention would be required. However, to preserve existing wetland hydrology and protect on-site and off-site water quality, retention facilities will be installed at three locations, as discussed in the **Runoff Management Plan** section below. The drainage plan for the proposed golf course proposes to maintain the existing subwatershed boundaries. The exception to this is the small rerouting of runoff directed towards the Carmel Bay ASBS northward into the Fan Shell watershed, to protect and improve water quality within the Carmel Bay ASBS. Retention is required in certain subwatersheds at the proposed golf course, including "Subwatershed 4", which will receive the former Carmel Bay ASBS runoff. The subwatershed to which this runoff would be redirected does not include any existing wetlands. As discussed in the sections that follow, additional measures would be implemented to protect water quality.

New Equestrian Center

The site drainage at the new equestrian center will be collected via a storm drain system and then routed to an on-site "treatment" detention basin in the western (lower) portion of the site. Events planned in the "Open Space and Event Area" at the new equestrian center (see **Figure 3-3**) would be planned so as to not impact the flow of runoff to the lower detention basin. Outflow from the basin will discharge into an existing drainage ditch, which feeds the large seasonal wetland on the western part of the site.

Roof drainage at the equestrian center will be collected in a separate system and channeled to the wetland area on the upper part of the site.

Spanish Bay Driving Range

Runoff from the two parking lots, at the eastern and western ends of the proposed Spanish Bay driving range, will be collected in buried detention-infiltration piping systems installed below or adjacent to the parking surfaces. These will provide pollutant retention and filtration/treatment as well as flow attenuation. The outflow will be directed to existing drainage swales and storm drains in the area.

Roads/Parking Lot Runoff

The project will involve the construction of roads, parking lots, infrastructure, and maintenance areas associated with the proposed facilities. Runoff from these areas can be expected to contain non-point pollution sources comparable to that from urban areas. The type of pollutants contained in street/parking lot runoff include oil and grease, heavy metals, other petroleum derivatives coming from engine drippings and wearing of tires, brake linings and asphalt pavement. General litter and debris can also be anticipated, as well as paint and solvent residue associated with maintenance activities. The project proposes to utilize oil and grease sediment traps, vegetated filtering strips and swales, and detention-retention systems to control these pollutant sources.

Maintenance Facility Washwater

Another potential source of pollutants is the wash water from equipment cleaning areas. Mowers and other equipment can become contaminated with residual golf course chemicals (pesticides/herbicides and fertilizers) attached to grass clippings and soil particles that can be washed into drainages without proper control or containment. Treatment and recycling systems are available to collect, treat, and reuse wash water from equipment cleaning areas. The project proposes to include such a treatment/recycle system for the maintenance facility to eliminate the potential for impact from washwater discharge to local drainages.

Animal Wastes

The existing equestrian center will be removed to make room for the proposed golf course, eliminating existing nutrient (nitrogen) and bacteriological pollutant sources associated with animal wastes in the area that presently drains into the Carmel Bay ASBS. The dispersed sources of animal wastes associated with horse trails in this area of the Del Monte Forest will also be reduced.

At the Sawmill site, the new equestrian center and associated horse trails will pose potential water quality runoff impacts to the existing man-made wetlands at the site and to downstream receiving waters. The project proposes to control these impacts through a combination of drainage diversions, source control, containment, and manure removal practices.

Underground Infrastructure

Underground infrastructure, such as joint utility trenches and the irrigation and drainage pipeline trenches (**Figure 5-1**) at the proposed project sites, could intercept and alter the flow of shallow groundwater. The greatest potential for this to occur is where the trenches and pipes intercept groundwater perched on the clay layer or Unnamed Sandstone. The permeable bedding material in the pipeline and utility trenches provides a conduit for shallow groundwater to flow from one area to another. This can be a problem, for instance, if normally confined saline groundwater is intercepted and allowed to migrate into turfgrass or wetlands areas. Although shallow groundwater inflow is a minor contributor of flow to the wetlands at the proposed golf course site (Mallory, *et al.*, 2001), mitigation measures for the potential negative effects to wetlands resulting from the placement of buried infrastructure would be implemented. At the current level of design, the exact location of the various trenches and pipes has not been identified. However, where the buried infrastructure would intercept shallow groundwater, the pipeline trenches would be designed to include the use of clay baffle/barriers placed at regular intervals along the length of the trenches (**Figure 5-2**). The baffles would act as a dam to prevent groundwater migration along the trench. Additional measures that would reduce or eliminate the negative effects to wetlands and sensitive habitats due to hydrologic changes are discussed in the **Runoff Management Plan** section that follows.

RUNOFF MANAGEMENT PLAN

Best Management Practices (BMPs) will be utilized at the proposed facilities to limit peak runoff, sediment discharges, and transport of nutrients and other pollutants off-site into downstream receiving environments.

The runoff management plan is intended to protect wetlands, dunes, and sensitive plant areas from changes to storm water runoff quantity and quality. Essentially all of the runoff at the proposed facilities will be treated using BMPs prior to entering sensitive areas. The only runoff that will not be treated on-site is that from the driveway transition areas (i.e., ingresses and egresses); the minor amount of runoff from these areas will be directed into existing street and road drainage systems. The BMPs will treat runoff from storms of any magnitude; however, runoff from storms of lesser magnitude would receive a greater degree of treatment due to longer detention times. These practices, as they relate to site drainage, include the following.

Vegetated Filter Strips and Bioswales

Site runoff will generally be directed through vegetated permeable drainage swales and filter strips in most cases. Direct piping to any of the existing seasonal drainage channels will be avoided. The vegetated swales will also retard flow, reducing peaking effects normally associated with development. Any appreciable subsurface drainage intercepted from the golf course may also be discharged into buffer areas for filtration, infiltration, and recycling of this water to vegetated areas of the site.

- **Natural Vegetated Buffers.** Natural vegetated buffers typically ranging in width from 25 to 100 feet would remain between established turfgrass and wetlands, dunes, and sensitive plant areas. Natural vegetated buffers are undisturbed natural areas that are left between developed and sensitive areas. Buffers are proposed in areas where natural wetlands exist. These buffers will provide effective water quality treatment for nitrogen removal between irrigated areas and wetlands. Most of the drainage from the golf play areas is away from the dunes toward engineered channels and detention basins before discharging to the Spyglass Hill golf course below. The runoff that drains toward the dune areas would be absorbed readily into the sandy soils.

- **Filter Strips.** Filter strips along the edge of the golf course and other developed surfaces will be incorporated to enhance vegetative filtering and nutrient uptake, and infiltration/absorption into the soil (**Figure 5-3A**). Filter strips aid in the removal of pollutants contained in sheet flow runoff. Vegetated filter strips are graded and reestablished with native vegetation; they function similarly to natural vegetated buffers. A combination of grasses and woody vegetation in filter strips is usually most effective. The filter strips should be constructed with a gentle, e.g., 2% to 6%, slope, extend a distance of 25 feet or more, and be graded in a manner to encourage dispersed, rather than channelized, flow. Filter strips could be used around various storm drains on the proposed golf course site.

- **Bioswales.** Biofilter swales (or "bioswales") are wide, densely vegetated channels that are used in place of, or to augment, conventional storm water conveyance systems (**Figure 5-3B**). As water travels through the vegetation, flow velocities are reduced, allowing suspended solids to settle and other pollutants to infiltrate into the soil or be absorbed on the vegetation. They are normally limited to relatively gentle slopes of 2% or less, and designed to achieve long detention times for maximum contact between the runoff water and the vegetation or soil. They are typically no more than a few feet deep and about 6 to 12-feet wide; the depth of the bioswales would be shallower in areas where the clay layer is shallower. Average flow velocities during the 2-year design storm should not exceed about 1 foot per second, and the bioswale should normally have sufficient capacity to safely convey the 25-year design storm (ASCE, 1998). Routine maintenance is needed to remove accumulated litter and debris, and to maintain a grass height of about 4 to 6 inches for optimum performance. Examples of where bioswales could be used at the proposed golf course site include between the maintenance building and driving range, and between the northwest side of Fairway #9 and tees on the tenth hole. At the Spanish Bay driving range, bioswales could be used where the retention-infiltration trench at the southern parking lot discharges into the open space area.

Detention/Retention

Detention basins will be incorporated to attenuate increases in peak flows associated with the development of the project and for protection against flooding, erosion, or other damage to downstream areas. The detention basins will be sized to detain the difference between peak 100-year post-project runoff and peak 10-year pre-project runoff, with release rates no greater than the pre-development 10-year peak discharge. Detention basins incorporated into the final plans may include both "dry" and "wet" basins to achieve different design objectives in different areas of the site.

- **"Dry" Detention Basins.** Dry detention basins are dry between storms, and only fill with water in response to storm runoff events (**Figure 5-4**). The outflow from the basin is regulated by a constricted outlet that limits the discharge of water to a prescribed rate (i.e., the 10-year pre-project peak storm flow). The surplus runoff water is stored in the detention basin during the storm, and slowly drains out of the basin after the storm passes. Depending on their location, configuration, and other design factors, dry detention basins can provide some degree of pollutant reduction; however, this is normally incidental to their primary function, which is the attenuation of peak runoff rate. One example of where these detention basins are planned for the treatment and detention of potential dry season nuisance flow is at the proposed golf course site, northwest of Fairway 12. Nuisance flow will also be captured and treated in "wet" detention basins where possible, and allowed to evaporate.

- **"Wet" Detention Basins.** Wet detention basins are designed to maintain a minimum "pool" level to enhance the pollutant removal/treatment functions of the basin (**Figure 5-5**). The wet pool typically supports emergent aquatic vegetation, which aids in the uptake and assimilation of nutrients and other pollutants. The basin may be designed to retain a wet pool for a limited portion of the rainy season, for the entire winter, or potentially through portions of the dry season. Supplemental water is sometimes added to maintain the desired water level and sustain the vegetation. To reduce peak flow rates, a wet detention basin is planned in the lower portion of the site at the new equestrian center.

- **Underground Retention and Retention-Infiltration Facilities.** Underground storm water retention storage may be used where needed as an alternative to or to supplement the capacity provided by detention basins. In some cases, such as at the northern parking lot at the Spanish Bay driving range, retention-infiltration facilities will be used. Retention-infiltration facilities would not be used in areas with shallow saline groundwater (such as, at the proposed golf course), since the infiltration component would not function properly. Unlike standard underground retention structures (**Figure 5-6**), the retention-infiltration facilities (**Figure 5-7**) allow runoff to infiltrate into the ground through drain rock and filter fabric. The underground retention and retention-infiltration facilities serve a similar purpose as the proposed detention basins. These underground facilities help maintain the existing site hydrology, and also aid in the removal of some pollutants, such as settleable solids. Underground retention storage can be provided at the proposed golf course clubhouse parking lot using a series of 4-foot diameter high-density polyethylene pipe culverts that would be buried beneath the parking surface. In areas where the clay layer could be breached by the construction of the underground retention facilities, a larger number of smaller diameter pipes could be used for a shallower design, or curtain drains could be used to route shallow saline groundwater flow around the retention system. Runoff is directed into one end of the system of pipes, and the water leaves through a small (constricted) outlet pipe at the opposite end. The outlet pipe is sized to limit the discharge rate to the pre-development 10-year peak flow. Storage volume within the series of pipes is sized to accommodate the difference between the 100-year peak post development storm and the 10-year peak pre-development storm. Further examples of underground retention facilities include retention trenches at the northern and southern parking lots at the Spanish Bay driving range, and in the parking lot at the golf cottages at the proposed golf course site.

Detention basins, where they are incorporated in the final development plans, will be key elements of the drainage system, and will be subject to review by Monterey County Public Works Department for conformance with County design standards.

Subdrains

Underdrains

As recommended by Balance Hydrologics and WRA (Mallory, *et al*., 2001; Joselyn & Levine, 2001), an underdrain system will be installed at the golf course to capture percolate and maintain playable conditions on greens, tees, and fairways, and to provide water quality treatment. When possible, the underdrain system would tie into the storm drain system. The storm system discharges to the detention and/or retention basins on the proposed golf course site before being released overland to adjacent wetland buffers.

Greens' Drainage

The greens are constructed of four main layers: thatch, a root zone soil mix, coarse sand, and pea-size gravel (**Figure 5-8**). A subdrain will capture and direct percolate from the greens into vegetated detention basins.

Curtain Drains

Groundwater with salinity levels of 1,000 ppm and above has been observed at the proposed golf course site at depths as shallow as 2 feet. This high salinity water has the potential to damage or stunt the growth of golf course turfgrasses as well as some of the native vegetation if its flow is impeded in a way that causes it to rise to the surface or otherwise disperse into the root zone (Mallory, *et al.*, 2001). Trees and turfgrass yellowed by high salinity groundwater have been observed in neighboring golf courses (Mallory, *et al.*, 2001). In order to maintain the existing subsurface hydrologic regime, subdrains are planned to be installed at various locations along grading contours upslope of fairways to capture shallow groundwater and divert it to wetlands or downstream drainageways. This mitigation approach was recommended by Balance Hydrologics (Mallory, *et al.*, 2001) to protect wetland function, native vegetation, and turfgrasses from the potentially high saline groundwater and will generally maintain better soil drainage conditions in managed areas by collecting and rerouting the perched groundwater. Areas with deep cuts that intercept groundwater will receive special attention to ensure that the water is properly intercepted and routed to downslope areas. Subdrains can be designed to intercept either the shallow water perched on the clay layer, the deeper saline water perched on the sandstone bedrock, or both zones. **Figure 5-9** illustrates how the subdrains will capture and reroute shallow groundwater at cut and fill areas.

Other Management Practices

Other management practices that will be employed wherever practicable include the following:

- **Trash Areas and Loading Docks.** Wherever practicable, loading docks, trash storage areas, outdoor work areas, and equipment or supply storage areas will be covered to minimize or prevent contact with rainfall and runoff of any pollutants from these locations. Drainage from dumpsters with wet wastes (e.g., food preparation and course maintenance facilities) will be covered and/or properly drained to a sump that is connected to the sanitary sewer. Interior mat/equipment wash racks for restaurants and food preparation areas shall be designed to drain to the sanitary sewer.

- **Roof Drains.** Wherever practicable, roof drains will be directed to vegetated areas or rock slope protection to enhance the dispersion of clean water runoff, and minimize concentrated discharge of runoff. Roof drainage will be collected in a separate system and channeled to the appropriate wetland areas.

- **Raised Inlets.** Where practicable, storm water inlets may be raised several inches to a few feet above the flow line to induce short-term ponding for enhanced treatment of settleable solids. This is most effective during small runoff events, out of season storms, and for "nuisance" return flows. Examples of where raised storm water inlets may be used is on the east side of Tee 6 and in front of Tee 4 at the proposed golf course site.

- **Runoff Control and Dispersion.** The drainage from roads and parking areas will be dispersed as necessary to eliminate concentrated and potentially erosive discharges directly into the seasonal drainage channels. In areas where there is a potential for oil, grease, and fuel spillage, containment dikes and/or covering (e.g., roofing) will be used to protect against accidental release and runoff of these pollutants. Runoff control and dispersion will be used as needed.

- **Oil and Grease/Sediment Traps.** Monterey County requires that either curb inlet media filters and/or storm drain interceptors be used to separate oil and capture sediment from parking areas. Storm drain interceptors (**Figure 5-10**) will be installed to intercept runoff from large parking areas at the golf course clubhouse, equestrian center, and driving range. These traps consist of buried concrete tanks where sediment and grit are allowed to settle, and oils and grease collect at the surface. The tanks are periodically pumped-out (at least annually) and the material disposed of at an approved site. Alternatively, curb inlet media filters can be used (**Figure 5-11**). These typically consist of a settling area followed by a filter (most commonly sand, a peat/sand mixture, gravel, or synthetic absorbent material). The media filter surface requires cleaning about twice annually.

- **Equipment Washdown/Recycle System.** An equipment washdown and recycling system will be used at the proposed golf course maintenance area to clean mowers and other equipment that may be contaminated with golf course chemicals, oils and grease. The system manufactured by Environmental Systems Design/Waste 2 Water has been selected for this facility. This system utilizes a fixed film biological wastewater treatment process to collect and breakdown organic contaminants present in the equipment rinse water and recycle for continued use.

- **Litter Control and Street Sweeping.** Routine policing of the grounds will be conducted to control and pick-up litter and other debris that could be washed into the local wetlands and drainages and carried into downstream waterways and the Pacific Ocean. Regular street sweeping can also be effective in controlling trash and debris as well as other runoff pollutants of concern, such as particulate matter and heavy metals. The Pebble Beach Company will include new paved areas into its street sweeping program for key areas (e.g., parking lots), with particular emphasis on the period immediately before the beginning of the rainy season.

Animal Waste Control Measures at the New Equestrian Center

Runoff generated from the new equestrian center has the potential to contain high concentrations of organic matter, ammonia, and other nutrients, and harmful pathogens associated with animal wastes, if not properly controlled. Management measures used to control the discharge and impacts from animal wastes are normally accomplished through various site design and housekeeping measures. Proposed measures for the project will include the following:

- Clean manure from uncovered land (i.e., arenas, grass staging areas, etc.) on a daily basis.

- Store collected manure and used shavings in covered, concrete containment structures. The containment structures are shown in five locations on **Figure EQ-3** of the *Del Monte Forest Preservation and Development Plan*. Each containment structure is divided into two compartments; one compartment will store manure, while the other will store used shavings. The containment structures will be emptied twice per week, with the waste being disposed of at an appropriate off-site disposal facility.

- Divert roof downspouts and other runoff around manure storage areas and animal activity areas.

- Incorporate vegetated buffer/filter strips around the site perimeter.

- Provide downstream detention storage/treatment basin.

SECTION 6

GOLF COURSE IRRIGATION AND TURF

IRRIGATION WATER DEMAND

Once established, the average annual irrigation water demand for the golf course is estimated to range between 1.07 and 2.16 acre-feet per acre per year (AFY/acre)[1]. The estimated water demands for each water use type are presented in **Table 6-1**. For the 92.9 acres of turfgrass on the proposed golf course, this equates to an annual water demand of roughly 100 to 215 acre-feet. During the first year grow-in period, the water demand will be greater by approximately 60% over the long-term needs.

Table 6-1
Estimated Water Demands for Proposed Golf Course Site

Water Use Type	Area (acres)	Water Demand* (ac-ft/yr)
Greens	3.1	3.3 to 7.2
Tees	5.8	6.2 to 13.4
Fairways	31	33.2 to 71.6
Primary Roughs	38	40.7 to 87.8
Secondary Roughs	15	16.1 to 34.7
Total	**92.9**	**99.4 to 215**

*Water use rate of 1.07 to 2.16 acre-feet per year

IRRIGATION WATER QUALITY

The proposed irrigation water source for the golf course is tertiary-treated wastewater from the Carmel Area Wastewater District (CAWD). To achieve tertiary treatment, secondary-treated wastewater is filtered to remove suspended solids and disinfected with chlorine prior to distribution. Currently, the reclaimed water is transported to the golf courses in the area by a distribution pipeline through Carmel and Pebble Beach. The reclaimed water is pumped directly to Pebble Beach, Cypress Point, and Spyglass Hill golf courses; water provided to other users[2] is first pumped to a 2.5 million gallon capacity storage tank at Poppy Hills.

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[1] Based upon CAWD/PBCSD Reclaimed Water Project 1994 to 2001 water usage for Spyglass Hill and Cypress Point Golf Course plus a 30 percent allowance for potable water use for flushing and make-up water. These golf courses are geographically close to the proposed golf course and similar in play area size.

[2] The following are currently using the recycled wastewater as an irrigation source:

- The Monterey Peninsula Country Club (Dunes and Shore Courses), Cypress Point Club, and the playing fields of Robert Lewis Stevenson School.
- The Pebble Beach Company's resort courses: Pebble Beach Golf Links, Spyglass Hill Golf Course, The Links at Spanish Bay, and Peter Hay Executive Golf Course.
- The Northern California Golf Association-owned Poppy Hills Golf Course.
- Other Pebble Beach Company-owned recreational open spaces: Collins Field, Pebble Beach Equestrian Center, and the driving ranges at Pebble Beach and Spyglass Hill.

