DRAFT

MANAGEMENT PLAN
REDWOOD SHORES LAGOON




CITY OF REDWOOD CITY, CALIFORNIA
Public Works Division

REVISED JULY 2003

Draft

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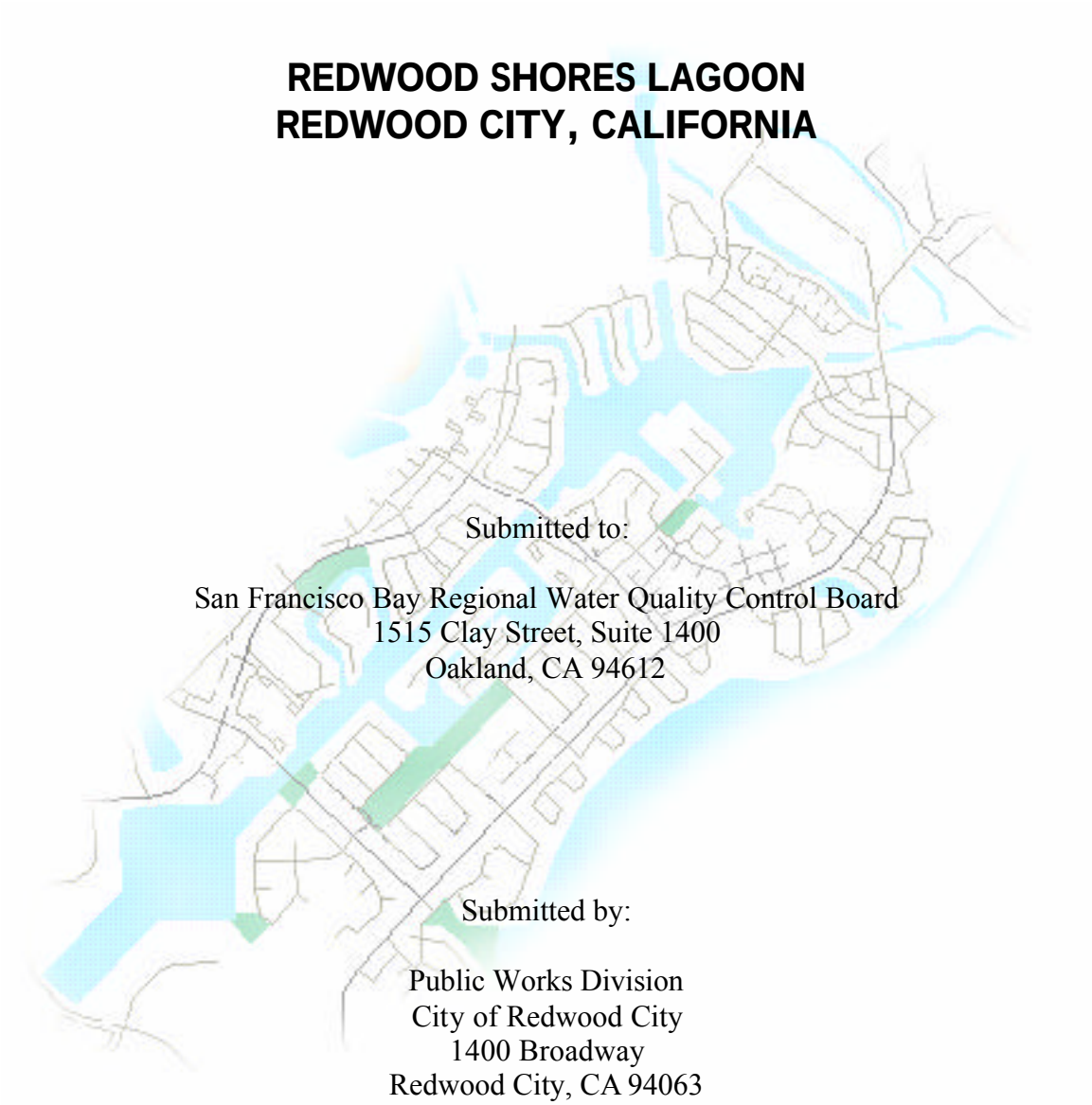

Submitted to:

San Francisco Bay Regional Water Quality Control Board
1515 Clay Street, Suite 1400
Oakland, CA 94612

Submitted by:

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City of Redwood City
1400 Broadway
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PREFACE

The San Francisco Regional Water Quality Control Board (Regional Board), as part of its broad-based responsibility for wastewater management and water quality enhancement, has developed detailed guidelines for the management of lagoons such as the Redwood Shores Lagoon in San Mateo County. Their purpose is to encourage responsible lagoon management and preserve the beneficial use of the lagoon and the contiguous waters of San Francisco Bay. To accomplish responsible lagoon management, the Regional Board may require that a lagoon management plan be prepared. It is intended that the plan serve as an operations manual for management personnel as well as to inform the Regional Board and its staff about the protection afforded the beneficial uses of the lagoon and contiguous waters.

"The City of Redwood City owns non-exclusive easements along the shoreline extending onto private properties. These non-exclusive easements were granted to the City for the following uses and purposes:

1. To store surface or stormwater runoff
2. To flow and move water within the property and to increase and decrease the elevation of water stored.
3. To clean and treat water stored or standing within the property.
4. To construct, reconstruct, maintain, operate, repair, renew and replace storm sewers or drains, storm drain structures and facilities appurtenant to storm drainage. Maintain the Lagoon to retain its original cross section.

The City's Public Works Division is responsible for the implementation of all of the lagoon management plan components. The specific individual in the Public Works Services Department who is currently responsible for implementation of the Plan components is:

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This management plan for Redwood Shores Lagoon was prepared by aquatic ecologist, Scott Cressey, under contract to the City of Redwood City and the supervision of Marilyn Harang. Mr. Cressey can be reached at Cressey & Associates, 147 Ashbury Avenue, El Cerrito, CA at 510-525-4389.

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1.0 INTRODUCTION

1.1 PROJECT LOCATION AND ADMINISTRATION

The Redwood Shores development is located on the Redwood Peninsula along the west shore of San Francisco Bay in the City of Redwood City, San Mateo County (Figure 1). The peninsula is bounded by Belmont Slough to the north, San Francisco Bay to the east, Steinberger Slough to the south, and the Bayshore Freeway to the west. Levees ring the peninsula, since the ground elevations are below that of the higher tides. Within the interior of the Redwood Peninsula lies Redwood Shores Lagoon. The lagoon is a focal point of the development and contributes to the area's visual aesthetics, aquatic habitat, and recreation (boating, swimming, and windsurfing). The lagoon also serves as a stormwater retention pond for the adjacent developing area, storing surface runoff during periods of high tide in San Francisco Bay. The City's Public Works Division manages the overall operation and maintenance of the lagoon, in cooperation with the city Department of Parks and Recreation and county, state, and federal oversight agencies.

1.2 BACKGROUND

Redwood Shores is characterized by flat land that was diked and filled, over time, to better serve human uses. First filled for farming and pasture land, the site was in salt production for many years, with grazing mostly on the high ground between the two sloughs. Belmont Creek, which was subsequently rerouted to Belmont Slough, meandered through the peninsula. During the mid-1930s, WPA funds were used to excavate a major waterway and diamond-shaped turning basin for a new port to serve San Francisco; however, these plans came to a halt when it was realized that large cargo ships would not be able to pass under the overhead power lines. For many years, a portion of the Redwood Peninsula was owned by San Mateo County Scavenger Company and was used as a dump and pig farm, and for a time in the 1930s and 1940s, an air landing strip was operated in the portion of the peninsula closer to the highway. Much of the remaining lands, which at that time were within the unincorporated area of San Mateo County, were owned by Leslie Salt. These lands were in salt production, with an area closest to the Bay used to farm oysters.

Over the past 30 years, the Redwood Peninsula has been converted to urban uses and transformed into one of the most significant master planned communities in the Bay Area. Development has proceeded generally from the center of the peninsula outward to the east and west, with the earliest residential uses located in a band to the south of the major channel. This original development was led by Leslie Salt in the early 1960s, emulating efforts begun at the same time in nearby Foster City. Redwood City then annexed the land and in 1964, General Improvement District 1-64 was formed. The district was comprised of all lands on the Redwood Peninsula. It was during this period that the present lagoon outfall was constructed, connecting a branch of Belmont Slough to the former turning basin. The purpose of the outfall, which allowed tidal waters to both enter and exit the basin, was to provide some degree of flushing for the lagoon system.

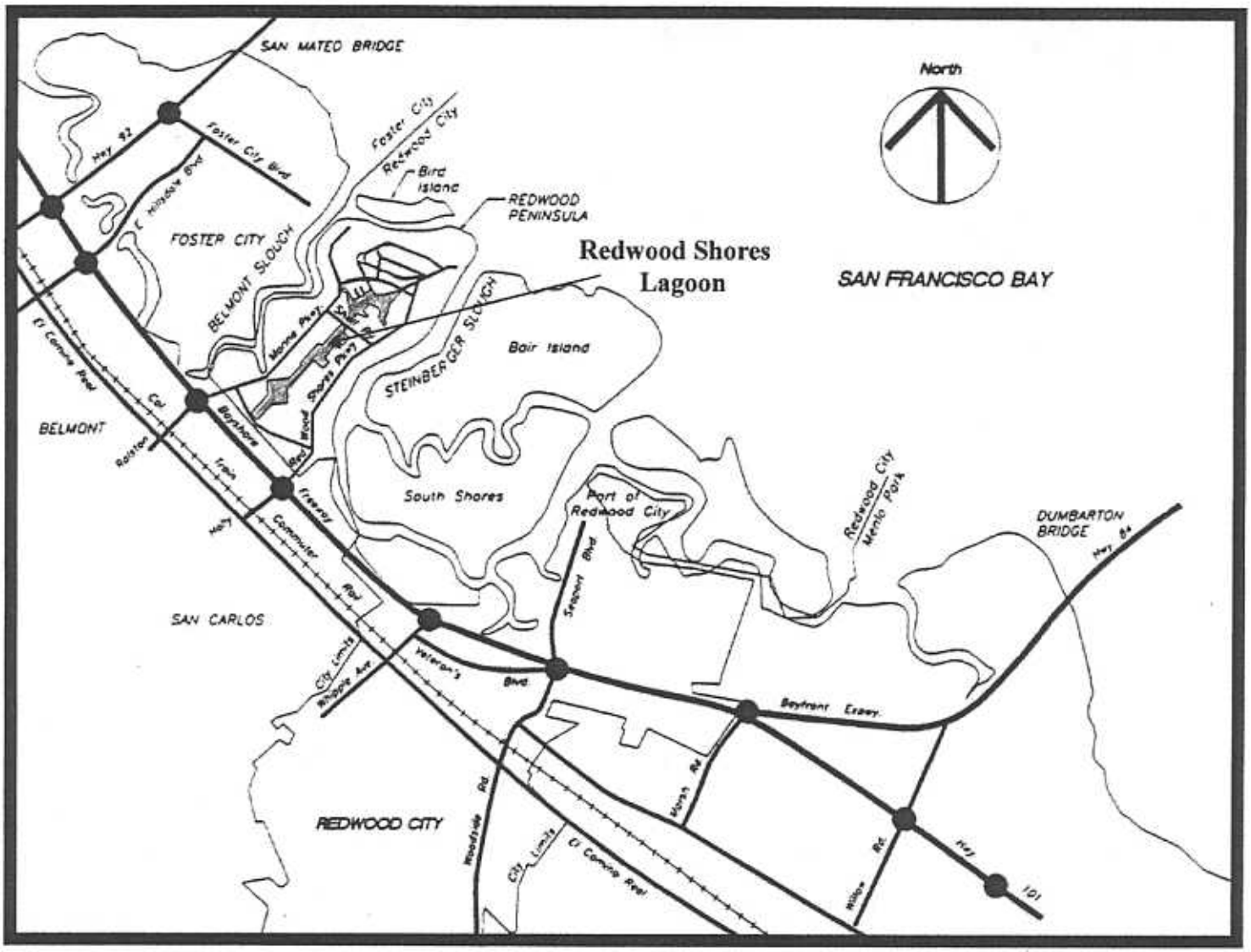


Figure 1. Redwood Shores Lagoon Location Map

In 1973, the sale of the property to Mobil Land marked a change toward higher residential densities and greater diversity of land uses with residential development oriented around channels and waterways and commercial uses focused along Highway 101. In 1978, Mobil Land, along with the City, began construction of much of the present day infrastructure, including extensions to the interior larger waterways. In 1989, Mobil sold the land to First City California North who, prior to the close of escrow, formed a partnership with KG Land called Peninsula Shores Ventures. This partnership later became Redwood Shores Properties, who is the fee title owner. In May 1993, KG Land purchased First City's interest and became the sole owner.

1.3 BENEFICIAL USES

In addition to serving the surrounding community as a stormwater retention basin, the beneficial uses of Redwood Shores Lagoon include:

- Feeding and resting habitat for waterfowl and migratory birds;
- Estuarine aquatic habitat;
- Sport fishing;
- Aesthetic enjoyment;
- Boating; and
- Swimming.

1.4 PURPOSE AND OBJECTIVES

The San Francisco Regional Water Quality Control Board (Regional Board), as part of its broad-based responsibility for wastewater management and water quality enhancement, has developed detailed guidelines for the management of lagoons such as the Redwood Shores Lagoon. Their purpose is to encourage responsible lagoon management and preserve the beneficial uses of the lagoon and the contiguous waters of San Francisco Bay. To accomplish responsible lagoon management, the Regional Board may require that a lagoon management plan be prepared. It is intended that the plan serve as an operations and monitoring manual for management personnel as well as to inform the Regional Board and its staff about the protection afforded the beneficial uses of the lagoon and contiguous waters.

Typical of lagoons receiving stormwater runoff from a developed watershed, the City of Redwood City's Redwood Shores Lagoon is subject to seasonal infestations of aquatic weeds and algae. A variety of Best Management Practices (BMPs) have been implemented in managing both the lagoon and its watershed to reduce the frequency and magnitude of aquatic weed and algae growth. However, it has still been necessary to employ both mechanical and chemical means of controlling aquatic plants and algae in order to maintain the lagoon's beneficial uses. This document describes the lagoon's existing operations, Best Management Practices (BMPs), aquatic weed control program, and self-monitoring water quality program. It also reviews additional steps and program alterations that might be taken to improve water quality and reduce the need for the application aquatic pesticides.

The objective of this lagoon management plan is to:

a) Describe Redwood Shores Lagoon's beneficial uses, existing water quality issues, and management programs intended to protect the beneficial uses of the lagoon;

b) Document compliance with permits concerning management of the lagoon;

c) Support the development, implementation and effectiveness evaluation of Best Management Practices (BMPs);

d) Demonstrate the restoration of water quality and protection of beneficial uses of the receiving waters following completion of resource or pest management projects;

e) Identify and characterize the aquatic pesticide applications; and

f) Assure that the water quality monitoring is representative of all pesticide and application methods used.