The purpose of using reclaimed water as an irrigation source is to reduce and ultimately eliminate the use of potable water on Del Monte Forest/Pebble Beach area golf courses. By eliminating this dependence, the potable water is made available for domestic and other municipal uses, and the golf courses are protected from cyclical drought conditions. The golf courses historically used over 800 acre-feet annually (AFA) of potable water. Since the golf courses began irrigating with reclaimed wastewater in 1994, a combination of potable water and reclaimed water has been used. Potable water has been needed to supplement the reclaimed water source because of process inefficiencies and downtime, an inability to meet peak golf course demand, and slight to moderate effects on turfgrass due to elevated levels of sodium in the reclaimed water. Currently, potable water is being used at regular intervals during April through November (approximately every four weeks) to flush sodium out of the root zone; additional potable water is used to satisfy extended peak demands. The option of adding a reverse osmosis (RO) treatment system to improve the reclaimed water quality has been investigated by Pebble Beach Company; a proposal for both RO treatment and additional storage capabilities at Forest Lake Reservoir has been submitted to the Monterey Peninsula Water Management District (MPWMD), and is currently being reviewed by that agency. If an RO system is built, it would be designed and operated to reduce the sodium and total dissolved solids content of the golf course irrigation water by roughly half of the existing levels. However, until this plant is constructed or another permanent solution is found to the water quality and peak demand problems, the golf courses will continue to use potable water for about 20 to 30 percent of their needs.

A summary of representative water quality data for the reclaimed water source is presented in **Table 6-2** along with recommended irrigation water quality guidelines. The data is from the 1996-2002 final effluent concentrations provided by the CAWD. Based on these data, the reclaimed water for the proposed golf course can be expected to have an average total dissolved solids (TDS) of about 814 mg/L, an average SAR of 4.3, and an average nitrate-nitrogen concentration of 16 mg/L. During the sampling period, the TDS concentration and sodium absorption ration (SAR) ranged from 648 to 1,111 mg/L and 1.8 to 6.3, respectively. Nitrate (as nitrogen) concentrations varied from less than 0.1 mg/L to 41 mg/L. The average sodium concentration was 157 mg/L, and the average chloride concentration was 212 mg/L; a maximum concentration of 233 mg/L and 325 was reported for sodium and chloride, respectively. If the RO treatment system is built, it would be designed and operated to treat roughly half of the total irrigation water, thereby reducing the sodium levels to about 75 mg/L and achieving a general reduction of total dissolved solids of about 50% of current levels.

The irrigation water quality guidelines also included in **Table 6-2** indicate that the quality of the irrigation water may pose “increasing problems” for irrigation of the turf, which is confirmed by the experience of the existing golf courses over the past several years. Periodic flushing with high quality (potable) water has been carried out at regular intervals during April through November to overcome the irrigation water quality problems associated with the reclaimed water. However, part of the problem with the existing golf courses is also related to the way the greens were originally constructed. The USGA design improves the health of the turfgrass and lessens impacts to water quality. This is achieved through the provision of better drainage, which in turn reduces the need for chemical and water (flushing) applications.

Table 6-2
Reclaimed Water Quality Summary (CAWD 1996-2002) and Recommended Irrigation Water Quality Guidelines[1]

Characteristic	Water Quality Average Concentration (Range) (CAWD, 1996-2002)	No Problem	Increasing Problems	Severe Problem	FAO Irrigation Water Guidelines
pH, units[2]	7.1 (6.2-7.9)	6.5-8.4	---	---	6.5-8.4
Total Dissolved Solids[3]	814 (648-1111)	---	---	---	450-1000
Conductivity (mmhos/cm)[4]	1.27 (0.99-1.58)	<0.75	0.75-3.0	>3.0	0.5-0.8
SAR (adj)[5]	4.3 (1.8-6.3)	<6.0	6.0-9.0	>9.0	<6.0
Sodium (mg/L)[6]	157 (101-233)	<69	>69	---	70-80
Chloride (mg/L)[6]	212 (98-325)	<142	142-355	>355	140-200
Boron (mg/L)[7]	0.42 (0.24-1.23)	<0.5	0.5-2.0	2.0-10.0	<0.7-1.5
Ammonium as nitrogen (mg/L)	NA	<5	5-30	>30	5-30
Nitrate as nitrogen (mg/L)[8]	16 (<0.1-41)	<5	5-30	>30	5-30
Bicarbonate (HCO_3^-) (meq/l)[9]	1.85 (0.2-4.5)	<1.5	1.5-8.5	>8.5	---
Heavy Metals	**For waters used continuously on all soils (mg/L)**	**For use up to 20 years on textured soils of pH 6.0 to 8.5 (mg/L)**		**Severe Problem**	**FAO Irrigation Water Guidelines (mg/L)**
Aluminum	5.0	20.0		---	---
Arsenic	.10	2.0		---	0.1
Cadmium	.01	2.0		---	.01
Chromium	.10	1.0		---	.10
Copper	.20	5.0		---	0.2
Lead	5.0	10.0		---	5.0
Nickel	.20	2.0		---	---
Selenium	.02	.02		---	.05
Zinc	2.0	10.0		---	3.0

NOTES TO TABLE 6-2:

1. Interpretations are based on possible effects of constituents on crops and/or soils. Guidelines are flexible and should be modified when warranted by local experience of special conditions of crop, soil, and method of irrigation.

2. pH values are based upon 1996-1999 filtered effluent data from CAWD; 2000-2002 data are not available.

3. Mmhos/cm x 640 – approximate total dissolved solids (TDS) in mg/L or ppm;
   mmhos x 1000 = micromhos.

4. Assumes water for crop plus water needed for leaching requirements (LR) will be applied. Crops vary in tolerance to salinity.

5. Adjusted Sodium Adsorption Ratio (SAR) is calculated from a modified equation developed by U.S. Salinity Laboratory to include added effects of precipitation or dissolution of calcium in soils and related to $CO_3 + HCO_3$ concentrations.

   To evaluate sodium (permeability) hazard:

   pHC is calculated value based on total cations, Ca + Mg and $CO_3 + HCO_3$. Calculating and reporting will be done by reporting laboratory. NOTE: Na, Ca – Mg, $CO_3 + HCO_3$ should be in me/l (milliequivalent per liter).

   Permeability problems related to low EC or high adjusted SAR of water can be reduced if necessary by adding gypsum. Usual application rate per acre-foot applied water is 200 to about 1,000 lb (234 lb of 100% gypsum added to 1 acre-foot of water will supply 1me/l of calcium and raise the Ecw about 0.2 mmhos). In many cases, a soil application may be needed.

6. Most tree crops and woody ornamentals are sensitive to sodium and chloride (use values shown). Most annual crops are not sensitive (use salinity tolerance tables). For boron sensitivity, refer to boron tolerance tables.

7. Below 0.5 mg/L – Satisfactory for all crops
   0.5-1.0 mg/L – Satisfactory for most crops; sensitive crops may show injury (may show leaf injury but yields may not be affected).
   1.0-2.0 mg/L – Satisfactory for semi-tolerant crops. Sensitive crops are usually reduced in yield and vigor.
   2.0-10.0 mg/L – Only tolerant crops can produce satisfactory yields.

8. Excess N may affect production or quality of certain crops, e.g. sugar beets, citrus, avocados, apricots, grapes, etc.

9. Leaf areas wet by sprinklers (rotating heads) may show a leaf burn due to sodium or chloride absorption under low-humidity, high-evaporation conditions. Evaporation increases ion concentration in water films on leaves between rotations of sprinkler heads.

Sources:
Water Quality Data Source: Carmel Area Wastewater District Laboratory, SAR Analytical Report, Final Effluent Quality, October 1999 – November 2000. Criteria Source: University of California Cooperative Extension Service, 1977; Central Coast Regional Water Quality Control Board *Water Quality Control Plan* (Basin Plan), 1994. FAO (Food and Agriculture Organization of the United Nations) Guidelines as contained in CH2M Hill, 1992. Agricultural Salinity and Drainage, UC Davis, 1993.

ENVIRONMENTAL ASSESSMENT

Vegetation

Water quality is an important consideration for irrigation because of potential effects on soil drainage and vegetation. Nitrates and metals in wastewater could also conceivably impact surface water and groundwater from runoff or deep percolation. Since there are no significant industrial water users in the wastewater service area, the potential for metal contamination is not a serious concern. Reclaimed wastewater typically has some limitations for horticultural uses, including high sodium, boron, or salt levels as measured by total dissolved solids (TDS). Long-term soil permeability and drainage can be adversely affected by sodium and salt build-up from irrigation waters. The surface soils in the proposed golf course area are fine sandy loams and are not particularly susceptible to development of drainage, compaction, or aeration problems from irrigation water. Crops, turfgrass and other vegetation need to be protected from immediate/acute salt shock and toxicity effects at high levels of minerals (TDS) from single time applications, as well as from such effects as discoloration, leaf drop and stunted growth from long-term build-up of salt, boron, and sodium in the soils.

Surface Water Runoff

Under proper operation, the use of tertiary-treated wastewater for golf course irrigation will not result in any noticeable impacts on surface water quality in local drainages, or downstream in the Pacific Ocean. By regulation, reclaimed water is not permitted to be irrigated in a manner that will result in direct runoff to streams or create ponded conditions within the irrigated area. There is no incentive for the golf course to apply more reclaimed water than is necessary, since the course will be under no obligation to "dispose" of a prescribed amount of treated wastewater. As a result, the irrigation rates will be established and maintained to closely match soil hydraulic properties and turf water consumptive needs. These rates can be established based upon seven years (1994-2001) of history at other golf courses in the area; namely, Spyglass Hill, Monterey Dunes, Monterey Shore, Cypress Point, Pebble Beach, Spanish Bay and Poppy Hills. Runoff due to irrigation practices from the golf course site will be negligible. It should be noted that runoff from the proposed golf course and driving range will not enter downstream drinking water supplies.

Nutrients

With respect to nutrient effects, the nitrate contained in the reclaimed water will supply a substantial portion of the required nitrogen for turf growth, reducing the amount of nitrogen fertilizer that will need to be applied to the golf course. Based on an average nitrate-nitrogen concentration of 16 mg-N/L in the reclaimed water and an annual irrigation water volume of roughly 100 to 215 acre-feet per year for the 92.9 acres of irrigated turfgrass, it is estimated that the reclaimed water can supply roughly 4,300 to 9,300 lbs of nitrogen per year to the turfgrass, which would amount to about 15 to 35 percent of the total estimated nitrogen required for turf maintenance. The nitrogen content of the reclaimed water will be taken into account in determining nitrogen fertilizer application needs; this will be done as a matter of efficiency and to reduce the potential for excess nitrate in percolating waters or runoff from the golf course. Currently, animal waste from the existing equestrian center and equestrian trails contribute to nutrient loading at the proposed golf course site; these sources will be removed from the site as part of the development plan. The existing equestrian center drains primarily to the Carmel Bay ASBS watershed, and to the largest natural and manmade wetlands at the proposed golf course site (located in the central portion of the site). Although nutrient loading to the Carmel Bay ASBS will be reduced by both the removal of the existing equestrian center and by the routing of the golf course drainage away from the ASBS, nutrient loading to some of the wetlands and all of the dune areas at the proposed golf course site will not be altered by the removal of the existing equestrian center. However, the removal of the equestrian trails on the site would result in a reduction of nutrients currently entering the wetlands and the dune areas from this source. Also, substantial nitrogen uptake and denitrification processes in the proposed buffer areas would aid in the reduction of nutrients entering the wetlands or other sensitive areas. See **Section 7** for further discussion of fertilizer management practices and an assessment of the potential nitrate-nitrogen loading impact on the adjacent wetlands.

Salt Loading

Irrigation with reclaimed water will add minerals (salts) to the local receiving environment. However, the impacts are mitigated by the fact that: (1) portions of the shallow groundwater in the proposed golf course area are already highly mineralized as a result of the leaching of salts from the marine sandstone and terrace deposits that underlie the site, and (2) the area drains to the Pacific Ocean, which is located a few thousand feet away and is the only water body located downstream of the site. Similar to nutrient loading, animal waste from the existing equestrian center contributes to salt loading; this source will be removed from the proposed golf course site as part of the development plan. **Table 6-3** provides a comparative listing of the typical range of salinity (specific conductance, μmhos/cm) and estimates total dissolved solids (TDS) of the various water sources in the project area.

Table 6-3
Typical Specific Conductance and Total Dissolved Solids Concentration for Various Water Sources (Source: Mallory, *et al.*, 2001)

Water Source	Typical Specific Conductance (μmhos/cm at 25°C)	Typical Total Dissolved Solids Concentration (mg/L)[1]
Rainwater	35-40	23-27
Pebble Beach tap water	500	335
Reclamation plant water	1,000-1,700	670-1,140
Proposed golf course irrigation water (Reclamation plant water Phase II (desalinated))	750	500
Spring and groundwater from Monterey shale bedrock	800-2,500	540-1675
Ocean water	52,000-55,000	35,000-37,000

Note: [1]Typical total dissolved solid (TDS) concentration based upon the empirical relationship between specific conductance and TDS concentration for the project site water quality monitoring data (January 2001-2002) (Mallory and Hecht, 2002).

To assess the potential impacts of golf course irrigation on wetland water quality, a simplified mass balance analysis was constructed for one of the key subwatersheds (#2) delineated by Balance Hydrologics, Inc. (Mallory, *et al.*, 2001). This watershed was selected because of its longer water ponding period and the associated tendency to support a greater wildlife population. Also, it encompasses a designated environmentally sensitive habitat area (ESHA) wetlands. The mass balance calculations are provided in **Appendix A**. The analytical approach assumes that, under long-term equilibrium conditions, a portion (10 to 20%) of the total annual mass of salts (i.e., total dissolved solids) contained in the irrigation water applied to the section of the golf course immediately bordering the wetland buffer area will migrate into and through the seasonal wetlands via shallow groundwater flow. The amount of shallow groundwater flow into the wetlands is limited by the relatively slow velocity of groundwater movement, estimated to be about 0.1 ft/day. Also, it is assumed that surface runoff from the entire golf course area will dissolve and transport a small portion (5 to 15%) of the salts contained in the irrigation water. This estimate is based results from a 3-yr water quality runoff study at the Dove Canyon Country Club golf course in Southern California, under reasonably similar conditions where reclaimed water was used for irrigation and rainfall averaged just under 20 inches/year during the study. The remaining salts are assumed to leach downward and join the deeper saline groundwater zone, is not a contributing factor in the water-salt balance affecting the wetlands. The salts reaching the wetlands will contribute to an incremental increase in the salinity level within the wetlands that can be approximated based on: (1) the total annual mass loading of salts (based on the average TDS concentration of the various water sources, including the irrigation water); and (2) the total estimated annual volume of water that flows through the wetlands (i.e., from rainfall runoff, shallow groundwater inflow, direct precipitation, and the portion of irrigation seepage losses assumed to reach the wetlands).

The TDS concentration of the seasonal wetlands fluctuates greatly during the year based on rainfall-runoff conditions, and from year to year. Balance Hydrologics (Mallory and Hecht, 2002) monitored surface and groundwater quality at the proposed golf course site from January 2001 to January 2002. Background (pre-development) concentrations of TDS concentrations in the surface waters at the monitored wetlands ranged from approximately 1,000 to 3,000 mg/L in the surface waters. Shallow groundwater TDS measurements ranged from 850 to 1,620 mg/L in the groundwater perched on the clay layer. Data collected for wetland drainage areas adjacent to irrigated turf at the nearby Spyglass Hill Golf Course in February and March 2001 indicated a TDS range of 1,050 to 2,300 mg/L (average =1,675 mg/L).

In addition to their water quality study, Balance Hydrologics performed a water budget of the wetlands on the project site as part of their *Phase One Hydrologic Analysis* (Mallory, *et al.*, 2001). They focused on Subwatershed 2 partly because it encompasses a designated ESHA wetlands. The water budget illustrated that surface water runoff is the largest single source of water to the wetlands at the new golf course site, followed by direct precipitation and shallow groundwater inflow. Based upon the water quality monitoring data and soil characteristics (i.e., transmissivity), Balance Hydrologics concluded that shallow groundwater inflow into the wetland is primarily influenced by the groundwater perched on the clay layer, and that the higher saline groundwater perched on the Unnamed Sandstone contributes a negligible quantity. Where saline water is found at the surface, the separation of the deeper saline water and the fresher surface water is distinct. The saline water is only flushed through the wetlands during storm events that are large enough to displace the volume of water in the pools (Mallory, *et al*., 2001). When the storm ends, the pools quickly re-stratify, and the deeper saline groundwater no longer contributes to flow through the wetlands (Mallory, *et al.*, 2001).

For modeling purposes, background TDS levels in rainfall runoff and shallow groundwater inflow were estimated from shallow surface water runoff and shallow groundwater inflow TDS levels measured at the wetlands. Since the groundwater perched on the clay layer is the primary shallow groundwater inflow source, only measurements from this groundwater unit were used to establish the "average" background concentration. Also, because of the relatively slow rate of groundwater movement (estimated to be about 0.1 feet per day), the wetlands are only affected by shallow seasonal groundwater that originates within a short distance (i.e., less than 100 feet) of the wetlands. Because of this, only the irrigated areas of the golf course immediately adjoining the wetland buffer are assumed to contribute seepage losses (and associated salts) to the wetland water budget.

The projected change in TDS concentration was modeled for two different irrigation water quality assumptions: (1) existing golf course irrigation supply (670 mg/L, reflecting the combination of reclaimed and potable water used at existing golf courses); and (2) RO-treated water (500 mg/L). The analysis also considered a range of annual irrigation amounts for the golf course, based upon historical water use at other adjacent golf courses (Spyglass Hill and Cypress Point). From this analysis, the post-development ("resultant") TDS concentration in the wetlands was estimated as shown in **Table 6-4**. An overall comparison with the TDS levels for other waters in the area is provided in **Table 6-5**.

Table 6-4
Estimated Resultant TDS Concentrations in Golf Course Site Wetlands

Model Assumptions	Resultant TDS (mg/L)	
	Existing Reclaimed Water Supply	RO-treated Water
Low Irrigation Rate 1.07 AFY/acre*		
• 10% leaching/5% runoff of salts to wetlands	1,590	1,560
• 20% leaching/15% runoff of salts to wetlands	1,690	1,630
High Irrigation Rate 2.16 AFY/acre*		
• 10% leaching/5% runoff of salts to wetlands	1,650	1,610
• 20% leaching/15% runoff of salts to wetlands	1,830	1,740

* acre-feet per acre per year

This analysis predicts the resultant TDS concentrations in the wetlands in Subwatershed 2 for both the existing irrigation water supply and the irrigation water supply with RO treatment to fall within the range of about 1,560 to 1,830 mg/L. This indicates that there may be a slight increase (less than 10% for most scenarios) in the average salinity levels in the wetlands as compared with existing conditions (approx. 1,525 mg/L). However, the resultant concentration estimates are well within the existing background range of concentrations found in the in the wetlands of Subwatershed 2 (approximately 1,000 to 3,000 mg/L). Also, as can be seen from the relatively small spread in TDS concentration values, the resultant effect is not highly sensitive to the individual assumptions (e.g., irrigation rate), within the range of reasonable values used in the model. The TDS concentrations will be minimized with the use of RO-treated water, partly because it will have the effect of reducing the amount of salts in the irrigation water. Additionally, with the RO-treated water, there will be reduced need for "salt flushing", which will decrease the overall amount of water (and associated salts) applied to the golf course. Therefore, with RO treatment, it is reasonable to expect the resultant concentrations to be approximated best by the estimates based on the low irrigation use amount (1.07 ac-ft/ac/yr); i.e., resultant TDS of 1,560 to 1,630 mg/L.

For further comparison with empirical evidence, data was checked for two existing wetland drainage areas adjacent to the Spyglass Hill Golf Course (Drainage at Stevenson Drive and Drainage in Wetland L) that were analyzed for salinity by Balance Hydrologics, Inc., in February and March 2001 (Mallory and Hecht, 2002). They were found to have specific conductance (adjusted) readings of 1,549 and 3,400 micromhos/cm, which correspond, respectively, to approximate TDS concentrations of about 1,050 and 2,300 mg/L (average=1,675 mg/L). The estimated TDS concentration range for the proposed golf course wetlands (Subwatershed 2) falls within the observed range found in wetland areas at the existing Spyglass Hill Golf Course, and closely approximates the average concentration.