2.0 DESCRIPTION OF THE LAGOON

2.1 LAGOON PHYSICAL DESCRIPTION

The main lagoon is approximately 9,000 feet long. It is oriented in a northeast to southwest direction between Marine Parkway and Redwood Shores Parkway (Figure 2). At the two ends, the lagoon becomes wider (the southwest end of the lagoon is diamond shaped). At mid-length it connects to two smaller lagoons located on either side of Marlin Drive. A recreational area known as Neptune Beach is part of the small lagoon on the southwest side of Marlin Drive. These two lagoons are interconnected under Marlin Drive by small diameter culverts. The lagoon includes several narrow channels in "Area I" on the northeast end of the property. The connection of these channels to the main lagoon is limited to one 54-inch pipe that enters the channel along Radio Road. The Area I Inlet is from Bay Slough and it discharges into Steinberger Slough at Discharge Facility #2.

The lagoon is connected to sloughs leading to San Francisco Bay at six locations (see Figure 2). There are two gravity inlets from Belmont Slough and one from Bay Slough. There is one gravity outlet to Belmont Slough from the diamond-shaped portion of the lagoon. The lagoon's primary water source is tidal flow from San Francisco Bay through Belmont Slough and Bay Slough. In addition, there are two pump stations, referred to as Lagoon Discharge Facility 1 and 2 which pump water from the lagoon to Steinberger Slough. During the summer, these discharge facilities generally operate on a gravity-outflow basis. Lagoon Discharge Facility No. 1, located in the vicinity of Waterside Drive, discharges water from the channel located between Redwood Shores Parkway and Steinberger Slough. Lagoon Discharge Facility No. 2, located adjacent to Radio Road, discharges water from the channel located just south of Radio Road.

The lagoon bottom is at elevation 93.0 (National Geodetic Vertical Datum (NGVD) +100'). The lagoon water level is kept at elevations 97.0 and 99.0 during the winter and summer, respectively. The surrounding grade elevation is approximately 102. The Redwood Peninsula is surrounded by exterior levees that vary in elevation between approximately 107.5 and 109.0. Storm drains connect to the lagoon at a number of points along its periphery. During periods of rain they discharge storm water into the lagoon. Most of the storm drains are connected to dewatering structures just upstream of the lagoon.

The local watershed contains some office buildings, but otherwise is a residential area. The perimeter of the lagoon is developed with single-family homes and private docks along the majority of shoreline, interspersed with several small public parks.

2.2 LAGOON OPERATIONS

Routine municipal maintenance tasks include maintenance of operating levels, water exchange and flushing rates, pump stations and other infrastructure, aquatic plant nuisance control, water quality protection, water recreation, regulation of encroachments and bank alteration, and other activities. The flushing rate is the rate at which the lagoon

Figure 2, The detailed map of lagoon, a 11 x 17 map depicting water quality testing stations, is a large file and can be viewed separately by clicking on “Lagoon Map”.

water is replaced with water from an external source, in this case from Belmont Slough and Bay Slough. Flushing rate may be defined as the number of times that the entire lagoon volume is exchanged over a given period of time. An average lagoon flushing rate of once every 7 days is considered to be the optimum exchange rate, but this is rarely achieved.

Lagoon water exchange is accomplished via the previously described inlets and outlets connected to the surrounding sloughs. Inflow to the lagoon takes place through the three gravity inlets when tide levels are higher than the level in the lagoon. Findings from previous studies, current operational experience and a review of local tide levels indicate that gravity inflow to the lagoon is more than adequate to restore lagoon levels following a low tide period. Out flow from the lagoon is through a gravity outlet to Belmont Slough and two pump stations which discharge to Steinberger Slough. Gravity discharge from the lagoon is limited by the short duration of tide levels low enough to permit gravity outflow. The two pump stations, when properly operated, can increase outflow to the level required to maintain adequate flushing of the lagoon as a whole.

2.2.1 Summer Flushing Rates

Current lagoon operating procedures call for maximum summer lagoon levels at 99.0. If the lagoon level were to drop to 98.5 during low tide and rise back to 99.0 over a day, the flushing rate would be approximately 1/12; that is, the volume of the lagoon would be exchanged once every twelve days. A study of lagoon water circulation conducted 1994 concluded that the existing lagoon system as a whole has a summer flushing rate of 1/14. However, individual segments of the lagoon such as the southern end and the two internal water bodies between Marlin Court and Davit Lane, experience poor circulation because of lesser exchange rates.

Only 10 percent of the tides have LLW at 98.0 or higher. Therefore, with the maximum lagoon level at 99.0, gravity outflow from the lagoon is possible during the low part of practically every tide cycle. Adding the effect of the pump stations, it can be concluded that with proper lagoon operation acceptable overall lagoon flushing rates may be attained throughout summer. However, localized low circulation areas may experience lower exchange rates.

2.2.2 Winter Flushing Rates

Maximum lagoon levels in the winter are kept at elevation 97.0 to reserve storage for storm runoff. To assure some exchange of the lagoon water during this period, the lagoon level must be lowered to less than 97.0 and then allowed to fill back to elevation 97.0. Fifty percent of the tides at Belmont Slough have LLW at or above elevation 97.0; therefore, no gravity outflow is possible during these tides. LLW between 97.0 and 96.5 occurs for approximately 20 percent of the tides and will permit gravity outflow, but not for a long enough period of time to lower the lagoon level to 96.5. This places a bigger burden on the pumps if overall lagoon flushing rates are to be maintained. As a result, water circulation and quality is better in the northeast half of the lagoon due to the consistent operation of the pump stations. In contrast, circulation in the southern half of the lagoon which relies only on the existing gravity outlet is typically not as good.

2.3 WATER QUALITY CHARACTERISTICS

Because Redwood Shores Lagoon's primary water source is tidal flow from South San Francisco Bay (Bay) through Belmont Slough and Bay Slough, the general water quality characteristics of the lagoon are similar to that of the adjacent Bay. The salinity of the lagoon varies considerably on a seasonal basis, ranging from 15 ppt during the rainy season to 27 ppt in the late summer and early fall. Salinity in the lagoon is often slightly less saline than the adjacent Bay because of its function as a stormwater retention basin and because Belmont Slough drains fresh water runoff into the Bay. Water temperatures in the lagoon range from 7 degrees C to 24 degrees C (45-75 degrees F) and are generally warmer than the adjacent Bay waters because the lagoon is shallow and its waters have a longer residence time. Dissolved oxygen levels in the lagoon usually range between 6.7 mg/L and 7.8 mg/L and pH between 8.0 and 8.2. The lagoon's turbidity levels range from 3.2 to 7.0 NTU with the turbidity being a mix of phytoplankton and suspended sediments.

2.4 AQUATIC BIOTA

The benthic macroinvertebrate and fish fauna of Redwood Shores Lagoon are typical of that found in the adjacent subtidal zone of South San Francisco Bay. Based on California Department of Fish and Game trawl data for the shallower waters of South San Francisco Bay, the fish population of the lagoon is likely dominated by juvenile herring and anchovy, topsmelt, yellowfin goby, staghorn sculpin, shiner perch, bat ray, skate, leopard shark, and brown smoothhound. Juvenile and adult striped bass are likely to also be present in the lagoon along with an occasional white sturgeon.

2.5 CITY OWNERSHIP, EASEMENT RIGHTS AND REGULATORY AUTHORITY[1]

2.5.1. CITY OWNERSHIP RIGHTS

Generally, the underlying land of the lagoon, from toe of slope inward (the deep portion of the lagoon) is owned in fee by the City of Redwood City. In the typical or usual case, the back lot lines of the privately owned lots extend into the lagoon and coincide with the toe of the lagoon slope, as illustrated in Figure 3, *Redwood Shores Lagoon Typical Cross Section – Case I*. Therefore, the slope, along with the remaining portion of the lot, is the private property of the homeowner. However, there are notable exceptions to this typical condition, as explained below and illustrated in Figures 4 and 5.

In some cases, as shown in Figure 4, *Redwood Shores Lagoon Typical Cross Section – Case II*, the back lot line of the private lots do not coincide with the toe of slope. The private ownership extends beyond the toe of slope into the bottom portion of the lagoon. This is the case in the subdivisions: Marina Park, Pelican Cove, Shorebird Solar, Shorebird Island, and

[1] The information contain in this section is based on recorded documents, deeds, and Redwood City Council Resolutions. This research was conducted and the information compiled by Charles Csicsman, Supervising Engineer, Engineering & Construction Division, Community Development Department, City of Redwood City, August 5, 2002.

FIGURE 3
Redwood Shores Lagoon Typical Cross Section – Case I

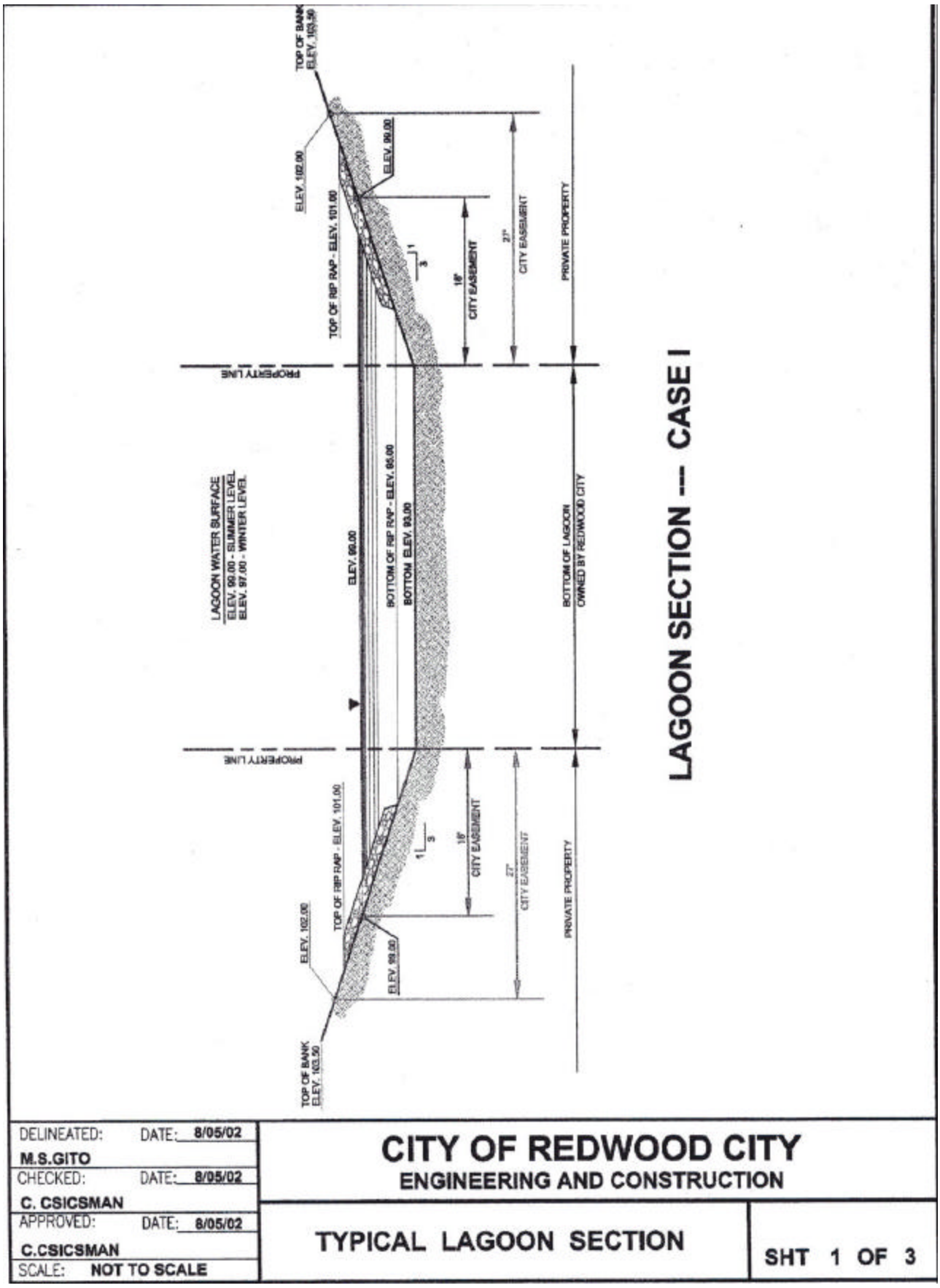


FIGURE 4
Redwood Shores Lagoon Typical Cross Section – Case II

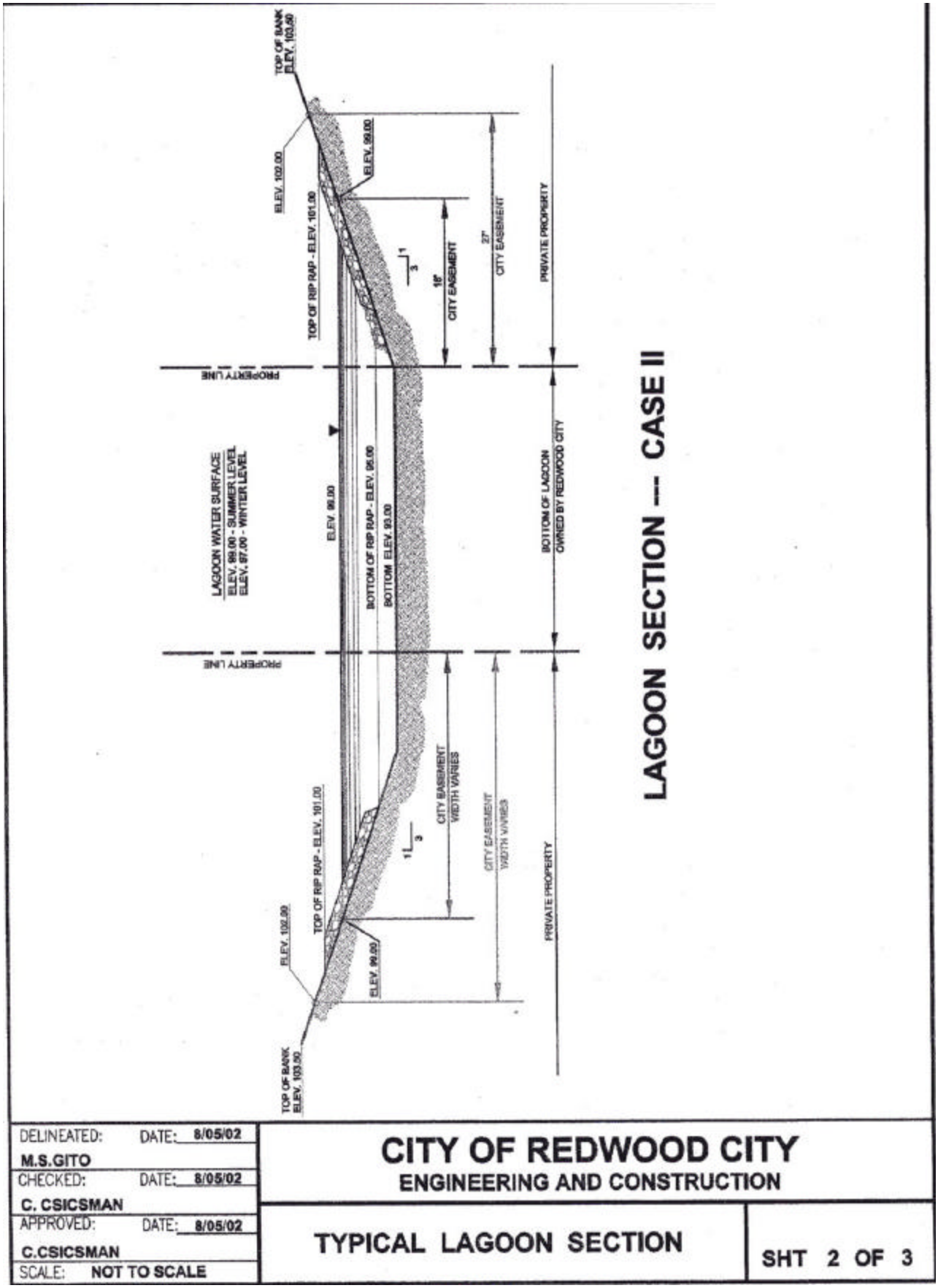
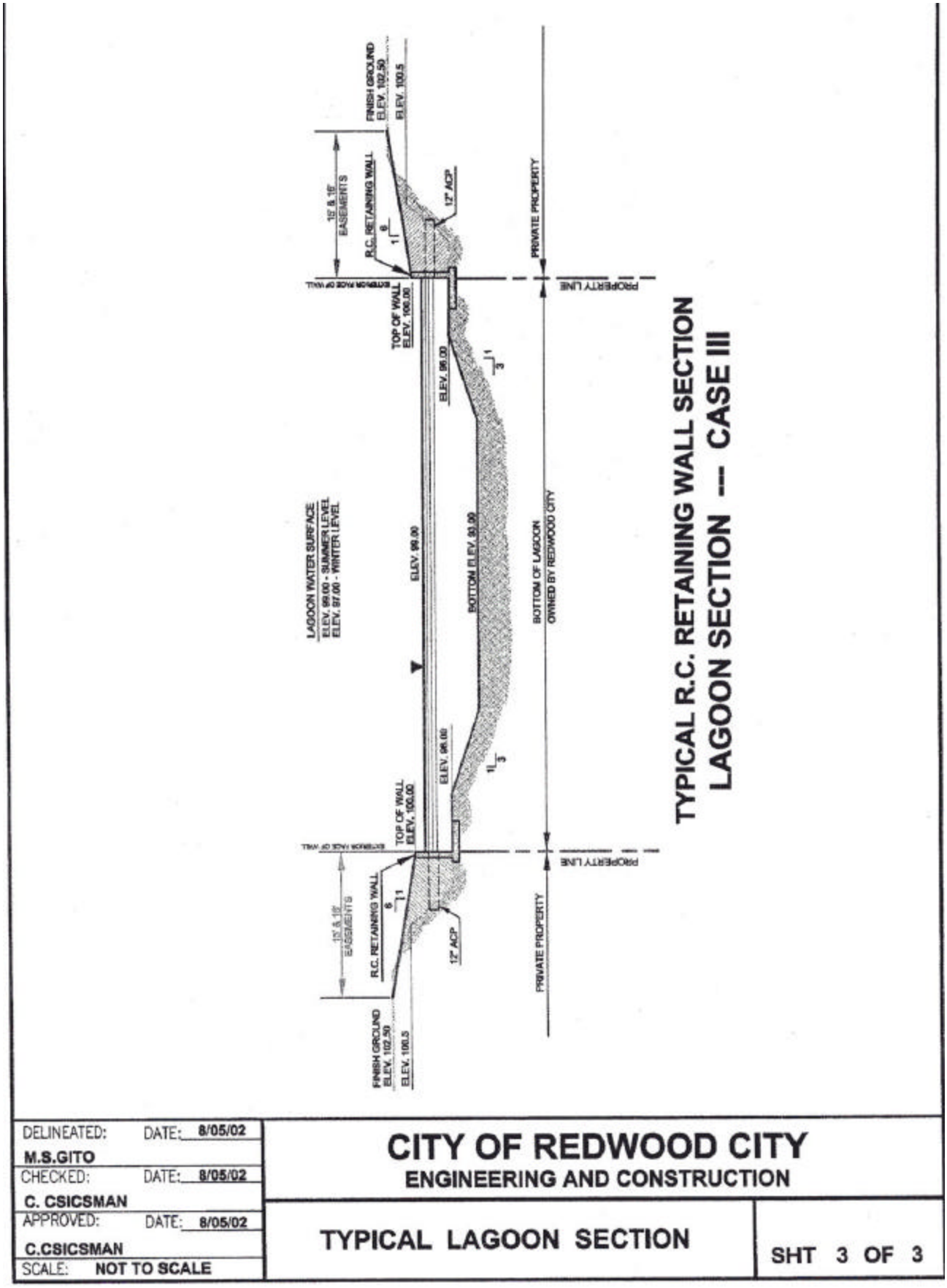


FIGURE 5
Redwood Shores Lagoon Typical Cross Section – Case III



Beacon Shores. In areas where there is a bulkhead (retaining wall) adjacent to the lagoon the City owns the land between the bulkheads, as illustrated in Figure 5, *Redwood Shores Lagoon Typical Cross Section – Case III.*

2.5.2 CITY EASEMENT RIGHTS

In addition to the ownership of the bottom of the Lagoon, the City owns non-exclusive easements along the shoreline extending onto private properties. The widths of these easements vary between fifteen and twenty-seven feet in general, and much wider in those areas where the back lot lines of the private lots extend beyond the slope into the Lagoon bottom. Adjacent to the portion of the Lagoon, where there are bulkheads, the City has a fifteen foot wide, and in some cases, a sixteen-foot wide easement.[2]

2.5.3 CITY REGULATORY AUTHORITY

The City's non-exclusive easements over the Lagoon were granted to the City for the following purposes:

a. To store surface or stormwater

b. To flow and move water within the property and to increase and decrease the elevation of water stored.

c. To clean and treat water stored or standing within the property.

d. To construct, reconstruct, maintain, operate, repair, renew and replace storm sewers or drains, storm drain structures and facilities appurtenant to storm drainage. Maintain the Lagoon to retain its original cross section.