Table 6-5
Comparison of TDS Model Prediction for Subwatershed 2 Wetlands with Other Waters

Water Source	Typical Total Dissolved Solids Concentration (mg/L)
Rainwater	23-27
Pebble Beach tap water	335
Existing Reclamation plant water	670-1,140
Proposed golf course irrigation water (With RO Treatment)	500
Spring and groundwater from Monterey shale bedrock	540-1675
Surface Water Drainage./Wetlands at Spyglass Hill Golf Course	1,050-2,300
Existing Water Subwatershed 2 Wetlands	1,000 – 3,000
Predicted Resultant Concentration at New Golf Course - Subwatershed 2 Wetlands	1,560 – 1,830

Public Health

The use of reclaimed water for golf course or other landscape irrigation needs has the potential to affect public health through exposure of people to viruses or pathogenic bacteria that may be contained in the treated wastewater. The California Department of Health Services (DHS) is responsible for establishing health-related standards for many types of wastewater recycling, including golf course and landscape irrigation. Use requirements established by DHS are based on providing a prescribed level of treatment and disinfection in order to ensure inactivation of viruses and bacteria. They are contained in California Code of Regulations, Title 22, Water Recycling Criteria, and are generally regarded as the most stringent (protective) water recycling standards in the U.S. Tertiary-treated reclaimed water is required for unrestricted use on golf courses. As defined in Title 22, disinfected tertiary reclaimed water is a "filtered and subsequently disinfected wastewater" and meets their disinfection requirements. The available supply of reclaimed water from CAWD for the proposed golf course is in full compliance with Title 22 requirements. Title 22 and associated guidelines developed by DHS also include other measures to be followed for protection of workers and the general public in areas in where the reclaimed water is used for irrigation; these guidelines are discussed under **Reclaimed Water Requirements** in the section to follow. Compliance with DHS standards will preclude the creation of any significant risks to the public health from the proposed use of reclaimed water.

MANAGEMENT PRACTICES

The following summarizes key management practices related to the golf course turfgrass and irrigation system. Additional information pertaining specifically to fertilizer practices and pest management is presented in **Sections 7** and **8**, respectively.

Turfgrass Selection

Turfgrass selection is critical for design, maintenance and environmental reasons. Preliminary recommendations for turfgrass have been developed by the Consulting Turf Agronomist (Michael J. O'Connor) taking into account the following factors:

- Climatological and soil condtions of the site.
- Compatibility with special status species and dune habitat.
- Establishment in coastal environments.
- Supplemental irrigation water quality.
- Resistance to annual grasses and weeds.
- Tolerance to high saline conditions and total dissolved solids (TDS).
- Desirability for golf in the playing and environmental setting.
- Compatibility with other grasses, including forbs and sedges.
- Winter recovery and tolerance to cool season pathogens.
- Establishment in sunny and shady environments.
- Drought tolerance.
- Resistance to disease and insects.
- Availability of seed that is clean of harmful pests and grown in accordance with good turf growing practices.

Final grass type selection will take into consideration the results of on-going USGA National Turfgrass Evaluation Performance (NTEP) studies. Preliminary grassing recommendations are as follows:

Tees and Fairways. Perennial ryegrass will be used to establish tees and fairways. The specific turf-types include Barlennium, Pinnacle and Premier II, previously used at the Spanish Bay golf course.

Putting Greens. Putting greens will be established with annual bluegrass (*Poa annua var. reptans*), though initial establishment may include roughstalk bluegrass (*Poa Trivialis*) and/or upright generation specific bentgrass varieties.

Primary Roughs. Primary roughs will be established with a mix of ryegrass and fescue. This blend is especially well suited for irrigation with reclaimed water. The objective with the rough area is also to simplify the managed areas and allow transition that encourages complimentary and low impact maintenance near the adjacent native habitats. The step cut in the rough may be eliminated on all or a portion of the course where the introduction of true natives is more desirable.

Secondary and Natural Areas. Natural areas altered by construction may be revegetated using fescue grasses and a combination of grasses suitable for coastal Monterey, including: Indian rice grass (*Achnatherum hymenoides*), slender wheatgrass (*Agropyron trachycaulum*), western wheatgrass (*Agropyron smithii*), Swithgrass (*Panicum virgatum*), little bluestem (*Schizachyrium scoparium*), blue grama (*Bouteloua gracilis*), and sideoats (*Bouteloua curtipendula*). These grasses are easily established in dry, medium-textured soils with adequate moisture and are also able to tolerate lower fertility and pH as well as saline or sodic soil conditions. *Achnaternum hymenoides*, *B. gracilis*, and *B. curtipendula* are native to California. While non-native, none of the other suggested grasses are considered weeds. Other native grasses used at other golf courses in the region that could be substituted for the non-native grasses include purple needlegrass (*Nassela pulchra*), red fescue (*Festuca rubra*), California brome (*Bromus carinatus*), tufted hairgrass (*Deschampsia caespitosa*), and California poppy (*Eschscholzia californica*). The variation in species will allow for seasonal fluctuation in surface runoff (wet or dry) and will adapt to specific management of soils (low or high pH) and provide soil stabilization and filtration as needed.

Irrigation System

General. The design of the irrigation system is the foundation upon which the day-to-day operation must rely. Design errors or poor decisions in the initial design and construction/installation of an irrigation system may result in significant loss of water over the life of the system, and potential effects to adjacent or downstream areas from the excess "nuisance" irrigation water flow. "Good water management" means that nearly all of the water applied to landscapes through a well-designed and maintained irrigation system is used by the plants being irrigated. Application of the appropriate amount of water requires knowledge of the plants' need for water, the water holding capacity of the soil, drainage characteristics, the quality of the irrigation water, and the irrigation system's performance.

Irrigation equipment and irrigation management capabilities have improved dramatically during the past 10 to 15 years. It is now common to provide electronic or computerized irrigation scheduling controls for a site using different types of irrigation equipment (e.g., geared rotors, impact rotors, spray heads, microspray heads, drip, bubblers) for different landscape zones requiring separate management. However, the use of modern technology alone does not guarantee that the site will be efficient in its use of water and that environmental concerns will be addressed. Although high tech equipment (in combination with a good design and installation) allows water to be applied uniformly across the site or adjusts the application amounts according to specific water needs of different planting zones, good management is also necessary to ensure that the water is applied when needed and in appropriate amounts, and that proper maintenance procedures are performed regularly.

Irrigation Equipment. The golf course irrigation system will be a state-of-the art Rainbird maxi V or equivalent computerized irrigation system linked to a golf course weather station. The system can sense the water usage each day and adjust each irrigation valve to the specific time of operation necessary to achieve efficient water distribution. The irrigation system will be linked to a DTN Weather Center Computer and Lightning System (in addition to remote wind, temperature, and rain sensors) to track temperature, relative humidity, solar radiation, wind direction and speed, and advancing lightning/precipitation. The data may be downloaded to the central computer, which computes local evapotranspiration and then adjusts the run time for each individually controlled sprinkler head to match the ET loss on a daily basis. Soil moisture probes will be installed as needed to ensure proper irrigation of various management areas.

The spacing of sprinklers will be designed to minimize surface runoff and avoid inadvertent drift. Field controls will be placed for maximum visibility. Valve-in-head sprinklers will be used with individual control wires installed for each of the irrigation heads back to the field controllers. Heads on fairways and roughs can be paired at the controller on an average of two heads per station. Greens will be irrigated with full and/or part-circle sprinkler heads to allow the superintendent to irrigate in the most efficient manner. This reduces disease potential and results in lower usage of pesticides. Quick coupler snap valves will be necessary near the naturalized dune and plant restoration areas in order to provide supplemental water for grow-in purposes.

Management of Salt Accumulation

Soil Amendments. To overcome potential detrimental effects of the irrigation water quality during the grow-in period, consideration will be given to incorporating soil amendments into the final topsoil mix. This may include, for example:

- Application of elemental sulfur to controlled areas via a pelleted material to reduce soil pH;
- Application of gypsum, a calcium sulfate salt, to reduce accumulation of sodium and other heavy metal salts for the top 6 inches (root zone area); and/or
- Application of dolomitic limestone to raise soil pH.

Flushing. Once the turf is established, the common agricultural practice to control salt buildup in the root zone is by flushing with higher quality water or simply by applying surplus water, depending upon the specific needs. Currently, at other golf courses in the Pebble Beach area, potable water is used at regular intervals during April through November to flush sodium out of the root zone. It is anticipated that this same practice will be used to some extent on the tees and greens for the proposed golf course; however the frequency and amount of flushing required is expected to be less than on other courses, due to the sandier nature of the soils at the proposed golf course site, incorporation of the most up-to-date construction techniques for golf courses, and based upon careful consideration of salt tolerance in the selection of turfgrasses and the design and construction of the greens in accordance with USGA standards. When the proposed reclaimed water project improvements are made, these potential impacts are either completely eliminated or dramatically attenuated, and the need for flushing is eliminated. The water from flushing operations will be collected in an underdrain system, then rerouted through a detention basin or a sand-soil peat filtering bed, followed by dispersal into areas where it will be allowed to percolate and ultimately mix with groundwater zones having naturally higher saline levels than those anticipated from the flushing operation.

pH Adjustment. Additionally, to mitigate potential problems associated with root and foliar absorption of salts on the proposed golf course, the design of the irrigation system may incorporate automatic or mechanical sulfuric injection techniques to assist with applying gypsum or acidifying materials with the irrigation water. This could be accomplished with fertigation equipment at the irrigation pump station, where the pH of the water can be controlled using sulfuric acid or a sulfuric/fertilizer blend. This has the effect of keeping the dissolved solids and salts present in the irrigation water in solution so that they can leach through the soil rather than accumulate in the top layers where they can cause damage to the turf. Examples of systems that will be evaluated for incorporation in the golf course design include: PlantStar, Werecon, Nutrifeed Turf Feeding Systems, and DGT/Voltmatic. If this practice is implemented it would be done selectively and in conjunction with soil pH monitoring to protect against altering the pH in the adjoining native buffer and wetland area.

Reclaimed Water Requirements

Construction and operation of water recycling irrigation systems are governed by requirements contained in California Administrative Code, Title 22 Water Recycling Criteria, which have been established to ensure protection of public health. Specific guidelines that will be followed to conform with Title 22 requirements are summarized below:

- **Cross-Connections.** No cross-connections will be allowed between the potable water system and reclaimed water system.

- **Backflow Preventers.** An approved backflow prevention device will be installed in all required locations where reclaimed water is present to protect the potable water supply system from accidental cross-connections.

- **Pipe Identification.** All reclaimed water piping below or above grade will be colored purple or labeled with purple tape with the imprinted words "CAUTION – NONPOTABLE WATER" in English and Spanish.

- **Hose Bibs.** No hose bibs will be installed on the reclaimed water system; quick-coupling valves will be used instead.

- **Drinking Fountains.** No public drinking fountains will be located near areas irrigated with reclaimed water. At golf courses where reclaimed water is used for irrigation, bottled drinking water is often provided where public drinking fountains cannot be located.

- **Pipe Separation.** Separation distances between buried reclaimed water lines and potable water lines will conform with recommendations of the State Department of Health Services (DHS), which normally include: (1) 10 feet horizontal distance, and (2) 12 inches vertical clearance. Lesser distances may be approved using special pipe, sleeving, or other measures approved by the DHS on a case-by-case basis.

- **Warning Tags, Stickers, and Labels.** All valves, valve boxes, quick couplers, storage tanks and other major appurtenances within the reclaimed water system will be affixed with appropriate warning tags, stickers or labels so that they can be easily identified as being part of the reclaimed water system. The warning labels will include the words "NONPOTABLE WATER – DO NOT DRINK" in English and Spanish.

- **Use Area Identification.** All publicly accessible use areas where reclaimed water is used will include signs that include the following working in English and Spanish: "NONPOTABLE WATER – DO NOT DRINK".

- **Ponding of Reclaimed Water.** The irrigation system will be designed and operated to avoid the creation of ponding conditions on the golf course or adjacent irrigated areas.

- **Runoff of Reclaimed Water.** The irrigation system will be designed and operated to preclude runoff of irrigation water outside of the designated irrigation area. Irrigation water captured by the proposed golf course drainage system will be routed to detentions basins for percolation or evaporation.

- **Windblown Spray.** The irrigation system will be designed and operated to prevent windblown spray from leaving the designated golf course irrigation area.

- **Testing.** Backflow prevention devices will be tested at the time of system start-up, and then at least annually thereafter. The testing will be performed by a certified tester and the results submitted to the local water purveyor, California American Water Company.

- **Onsite Observation Reports.** An annual (or more frequent) walk-through inspection by the golf course superintendent will be made of the reclaimed water irrigation system to verify compliance with operational requirements. The inspection results will be recorded on a standard form and, at a minimum, will include observation of the following items:

    - Any evidence of irrigation water ponding.

    - Any evidence of irrigation runoff.

    - Proper placement of warning signs, tags, labels, and stickers.

    - Any evidence of leaks or breaks in irrigation piping.

    - Any evidence of broken or faulty irrigation equipment.

    - Corrective actions being taken to remedy problems observed.

SECTION 7

FERTILIZERS AND NUTRIENT MANAGEMENT

This section addresses fertilizer and nutrient management as it relates to the proposed golf course and the driving range at Spanish Bay. Typical golf course fairways, tees, greens, and roughs are fertilized regularly. Typical yearly application rates expected for the proposed golf course are 6 to 8 lb/1,000 ft^2 of total nitrogen for fairways and rough areas and 8 to 10 lb/1,000 ft^2 for tees and greens. The fertilizers generally are applied several times per year to avoid heavy doses of nutrients that could exceed the rate of plant uptake. The buffer areas may undergo a one-time fertilization during construction; subsequent fertilization is on a rare, as-needed basis to maintain a healthy ground cover of native annual and perennial grasses, forbs, and woody vegetation.

Nitrogen is the primary fertilizing agent and is of potential water quality concern for the adjacent seasonal wetlands, dunes, and sensitive plant areas. This is addressed by managing fertilizer application rates, regular soils testing, vegetated buffer areas, and bioswales. However, there are no identified existing or potential potable uses of groundwater in the project area that could be affected by nitrate additions from the golf course. In addition to the nitrogen in the fertilizer, the reclaimed water to be used for irrigation also contains a moderate to high level of dissolved nitrate-nitrogen. This is a relatively small amount compared to the nitrogen applied with the fertilizer, and will not by itself fully meet the nitrogen requirements of the turfgrass. Nonetheless, this source of nitrogen will be accounted for in making fertilizer application recommendations.

ENVIRONMENTAL ASSESSMENT

Nitrate Loading Factors

A variety of factors influence the transport of nitrogen from turf areas to surface waters, including climate, rainfall intensity and duration, soil texture, management practices, plant uptake ability, volatilization, and soil moisture conditions. The greatest concern is that of nitrogen fertilizer being transported by surface runoff from the area of application before it is absorbed and utilized by the vegetation. The majority of nitrogen transported to surface water consists of sediment-bound nitrogen (Balogh & Walker, 1992). The increased nitrogen delivered to a surface water body can serve as a nutrient enrichment, causing stimulation of aquatic growth and, possibly, increased eutrophication of the water body and potential direct impacts to sensitive aquatic organisms.

Management factors such as application rates, timing of application, the form (solubility) of application, and amount of irrigation all contribute to nitrogen's ability to move from the area of application into ground or surface waters. Irrigation and subsequent soil moisture levels have to be monitored and kept as low as possible to reduce the likelihood of seepage losses. The amount and timing of fertilization is important to maximize plant uptake and minimize the potential for surface runoff. The amount of irrigation and subsequent soil moisture levels are important to reduce potential leaching of nitrogen.

The layout of the golf course and driving range has avoided the placement of fairways, tees, greens, and other maintained turf where unfiltered runoff can directly enter any of the seasonal drainages, wetlands, dunes, or sensitive plant areas on the site. This will greatly reduce the potential for runoff of residual nitrogen from fertilizer applications. Special care will be taken in the final golf course turf design and operations to minimize the opportunity for golf course runoff to enter natural water bodies without first passing through a vegetated buffer area (i.e., buffer grasses, rough or transition area). Additionally, it is well documented that natural and enhanced stream corridors and wetlands have the ability to absorb and remove a significant amount of nitrate-nitrogen through plant uptake and denitrification in the soil *(*Pionke and Lowrance, 1991*)*; nitrogen uptake by riparian woodland and wetland vegetation has been reported in the range of 60 to 200 lbs N/acre/year.

Golf Course Nitrate Loading Analysis

To assess the potential impacts of golf course fertilizer use on wetland water quality, a nitrate loading analysis was completed for one of the key subwatersheds within the proposed golf course. Five subwatersheds were delineated by Balance Hydrologics, Inc. (Mallory, *et al.*, 2001) in the golf course area. Subwatershed 2 was selected for the analysis because of its longer water ponding period, which makes it more likely to support greater wildlife populations than other wetlands in the area.

Similar to the salt balance presented in **Section 6**, the nitrate loading analysis involved the construction of an annual water-chemical mass balance to derive an estimate of the "resultant" average nitrate-nitrogen concentration in the seasonal wetland area at the downstream limit of Subwatershed 2. The calculations and step-by-step description of the methodology are presented in **Appendix A**.

Briefly, the analysis uses an input-output model in which the following was assumed:

1. Nitrate may reach the wetlands via shallow groundwater or surface runoff.

2. The amount of nitrate leaving the golf course via groundwater or runoff is a function of the total applied nitrogen. Leaching losses through the groundwater were estimated at 5% to 10% (Petrovic, 1990), while runoff losses of 1% to 3% were assumed, based on estimates reported in the literature (Balogh and Walker, 1992).

3. The volume of water reaching the wetlands was determined from the water balance calculations by Balance Hydrologics, Inc. (Mallory, *et al.*, 2001) for "normal" year conditions. Added to this was a factor for irrigation seepage losses from the golf course, which was estimated to be 10% of the irrigation water applied to the golf course turf areas (3.6 acres) immediately bordering the wetland buffer.

4. Losses of nitrate were estimated to occur as a result of denitrification in the shallow groundwater, based on the volume of "saturated" soil and estimated organic content. The amount of soil available for denitrification is dependent upon the buffer area. Calculations were made for buffer areas of 25 and 100 feet, which are representative of the proposed buffer areas to be provided around the golf course, driving range, and equestrian area.

5. Losses of nitrate in surface runoff from the golf course were estimated to be in the range of 10% to 30%, based on the application of various management practices for filtering, detention, and absorption of surface runoff.

6. The "resultant" average nitrate concentration in the wetlands was calculated from the total annual mass of nitrate reaching the wetlands, divided by the total flow-through volume of runoff, direct precipitation, shallow groundwater, and irrigation return flow.

The results of the analysis indicate a projected nitrate-nitrogen concentration in the wetlands to be in the range of 0.62 to 3.11 mg/L (as nitrogen). In comparison, background levels of nitrate in the surface water and shallow groundwater in the wetlands in Subwatershed 2 are non-detectable (generally, less than 1 mg/L), while nitrate in other drainages on the site had background concentrations up to 1.5 mg/L (as nitrogen). The highest background concentrations of nitrate were in the drainage receiving runoff from the existing equestrian center. However, significantly higher levels of ammonia and organic nitrogen (concentrations of 1.4 to 14.0 mg/L, as nitrogen) were found in shallow piezometers located within Subwatershed 2, and at levels as high as 12 mg/L (as nitrogen) in surface runoff from the equestrian center drainage. The low background levels of nitrate occurring in combination with high ammonia and organic nitrogen concentrations is indicative of the natural capacity of water-logged soils and wetlands to assimilate and remove nitrate (i.e., through biological denitrification). In contrast, ammonia and organic forms of nitrogen require an oxidizing environment for chemical conversion and biological uptake or breakdown, which only occurs to a significant degree during the time of the year when the wetlands go dry. Therefore, the existing nitrogen inputs to the wetlands, believed to be largely from equestrian sources, are not readily assimilated. As a result, the modeling analysis indicates that the total annual nitrogen loading contribution to the wetlands from the golf course (estimated to be 0.62 to 3.11 mg/L) may fall below the average background total nitrogen levels that currently exist in the wetlands. Moreover, the input of nitrogen from the golf course, to the extent that it occurs, will be in the nitrate form, which is most amenable to assimilation and removal by plant uptake and denitrification – a natural wetland function.

Currently, animal waste from the existing equestrian center and equestrian trails contribute to nutrient loading at the proposed golf course site; these sources will be removed from the site as part of the development plan. The existing equestrian center drains primarily to the Carmel Bay ASBS watershed, and to the largest natural and manmade wetlands at the proposed golf course site (located in the central portion of the site). Nutrient loading to the Carmel Bay ASBS and to a large portion of the golf course site will be reduced by the removal of the existing equestrian center. There will be no direct effect to nutrient loading to some of the wetlands and all of the dune areas at the proposed golf course site by the removal of the existing equestrian center. However, removal of the equestrian trails on the site would result in a reduction of nutrients currently entering the wetlands and the dune areas. Also, substantial nitrogen uptake and denitrification processes in the proposed buffer areas would aid in the reduction of nutrients entering the wetlands or other sensitive areas.