The deed to the bottom of the channel and the easement deeds over private property, authorize the City to establish reasonable rules and regulations for the common health, safety and welfare of the users and the environment. Implementation of rules and regulations are predicated on compliance with the federal Clean Water Act, as enforced by the State of California through San Francisco Bay Regional Water Quality Control Board through National Pollution Discharge Elimination System (NPDES) permitting.

[2] Research by Charles Csicsman, August 5, 2002

3.0 WATER QUALITY MANAGEMENT

3.1 WATER QUALITY ISSUES

Redwood Shores Lagoon receives urban runoff which typically contains a broad range of pollutants that have potential to affect lagoon water quality. The primary constituents of urban runoff that are a problem to the lagoon's beneficial uses are nutrients, fecal coliform bacteria, and sediment. Nutrients from landscaping fertilizer and animal wastes encourage the excessive growth of rooted aquatic plants and algae, both planktonic (small and free-floating) and filamentous (initially attached, but breaks free to form mats). In Redwood Shores Lagoon, the predominant rooted aquatic plant is widgeon grass (*Ruppia maritima*), a plant with thread-like leaves that favors brackish water. Fecal coliform bacteria from animal waste entering the lagoon is mostly from dog dropping entering via the local storm drains, and from geese and duck dropping on beaches and grassy areas adjacent to the lagoon. While storm drain inflow of animal waste occurs most often during the rainy season, waterfowl contribution to elevating fecal coliform bacteria levels often occurs at the public beaches and picnic areas at a time when water contact is likely, thereby creating a public health concern. Excessive sediment input to the lagoon from storm drains and intake waters from the Bay reduce the depth of the lagoon and interfere with storm water inflow and boating. Reducing the depth of the lagoon also favors the growth of rooted aquatic weeds and attached filamentous algae. Water circulation in the lagoon, already a problem in the Area I section in the northeast end of the lagoon, is further restricted by excessive sedimentation.

3.1.1 Nutrients

In most natural water bodies, the key nutrients limiting the growth of aquatic plants and algae are the biologically available forms of phosphorus and nitrogen. Of these two nutrients, phosphorus is more commonly the limiting factor for aquatic plant and algae growth. The chemical form of phosphorus that is available for biological uptake is phosphate. For this reason, the concentration of phosphate is more valuable to know than total phosphorus. However, phosphorus represents the total potential source of this nutrient that could become phosphate. Because of its availability for biological uptake and because it is generally the limiting factor for plant growth, phosphate has a low residence time in water before it's consumed by plant life. The remaining portion of phosphate not consumed by plants is absorbed by suspended and settled sediments. To avoid algal blooms, it is generally recognized that water column concentrations of inorganic phosphate as P should be less than 0.01 mg/L.

The forms of nitrogen dissolved in water are relatively unstable. Through the nitrification process, nitrogen shifts between ammonia, nitrate, and nitrite. Ammonia can be nitrified to nitrate by bacteria. Organisms that oxidize ammonia to nitrite coexist with those that oxidize nitrite to nitrate, so nitrite doesn't accumulate in a natural environment as a result of nitrification. Therefore, nitrite is typically found at very low levels com-pared to ammonia and nitrate. The sum of these various forms of nitrogen that could be available for plant growth is reported as Total Nitrogen (probably the sum of the other nitrogen component analyses) or as Kjeidahl Total Nitrogen (an analysis technique for organic nitrogen plus

ammonia). Generally, nitrate is regarded as the best indicator of nitrogen available to plants, and that water column concentrations of inorganic nitrate as N should be less than 0.3 mg/L to avoid algal blooms.

Nutrients dissolved in the water column are more important to plant and algae growth than that in the sediment because it is readily available and easily assimilated by plants. However, phosphorus in the sediment also contributes to the growth of plants and algae. The literature on this subject is contradictory, but it is generally accepted that iron, aluminum, and calcium phosphates in aerobic sediments (the surface layer only) are slightly soluble, and that a dynamic equilibrium exists between phosphates in the sediment and in the overlaying water. As this equilibrium is disrupted by the absorption of phosphates in the water column by plants, more phosphorus will be released by the sediment. Phosphorus from the sediments is important in regulating phytoplankton productivity in waters with naturally low levels of phosphates in the water column. Where excessive phosphorus exist in the water column, the sediments act as a sink to accumulate phosphorus. Rooted aquatic plants are capable of absorbing phosphorus from the sediment. The roots of these plants lie in the deeper portions of the sediment where anaerobic conditions favor the solubility of iron and aluminum phosphates.

3.1.2 Fecal Coliform Bacteria

Bacterial levels in the lagoon can get sufficiently high during the summer months to warrant closing the beaches to swimming for the protection of public health. The source of the bacteria may vary, but appears to be mostly a result of animal waste from the large numbers of waterfowl using the lagoon. Other potential sources of bacteria are sewage bypasses and domestic animal wastes subsequently washed into the City's storm drain system, discharging to the lagoon during winter rains. Bacteria levels offshore of public beaches are assumed to be aggravated by the tendency for people to feed the waterfowl which congregate at these locations for handouts of food. The lower the flushing rate during the summer months, the more likely it is that the bacteria levels will rise to levels potentially dangerous to human health. This is particularly true at the Neptune Beach area where water circulation is poor. In addition to Neptune Beach, another area of waterfowl concentration is the at boat ramp on the west end of the lagoon.

3.1.3 Sedimentation

Sources of sediment to Redwood Shores Lagoon are primarily from two sources: 1) inflow waters from Belmont Slough and Bay Slough; and 2) storm drains directing local runoff into the lagoon. Inflow waters from adjacent sloughs carry suspended sediments into the lagoon where a portion of them drop out of the water column in the quiet waters of the lagoon. Wind may re-suspend a portion of these sediments, and finer particles may stay in suspension until the water is discharged from the lagoon. One area of excessive sediment deposition near a Bay water inlet is the channel receiving inflow from Inlet Belpipes 3&4. Much of this channel along Boardwalk has extensive sediment deposition. Sediment input from storm drains have resulted in sediment deposition in front of several storm drain outfalls to the lagoon sufficient to impede the discharge of storm waters. Four of these locations are: opposite Quay Lane; Neptune Beach; both sides of the channel crossed by Marlin Drive near Marlin Court; and the corner of Starboard Drive and Bark Drive.

3.1.4 Water Circulation

The two larger basins near the west and east ends of Redwood Shores Lagoon are connected by a central channel (see Figure 2). Numerous narrow channels connect to these basins and the central channel in a manner that causes restricted water circulation throughout much of the lagoon. The Area I section at the northeast end of the lagoon is particularly limited in water circulation, but even the Neptune Beach area off the central channel and the Shorebird Island channels have water circulation problems. Poor water circulation promotes sedimentation, excessive growths of water weeds and algae, and stagnant water with depressed dissolved oxygen levels from decaying plant matter.

3.2 WATER QUALITY OBJECTIVES

The San Francisco Regional Water Quality Control (Regional Board) requires that the lagoon management plan protect the beneficial uses of both the lagoon (see Section 1.3 for lagoon beneficial uses) and that of the receiving waters, South San Francisco Bay. The beneficial uses of South San Francisco Bay are: Recreation; Fish migration and habitat; Feeding and resting habitat for waterfowl and migratory birds; Industrial water supply; and Navigation.

Redwood Shores Lagoon's water quality objectives to protect the beneficial uses of the lagoon and that of South San Francisco Bay are listed below in Table 1.

Table 1. Redwood Shores Lagoon Water Quality Objectives

Parameter	Criteria
pH	6.5 – 8.5
Dissolved oxygen	Minimum of 5.0 mg/L
Chlorophyll-a	50.0 ug/l
Fecal coliform bacteria	A median not to exceed 240 MPN/100 mL in 5 consecutive samples with no single sample exceeding 1,000 MPN/100 mL
Color	No significant increase over that in sloughs
Oil, grease, and visable films	None
Floatables	None
Aquatic growths	None sufficient to cause nuisance conditions
Turbidity in Belmont, Steinberger and Bay sloughs that receive lagoon discharge	Background Levels / Max. Incremental Increase 50 NTU / 5 NTU 50-100 NTU / 10 MTU 100 NTU / 10 % of background

3.3 WATER QUALITY MANAGEMENT PROGRAM

3.3.1 Stormwater Pollution Prevention Program

The City conducts a stormwater pollution prevention program (STOPPP) to help control and prevent pollutant loading to the lagoon. The program identifies and mitigates potential and actual sources of pollutants in runoff through a comprehensive program of business

inspections, municipal maintenance practices, construction site controls, illicit discharge elimination, and public education. Water quality protection measures are implemented in conformance with STOPPP Performance Standards for Management of Lagoons, a component of the San Mateo Countywide Stormwater Management Plan under Municipal Stormwater NPDES Permit No. CAS0029921 issued to the City/County Association of Governments (C/CAG). These performance standards are presented in Section 5.0 of this document.

3.3.2 Lagoon Water Exchange

Water quality is maintained by maximizing the lagoon tidal water exchange rate. By doing so, bay-like conditions are maintained as much as possible to prevent development of thermal gradients, stagnant conditions, lengthy periods of low salinity, and aquatic insect infestations. Water exchange also helps mix, dilute, and move pollutants in urban runoff through the system. A steady current through the lagoon is encouraged by setting the pumping rate to match the inflow. While the optimum flushing (water exchange) rate for the lagoon is once per seven days (1/7 days), the complexities of the lagoon system result in an overall summer flushing rate of 1/ 14 days.