The probable source of the existing nitrogen levels in the wetlands (high ammonia and organic nitrogen levels) appears to be related to horse traffic on several riding trails that traverse the wetland watershed. A portion of the trails cross directly through the wetlands. These horse trails will be relocated as part of the project, which will eliminate this existing source of nutrient input to the wetlands. The estimated reduction in nitrogen loading to Subwatershed 2 from elimination of the horse trails is potentially significant, and was estimated by analyzing the amount of horse activity in the area. Based on data from the Pebble Beach Company, it is estimated that approximately 60,000 horse trail rides occur in Subwatershed 2 every year. These include visitors as well as owners who board their horses at the center. The horses begin in the existing equestrian center (located outside of Subwatershed 2) and traverse the subwatershed, mostly on trail rides that lead to the beach. Using information on trail length, horse riding time, and total rides, the total "horse time" in the watershed was estimated. Then using information on the estimated annual nitrogen contribution in horse manure and urine, the total nitrogen contribution to the watershed was estimated. Assuming that 50% of the nitrogen is lost to volatilization and only the trail segment (about 1/3 of the total) crossing directly through the wetland actually contributes nitrogen to the wetland, the annual loading of nitrogen from existing horse trail rides was estimated to range from about 9 to 18 lb/year. In comparison, the estimated total nitrogen input from the proposed golf course may range from a low of 10 lb/yr to a high of 52 lb/yr. The assumptions and calculations are presented in **Appendix A**.

This analysis indicates that the conversion of the site to a golf course may (for the low estimate of 10 lb/yr loading) result in a net reduction in the total nitrogen loading to the wetlands as compared with the existing nitrogen loading from the horse trails. For the worst-case assumptions, the estimated total mass loading of nitrogen to the wetlands (52 lb/yr loading) would represent an increase over the current conditions. However, because it would be distributed more evenly through the wetlands, the estimated resultant concentration of 3.11 mg/L (as N) would be at or below the total nitrogen concentrations observed in the localized area currently impacted by the horse trails. This is supported by the background data showing total nitrogen concentrations as high as 14 mg/L in certain areas of the wetlands. The conditions in these areas, which are in close proximity to the designated ESHA wetlands, can be expected to improve in regard to nitrogen loading and concentrations as a result of the conversion from equestrian uses to the proposed golf course.

FERTILIZERS AND NUTRIENT MANAGEMENT PLAN

The objective of a golf course nutrient management or turfgrass fertility plan is to develop and maintain a vigorous healthy turf that can withstand environmental stress, while minimizing adverse impacts from chemical use. Maintenance of a healthy turf through appropriate fertilization, irrigation, and mowing also maximizes the natural genetic pest resistance potential of the plant cultivars.

General Management Principles

Careful and scientifically managed application of chemical fertilizer is required to insure that nutrients applied are not transported to surface water or groundwater. Nitrogen and, to a lesser extent, phosphorous and potassium are the principal nutrients applied in a chemical fertilizer form to intensively managed landscapes and are the biggest concern regarding impacts on water quality. Various management practices are available to minimize water quality impacts, and these principles have been incorporated into the BMP Plan. The key principles that will guide nutrient management for the golf course include the following:

1. Use realistic application rates based on soil and plant tissue testing.

2. Consider the total load of readily available nitrogen applied with the reclaimed water.

3. Use slow release forms of granular fertilizer (particularly nitrogen).

4. Time applications to coincide with periods of plant growth and uptake; avoid applications immediately prior to rainy periods.

5. Manage irrigation applications for high efficiency, minimizing runoff and deep percolation losses. This will be accomplished with the use of a sophisticated computer-controlled irrigation system with an on-site weather station.

6. Maintain and calibrate application equipment and apply uniformly over areas of similar nutritional needs.

7. As part of the golf course design, incorporate and maintain vegetated filter strips, bioswales, detention basins, and natural buffer areas to promote the capture and retention of nutrients that may be contained in golf course runoff.

Soil and Plant Tissue Testing

Plant tissue testing of the turfgrasses from the various management areas (greens, tees fairways, etc.) will initially be completed on a 30-day schedule for the major elements (nitrogen, phosphorus, potassium) during the first year. Thereafter, plant tissue testing will likely be needed only on a three- to four-month cycle. Typically, soil testing will be conducted twice a year (spring and fall) to determine the nutrient reservoir status of the soil. The results of the analysis will guide the selection of the appropriate fertilizer and rates and methods of application.

Recycled Water Nitrogen Content

Recycled water supplies turfgrass with a constant, low dosage of available nutrients. Turfgrass is very effective in using this source of nitrogen and phosphorous. Incorporating irrigation water nitrogen into the nutrient budget allows for a reduction of higher-dose applications of nitrogen, which, in turn, increases uptake efficiency, reduces the total environmental load of nutrients added to the soil and decreases the risk of off-site transport (Balogh & Walker, 1992). Fertility management with recycled wastewater is an important component of environmentally sound and sustainable fertilization practices. Although the nitrogen content in the recycled water varies seasonally, based on an average nitrate-nitrogen concentration of 16 mg-N/L in the recycled water supply and an average irrigation water demand of approximately 100 to 215 acre-feet per year for the golf course, approximately 4,300 to 9,300 pounds of nitrogen can be supplied to the golf course via the irrigation water source. This amounts to approximately 15 to 35 percent of the projected annual nitrogen requirement for the golf course turfgrass. Additional nitrogen could be added to the irrigation water; this process is referred to as “fertigation.” However, there are times when fertilizer would be used independent of irrigation. For example, in the springtime, when the ground is still moist from rainfall and irrigation is minimized, fertilizer may be applied to facilitate turfgrass growth.

Fertilizer Selection

Depending upon the determined nutritional status of the plant tissues and soil reservoir, fast release, slowly available, or combined forms of nutrients will be selected for application to turf areas. The selection may include organic, synthetic granular, or foliar application sprays. In general, infrequent applications of slow release fertilizers, including organic sources, are preferred, as they match solubility with plant uptake rates and help to maintain healthy populations of soil micro-organisms.

Cultivation Practices

Golf course management involves the use of numerous cultural practices to maintain optimum playability and minimize impacts. In addition to fertilizer application, pest control, and advanced irrigation technology, a variety of cultivation and mechanical practices are also used to manage the course effectively. These include:

- Planting, utilizing a mix of appropriate species including turf hybrids especially suited to climatic and cultural conditions.

- Use of native and low maintenance species as vegetative buffers to reduce erosion and runoff potential.

- Use of hardy plant varieties that demonstrate a resistance to predators and diseases, thus reducing dependence on agricultural chemicals.

- Use of mechanical practices, such as mowing, aeration, top dressing, etc. to reduce the need for chemical application.

- Soil and plant tissue testing under the direction of the Golf Course Superintendent prior to fertilization to ensure appropriate application rates.

Plant Species Selection

Turfgrass cultivars will be utilized at the proposed golf course that are hardy, low in disease susceptibility, and resistant to pests. The physical properties of grasses also make them well suited to filter and bind chemicals in water. These include the presence of thatch as a filtering mechanism, high surface area volume, and extensive, fibrous root systems capable of supporting large microbial populations which absorb fertilizers and breakdown pesticides. The proposed turf cultivars are described in **Section 6**.

Propagation and Plant Establishment

After completion of grading operations, the site will be stabilized (if needed due to seasonal constraints) prior to completion of site improvements, and in accordance with the approved Erosion Control Plan. The irrigation system will be installed and pressure tested prior to and concurrent with the start of a planting program. The need for pre-emergent weed control, fertilization and/or soil amendments will be determined based on the results of soil testing and recommendations.

Planting in erosive areas will utilize sod, seeding and plug planting of native grasses and forbs, mulching or erosion control blankets, and/or hydromulching using soil tackifiers to reduce potential impacts. Irrigation will be carefully monitored during the plant establishment period to ensure that rapid plant cover is attained.

Vegetated Buffers

The plan incorporates the use of vegetative buffers, gently sloped berms, selective use of subdrains and small vegetated collection-treatment basins to separate intensive use areas from sensitive habitat areas adjacent to the site. These buffers will provide transition areas with vegetation requiring minimal maintenance to capture nutrients or other chemicals that may be carried in runoff from the turf areas. The berms will be utilized to reverse the natural ground slope in certain areas to prevent runoff from the turf areas from entering sensitive areas where a sufficient buffer is not provided.

SECTION 8

TURFGRASS PEST MANAGEMENT

This section addresses the issues and approach to turfgrass pest management at the proposed golf course, which also apply, to a lesser extent, to the proposed driving range at Spanish Bay.

The demand for turfgrass of high quality and uniform playing surface on golf courses often requires intensive management to control pests. This is particularly true for tees and greens, which occupy only a small amount of the overall golf course, but require a disproportionately high amount of turfgrass management. Pesticides are used to control or reduce the adverse effects of pests, including harmful insects, unwanted plants, and pathogenic organisms (Note: the term "pesticides" includes insecticides, herbicides, fungicides, rodentcides, etc.). Turfgrass diseases are a significant problem on golf courses, even under good management conditions (Balogh and Walker, 1992). Close mowing, frequent nutrient application, irrigation, and moist surface soil conditions favor the occurrence of infectious fungal diseases. These problems can be avoided or minimized by use of good cultivation practices (irrigation and mowing) designed to favor selected turfgrasses with good pest and disease resistance.

ENVIRONMENTAL ASSESSMENT

In combination with biological or other pest control measures, pesticides are typically used for golf course turf maintenance. These chemicals are applied selectively and much less frequently than fertilizers. Usually pesticides are applied no more than once or twice per year; but they may need to be used more frequently for special problem areas. The pesticides and herbicides typically used on golf courses are neither highly mobile nor persistent; they dissipate rapidly as a result of volatilization, photodegradation, microbial action, hydrolysis, and soil absorption.

Potential Groundwater Impacts

Pesticide movement to groundwater is generally associated with the following conditions:

- Coarse alluvial soils that may have interbedded fine grain material.
- Application of excessive quantities of irrigation water or other sources.
- Unconfined aquifers with a depth to water table less than thirty feet.
- Extensive or concentrated pesticide applications to the soils occurring over many years.
- Use of pesticides that are highly persistent and mobile in the soil-water systems.
- Careless handling and disposal of unused pesticides, wash water, and containers.

These impacts have been historically associated with poorly managed agricultural operations, and not professionally managed landscapes and golf courses. Soils on the proposed golf course are generally moderately permeable. Golf course irrigation will be controlled by an automated system specifically designed to prevent excessive watering and to minimize runoff from the site. Because irrigation will be held to a minimum, the amount of excess irrigation water lost to groundwater will also be minimal. This will significantly reduce the potential for pesticides to be transported to groundwater.

Pesticide use on golf courses is relatively small compared with intensive agricultural operations. The most intensively managed areas, tees and greens, occupy a very small part of the overall golf course. Agricultural pesticide use tends to be a broadcast application for a broad spectrum of pests, as opposed to golf course use, where pesticides are applied more discretely for narrow-spectrum problems. The pesticides in common use on golf courses are usually undetectable one to two weeks after application.

Potential Surface Water Impacts

The principal threat to water quality from pesticides/herbicides for the proposed golf course would most likely occur in the event of: (1) a significant rainfall event immediately following chemical application, or (2) spillage in the area where the chemicals are handled and/or stored. There could be a potentially significant impact on the surface water quality of on-site drainages and wetlands and more remotely downstream in the Pacific Ocean if either of the above noted events were to occur when surface water courses are flowing immediately after rainfall events. The plan incorporates measures to minimize and avoid these impacts, including safeguards and controls over storage and handling, emergency spill response, vegetated buffer areas, and several detention basins between the turf areas and drainage channels to absorb and attenuate the effects.

Appendix B discusses the results of storm water quality monitoring data in the Del Monte Forest from 1995 to 2002. The samples were generally screened for thirty-one chlorinated pesticides, twenty-one organophosphate pesticides, and seven pesticides that required special analytical treatment (glyphosphate, Garlon®, dithiocarbamates, ethofumesate, dicamba, MCPP, and 2,4-D)[1]. In general, samples were taken for two storm events, with the first sampling taking place after the first storm of the season. Of the sixty-seven pesticides that were sampled for, only thirteen were detected (a total of 32 individual detections) over the seven-year sampling period; none were found at high concentrations. Several chlorinated pesticides that were detected during the 2001-2002 sampling season suggest household and/or other non-golf course pesticide applications contribute to pesticides in the storm water runoff. Heptachlor, a pesticide that has been banned since 1988 for all uses except for fire-ant control, was detected, and endosulfan I and delta-BHC, both chlorinated pesticides that are not used by local golf courses, were also detected. None of the pesticides recommended for use at the proposed golf course site were detected in the storm water sampling. The existing golf courses do not necessarily contain the same design BMPs, such as natural vegetated buffers and runoff detention measures, that will be part of the proposed facilities. The more intensive BMPs proposed for use at the new golf course site are designed to avoid the transport of pesticides to wetlands and offsite.

[1] 1995/1996: 30 chlorinated pesticides, 21 organophosphates, 4 pesticides required special analysis
1998/1999: 33 chlorinated pesticides, 27 organophosphates, 7 pesticides required special analysis
2001/2002: 23 chlorinated pesticides, 20 organophosphates, 7 pesticides required special analysis

PEST MANAGEMENT PLAN

Policy Guidelines

The focus on the pest management (insect, disease, weeds, etc.) aspects of this plan is to minimize the use of chemical means of control whenever feasible or practical to do so. First consideration is given to the use of Integrated Pest Management (IPM) Practices.

An integrated approach to vegetation management and pest control is the most appropriate. When management planning and environmental analysis indicates chemical control should be utilized, the least harmful chemical should be selected and applied at the lowest possible rate to provide control. When selecting the pesticide, consideration must be given to the herbicide's persistence, toxicity, runoff and leaching potential. This requires taking into account both the characteristics of the pesticide and the soil and site conditions. Very often, complete eradication of the pest problem is not necessary and mechanical or hand labor methods can be used preceding or following chemical control. The criteria for use and selection of herbicides and pesticides to be used include: public health and environmental safety, performance results, and lastly, cost considerations. Pesticides are assessed through the use of a screening system that includes a consideration of toxicity (LD_{50}), persistence or half-life, and solubility/leachability.

Pesticide use is strictly regulated by federal and state laws to ensure proper selection and application of these chemicals. The proposed golf course will be required to follow those laws, which include the designation of a certified Pest Control Advisor, a recommendations report prior to pesticide applications that considers IPM first, and reports of on-going pesticide use.

Maintenance operations should be conducted with full awareness and consideration of application impacts on water quality. Annual planning programs based on turf condition inventories and scouting reports should be prepared for the control of undesirable vegetation, insects, diseases, and rodents and indicate the location of applications, types of materials, rates to be applied, pests to be controlled, and other pertinent information concerning chemical application.

These programs should be reviewed for need, appropriateness, and safety, and once approved, changes should be adhered to. If changes in the type and amount of pesticides recommended for use are deemed necessary, they should be submitted to the County Agricultural Commissioner for a review and approval process. Only the safest materials shall be used at the lowest possible rate to accomplish the desired results. In preparing vegetation control programs, special consideration shall be given to the possible movement of pesticides into surface and groundwater and the movement of pesticides absorbed by clay particles eroding into streams and flood control channels.

Environmental Considerations

The following environmental considerations are incorporated into the IPM plan for the golf course.

1. **Alternative Physical Measures.** In sensitive areas of the project ,where there are special habitats, high contact with the public, or community concerns, alternatives to the chemical program will be implemented. These include sensitive areas of the site (e.g., dunes and sensitive plant areas) and areas adjacent to wetlands. Berms and buffers have been incorporated into the plan to further reduce impacts on these -areas.

2. **Habitat Interaction.** All vegetation control will be implemented in a manner that avoids any spraying into sensitive habitat areas, such as dunes, wetlands, sensitive plant areas, and other vegetated areas along seasonal drainage channels.

3. **Vegetated Buffers.** Vegetated buffer strips have been designated adjacent to seasonal wetlands and drainage channels. Herbicides will not typically be applied within these vegetated buffer areas. If vegetation control is necessary within the buffer areas, it will be performed by using a combination of mechanical and hand removal with occasional, selective applications of herbicides or use of approved organic pesticides. Established buffer strips allow an additional level of protection from potential surface water contamination.

Chemical Vegetation Control Principles

Pre-application planning is essential in a successful chemical application program. This planning includes identifying the problem and formulating the best methods to achieve the desired result. For example, prior to installing the turf and landscape components, complete weed eradication may be needed. An assessment will be made to determine the most appropriate method of control. When planning for control of vegetation by chemical application, the following factors should be considered:

1. **Timing of Application**. Timing of application is a key factor to achieve successful results. The application of pre-emergent herbicide needs to precede germination of annual weeds to provide control, although spraying after germination when the vegetation is short can be used to reduce fire hazard in low-maintenance areas. Systemic herbicides must be applied when vegetation is actively growing. This coincides with optimum soil moisture and soil temperature conditions. Air temperature and wind conditions can also dictate timing of application. Some herbicides require hot days, others humidity, and some act only when the air temperature is cool. Post-application rainfall enhances the effectiveness of some herbicides but is detrimental to the efficacy of others.

2. **Selection of Pesticide**. No vegetation control program can be successful unless the correct herbicide is used. In addition to being capable of achieving the desired control, it must be safe for the applicator, safe to golf course users, and environmentally safe to adjacent landscaping, wildlife habitat and water quality. Pesticide toxicity and modes of transport and uptake mechanisms must be well understood, and it should be economical to use in relation to other methods of control. The amount of chemical, the method of accomplishing the work, the rate of chemical material to use, and the method of application also need to be coordinated to achieve the desired results. A measured amount of the active ingredient of a chemical evenly distributed over a unit of area is necessary when applying pre-emergent herbicides to the soil, or, when spraying contact or systemic herbicides on small post-emergent vegetation.

3. **Application Rate**. Systemic or contact herbicides must be correlated with the total leaf area present, and the amount of carrier required to give thorough wetting of the plants. Therefore, it is common practice to use varying rates of the active ingredient per acre, according to the density of foliage. For example, 100 gallons of spray may be required to thoroughly wet an acre of low grasses on which 4 pounds of the active ingredient of an herbicide will achieve good results. An acre of taller grass mixed with some brush might require application of 300

gallons containing 12 pounds of the active herbicide ingredient in order to adequately cover the larger biomass (living tissue), as compared to a smaller application amount on mowed grass.

4. **Application Equipment and Techniques**. Nozzle pressure for spraying of herbicides should be held generally to about 40 psi in order to avoid drift. In some instances, pressures of up to 200 psi must be used to obtain the desired coverage when spraying golf play areas. Due to drift, extreme caution must be exercised with this practice. Surfactants or adjuvants must be chosen properly. They may add to the effectiveness of one chemical or be detrimental to another. Their use must be considered when planning a herbicide vegetation control program.

   Speed of travel, either in a spray vehicle, or on foot with back-pack sprayer, must be coordinated with the dosage rate required, and with the output as affected by the pressure and the nozzles. Too much travel speed for the calculated rate and pressure would result in a thin and perhaps ineffective application, while slower than calculated speed would result in over application, with possible impacts to adjacent habitats.

   Lack of proper agitation within the spray tank can result in settling of suspended herbicidal materials and an ineffective spray operation. It is essential that all factors be weighed and coordinated to get the best results. Care must also be exercised in filling tanks and cleaning equipment to prevent environmental contamination.

Pesticides Proposed for Use

Table 8-1 lists and summarizes the characteristics of the key pesticides that are typically used at golf courses. The chemicals that have been recommended for use at the proposed golf course are highlighted. These chemicals were selected based upon turfgrass management needs, previous effectiveness and performance (including experience with specific products/pests in the Pebble Beach area), and pesticide properties.

Appendix C provides a description of pesticide selection and use requirements, and also includes background information regarding pesticide toxicity, persistence, and mobility terminology used in **Table 8-1**.

Table 8-1
Sample List of Pesticides Used at Golf Courses

Trade Name	Common Name	Use[2]	RelativeToxicity		Persistence[4] (half-life)	Pesticide Groundwater Movement Rating	Areas Treated[5]
			Human	Aquatic			
Pesticides Recommended for Use at the Proposed Golf Course Site							
Cleary's® 3336 wsp	Thiophanate-methyl	F	PNT[3]	Slightly	Non.	V. Low	T G F PR
Confront®	Clopyralid	H	Slightly	PNT	Non.	V. High	T F PR SR
Manage®	Halosulfuron-methyl	H	PNT[3]	Slightly	Mod.	High	T F PR SR
Merit 75® (wsp)	Imidacloprid	I	Slightly	Slightly	Mod. to Pers.	Mod. to High	T G F
Primo Maxx®	Trinexapac-ethyl	GR	Slightly	Slightly	Non. to Mod. Pers.	Low to Mod.	G T F PR SR
Proxy®	Ethephon	GR	PNT[3]	Slightly	Non.	Ext. Low	T F PR
Roundup Pro®	Glyphosate	H	Slightly	PNT	Mod. Pers.	Ext. Low	Spot Treat
Subdue Maxx®	Metalaxyl	F	Slightly	Slightly	Mod. Pers.	V. High	T G
Trimec Classic®	MCPP	H	Slightly	PNT	Non.	High	T F PR
Trimec Classic®, Vanquish®, Banvel®	Dicamba	H	Slightly	PNT	Non.	V. High	T F G PR
Turflon II Amine®, Confront®	Triclopyr	H	Slightly	PNT	Mod. Pers.	V. High	F PR SR
Additional Pesticides Typically Used by Golf Courses							
Banner Maxx®	Propiconazole	F	Slightly	Moderately	Pers.	Mod.	T G F PR
Barricade®	Prodiamine	H	PNT[3]	Highly	Non. to Pers.	Ext. Low	T F PR
Chipco® 26019 FLO	Iprodione	F	PNT[3]	Highly	Non.	Low	T G F PR
Compass®	Trifloxystrobin	F	Slightly	V. Highly	Non.	Not available	T G F PR SR
Daconil®	Chlorothalonil	F	Slightly	Highly	Non.	Low	T G F PR
Eagle®	Myclobutanil	F	Slightly	Moderately	Non.	Mod.	T G F
Heritage® 50 WG	Azoxystrobin Technical	F	PNT[3]	Highly	Non.	Low	T G F PR
Nemacur®	Fenamiphos[1]	I	Highly	V. Highly	Mod. Pers.	High	G
Pre-M 60® (wdg)	Pendimethalin	H	PNT[3]	Highly	Mod. Pers.	V. Low	T F SR
ProStar® WP	Flutolanil	F	Slightly	Moderately	Pers.	Not available	T G
Sevin®	Carbaryl	I	Moderately	Highly	Non.	Low	T G F
Tupersan®	Siduron	H	PNT[3]	Moderately	Mod. Pers.	Mod.	F PR
Turfcide® 10%, Penstar Flo®	PCNB	F	PNT[3]	Highly	Non.	V. Low	G
Turflon II Amine®, Trimec Classic®	2-4-D	H	Moderately	Slightly	Non.	Mod.	T F PR

Note: wsp = water soluble packets; wdg = water dispersible granule; [1] It is possible that no insecticidal treatment will be needed for control; [2] F = Fungicide, H = Herbicide, I = Insecticide, GR = Growth Regulator; [3]PNT = Practically non-toxic; [4]Pers. = Persistent, Non. = Nonpersistent, Mod. = Moderately Persistent; [5]T = Tees, G = Greens, F = Fairway, PR = Primary Roughs, SR = Secondary Roughs

Risk Assessment

Prior to final pesticide selection, a risk analysis will be completed and included in the pesticide use report submitted to the Agricultural Commissioner as part of the reporting requirements for pesticide use and, at the discretion of the Commissioner, will be subject to peer review by the UC Extension Service, Regional Water Quality Control Board (RWQCB), California Department of Fish and Game (DFG), or other qualified other review authority. The risk analysis will include the following:

Groundwater Risk Analysis

Human Health Risk. This involves an estimate of the worst-case pesticide (for proposed pesticides) concentrations in groundwater and comparison to lifetime drinking water Health Advisory Levels (HALs); HALs are based upon federal maximum contaminant levels (MCLs) when available. Only screening-level risk assessment is needed, since groundwater is not a drinking water source, nor is it likely it will be developed as one.

Fish, Amphibian, and Aquatic Invertebrate Risk. Groundwater contamination by pesticides could impact groundwater-influenced wetlands. This involves an estimate of the worst-case pesticide (for proposed pesticides) concentrations in groundwater and comparison to EPA LC_{50} aquatic toxicity categories (pesticides).

Surface Water

Pesticides. A two-tiered risk screening will be used to assess risk of pesticides in surface water. Tier-I risk screening is used to determine which of the proposed pesticides are the highest-risk (based upon toxicity, persistence, and leachibility). Tier-II risk screening determines the concentrations of the highest-risk pesticides in the runoff/receiving waters and compares them to maximum allowable concentrations (i.e., for aquatic organisms).

USE AND HANDLING OF PESTICIDES

General Use and Safety Procedures

Pesticides are toxins and should always be handled with great caution. The following program for the use and handling of pesticides is designed to minimize the likelihood of injury from exposure to these chemicals to applicators, the public, and the environment.

- Applicators should always read the label before using pesticides, noticing warnings and cautions before opening the container. This process should be repeated every time, no matter how often a pesticide is used, or how familiar the work crew is with the material. Applicators should apply the pesticide only in amounts recommended and at times specified.

- Applicants should avoid inhaling sprays or dusts. Training must be completed before an employee is allowed to handle pesticides and at least annually thereafter. Applicators should never smoke, eat, or chew when mixing or spraying. Applicators should not use the mouth to siphon liquids from containers or to blow out clogged lines. Applicators should not work in the drift of spray material, nor spray with leaking hoses or connections. Chemicals should be confined to the area being treated and drift avoided by stopping treatment if the weather conditions are not favorable. Spray wands shall never be directed to water bodies or unintended wetland and riparian vegetation. Should pesticides be accidentally spilled on the skin or clothing, contaminated clothing should be removed immediately and the contaminated area washed thoroughly.

- Personnel involved in spray operations must be knowledgeable of the material(s), hazards, methods and purpose of the particular operation with which they are involved.

- As directed on the label, protective clothing, a mask or respirator, and eye protection shall be worn, especially when handling chemicals in a concentrated form. All applicators should be fitted and tested for respirators on a regular basis.

- For all activities involving the use of pesticides, the golf course shall make prior arrangements for emergency medical care and post in a prominent place at the work site, or in the application vehicle if there is no designated work site, the name, address and telephone number of the physician, clinic, or hospital emergency room providing care. When the employer has reasonable grounds to suspect that any employee has a pesticide illness or when an exposure to a pesticide has occurred that might reasonably be expected to lead to an employee's illness, the employer shall take the employee to a physician immediately, along with the pesticide label if possible.

- A warning decal, "**Warning, Not Drinking Water**," shall be placed on the rear and both sides of the tank of all spray units over 50 gallons. A "**Do Not Drink**" decal should be placed near each of the fresh water tank valve outlets so that it can be easily seen by anyone at the position. Placard holders should be mounted near the main outlet of the tank so that it is easily visible from the rear of the unit. Placards with the name of the chemical being used and with warnings should be in place during all spraying.

- Clean water and soap for routine washing of hands and face and for emergency washing of the entire body must be readily available for employees at the work site. There should be a minimum of 10 gallons of water for one employee and a minimum of 20 gallons for two or more employees. In addition to labeling tanks for the protection of the public, all warnings and precautions appearing on each pesticide label will be strictly adhered to by applicators for their own personal protection.

- The golf course will maintain an area where Material Safety Data Sheets (MSDS) and other information are readily available to employees; a hazard communication program should be implemented for employees.

- First aid training should be made available. All trucks should be equipped with first aid kits and eyewash stations.

- Safe handling, mixing, storage and disposal practices shall be employed, and emergency response measures shall be developed and utilized. Equipment, including hoses and spray wands or guns, shall be clean and checked for safe and proper operation prior to beginning of operation. Cross contamination from prior uses should be avoided. All spray equipment should be cleaned and "detoxed" with Nutra-sol (or equivalent) between applications. Dispose of rinsate appropriately, with the first choice on the treatment area.

Mixing and Formulation

Pesticides should be accurately measured to ensure correct rate of use and should be loaded and mixed in accordance with label specifications. Wettable powders should be pre-mixed into a slurry form before adding to the main spray tank. Tanks in small sprayers are mixed to provide the proper amount of spray for the job and not have leftover material. Mixing should not take place within 100 feet of a seasonal drainage channel or storm drain.

Application

1. **Equipment.** Acquire and maintain the most recent and accurate application equipment to ensure that only the amount specified is applied to the target area, and that tight control on spray area is maintained.

2. **Calibration.** Operators must calibrate their equipment daily prior to the start of application to ensure the correct amount of chemical is being applied. Calibrations include: speed of travel (walking speed of an average person equals 3 miles per hour), and together with nozzle output shall be calibrated to attain the desired rate of application. Nozzle output should be calibrated at least twice each working day for sensitive areas. In addition, seasonal calibrations are needed when spray seasons change to recalibrate the entire system to prepare for the new application.

3. **Timing of applications.** Normally spray crews should begin work in the early morning to take advantage of reduced wind conditions. Sensitive areas where drift is a concern should be sprayed during these intervals. In addition, drift control agents can be added to the tank to lessen off-target drift. Regulations enforced by California Department of Food and Agriculture (CDFA) do not allow application of certain pesticides when wind speeds exceed 10 mph. Specifications in individual product labels may vary with regard to wind restrictions. Spray rig operators should carry pocket anemometers to measure wind speed and spray operations must be stopped before winds reach the velocity where pesticides may drift off site.

4. **Weather.** Weather condition restrictions include wind and rain. No herbicides can be applied when wind speed approaches 10 mph, because of the potential for drift into non-target areas that could affect sensitive plant species, animals, or humans. No herbicides should be applied when rain is forecast within 48 hours; herbicides applied prior to a rain strongly adhere to soil particles. Therefore, if runoff occurs immediately after an application, it is very possible that the herbicide may contaminate surface water.

Equipment Repair

Maintenance employees who are responsible for delivering malfunctioning pesticide application equipment to an equipment shop or field mechanic should follow these required safety procedures:

- Spray tanks must be flushed (triple rinsed) with water to remove pesticide residue before servicing or repairing.

- All pipes, hoses and other locations that may contain pesticides must be flushed to prevent any pesticides from draining back into the tanks.

- The name, recommended protective devices or equipment necessary, and poisoning symptoms of the last substance used in the spray tank shall be transmitted in writing and attached to the piece of equipment.

Disposal of Empty Chemical Containers

Proper signs must be posted on pesticide storage buildings and areas for emergency response. The signs must be placed so they will be readily visible to fire personnel entering each area. Chemical pesticides must be stored in separate ventilated rooms from fertilizers or other materials. The storage area must be kept locked when not in use. A metal pesticide storage warning sign written in English and Spanish must be posted in areas where containers that hold or have held pesticides are stored. Generally, containers should be provided with secondary containment berms. Inventory, MSDS, and disposal manifest information will be maintained onsite.

Special attention should be given to disposing of empty pesticide containers. Pesticide containers that have held less than 28 gallons of a liquid pesticide must be rinsed and drained by the user at the time of use. The containers should be triple rinsed with the rinse solution from the container sprayed into the spray tank. Allow the container to drain 30 seconds into the spray tank after each rinsing. It is important that the rinse solution go into the mix tank and then be sprayed into the treatment area. In most instances, pesticide containers should then be perforated, crushed, or broken to eliminate the possibility of their unauthorized reuse.

If chemicals have been purchased in large metal drums, it is permissible to use smaller containers on hand that originally held the same material. Some containers are recyclable and can be refilled with the same pesticide. Coordinate with the Monterey County Agricultural Commissioner for information on proper disposal areas. Empty containers should be taken to approved disposal sites, and the operators of the disposal site notified of the contents of the containers for some types of pesticides.

Pesticide Spill and Response Plan

A spill response plan will be activated for spills or leaks of management chemicals used on the golf course. This plan will comply with applicable federal, state, and county laws. Major provisions of the proposed accidental spill response plan are the following:

1. Information and materials.

The following information and materials must be in place and an inventory of these items posted in the chemical storage area:

- Telephone numbers for emergency assistance, including local law enforcement and fire departments.

- Sturdy gloves, footwear, and aprons that are chemical-resistant to most pesticides (such as foil-laminate gear), and protective eye wear.

- An appropriate respirator, if any of the spill materials require such during handling activities or for spill cleanup (reference Material Safety Data Sheets on file for each product used).

- Containment "snakes" or booms to confine the leak or spill to a small area.
- Absorbent materials, such as spill pillows, absorbent clay, dry peat moss, or sawdust to soak up liquid spills.
- Seeping compound to keep dry spills from drifting or wafting during clean up.
- A shovel, broom, and dustpan made from non-sparking and non-reactive materials.
- Heavy-duty detergent.
- A fire extinguisher rated for all types of fires.
- Any other spill clean-up items specified on the labels of any products used.
- A sturdy plastic container with tightly closing lid that will hold the volume of material from the largest pesticide container being handled.

2. Spill Response.

- **Reporting the Spill.** As soon as possible after a spill has been identified, the golf course superintendent will be notified and have responsibility for reporting all spills to the list of responsible parties, including the Pebble Beach Community Services District Fire Department, the County Emergency Agency responsible for rapid response, and the County/Town/City/State Hazardous Substance Information Office. The following will be reported:

    a. Name and phone number of reporting party

b. Time and location of spill

c. Identity and quantity of material released

d. Status of clean-up and containment

- **Controlling the Spill.** On-site responders will: (a) protect themselves with appropriate protective closing and eye-wear, (b) stop the source of the spill, (c) protect others by warning them of the spill, and (d) stay at the site until the spill is cleaned up.

- **Containing the Spill.** On-site responders shall: (a) confine the spill as quickly as possible, (b) protect water sources and water resources, (c) absorb liquids with absorbent material,and (d) cover dry materials to prevent them from becoming airborne or solubilized.

- **Cleaning Up the Spill.** On-site responders shall: (a) clean up the spill; (b) decontaminate the spill site; (c) neutralize the spill site; (d) decontaminate equipment; and (e) decontaminate themselves.

Proposed Maintenance Facility

Architectural drawings and landscape plans for the golf clubhouse, driving range, equestrian center, primary maintenance buildings, pesticide storage, soil/greenwaste storage bins, equipment wash pad, and ancillary and support facility details have all been prepared as part of the Pebble Beach Company Del Monte Forest Preservation and Development Plan.

The site and landscape plans prepared for the proposed golf course maintenance facility detail how the 10,800-square-foot building will be benched and buffered into the topography of the 1.3-acre site.

The maintenance building will be used for golf course equipment storage and other maintenance operations, as well as for the safe storage and clean-up of fertilizers, pesticides and other materials. An all-weather access road serves the maintenance building and provides emergency and service vehicle access.

The proposed golf course will install a recycle washwater system for the turfgrass equipment wash pad area where the potential concentration of hazardous waste on a daily basis is highest. The recycling wash water system will be capable of capturing grass clippings, oil, grease, and trace organics prior to water treatment. The system installed will be a closed-loop wash/recycle rinsate system independent of the storm water drainage system. The chemical rinsate management systems will provide secondary back up to guard against accidental spills. The facility will meet or exceed the California EPA requirements for bulk handling and storage of pesticides. The system also filters residual concentrations of turfgrass chemicals and non-phytotoxic materials such as fertilizers. A back-up overflow system is normally installed to collect potential spills and divert the rinsate onto the wash pad apron and/or collection system.

Notification and Reporting Pesticide Use

A record of use of all pesticides must be reported to the Monterey Agricultural Commissioner on a monthly basis. The Pesticide Use Report must be submitted no later than the tenth of each month following the month covered in the report. The maintenance department should maintain a file containing daily spray report forms listing date, location, pesticides, amount used, purpose, weather, wind direction, spray personnel, worker safety or spill incidents, and any other pertinent information, including all safety items used by the applicators and support personnel. These forms may be used in formulating subsequent spray programs. The information on the Daily Chemical Use Report must be maintained for 5 years.

Accurate records shall be kept by the Golf Course Superintendent, and the following information shall be included:

1. Location of application (including width of application, description of location relative to fairway, roadway, ditch or channel).
2. Name of chemical(s) used (including percent of active ingredient and, if stated on label, the formulation, i.e., W, E.C., etc.).
3. Rate of chemical(s) applied per acre.
4. Purpose and objective of treatment.
5. Total acres treated.
6. Total gallons sprayed.
7. Actual time of spraying.
8. Approximate wind speed and direction.
9. Personnel and equipment involved.
10. Remarks (to clarify any unusual circumstance or incidents relating to the use of the chemical).

SECTION 9

EMERGING TECHNOLOGIES

The project will consider and, as their effectiveness is demonstrated, employ new and emerging technologies to provide safe and effective environmental management. This commitment will be implemented through on-going consultation with professionals in turfgrass management who are familiar with innovative non-chemical management strategies used at other courses, and who keep informed of university and private research in the area of biological control. Such emerging technologies are currently being developed under a system that is a successor to Integrated Pest Management, termed Ecologically Based Pest Management (ECPM) (National Research Council, April 1994). The ECPM relies to a much greater degree on understanding and predicting the causative factors to pest and disease infestations, as well as the ecological inter-relationships between pest organisms, other predator, prey, and disease organisms, and the environment. In this approach, (a) cultural techniques (irrigation, mowing, etc.) are used to manage environments that are less favorable to pest and disease problems, (b) models are used to predict conditions that are favorable to outbreaks, (c) monitoring and problem area mapping is used to identify specific shallow areas requiring intervention, and (d) narrow-spectrum pesticides and biological control methods are used to manage outbreaks (not necessarily eradication). Cultural maintenance (as opposed to chemical applications) is used for preventative controls and treatment is used when monitoring or modeling indicates developing problems.

The BioJect fermentation unit is an example of an ECPM emerging technology that may be considered for use at the project site. The BioJect injects live, naturally occurring soil bacteria (*Pseudomonas aureofaciens*, *Bacillus thuringensis*) through the irrigation system into the soil, which aids in the control of leaf pathogens in turfgrass. *Azospirillium* is an N-fixing bacteria that can be inoculated into the soil through the BioJect system to reduce the amount of fertilizer N application. This system is presently in use at several other golf courses in the San Francisco and Monterey Bay Areas including Spyglass Hill and Pebble Beach, but has only a few years of operating experience. The continuing experience at these other golf courses will be monitored to help determine the appropriateness and viability of this system at the project.

Several other non-chemical/biological treatments using parasitic nematodes and bacteria are available for insect control. Often these biological controls do not provide the degree of reliability and consistency needed. The following biological controls will be evaluated by the project during operational trials as part of their commitment to consideration of emerging technologies and biological control to reduce or minimize use of chemical controls:

- *Steinernema carpocapsae* (parasitic nematode, as insecticides)
- *Steinernema glasen* (parasitic nematode, as insecticides)
- *Heterorhabditis bacteriophora* (parasitic nematode, as insecticides)

Other biological controls, possibly introduced through the BioJect system, or similar application strategies will be considered and evaluated by the project, when recommended by the consulting turfgrass management professionals, such as.

- Azatin EC (botanical pesticide for broad spectrum insect control, derived from Neemtree, *Azadirachta indica*). Registered for use on ornamentals, spray-on monitoring.

- Pyrellin EC (botanical insecticide derived from crushed, dried flowers of a perennial daisy, *Chrysanthemum cineraifolium*). Commonly used by organic farmers. Quickly dissipates by UV light, so use late in day.

- Nematrol (botanical nemacide derived from sesame plant). Can be applied directly to soil with a spreader.

- Insecticidal soap (broad spectrum contact insecticide derived from plant and animal fatty acids). Can be used with above compounds. Best use is as an initial application in areas of heavy infestation.

- Soap-based herbicides (rapidly biodegradable contact broad spectrum natural herbicide soap for use on unwanted weeds and brush). Best use is on young annual grasses, less effective on woody plants and weeds with tap roots.