3.3.3 Aquatic Weed and Debris Control

The lagoon is subject to seasonal nuisance growths of aquatic weeds and algae. The City employs a variety of measures in order to avoid complete dependence on and minimize use of aquatic pesticides. Measures include the adjusting of water levels to reduce growing area during the spring and improve chemical contact with the target pest; maximizing of water exchange to mitigate potential for stagnation, stratification, and increased temperatures; conducting pollution prevention efforts in the watershed to minimize introduction of nutrients into the lagoon; employing mechanical harvesting to control weed growth and remove the nutrient-rich biomass from the lagoon; and using action levels for herbicide application. Herbicide applications are spot applied rather than broadcast sprayed whenever possible, and are applied during optimal stages of growth and weather conditions to maximize effectiveness.

The City hires a professional service to monitor and manage nuisance plant growth and debris. Tasks include visual monitoring of plant growth, mechanical harvesting, herbicide application, and trash and debris cleanup. Trash and debris find their way into the lagoon by way of Belmont and Bay sloughs, storm drain inlets, and lagoon users. These materials, along with the weed biomass from the harvesting operation, are removed for the lagoon and disposed or recycled.

3.4 AQUATIC WEED AND ALGAE MANAGEMENT PROGRAM

3.4.1 The Problem

Nuisance growths of widgeon grass (*ruppia maritima*) and filamentous algae (*cladophora*) have been problematic from the earliest years of lagoon operation. Left unchecked, nuisance growth can have a severe impact on aesthetic and recreational benefits, as well as water quality in the worst of conditions. Nuisance plant growth is believed to be largely a consequence of lagoon design. Shallow slopes, a shallow depth, nutrient inflow from storm drains, and a loss of natural tidal action all contribute to promoting conditions favorable for

nuisance growth.

3.4.2 Treatment Period

The aquatic plant and algae nuisance season typically extends from late April into September. The extensive growth of widgeon grass occurs primarily May through July. Nuisance algae growth extends from late April into September. While mechanical harvesting is presently employed for the removal of widgeon grass where feasible, widgeon grass in the shoreline waters too shallow for the mechanical harvester are spot-treated with Reward, an herbicide with diquat as its active ingredient. Some algae are removed as a byproduct of mechanical harvesting the widgeon grass. However, much of the algae must be spot treated with EarthTec/AgriTec, a copper-based algaecide.

3.4.3 Tools and Techniques

The strategy for controlling aquatic weeds and algae in the lagoon is to favor the growth of widgeon grass over filamentous and planktonic algae. By regularly removing the widgeon grass through mechanical harvesting, the lagoon's nutrients assimilated by these aquatic macrophytes are also removed from the lagoon. For this reason, blooms of planktonic algae (microscopic, free floating algae) are treated with EarthTec/AgriTec whenever the lagoon's water clarity becomes less than 2 feet as a result of planktonic algae. The mechanical harvesting and application of aquatic pesticides are conducted by the lagoon maintenance contractor.

Mechanical harvesting is utilized extensively in areas negotiable by harvesting equipment. Generally, a minimum water depth and clearance from stationary encroachments (e.g., docks and boardwalks) are required for safe equipment operation.

Pesticides are applied to areas deemed not feasible for harvesting. The aquatic pesticides shown below in Table 2 are applied to Redwood Shores Lagoon in the manner described. The Regional Board shall be notified of an aquatic pesticide not on this list prior to its use.

Table 2. Aquatic Pesticides Used for Redwood Shores Lagoon Aquatic Weed and Algae Control

Pesticide Name	Active Ingredient	Target Pest/Application	Application Method
EarthTec/AgriTec	Copper	Surface and subsurface filamentous algae	Injected into water column or surface sprayed
Cutrine-Plus	Copper	Surface and subsurface filamentous algae	Injected into water column or surface sprayed
Reward	Diquat dibromide	Widgeon grass	Subsurface injection into water column

3.4.4 Aquatic Pesticide Application Equipment

To treat the lagoon with pesticides, the lagoon maintenance contractor uses a boat equipped with a pesticide injection system. The Reward, and possibly the algaecides are drawn directly from a mix chamber and are injected into the lower water column as the boat moves through the problem area. A flowmeter-operated valve system monitors the delivery rate and allows a predetermined amount of the pesticide concentration in the water column.

The surface spraying of copper-based algaecides is accomplished with the same boat, but set up with a pump and tank spray equipment. The pump speed/pressure is set to minimize spray drift and spraying is confined to periods of little or no wind. Listed below are the series of steps followed for the surface spraying of these pesticides:

1. Tank mix the herbicides/algaecides as outlined above.
2. Work with the wind to keep it at applicators back.
3. Cover treatment area from open water area being sprayed.
4. Check tank mix level frequently to insure proper dosage rates are being applied.
5. Close chemical intake valve when pump is not in use.
6. Upon completion, flush the tank and pump system with water for a minimum of three minutes.

3.4.5 Potential Adverse Impacts from Pesticide Applications

Potential short-term adverse impacts to the lagoon's beneficial uses from the application of Reward are restricted to: 1) reducing the natural feed for waterfowl with the removal of widgeon grass; 2) human skin irritation upon contact with treated waters; and 3) direct and/or indirect negative impacts on non-target aquatic biota. However, because only isolated shoreline sections are chemically treated on an intermittent basis and are relatively small as compared to the lagoon as a whole, the risk of adverse impacts are considered small.

An assessment of the potential for long-term adverse impacts from the application of EarthTec/AgriTec and Cutrine-Plus focuses on the accumulation of copper in the sediments. Each use of copper-based pesticides make an incremental addition to the accumulation of copper in the sediments and biota of the waters where applied, and potentially the bay waters into which the treated lagoon ultimately drains. Deposit-feeding clams and other benthic invertebrates bio-accumulate copper and pass it upward into the food web. Elevated levels of copper are particularly toxic to plankton and larval fish and invertebrate. The application of copper-based algaecides to Redwood Shores Lagoon may contribute incrementally to this long-term accumulation of copper in the lagoon and nearby estuary. Mitigation of this copper contribution to the long-term accumulation consists of applying the minimum algaecide concentration needed to be effective, and to use copper-based pesticides in a judicious and prudent manner.

4.0 WATER QUALITY MONITORING PLAN

The following water quality monitoring plan is extracted from the City's 2002 approved self-monitoring plan submitted to the State Water Resources Control Board as a condition of Redwood Shores Lagoon's NPDES General Permit for discharge of aquatic pesticides to waters of the United States. Included below with the NPDES General Permit self-monitoring plan are elements of the City's past water monitoring plan such as nutrients, bacteria, and turbidity measurements in the lagoon's receiving waters.

4.1 OBJECTIVE

The objectives of the field sampling component of the Water Quality Monitoring Plan are two-fold. One is to document representative levels of nutrients and fecal coliform bacteria in the lagoon, plus turbidity in both the lagoon and outfall areas. These measurements in combination with several of the NPDES General Permit monitoring parameters (dissolved oxygen, pH, temperature, and salinity) satisfy water quality objectives to protect the beneficial uses of both the lagoon and its receiving waters.

The second objective is to satisfy the conditions of the NPDES General Permit for aquatic pesticide application by documenting representative water quality conditions in the pesticide treatment area and its outflow (if occurring) both before and after treatment with the aquatic pesticide. The resulting representative water quality data can then be used to evaluate the potential impacts on beneficial uses by the pesticide application. The water quality data resulting from this monitoring program is then used to assess the potential impacts of aquatic pesticide applications and to develop, evaluate, and refine BMPs.

The general water quality monitoring has been ongoing for many years. The NPDES General Permit monitoring as a requirement of the application of aquatic pesticides is a new program developed in 2002 and implemented in 2003. There is some overlap of data collected for these two programs. Salinity, water temperature, pH, dissolved oxygen, and turbidity are duplicate components of these two monitoring programs. A goal of the monitoring program described in this management plan is to avoid duplication of data collection where feasible. However, to avoid confusion between the data collection and analysis activities of these two water quality monitoring programs, they are described separately in the following sections.