SECTION 10

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APPENDIX A

GOLF COURSE
SALT AND NITROGEN LOADING ANALYSIS

SALT LOADING

Methodology

The purpose of the salt loading analysis is to estimate the concentration of total dissolved solids (TDS) from the contribution of irrigation water in the seasonal wetlands located adjacent to and immediately downgradient of the proposed golf course. The analysis was completed using a mass balance approach, where the long-term ("equilibrium") concentration was estimated by the following equation:

$$C = \frac{m_{irr} + m_{sw} + m_{gw} + m_{ppt}}{(V_{irr} + V_{sw} + V_{gw} + V_{ppt}) - V_{ET}}$$

where:

C = Resultant TDS concentration in wetland (mg/L)

m_{irr}, m_{sw}, m_{gw}, m_{ppt} = Annual mass of salts in irrigation water, surface water, groundwater, and direct precipitation, respectively (mg/yr)

V_{sw}, V_{gw}, V_{irr}, V_{ppt} = Annual volume of surface water runoff, shallow groundwater inflow, irrigation water, and direct precipitation, respectively (L/yr)

V_{ET} = Annual volume of water lost to evapotranspiration from the wetland (L/yr)

The potential impact on groundwater and wetland water quality was assessed by examining one of the subwatersheds on the proposed golf course site as an example. Five subwatersheds were delineated by Balance Hydrologics, Inc. (Mallory, *et al*., 2001). Subwatershed 2 (Mallory, *et al*., 2001) was selected for the analysis because of its longer water ponding period. Wetlands with longer ponding periods tend to have more wildlife than those with shorter ponding periods.

Data and Assumptions

1. **Water Balance—Existing Conditions.** Under existing conditions, the total volume of water entering the wetlands is composed of surface water runoff, shallow groundwater inflow, and direct precipitation. Water leaves the wetland through evapotranspiration, groundwater outflow, and runoff overflow. However, the only "losses" that are used to estimate the TDS concentration in the wetland (i.e., leaving the wetland) are those losses from evapotranspiration. The water balance performed by Balance Hydrologics (Mallory, *et al.*, 2001) was used to

determine the volume of water entering the wetlands. As discussed later (see page A-4), one assumption of their water budget analysis was the exclusion of groundwater perched on the Unnamed Sandstone from groundwater inflow. The "normal" year rainfall was used for the water balance analysis rather than attempting to estimate "dry" and "wet" rainfall year[1] conditions. This approach was followed since the wetland water quality is affected by shallow groundwater flow (and potentially irrigation seepage losses), which moves slowly, causing effects to span several years time. Thus, for any given "rainfall" year, the water quality effects would be partially dependent on the prior few rainfall years, making a reasonable estimate speculative, at best. A long-term "equilibrium" (i.e., average) approach is more appropriate under these circumstances. **Table A-1** summarizes the water balance volumes that approximate existing conditions.

Table A-1

Existing Conditions Annual Water Balance

Water Source	**Annual Water Volume**	
	L/yr	**AF/yr**
Surface water runoff (V_{sw})	7.30×10^6	5.92
Shallow groundwater inflow (V_{gw})	1.18×10^5	0.10
Direct Precipitation (V_{ppt})	1.20×10^6	0.97
Evapotranspiration losses from wetland (V_{ET})	(1.18×10^6)	(0.96)
Total	$\mathbf{7.44 \times 10^6}$	**6.03**

2. **Water Balance Changes with Proposed Golf Course**. With the development of the proposed golf course, it is estimated that a portion of the irrigation seepage losses will contribute flow into the wetlands via shallow groundwater. However, based on shallow groundwater monitoring information and estimates of groundwater flow rates (Mallory, et. al., 2001), the only portions of the golf course likely to contribute to the wetlands in this subwatershed include approximately 3.6 acres of irrigated turf immediately bordering the wetland buffer area. Overall, irrigation seepage losses are estimated, conservatively, to amount to about 10% of the total irrigation water applied. Based on an estimated groundwater flow velocity of about 0.1 feet/day, we estimate that roughly 10 to 20% of the irrigation seepage losses will migrate laterally toward the wetlands. The remaining irrigation seepage losses are assumed to be lost to evapotranspiration in buffer areas or to percolate downward and join the deeper saline groundwater zone, via discontinuities, breaks, and slow movement through the clay layer. The deeper groundwater is not a source of inflow to the wetlands and is not a factor in the water balance calculations.

   The remaining portions of the golf course are further removed from the wetlands, and are assumed not to contribute any shallow groundwater flow to the wetlands. Shallow groundwater flow in the upper part of the subwatershed (either from irrigation or from natural sources) is intercepted by shallow surface drainage features, uptake by vegetation, or percolation downward into the deeper saline groundwater zone.

[1] The dry year is estimated to be the 25th quartile of monthly precipitation values, while wet year precipitation is estimated to be the 75th quartile of the monthly value.

Based on the above, the estimated annual water volume contribution to the wetlands from irrigation seepage losses is:

- Total Annual Irrigation Volume:

$$= (3.6 \text{ ac})(1.07 \text{ to } 2.16 \text{ AFY/ac})$$

$$= 3.85 \text{ to } 7.78 \text{ acre-feet/yr}$$

$$= 4.75 \times 10^6 \text{ to } 9.59 \times 10^6 \text{ L/yr}$$

- For 10% contribution of irrigation seepage losses:

$$V_{irr} = (0.10)(0.10)(4.75 \times 10^6 \text{ to } 9.59 \times 10^6 \text{ L/yr}) = 4.75 \times 10^4 \text{ to } 9.59 \times 10^4 \text{ L/yr}$$

- For 20% contribution of irrigation seepage losses:

$$V_{irr} = (0.10)(0.20)(4.75 \times 10^6 \text{ to } 9.59 \times 10^6 \text{ L/yr}) = 9.50 \times 10^4 \text{ to } 1.92 \times 10^5 \text{ L/yr}$$

Therefore, the overall wetlands water balance under proposed conditions is reflected in the **Table A-2** below.

Table A-2

Proposed Conditions Annual Water Balance

Water Source	**Annual Water Volume**	
	L/yr	**AF/yr**
Surface water runoff (V_{sw})	7.30×10^6	5.92
Shallow groundwater inflow (V_{gw})	1.18×10^5	0.10
Direct Precipitation (V_{ppt})	1.20×10^6	0.97
Irrigation seepage losses	4.75×10^4 to 1.92×10^5	0.04 to 0.16
Evapotranspiration losses from wetland (V_{ET})	(1.18×10^6)	(0.96)
Total	**7.49×10^6 to 7.63×10^6**	**6.07 to 6.19**

3. **Irrigation Water TDS Concentration.** The analysis assumes that the annual amount of irrigation water is comprised of 30% potable and 70% reclaimed water, which reflects the current approximate use at other existing golf courses in the area. Our analysis also includes calculations under the assumption that the RO treatment and storage plan is implemented, which would eliminate the use of potable water and reduce the overall irrigation water TDS concentration.

   - Concentrations of TDS in potable and reclaimed water are currently estimated to be 335 mg/L and 814 mg/L, respectively[2]. Therefore, the weighted average concentration of TDS in irrigation water is: C_{irr} = 0.30(335 mg/L) + 0.70(814 mg/L) = 670 mg/L.

   - If RO treatment is implemented, C_{irr} = 500 mg/L

   - Irrigation water volume application rate is estimated to be 1.07 to 2.16 AFY/ac[3].

4. **Background TDS Concentration.** The TDS concentration of the seasonal wetlands fluctuates greatly during the year based on rainfall-runoff conditions, and from year to year. Balance Hydrologics (Mallory and Hecht, 2002) monitored surface and groundwater quality at the proposed golf course site from January 2001 to January 2002. Background (pre-development) TDS concentrations at the monitored wetlands ranged from approximately 1,000 to 3,000 mg/L in the surface waters. Shallow groundwater TDS measurements ranged from 850 to 1,620 mg/L in the groundwater perched on the clay layer.

   In addition to their water quality study, Balance Hydrologics performed a water budget of the wetlands on the project site as part of their *Phase One Hydrologic Analysis* (Mallory, *et al.*, 2001). The water budget illustrated that surface water runoff is the largest single source of water to the wetlands at the new golf course site, followed by direct precipitation and shallow groundwater inflow. Based upon the water quality monitoring data and soil characteristics (i.e., transmissivity), Balance Hydrologics concluded that shallow groundwater inflow into the wetland is primarily influenced by the groundwater perched on the clay layer, and that the lower/deeper groundwater perched on the Unnamed Sandstone (with higher salinity) contributes a negligible quantity of inflow. In localized pools where the more saline groundwater is exposed near the surface, the separation of the deeper saline water and the fresher surface water is distinct. The saline water is only flushed through the wetlands during storm events large enough to displace the volume of water in the pools (Mallory, *et al.*, 2001). When the storm ends, the pools quickly re-stratify, and the deeper saline groundwater no longer contributes to flow through the wetlands (Mallory, *et al.*, 2001).

   For modeling purposes, background TDS levels in rainfall runoff and shallow groundwater inflow were estimated from shallow surface water runoff and shallow groundwater inflow TDS levels measured at the wetlands. Since the groundwater perched on the clay layer is the primary shallow groundwater inflow source, only measurements from this groundwater unit were used to establish the "average" background concentration. The background TDS concentration was estimated by averaging seven (7) surface water and groundwater TDS concentrations measured

[2] Based upon CAWD reclaimed water (filtered effluent) concentrations, 1996-2002.
[3] Based upon CAWD/PBCSD Reclaimed Water Project 1994 to 2001 water usage for Cypress Point and Spyglass Hill Golf Courses; these golf courses are geographically close to the proposed Pebble Beach Golf Course and similar in play area size.

on the project site; these measurements are summarized in **Table A-3**. The concentration of TDS in direct precipitation was assumed to be 25 mg/L.

Table A-3

Background TDS Concentrations

Source	Concentration (mg/L)	Monitoring Site[1]
Surface Water	1,000	Step-pool surface
	1,050	Step-pool surface
	1,840	Step-pool surface
	3,000	Wetland M
Shallow Groundwater (perched on clay layer)	850	Piezo 1-01
	1,350	Piezo 1-01
	1,620	Piezo 1-01
Average:	**1,525**	-

Notes: [1] See Mallory and Hecht, 2002 for a description of the monitoring sites.

5. **Mass Loading of Salts from Irrigation Water.** Irrigation water will be applied to approximately 5.4 acres over the entire Subwatershed 2. However, only a portion of the dissolved solids is transported to the wetlands through natural surface water runoff (during storm events) or with shallow groundwater inflow. Conservatively, it is assumed that, in the long-term, all salts contained in the irrigation water accumulate and add to the concentration in (a) shallow groundwater, (b) lower saline groundwater, and (c) surface runoff. Losses due to uptake by vegetation and incorporation in the soils is ignored. Salts that migrate and accumulate in the lower/deeper (saline) groundwater are assumed not to have any measurable effect on the wetlands. The estimated contribution from shallow groundwater, as noted before, is estimated to be about 10% to 20% of the irrigation seepage losses in the 3.6 acres of irrigated turf immediately bordering the wetland buffer area. Also, it is assumed that a small portion of the salts will be picked up in surface water runoff from the entire irrigated area (5.4 acres), and transported to the wetland along with surface water inflow. This contribution of salts is estimated to be in the range of about 5 to 15% of the total mass applied to the golf course area in this subwatershed.[4] The remaining salts associated with the irrigation water are assumed to leach downward and become part of the deeper saline groundwater zone. Once reaching the deeper groundwater, these salts are no longer a contributing factor to the wetland water-salt balance. The estimated range of mass loading of salts from the irrigation water is based upon these assumptions and the range of salt concentrations from non-RO and RO-treated irrigation water, as follows:

[4] The estimate of 5 to 15% TDS contribution to surface runoff is based on the results of a 3-yr (1993-95) water quality runoff study from the Dove Canyon County Club Golf Course (Orange County, California), which was conducted under conditions reasonably similar to the proposed new Pebble Beach Golf Course. This included use of reclaimed water for irrigation and an average rainfall of 19.75 inches/year during the study period.

Existing irrigation water supply (without RO Treatment):

Low Estimate - 10% leaching of salts to wetlands from adjacent irrigated turf and 5% from surface runoff:

$m_{irr} = m_{irr,gw} + m_{irr,sw}$

$=(670\text{mg/L})[(3.58\text{ ac})(0.10) + (5.44\text{ ac})(0.05)] \times (1.07 \text{ to } 2.16\text{ AF/ac/yr})(43{,}560\text{ ft}^2/\text{ac})(28.3\text{ L/ft}^3)$

$= \underline{5.57 \times 10^8 \text{ to } 1.12 \times 10^9 \text{ mg/yr}}$

High Estimate - 20% leaching of salts to wetlands from adjacent irrigated turf and 15% from surface runoff:

$m_{irr} = m_{irr,gw} + m_{irr,sw}$

$= (670\text{mg/L})[(3.58\text{ ac})(0.20) + (5.44\text{ ac})(0.15)] \times (1.07 \text{ to } 2.16\text{ AF/ac/yr})(43{,}560\text{ ft}^2/\text{ac})(28.3\text{ L/ft}^3)$

$= \underline{1.35 \times 10^9 \text{ to } 2.73 \times 10^9 \text{ mg/yr}}$

Irrigation water supply with RO Treatment:

Low Estimate - 10% leaching of salts to wetlands from adjacent irrigated turf and 5% from surface runoff:

$m_{irr} = m_{irr,gw} + m_{irr,sw}$

$= (500\text{mg/L})[(3.58\text{ ac})(0.10) + (5.44\text{ ac})(0.05)] \times (1.07 \text{ to } 2.16\text{ AF/ac/yr})(43{,}560\text{ ft}^2/\text{ac})(28.3\text{ L/ft}^3)$

$= \underline{4.15 \times 10^8 \text{ to } 8.39 \times 10^8 \text{ mg/yr}}$

High Estimate - 20% leaching of salts to wetlands from adjacent irrigated turf and 15% from surface runoff:

$m_{irr} = m_{irr,gw} + m_{irr,sw}$

$= (500\text{mg/L})[(3.58\text{ ac})(0.20) + (5.44\text{ ac})(0.15)] \times (1.07 \text{ to } 2.16\text{ AF/ac/yr})(43{,}560\text{ ft}^2/\text{ac})(28.3\text{ L/ft}^3)$

$= \underline{1.01 \times 10^9 \text{ to } 2.04 \times 10^9 \text{ mg/yr}}$

6. **Mass Loading of Salts from Background Sources.** The mass of salts entering the wetlands from background sources (surface water runoff, shallow groundwater inflow, and direct precipitation) is equal to the concentration of salts in these sources, multiplied by their respective water volumes.

   - Surface water runoff:

$$m_{sw} = (C_{sw})(V_{sw})$$
$$= (1{,}525 \text{ mg/L})(7.30 \text{ x } 10^{6} \text{ L/yr})$$
$$= \underline{1.11 \text{ x } 10^{10} \text{ mg/yr}}$$

   - Shallow groundwater inflow:

$$m_{gw} = (C_{gw})(V_{gw})$$
$$= (1{,}525 \text{ mg/L})(1.18 \text{ x } 10^{5} \text{ L/yr})$$
$$= \underline{1.80 \text{ x } 10^{8} \text{ mg/yr}}$$

   - Direct precipitation:

$$m_{ppt} = (C_{ppt})(V_{ppt})$$
$$= (25 \text{ mg/L})(1.18 \text{ x } 10^{6} \text{ L/yr})$$
$$= \underline{2.95 \text{ x } 10^{7} \text{ mg/yr}}$$

7. **Total Mass Loading.** The total mass of salts entering the wetlands is the sum of the mass loading from irrigation water and all background sources. The annual mass loading is estimated to fall within a range of values that varies according to whether or not RO treatment is implemented, the amount of irrigation water applied to the golf course, and the estimated range in the percentage of salts that ultimately reach the wetlands. The calculations are as follows:

Existing irrigation water supply (without RO Treatment):

Low Estimate - 10% leaching of salts to wetlands from adjacent irrigated turf and 5% from surface runoff:

$$m_{Total} = m_{irr} + m_{sw} + m_{gw} + m_{ppt}$$
$$= \underline{1.19 \text{ x } 10^{10} \text{ to } 1.24 \text{ x } 10^{10} \text{ mg/yr}}$$

High Estimate - 20% leaching of salts to wetlands from adjacent irrigated turf and 15% from surface runoff:

$$m_{Total} = m_{irr} + m_{sw} + m_{gw} + m_{ppt}$$

$$= \underline{1.27 \times 10^{10} \text{ to } 1.40 \times 10^{10} \text{ mg/yr}}$$

Irrigation water supply with RO Treatment:

Low Estimate - 10% leaching of salts to wetlands from adjacent irrigated turf and 5% from surface runoff:

$$m_{Total} = m_{irr} + m_{sw} + m_{gw} + m_{ppt}$$

$$= \underline{1.17 \times 10^{10} \text{ to } 1.21 \times 10^{10} \text{ mg/yr}}$$

High Estimate - 20% leaching of salts to wetlands from adjacent irrigated turf and 15% from surface runoff:

$$m_{Total} = m_{irr} + m_{sw} + m_{gw} + m_{ppt}$$

$$= \underline{1.23 \times 10^{10} \text{ to } 1.33 \times 10^{10} \text{ mg/yr}}$$

Results and Discussion

The resultant TDS concentration is estimated to fall within a range of values determined from the preceding estimates of the total mass loading of salts entering the wetlands divided by the total volume of water entering the wetlands (less evapotranspiration). The calculations are as follows:

Existing irrigation water supply (without RO Treatment):

Low Estimate - 10% leaching of salts to wetlands from adjacent irrigated turf and 5% from surface runoff:

$C = m_{Total} / V_{Total}$

$= (1.19 \times 10^{10} \text{ to } 1.24 \times 10^{10} \text{ mg/yr}) / (7.49 \times 10^{6} \text{ to } 7.53 \times 10^{6} \text{ L/yr})$

= **1,590 to 1,650 mg/L**

High Estimate - 20% leaching of salts to wetlands from adjacent irrigated turf and 15% from surface runoff:

$C = m_{Total} / V_{Total}$

$= (1.27 \times 10^{10} \text{ to } 1.40 \times 10^{10} \text{ mg/yr}) / (7.53 \times 10^{6} \text{ to } 7.63 \times 10^{6} \text{ L/yr})$

= **1,690 to 1,830 mg/L**

Irrigation water supply with RO Treatment:

Low Estimate - 10% leaching of salts to wetlands from adjacent irrigated turf and 5% from surface runoff:

$C = m_{Total} / V_{Total}$

$= (1.17 \times 10^{10} \text{ to } 1.21 \times 10^{10} \text{ mg/yr}) / (7.49 \times 10^{6} \text{ to } 7.53 \times 10^{6} \text{ L/yr})$

= **1,560 to 1,610 mg/L**

High Estimate - 20% leaching of salts to wetlands from adjacent irrigated turf and 15% from surface runoff:

$C = m_{Total} / V_{Total}$

$= (1.23 \times 10^{10} \text{ to } 1.33 \times 10^{10} \text{ mg/yr}) / (7.53 \times 10^{6} \text{ to } 7.63 \times 10^{6} \text{ L/yr})$

= **1,630 to 1,740 mg/L**

This analysis predicts the resultant TDS concentrations in the wetlands in Subwatershed 2 for both the existing irrigation water supply and the irrigation water supply with RO treatment to fall within the range of about 1,560 to 1,830 mg/L. This indicates that there may be a slight increase (less than 10% for most scenarios) in the average salinity levels in the wetlands as compared with existing conditions (approx. 1,525 mg/L). However, the resultant concentration estimates are well within the existing background range of concentrations found in the in the wetlands of Subwatershed 2 (approximately 1,000 to 3,000 mg/L). Also, as can be seen from the relatively small spread in TDS concentration values, the resultant effect is not highly sensitive to the individual assumptions (e.g., irrigation rate), within the range of reasonable values used in the model. The TDS concentrations will be minimized with the use of RO-treated water, partly because it will have the effect of reducing the amount of salts in the irrigation water. Additionally, with the RO-treated water, there will be reduced need for "salt flushing", which will decrease the overall amount of water (and associated salts) applied to the golf course. Therefore, with RO treatment, it is reasonable to expect the resultant concentrations to be approximated best by the estimates based on the calculations using the low irrigation use amount (1.07 ac-ft/ac/yr); i.e., resultant TDS of 1,560 to 1,630 mg/L.

For further comparison with empirical evidence, data was checked for two existing wetland drainage areas adjacent to the Spyglass Hill Golf Course (Drainage at Stevenson Drive and Drainage in Wetland L) that were analyzed for salinity by Balance Hydrologics, Inc., in February and March 2001 (Mallory and Hecht, 2002). They were found to have specific conductance (adjusted) readings of 1,549 and 3,400 micromhos/cm, which correspond, respectively, to approximate TDS concentrations of about 1,050 and 2,300 mg/L (average=1,675 mg/L). The estimated TDS concentration range for the proposed golf course wetlands (Subwatershed 2) falls within the observed range found in wetland areas at the existing Spyglass Hill Golf Course, and closely approximates the average concentration.

NITROGEN LOADING

Methodology

The purpose of the nitrate loading analysis is to estimate the concentration of nitrate-nitrogen in the water in the seasonal wetlands located adjacent to and immediately downgradient of the proposed golf course. The analysis was completed using a mass balance approach, where the long-term ("equilibrium") concentration was estimated by the following equation:

$$C = \frac{(m_{sw} + m_{gw} + m_{irr}) - (m_d + m_{up})}{(V_{sw} + V_{gw} + V_{irr}) - V_{ET}}$$

where:

C = Resultant nitrate-nitrogen concentration in wetland (as nitrogen, mg/L)

m_{sw}, m_{gw}, m_{irr} = Annual mass of nitrate-nitrogen in surface water runoff, shallow groundwater inflow, and irrigation water, respectively (lb/yr)

m_d, m_{up} = Annual mass of nitrate-nitrogen lost to denitrification and plant uptake, respectively (lb/yr)

V_{sw}, V_{gw}, V_{irr} = Annual volume of surface water runoff, shallow groundwater inflow, and irrigation water, respectively (L/yr)

V_{ET} = Annual volume of water lost to evapotranspiration of the wetland (L/yr)

The potential impact on groundwater and wetland water quality was assessed by examining one of the subwatersheds on the proposed golf course site as an example. Five subwatersheds were delineated by Balance Hydrologics, Inc. (Mallory, *et al.*, 2001). Subwatershed 2 was selected for the analysis because of its longer water ponding period. Wetlands with longer ponding periods tend to have more wildlife than those with shorter ponding periods. The background concentration of nitrate in groundwater influencing wetlands in Subwatershed 2 was non-detectable in monitoring performed from January 2001 through January 2002 (Mallory and Hecht, 2002). However, total nitrogen values of 1.4 to 14.0 mg-N/L were measured in shallow piezometers in Subwatershed 2 during this period, indicating a significant source of nitrogen input. The existing horse trails through the wetlands appear to be the most likely source. Also, concentrations of nitrate were detected in the subwatersheds that drain the existing equestrian center. The horse trails, as well as the equestrian center, will be relocated as a result of the proposed project, eliminating this existing animal waste nutrient (nitrrogen) contribution to the local wetlands.

Data and Assumptions

1. **Water Balance.** The same water balance described in the previous section (Salt Loading) was also used to determine the nitrate-nitrogen concentrations. The total estimated volume of water entering the wetlands on an annual basis ranges from 7.49×10^6 to 7.63×10^6 L/yr.

2. **Mass Loading of Nitrogen from Irrigation Water.** The land use conditions and estimated annual nitrogen application rates and totals are summarized in **Table A-4** for Subwatershed 2. Fertilizers would only be applied to the greens, tees, fairways, and roughs. It is assumed that the amount of fertilizer used will be adjusted to account for the nutrients available in the reclaimed water used for irrigation, so that the total nitrogen application rate is similar to those summarized in **Table A-4**. Therefore, the mass of nitrogen in the irrigation water (m_{irr}) shown in the table is assumed to be the combined amount from applied fertilizer and reclaimed water component.

Table A-4

Annual Nitrogen Application

Subwatershed 2 Land Uses	**Application Rate (lb/1000 ft^2)**	**Land Area (ft^2 and acres)**	**Mass of Nitrogen Applied (lb)**
Greens and Tees	8-10	19,200 (0.44)	150-190
Fairways and Roughs	6-8	218,000 (5.00)	1,310-1,740
Upland Woodland Areas	0	273,100 (6.83)	0
Preserved Woodland / Wetland Buffers	0	637,700 (14.6)	0
Impervious Surfaces	0	296,200 (6.80)	0
Wetlands	0	32,670 (0.75)	0
TOTAL	**-**	**1,476,870 (33.9)**	**1,460-1,930**

[1]Assume 100-foot buffer around wetland area and all non-developed areas (e.g., play areas and impervious surface) act as a vegetated buffer.

- It is assumed that 1-3% of the nitrogen applied would leave with the surface water (Balogh & Walker, 1992). Therefore the following amounts of nitrogen are assumed to be present in the surface water runoff (m_{sw}):

@ 1%: $m_{sw} = 0.01 \times 1{,}460$ lb/yr = **14.6 lb/yr ($m_{sw,min}$)**

$m_{sw} = 0.01 \times 1{,}930$ lb/yr = 19.3 lb/yr

@ 3%: $m_{sw} = 0.03 \times 1{,}460$ lb/yr = 43.8 lb/yr

$m_{sw} = 0.03 \times$ 1,930lb/yr = **57.9 lb/yr ($m_{sw,max}$)**

- The conclusion of a literature review by A.M. Petrovic (1990) is that nitrogen leaching losses "…generally were far less than 10%." Later case studies give leaching losses of 2 to 6%. For the purposes of this analysis, it is assumed that 5-10% of the nitrogen would leach to the groundwater. Therefore, the following amounts of nitrogen are assumed to enter the shallow groundwater (m_{gw}) as a result of golf course nitrogen applications:

  @ 5%: $m_{gw} = 0.05 \times$ 1,460 lb/yr = **73 lb/yr ($m_{gw,min}$)**
  $m_{gw} = 0.05 \times$ 1,930 lb/yr = 96.5 lb/yr

  @ 10%: $m_{gw} = 0.10 \times$ 1,460 lb/yr = 146 lb/yr
  $m_{gw} = 0.10 \times$ 1,930 lb/yr = **193 lb/yr ($m_{gw,max}$)**

3. **Nitrogen Losses.** Nitrogen losses are expected to occur through plant uptake, sediment deposition (i.e., in detention basins), and denitrification in the soil of the buffer areas adjacent to and downgradient of the golf course turf areas. The amount of nitrogen lost to plant uptake and sediment deposition is assumed to affect only the surface runoff, while the amount of denitrification that occurs in the soil is assumed to affect only the shallow groundwater flow. Therefore, nitrogen "losses" are divided into two categories: (1) those that decrease the amount of nitrogen in surface water (m_{up}); and (2) those that decrease the nitrogen in the shallow groundwater (m_d).

- **Surface water nitrogen losses**

  - Various studies have found that the types of management practices proposed for the proposed golf course (i.e., buffers, vegetated filter strips and bioswales, detention basins, and infiltration-retention systems) can be effective in reducing the nutrient concentrations in surface runoff by up to 30% (Horner, R., *et al*. 1994; Schuler, *et al*. 1992).

  - Assume 10-30% of the nitrogen surface water runoff is lost to plant uptake and sediment deposition through application of proposed BMPs:

    @ 10%: $m_{up} = 0.10\ m_{sw,min} = 0.10 \times$ 14.6 lb/yr = **1.46 lb/yr ($m_{up,min}$)**
    $m_{up} = 0.10\ m_{swmax} = 0.10 \times$ 57.9 lb/yr = 5.79 lb/yr

    @ 30%: $m_{up} = 0.30\ m_{sw,min} = 0.30 \times$ 14.6 lb/yr = 4.38 lb/yr
    $m_{up} = 0.30\ m_{sw,max} = 0.30 \times$ 57.9 lb/yr = **17.4 lb/yr ($m_{up,max}$)**

- **Shallow groundwater nitrogen losses**

  - Nitrate contained in shallow groundwater flow is subject to denitrification where sufficient organic matter is present. The amount of denitrification that occurs can be approximated based on the size of the buffer areas (i.e., soil volume) and the associated organic matter content.

- Based on previous groundwater denitrification studies, the following linear regression was derived for estimating denitrification rates (Andersen, Damann L., 1998):

  Denitrification rate (ug NO_3-N/g-d) = 0.442 × Soil organic content (% wt) + 0.0194

  The following values were assumed:

  - → Soil organic content = 0.5-1.0%
  - → Soil density = 100 lb/ft^3
  - → Saturated soil depth = 1 ft
  - → Denitrification area (woodland/wetland buffer area):

    25-foot buffer: 540,700 square feet

    100-foot buffer: 637,700 square feet

  Therefore, the estimated denitrification rate is:

  @ 0.5%: [(0.442)(0.5)] + 0.0194 = 0.240 ug NO_3-N/g-d

  @ 1.0%: [(0.442)(1.0)] + 0.0194 = 0.461 ug NO_3-N /g-d

Then, total estimated nitrogen losses from denitrification are:

For 25-foot buffer:

$$m_d = \frac{0.240 \text{ to } 0.461\,\mu\text{g NO}_3\text{ - N}}{\text{g} - \text{day}} \times (540{,}700\text{ft}^2 \times 1\text{ft}) \times \frac{100\text{lb}}{\text{ft}^3} \times \frac{454\text{g}}{\text{lb}} \times \frac{\text{lb NO}_3\text{ - N}}{454 \times 10^6\,\mu\text{g NO}_3\text{ - N}} \times \frac{365\text{days}}{\text{yr}}$$

$$= 4{,}740 \text{ to } 9{,}100 \text{ lbNO}_3\text{ - N/yr}$$

For 100-foot buffer:

$$m_d = \frac{0.240 \text{ to } 0.461\,\mu\text{g NO}_3\text{ - N}}{\text{g} - \text{day}} \times (637{,}700\text{ft}^2 \times 1\text{ft}) \times \frac{100\text{lb}}{\text{ft}^3} \times \frac{454\text{g}}{\text{lb}} \times \frac{\text{lb NO}_3\text{ - N}}{454 \times 10^6\,\mu\text{g NO}_3\text{ - N}} \times \frac{365\text{days}}{\text{yr}}$$

$$= 5{,}590 \text{ to } 10{,}730 \text{ lbNO}_3\text{ - N/yr}$$

The total amount of nitrogen expected to enter the wetland is equal to the nitrogen "mass loading" minus the nitrogen "losses." Therefore, the following is the total amount of nitrogen estimated to enter the wetlands from surface runoff and shallow groundwater inflow, respectively:

- Surface water runoff:

  Minimum: $m_{sw,min}$ – (30%) = 14.6 lb/yr – 4/38 lb/yr = 10.22 lb/yr = $\underline{4.64 \text{ x } 10^6 \text{ mg/yr}}$

  Maximum: $m_{sw,max}$ – (10%) = 57.9 lb/yr - 5.79 lb/yr = 52.11 lb/yr = $\underline{2.37 \text{ x } 10^7 \text{ mg/yr}}$

- Shallow groundwater inflow: No nitrate-nitrogen input to wetlands.

  Our calculations show that the capacity of the shallow soil-groundwater for denitrification is much larger than the amount of nitrate-nitrogen estimated to be contained in the shallow groundwater flow as a result of golf course nitrogen loading. Therefore, the shallow groundwater zone in the buffer area between the golf course and the wetlands is an effective "sink" for groundwater nitrate and the only significant nitrogen input to the wetlands is from surface water runoff. This conclusion is supported empirically by shallow groundwater monitoring by Balance Hydrologics, Inc. (Mallory and Hecht, 2002) which has shown evidence of ammonia and organic nitrogen, but little or no nitrate present in the wetlands.

Results and Discussion

The resultant nitrate-nitrogen concentration is estimated as the range of the total mass loading of nitrogen entering the wetlands divided by the total volume of water entering the wetlands (less evapotranspiration). The total mass of nitrogen entering the wetland is 4.64 x 10^6 to 2.37 x 10^7 mg/yr, while the total volume of water entering the wetlands (less evapotranspiration losses) is 7.49 x 10^6 to 7.63 x 10^6 L/yr. Therefore, the resultant nitrate-nitrogen concentration is estimated to be:

C = m_{Total} / V_{Total}

= (4.64 x 10^6 to 2.37 x 10^7 mg-N/yr) / (7.49 x 10^6 to 7.63 x 10^6 L/yr)

= 0.62 to 3.11 mg-N/L (nitrate as nitrogen)

= (4.43)(0.62 to 3.11 mg/L) (Note: 4.43 is molecular weight conversion from NO_3-N to NO_3)

= 2.75 to 13.8 mg/L (nitrate as nitrate)

Background levels of nitrate-nitrogen in the surface water and shallow groundwater in the wetlands in Subwatershed 2 are non-detectable (generally, less than 1 mg/L), with levels in other drainages on the site up to 1.5 mg/L (as nitrogen). The highest background concentrations of nitrate were in the drainage receiving runoff from the existing equestrian center. However, ammonia and organic nitrogen (TKN) were found at levels ranging from 1.4 to 14.0 mg/L (as nitrogen) in shallow piezometers located within Subwatershed 2, and at levels as high as 12 mg/L in surface runoff from the equestrian center drainage. This indicates that the estimated total annual nitrogen loading contribution to the wetlands from the golf course (0.62 to 3.11 mg/L) may fall below the average background total nitrogen levels that currently exist in the wetlands. The background nitrogen data from the shallow piezometers may be indicative of a localized condition in the wetlands; however, the monitoring locations were selected by Balance Hydrologics, Inc., to provide information on the areas having the most significant wetland habitat values (longest ponding period) and in close proximity to a designated ESHA (environmentally sensitive habitat area) wetland.

The probable source of the existing nitrogen levels in the wetlands appears to be related to equestrian activities. Subwatershed 2 does not receive any runoff from the existing equestrian center; however, it receives nonpoint source contributions of nitrogen from horse traffic on several riding trails that traverse the wetland watershed. A portion of the trails cross directly through the wetlands. Both the equestrian center and the horse trails will be relocated as part of the project, which will eliminate existing animal waste nutrient impacts to the wetlands. The ammonia and organic nitrogen found in the shallow groundwater in Subwatershed 2 wetlands is very likely due in large part to these existing equestrian tails. Comparably high levels of ammonia and organic nitrogen were found in the drainage from the equestrian center. The estimated reduction in nitrogen loading to Subwatershed 2 from elimination of the horse trails is potentially significant, as reviewed below.

Based on data from the Pebble Beach Company, it is estimated that approximately 60,000 horse trail rides occur in Subwatershed 2 every year. These include visitors as well as owners who board their horses at the center. The horses begin in the existing equestrian center (located outside of Subwatershed 2) and traverse the subwatershed, mostly on trail rides that lead to the beach. Using information on trail length, horse riding time, and total rides, the total “horse time” in the watershed was estimated. Then using information on the estimated annual nitrogen contribution in horse manure and urine, the total nitrogen contribution to the watershed was estimated. Assuming that 50% of the nitrogen is lost to volatilization and only the trail segment (about 1/3 of the total) crossing directly through the wetland actually contributes nitrogen to the wetland, the annual loading of nitrogen from existing horse trail rides was estimated to range from about 9 to 18 lb/year. In comparison, the estimated total nitrogen input from the proposed golf course may range a low of 10 lb/yr to a high of 52 lb/yr. The assumptions and calculations are presented in **Table A-5**.

This analysis indicates that the conversion of the site to a golf course may (for the low estimate of 10 lb/yr loading) result in a net reduction in the total nitrogen loading to the wetlands as compared with the existing nitrogen loading from the horse trails. For the worst case assumptions, the estimated total mass loading of nitrogen to the wetlands (52 lb/yr loading) would represent an increase over the current conditions. However, because it would be distributed more evenly through the wetlands, the estimated resultant concentration of 3.11 mg/L (as N) would be at or below the total nitrogen concentrations observed in the localized area currently impacted by the horse trails. The conditions in this localized area, which is in close proximity to the designated ESHA wetlands, can be expected to improve in regard to nitrogen loading as a result of the conversion from equestrian uses to the proposed golf course.

Table A-5

Estimated Nitrogen Contribution from Existing Horse Trails

Assumptions:

- 60,000 trail rides per year
- Trail ride length through Subwatershed 2 (two trails): 1,200 to 1,500 feet, round trip
- Approximately 1/3 of trails traverse directly
- Average pace of horses at a walk: 2.8 to 4.5 mph
- Average daily waste production from 1,000 lb horse:
  - Manure: 45-50 lb/day (OMAF, 2002; UNR, 2002)
  - Urine: 19-67 lb/day (UNR, 2002)
- Nitrogen content of waste:
  - Manure: 0.6% at 45 lb/day = 0.27 lb/day (OMAF, 2002)
  - Urine: 37% of total nitrogen = 0.16 lb/day (NAS, 1978)
  - Total: 0.43 lb/day
- 50% of nitrogen lost to volatilization from ground surface.(NAS, 1978)

Calculations:

- Average time in watershed per trail ride for 1,200 to 1,500 ft round trip:
  - 3 to 6 minutes, or
  - 0.05 to 0.10 hour
- Total annual horse hours in watershed:
  - 60,000 rides at 0.05 to 0.10 hours/ride
    = 3,000 to 6,000 hr/yr
    = 125 to 25 days/yr
- Total nitrogen excreted in manure and urine:
  - 125 days at 0.43 lb/day = 54 lb/yr
  - 250 days at 0.43 lb/day = 108 lb/yr
- Total nitrogen available for infiltration and runoff adjusted for volatilization:
  - (0.50)(54 to 108 lb/yr) = 27 to 54 lb/yr
- Direct contribution from trails through wetlands:
  - (0.33)(27 to 53 lb/yr) = 9 to 18 lb/yr

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APPENDIX B

STORM WATER QUALITY MONITORING SUMMARY

BACKGROUND

Beginning in the fall of 1995, Pebble Beach Company hired Kinnetic Laboratories, Inc. and Environmental & Turf Services to conduct water quality monitoring of storm water runoff from its golf courses and upstream areas. The purpose of the monitoring is to characterize the quality of the runoff and to determine what, if any, impacts the golf courses may have on storm water quality. The constituents sampled that are of interest to this report are pesticides and nutrients (ammonia as nitrogen, nitrate as nitrate, and phosphorus). The samples were generally screened for thirty-one chlorinated pesticides, twenty-one organophosphate pesticides, and seven pesticides that required special analytical treatment (glyphosphate, Garlon®, dithiocarbamates, ethofumesate, dicamba, MCPP, and 2,4-D)[1]. Samples were taken for two storm events, with the first sampling taking place after the first storm of the season. The following sections briefly summarize are the key findings of the monitoring reports.

Pesticides

Of the sixty-seven pesticides that were sampled for, only thirteen were detected (a total of 32 individual detections) over the seven-year sampling period; none were found at high concentrations. So, out of a total of 7,526 tests over seven years, only 36 (0.48%) had some detection. The number of detections were evenly split between chlorinated pesticides (18 detections) and the pesticides requiring special analytical treatment (18 detections); no organophosphate pesticides were detected during the sampling period.

<u>Chlorinated Pesticides</u>
Nine chlorinated pesticides were detected during the sampling period. Half of these detections (9) occurred during the 2001-2002 sampling season. None of the pesticides recommended for use at the proposed golf course site (see **Table 8-1**) were detected in the monitoring. Several chlorinated pesticides detected during the 2001-2002 sampling season suggest household and/or other non-golf course pesticide applications contribute to pesticides in the storm water runoff. Heptachlor, a pesticide that has been banned since 1988 for all uses except for fire-ant control, was detected, and endosulfan I and delta-BHC, both chlorinated pesticides that are not used by local golf courses, were also detected.

<u>Pesticides Requiring Special Analytical Treatment</u>
Garlon®, which shares the active ingredient (triclopyr) with other herbicides proposed for widespread use (Turflon II Amine® and Confront®), was the most commonly detected pesticide, detected six of the seven years (12 detections total); it is practically nontoxic to aquatic life, though

[1] 1995/1996: 30 chlorinated pesticides, 21 organophosphates, 4 pesticides required special analysis
1998/1999: 33 chlorinated pesticides, 27 organophosphates, 7 pesticides required special analysis
2001/2002: 23 chlorinated pesticides, 20 organophosphates, 7 pesticides required special analysis

it does have a very high groundwater movement rating. Of the 12 total detections of Garlon®, nine of the detections occurred at Stillwater Cove. Glyphosphate (RoundUp®), which may be used to spot treat problem areas at the proposed golf course site, was detected three of the seven years, with the last detection occurring during the first storm of the 1999-2000 sampling season. Glyphosphate is also is an herbicide that is practically nontoxic to aquatic life; it has an extremely low groundwater movement rating. Dicamba was detected twice during the sampling period (both detections occurred at Fanshell Beach); it is proposed to be available for use. Dicamba is practically non-toxic to aquatic life, and has a very high groundwater movement rating. None of the other eleven pesticides that were detected are proposed for use on the proposed golf course site.

Nutrients

Nutrient levels were noted to be highest during the first storm during all monitoring periods. This is most likely due to chemical build-up in and on the soil during the dry season.

Ammonia as Nitrogen (NH_3-N)

The reported concentrations of NH_3-N were generally above detection limits, but were generally below the California Ocean Plan objective for protection of marine aquatic life[2]. The daily maximum (2.4 mg/L) was exceeded in two of the 125 total sampling events. These higher concentrations were detected at Stillwater Cove (1997/1998) and at 8th Hole Spanish Bay (2000/2001). The higher concentrations were most likely due to a fertilizer application occurring immediately prior to the sampling. The reported concentrations were similar for all sampling years, with the highest mean concentrations over the sampling period occurring at monitoring stations located at Stillwater Cove (0.60 mg/L), Fan Shell Beach (0.61 mg/L), and 8th Hole Spanish Bay (0.67 mg/L). The 7-year mean concentrations at these three sampling stations are either equal to, or higher than the 6-month median water quality objective in the California Ocean Plan (0.60 mg/L). The 7-year mean concentrations at Stillwater Cove is approximately 5.5 times greater than the mean concentration at the upstream "control" site (Palmero Way), suggesting that the golf courses and residential development are contributing to nutrient levels in the surface waters in this watershed (Carmel Bay ASBS Watershed, see **Figure 3-1**). However, the difference between the 7-year mean between the other upstream control (PQR) and downstream monitoring sites (Carmel Way and 10th Hole Pebble Beach) in this watershed is not as great (the downstream levels are approximately two times greater than the upstream). It should be noted that the proposed facilities would not drain into the Carmel Bay ASBS Watershed.

Nitrate as Nitrate (NO_3)

The reported concentrations of NO_3 were also generally above detection limits, but well below state drinking water standards[3] (the only comparison, since there is no regulatory limit for nitrates discharging into the ocean). Although concentrations of NO_3 were similar up-and down-gradient of Pebble Beach Golf Course, higher concentrations were reported down-gradient of Cypress Point Golf Course. These higher concentrations may be attributed to golf course fertilization practices. The reported concentrations were similar for all sampling years, with the highest concentrations

[2] Water quality objective for NH_3-N: 6-month median = 0.6 mg/L, daily maximum = 2.4 mg/L, instantaneous maximum = 6.0 mg/L (SWRCB, 2001).

[3] The drinking water objective is 45 mg/L (NO_3)

consistently recorded at monitoring stations located at Stillwater Cove, Fan Shell Beach, and Spyglass Hill.

Total Phosphorus (as Phosphate)

Phosphate levels were generally above the detection limits, but were, for the most part, well below concentrations to cause harm. Phosphate concentrations were noted to be higher down-gradient of both the Pebble Beach and Cypress Point Golf Course, indicating that the golf courses may be contributing to higher nutrient levels. The phosphate levels exceeded EPA criterion for streams discharging into lakes at nearly all of the monitoring stations; however, phosphate runoff into oceans is less of a threat than runoff into lakes, which are susceptible to eutrophication. The reported concentrations were similar for all sampling years, with the highest concentrations consistently recorded at monitoring stations located at Stillwater Cove, Fan Shell Beach, and Carmel Way.

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APPENDIX C

SUMMARY OF KEY REQUIREMENTS FOR PESTICIDE SELECTION AND USE

PLANNING AND PROCEDURES FOR PESTICIDE USE

Although pesticides may be federally registered, many cannot be used in California because they have failed to meet California's strict regulatory review process. California also requires a written recommendation by a licensed Pest Control Advisor (PCA) prior to the application of any pesticide. It must first be determined if the herbicide being considered is registered for use in California. If the pesticide is registered in California, it must then be determined if it can be legally used for the proposed application. Specific uses and restrictions are spelled out on the label and in State regulations.

If a restricted material (pesticide) is to be used, a Notice of Intent must be filed with the County Agricultural Commissioner's Office at least 24 hours before use. The person filing the Notice of Intent and obtaining permits must be a certified applicator.

Pest Control Advisor (PCA) Requirements

The following persons must be licensed as pest control advisors:

- Any person who provides recommendations concerning any agricultural use (the definition of agricultural use includes applications of pesticides at golf courses).

- Any person who offers themselves as an "authority" on any agricultural use.

- Any person who acts as a general advisor on any agricultural use who solicits services or sales outside of a fixed place of business.

A person can be issued a pest control advisor's license when they meet the following minimum requirements:

- Possession of a Bachelors Degree (BA or B.S.) in the Agricultural Sciences, Biological Sciences, or Pest Management.

- Sixty semester units (90 quarter units) of college level curriculum in the Agricultural Sciences, Biological Science, or Pest Management, plus two years of technical experience as an assistant to a licensed pest control advisor or equivalent.

Once educational requirements have been met, the person must pass a written examination given by the State. An applicant must pass the laws and regulations exam and at least one other category (weeds, insects, etc.), in order to receive a license from the State Department of Food and Agriculture (CDFA). Once licensed by the State, a pest control advisor must register with each country in which they will be making recommendations. This registration must be renewed on an annual basis with each county.

All pesticide use recommendations related to the management of the golf course should be made by a pest control advisor trained in IPM (Integrated Pest Management) principles. IPM guidelines are followed so that non-chemical methods are considered first and then the least toxic chemical selected if non-chemical means are not feasible.

Pesticide Recommendation Requirements

Before a herbicide or pesticide can be applied, it must be determined whether herbicide use follows the Best Management Practice for Integrated Pest Management developed by the University of California Agricultural Extension Service for the control of vegetation in the subject situation. Herbicides are not always the most practical, environmentally sound, or economical method of vegetation control. Potential environmental impacts must also be taken into consideration. In some instances, however, herbicides may be the most environmentally sensitive method of vegetation control. Herbicides can be applied selectively with minimal impact to non-target species. Mechanical and hand labor methods do not always offer the maximum specificity and minimum disturbance to a sensitive area. For instance, it is difficult for mechanical equipment to control a selective group of plants without damaging desired vegetation. Hand labor must be carefully directed as crews can trample and damage desirable vegetation and sensitive habitat.

Mechanical and hand labor methods may be preferred in certain situations due to stages of growth, environmental concerns and costs. If herbicide application is proposed as the preferred method, and the selected herbicide is labeled for the specified use, it must be determined what rate or dosage should be applied to the target area. Many herbicide labels provide a range of rates which can be used, depending on the situation. In most situations even though a higher rate can be used, the lowest practical rate should be used in herbicide applications.

Application/Recommendations Report

Before an herbicide can be applied for agricultural use, state law requires that a written recommendation or application plan must be prepared by a licensed pest control advisor. The plan must provide all of the information necessary to make a legal application of a specific pesticide or herbicide or mixture of chemicals labeled to be used together. The following is a description of the information which is required by California law to be on a pest control recommendation:

1. Owner/operator of property to be treated.
2. Location of property to be treated.
3. Commodity, crop or site to be treated.
4. Total acreage or units to be treated.
5. Identification of pests to be controlled by recognized common name.
6. Name of each pesticide and method of application.
7. Dosage rate per acre, dilution rate, and volume of spray per acre.
8. Suggested schedule time or conditions, including label restrictions on use.
9. Safety interval and posting requirements, if required on the product label.

10. Warning of the possibility of damages by the application from hazards that are known to exist (threatening of adjacent property, water, wildlife, etc.)
11. Signature and address of the person making the recommendation, the date, and name of employer, if any.
12. The criteria used for determining the need for the recommendation.
13. Certification that alternatives and mitigation measures that would substantially lessen any significant adverse impact on the environment have been considered and, if feasible, adopted (IPM requirements met).

Pesticide Specifications Software

ACS is a computer software system developed by Crop Data Management Systems Inc. (CDMS) to assist Pest Control Advisors (PCA's) in preparing written pesticide use recommendation reports. Several other pesticide application software systems are also available.

With software, the PCA can prepare pesticide use recommendations that are automatically checked against data contained in the pesticide label database. As the PCA enters the proposed chemical and application rate, the software system checks to see that the recommended rate is within the range set by the manufacturer on the label. In addition, the system provides any restrictions, percentages, or limitations specified on the label as part of the recommendation. The recommendation can then be printed out in a standard format with all the pertinent information attached as required by law. A PCA can access the label database regularly to check for label changes, which are automatically updated by the system. The database also provides information regarding treatments of specific pests. For example, the PCA can enter the name of the pest and receive a list of options that can be considered to control the pest. The system also provides current Material Safety Data Sheet (MSDS) information for commonly used pesticides for use by the applicators. It provides the applicator in the field with consistent up-to-date recommendations, label data and MSDS information critical to the legal application of herbicides. An automated pesticide specifications software system, such as ACS, will be implemented by the Golf Course Superintendent to assist in preparing integrated vegetation control plans.

PESTICIDE SCREENING AND SELECTION

Screening Principles

In order to prevent non-point pollution problems, close attention must be paid to management of pesticide applications. Numerous studies and summaries have focused on selection criteria for minimizing non-point movement of chemicals from turf sites. In order to determine if certain materials should be precluded from use at the golf course (even though they are registered by the U.S. Environmental Protection Agency and the State of California), a system of qualitative and quantitative models should be used to evaluate all pesticides being considered for use. From this evaluation, a recommended pesticide list can be developed for each pest category for use in the Integrated Pest Management program.

Protection of surface water and groundwater quality requires consideration of many factors including the following:

1. Hydrologic conditions of the site
2. Properties of the soil
3. Properties of the pesticide
4. Management practices

Integrating all of these factors results in reduced probabilities for unwanted chemical movement.

Hydrologic Conditions. Depth to groundwater and direct surface runoff potential are important considerations in protecting natural resources. Attenuation of chemical concentration occurs through distance traveled and by the medium over which water must move. By timing pesticide applications to periods when no rainfall is forecast within 48 hours, or by selecting materials that have a low propensity for leaching and a short half life, water quality can be protected.

Soils. Soil texture, permeability, water holding capacity, pH and organic matter content are important considerations for pesticide selection. Texture and permeability will greatly affect how fast water percolates through the soil profile. Organic matter content influences soil water holding and ion exchange capacity. As the organic matter content increases, the soil can hold more water, reducing percolation, and adsorption capacity increases, holding pesticides in the root zone favoring microbial degradation. Soil pH also affects the sorption of basic and acidic pesticides and it affects microbial activity favoring breakdown of materials.

Pesticide Properties. Much of the propensity for pesticide movement in the soil solution is based on the chemical properties of the materials. Those that are highly soluble in water are more prone to leaching. Many materials are adsorbed to the soil, primarily to the organic matter component. A few are volatile and are lost as vapors. All of these properties are considered in the degradation rate, the speed at which the materials are broken down in the environment after they have been effective for the pests targeted at application. In order for a pesticide to contaminate groundwater, the chemical must move through the soil faster than it degrades. One index of pesticide leaching is the soil binding of the material to the organic matter (organic carbon) fraction. This is indicated by a Koc value for each chemical. An index of the speed at which degradation occurs is the length of time required for 50 percent of the material to disappear. This is the half-life or $T_{1/2}$ value of the compound. These Koc and $T_{1/2}$ values will change for each soil type. However, "mean" values can be determined and can be used to assess which materials might be the most sensitive as to leaching potential. An additional factor involved is application rate. Pesticides applied at low rates are more favorable since the quantity of parent compound to be degraded is smaller.

Management Practices. Application methods, pesticide rates and application timing must be critically evaluated to protect water quality. A qualified PCA and a licensed applicator, in consultation with specialists who are aware of and sensitive to local environmental conditions, should be able to provide the margin of safety required for wetlands and water quality protection in most situations.

A number of qualitative and quantitative analytical models have been developed to evaluate sites for the factors previously discussed. While none of these provide an absolute guarantee as to protection of water quality, they can determine the degree to which care must be exerted through management skills at the time of application.

Screening Models

Several models can be used in the assessment of pesticides for use at the golf course. The most basic models are screening models that use chemical and site information to determine potential to leach or be lost through surface runoff. Leaching can be assessed with GUS model (*Gustafson 1989*), the PLP model (*Warren and Weber 1994*), and SCS rating model (*Gnoss 1991, Wauchope et al. 1992*). Surface runoff can be assessed with the SCS rating model, in addition to a few others.

Screening Steps

Selection for each pesticide should be based on the following steps:

1. Step-wise models should be used to evaluate pesticides based on their chemical characteristics and site conditions. Stepwise models (as in the California Pesticide Contamination Prevention Act; Deubert 1990; GUS model, Gustafson 1989; Augustijn-Beckers et al. 1991; SCS Ranking in Gnoss 1991; Warren and Weber 1994) provide a series of "if-then" situations to evaluate pesticides. These models are often used to identify potential exposure of the pesticides to the environment and non-target organisms in surface runoff and subsurface leaching.

2. The levels of potential exposure of a pesticide through surface runoff and subsurface leaching can be determined from these step-wise models.

3. The level of risk associated with exposure is then evaluated with toxicity data to determine the potential hazard that exposure to a pesticide can cause. Aquatic toxicity is the primary environmental focus because aquatic organisms are unable to move from sources of contamination, and thus have a high degree of susceptibility.

CERTIFICATION FOR APPLICATORS OF RESTRICTED MATERIALS

The amended Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) has two key provisions:

1. The U.S. Environmental Protection Agency (EPA) is required to classify all pesticide products for “general” or “restricted” use.

2. Restricted use pesticides may be used only by or under the direct supervision of, certified applicators.

California has a list of restricted materials (pesticides) that includes any material that the EPA has designated as restricted. General use pesticides are those that will not ordinarily cause unreasonable adverse effects to the user or the environment when used in accordance with their registered labeling instructions. Such products are available to the public without restrictions other than those specified in the labeling.

Restricted use pesticides are those which may cause adverse effects to the environment or the applicator unless applied by competent persons who have demonstrated their ability to use these products safely and effectively. Qualified applicators are identified through an applicator certification program. These are two types of applicators:

1. **Private Applicators**. Farmers, ranchers, orchardists or other applicators that use or supervise the use of restricted materials to produce an agricultural commodity on property they own or rent.

2. **Commercial Applicators**. Those who apply or supervise the use of restricted materials on any property other than as provided by the definition of “private applicator.” Golf course employees are therefore commercial applicators.

Federal law states that no person shall apply restricted use pesticides, unless that person is certified or is supervised by a certified applicator. Commercial applicators will be certified by the California Department of Food and Agriculture (CDFA) after passing examinations designed to meet EPA competency standards.

PESTICIDE TOXICITY

Before any pesticide can be released for sale and use, it usually must go through extensive toxicity testing and federal and state regulatory review. Lethal levels for humans, fish and other mammals are established. Once these levels are established, the pesticide is placed in one of four pre-defined categories. The categories define the relative toxicity of the pesticide/herbicide and/or specific hazard to eyes or skin. The toxicity of a pesticide is defined as LD_{50} or LC_{50}. LD_{50} is defined in both oral and dermal dosages. LD_{50} is the lethal concentration in the air or water which will kill 50 percent of a test population by inhalation and is measured in milligrams per liter. The higher the LD_{50} number, the less toxic the substance is to organisms.

Before spraying, the pesticide with the lowest toxicity adequate to do the job (i.e., highest LD_{50} number) should be selected. There are other factors that must be considered in choosing a pesticide, such as what the side effects of the use of the chemical will have on the environment and the effect the pesticide will have in destroying predators and parasites. Great care should be taken when choosing any material known to concentrate in animal tissues (a bioaccumulator). Safety must be the most important factor in selecting pesticides, rather than the cost of the material.

The following scale is useful in judging the toxicity of pesticides:

Commonly Used Oral Term	LD_{50}	Probable Lethal Dose for Man	Category
Extremely Toxic	< 1	A taste or grain	I
Highly Toxic	1 to 50	1 pinch, 1 teaspoon	I
Moderately Toxic	50 to 500	1 teaspoon, 2 tablespoons	II
Slightly Toxic	500 to 5,000	1 oz., 1 pint	III, IV
Practically Non-Toxic	5,000 to15,000	1 pint, 1 quart	-
Relatively Harmless	15,000	1 quart	-

These toxicity values are expressed as LD_{50} in terms of milligrams of the chemical per kilogram of body weight of the test animal (mg/kg). Although LD_{50} ratings may not appear on pesticide labels, the following terms are set by law and can be used to judge the hazard of the material. There are four general categories of pesticides based on these toxicities. Knowledge of the meaning of the **signal** words and symbols forewarns the pesticide user of potential hazards associated with the chemicals.

- Category One pesticides have the signal words **"Danger,"** **"Poison,"** and the skull and crossbones symbol on the label. Some pesticides labels carry only the word **"Danger"** without the signal word **"Poison"** or the skull and crossbones symbol. These pesticides are also in Toxicity Category One due to specific hazard such as potential eye or skin injury. **"Danger"**, **"Poison"** and the skull and crossbones symbol are required on the labels for all highly toxic compounds, those with an LD_{50} range of 0 to 50 mg/kg.

- For Category Two pesticides, **"Warning"** is required on the labels of moderately toxic compounds, and have an LD_{50} range of 50 to 500 mg/kg.

- **"Caution"** is required on the labels of Category Three and Four compounds and are considered slightly toxic with an LD_{50} range of 500 to 5,000 mg/kg.

- No special words are required for compounds with an LD_{50} greater than 5,000 mg/kg; however, they must have the statement, **"Keep Out of Reach of Children."**

The following table summarizes the categories, their toxicity range, the corresponding signal word and the route or mode of entry into the body. The signal word forewarns the pesticide user of potential hazards associated with the pesticides. Pesticides may enter the body by one or all of the three of the following routes: skin absorption (dermal), eating or drinking contaminated items (ingestion), or breathing (inhalation).

Table C-1

Signal Words and Categories of Toxicity

Toxicity Categories	Signal Words	Relative Toxicity	LD_{50} Oral	LD_{50} Dermal	LC_{50} Inhalation
I	Danger/poison (Skull and crossbones)	Highly toxic	0-50	0-200	0-2,000
I	Danger	(Usually due to a specific hazard, such as eye or skin injury. Not necessarily high toxicity.)			
II	Warning	Moderately Toxic	51-500	201-2,000	2,001-20,000
III	Caution	Low order toxicity	over 500	2,001-20,000	---

PESTICIDE PERSISTENCE AND MOVEMENT TO GROUNDWATER RATING

The ability of a pesticide to move towards groundwater, referred to as "pesticide movement rating," is based upon from the Groundwater Ubiquity Score (GUS), an empirically derived score relating persistence and sorption in soil.

The persistence of a pesticide in the soil is based upon its soil half-life, or the time it will take for half of the original concentration to degrade. The pesticides were categorized as "non-persistent," with a half-life of less than 30 days, "moderately persistent," with a half-life of 30 to 100 days; or "persistent," with a half-life greater than 100 days. The soil half-life value is an approximation that may vary with variations in site, soil, and climatic conditions.

The sorption coefficient is a parameter that describes the tendency of a pesticide to bind to soil particles. A pesticide with a higher K_{oc} value binds itself to soil particles more than a pesticide with a lower K_{oc} value. A pesticide with a low K_{oc} value is more likely to move through the soil profile with infiltrating water. Pesticides that more readily sorb to the soil are more likely to remain in the root zone where they are available for plant uptake and microbial or chemical degradation. However, a pesticide with a very high K_{oc} is strongly sorbed to the soil and may be more persistent because it is protected from microbial degradation and plant uptake (E.A. Kerle, J.J. Jenkins, and P.A. Vogue, 1996). Therefore, it may be advantageous to select pesticide with a moderate to high K_{oc} value, rather than a very high K_{oc} value, to facilitate breakdown in the soil.

The GUS is determined by the equation

$$GUS = \log_{10}(\text{half-life}) * [4 - \log_{10}(K_{oc})]$$

The movement ratings range from “extremely low” to “very high,” based upon the following:

- GUS less than 0.1: “extremely low” potential to move toward groundwater
- GUS range 1.0-2.0: “low”
- GUS range 2.0-3.0: “moderate”
- GUS range 3.0-4.0” “high”
- GUS greater than 4.0: “very high”

The soil half-life and sorption coefficients primarily obtained through the Oregon State University Extension Pesticide Properties Database (P.A. Vogue, E.A. Kerle, and J.J. Jenkins, 1994). Information on pesticides not included in this database was obtained through fact sheets, other databases, and technical papers.

REFERENCES

E.A. Kerle, J.J. Jenkins, and P.A. Vogue. (1996). “Understanding pesticide persistence and mobility for groundwater and surface water protection.” EM 9561, Oregon State University Extension Service. [on-line] http://eesc.orst.edu/agcomwebfile/EdMat/EM8561.pdf

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