4.2 NPDES GENERAL PERMIT MONITORING PROGRAM

This simple concept of sampling a pesticide treatment area and its outflow before and after application of an aquatic pesticide becomes potentially very complex in its implementation in Redwood Shores Lagoon. There are two reasons for this. The first is because Redwood Shores Lagoon is comprised of many interconnected small and large sloughs (see Figure 2). The second reason is that the April through October applications of AgriTec and Reward typically involve spot-treatments occurring several days a week in a wide variety of locations throughout this large and convoluted lagoon. Responding to observed or reported widgeon grass growths and/or algal blooms in areas infeasible for mechanical harvesting, the lagoon maintenance contractor may treat 30 different small problem areas in scattered locations during a given day, and this may occur several days per week throughout the summer.

Because it is impractical to sample each of these small areas being treated, the sampling design presented below uses seven fixed sampling locations to represent the various components of the lagoon and its points of outflow. One set of pre- and post-treatment samples will be collected monthly at these stations during the period of April 1 through September 30 for those months of pesticide application. Actual pesticide application may be more frequent during a given month, but the single sampling set will serve to document representative conditions associated with a month's pesticide applications.

4.2.1 Aquatic Pesticide Monitoring Sampling Locations

The selection of the sampling sites is based on the need to document the quality of the treatment area water in: 1) inflow water; 2) the portion of the water body receiving treatment; and 3) near the discharge pumps to evaluate potential for residual pesticides to be discharged from the lagoon. The lagoon is operated to promote continuous flow-through for water quality maintenance, but this could be temporarily modified should monitoring reveal excessive pesticide levels in the waters near the discharge pumps. To monitor water quality for pesticide treatment of Redwood Shores Lagoon, the following seven fixed locations will be sampled (see Figure 2):

Station 1. In the diamond basin within 50 feet of the Belmont Slough outfall facility;
Station 2. 50 feet offshore of Neptune Beach;
Station 3. Within 20 feet of the inlet at Belpipes 1&2 [sample while inflow is occurring];
Station 4. The northwest end of the outlet channel for Discharge Facility #1;
Station 5. Within 200 feet of Discharge Facility #2;
Station 6. The middle of the slough in Area I located between Radio Road and Canvasback Way; and
Station 7. The junction of the two most northeasterly lagoon sloughs in Area 1 south of Seabrook Court.

4.2.2 Aquatic Pesticide Monitoring Sampling Methods

The City currently conducts monthly monitoring of the general water quality characteristics of Redwood Shores Lagoon and will continue to do so. The aquatic pesticide monitoring program consists of pre- and post-treatment sample collection and the laboratory analyses of the samples for the active ingredient (the toxic component) in the pesticide used in the treatment. The type, location, and number of samples collected are summarized below in Table 3.

4.2.3 Aquatic Pesticide Monitoring Sampling Frequency and Duration

Within 48 hours prior to a treatment event, water samples will be collected from stations R-1 through R-7 as appropriate for the locations of the upcoming treatment area (see Figure 2 for locations). In most cases, all seven stations will be sampled to allow the lagoon maintenance contractor flexibility in treating problem areas observed while in the field. However, there may be certain times of the year when aquatic pesticide applications are confined to a particular area.

Table 3. Pre- and Post-Treatment Aquatic Pesticide Sampling and Analyses

Analysis Parameter	Lagoon Sampling Locations	QC Samples	Laboratory Test
Pesticide Residue: Copper Diquat	Seven fixed sampling stations throughout the lagoon.	One Field Blank per day's sampling; One Replicate per day's sampling; and a Laboratory matrix spike	EPA Methods 200.7/6010B for copper; EPA Method 549.1 for Diquat.

of the lagoon. At those times, individual stations will be selected as appropriate to represent the treatment areas and the nearest discharge facility.

Three to 5 days after the aquatic pesticides treatment event, the same stations will be sampled and analyzed again for residuals of the pesticides applied. The schedule for post-treatment sampling is based on whether the applied pesticide is a systemic or a contact-type of product. All aquatic pesticides proposed for the project at this time are contact pesticides. Aquatic weeds and algae react upon contact with "contact-type" pesticides. For the Redwood Shores monitoring project, one representative "treatment event" will be sampled per month. A summary table of the water quality monitoring sampling schedule for April 1 through September 30 is provided as Table 4.

4.2.4 Aquatic Pesticide Monitoring Sample Collection and Handling

The 7-foot maximum depth of the lagoon is well mixed and is unlikely to thermally stratify. For this reason, and because some of the pesticides will be injected into the water column, the water to be sampled for pesticide residue analyses will be collected from the mid-depth of the water column.

For purposes of quality control, each field sampling event will include a duplicate sampling from one of seven candidate sampling stations. A random number table will be used to determine which of the candidate stations will be the site of the duplicate sampling.

Also for quality control, each field sampling will include one field blank. The field blank will be prepared by filling the appropriate number of sample bottles with distilled water at the initiation of the sampling period, capping and labeling it, and keeping it with the other samples throughout the day's sampling. At the conclusion of the sampling period it will accompany the other samples to the laboratory for analyses for the active ingredients of the pesticide to be applied. Laboratory quality control will include adding a matrix spike to each day's set of samples. To minimize the risk of contamination, the subsequent protocols will be followed:

1) Water sample collection will <u>not</u> be conducted out of the "treatment" boat (residue risk of cross contamination);
2) Latex gloves will be worn during sampling;
3) Sample container labels will be filled out with permanent ink prior to attachment to the container;
4) Sample labels will include: location, date, and time of sample collection.

5) Sampling equipment such as a Kemmerer bottle will be rinsed with lagoon water from each sampling site prior to retaining the water sample from that site;
6) Samples to be tested for Diquat will be kept out of the sun and stored in a cooler, samples for copper testing will be preserved with nitric acid at the time of sampling.

All data collected in the field are recorded on the sampling field sheets provided in Appendix A. Pertinent field information such as depth of sample, date, time of sampling and general weather conditions will be recorded on this form. All samples must be identified such that a data reviewer or user can distinguish the site, sampling location, sample date and time, matrix, sampling equipment and sample type (normal field sample or QC sample).

Detailed equipment and procedure descriptions are included in the surface water sampling SOP presented in Appendix A of the NPDES General Permit Self Monitoring Plan's Quality Assurance Project Plan (QAPP) on file with the City's Public Works Division. Field coordinators must ensure that field personnel are trained on the sample collection and handling procedures prescribed in the QAPP and that all field activities are conducted following the lagoon maintenance contractor's health and safety procedures.

Sample possession during all sampling efforts must be traceable from the time of collection until results are reported and verified by the laboratory and samples are disposed of. Sample custody procedures will provide a mechanism for documenting information related to sample collection and handling.

A generous amount of ice will be packed with the samples. The ice may be contained in resealable bags, but must contact the samples to maintain temperature. The methods of shipment, courier name, and other pertinent information are entered in the "Received By" or "Remark" section of the chain of custody form.

4.2.5 Aquatic Pesticide Monitoring Quality Assurance Plan

The Quality Assurance Project Plan (QAPP) for the NPDES General Permit monitoring describes both field and laboratory protocols and QA/QC procedures. Because of its length, the QAPP is a separate document on file with the City's Public Works Division.

4.2.6 Aquatic Pesticide Monitoring Record Keeping

Records will be maintained with the following information for each pesticide application event:

a) The location of the treatment area (address and coordinates);
b) The name of the water body treated;
c) Project size (water surface area and volume of water treated);
d) Name, formulation, concentration, and amount of pesticide used;
e) Field and laboratory water analyses for pre- and post-treatment water quality; and
f) Documentation of activities in compliance with the General Permit Section D of the Permit (reiterated as Section 5.2 of the Self Monitoring Plan Best Management Practices).

Table 4
Redwood Shores Lagoon Water Quality Sampling Schedule, April 1 through September 30

Sampling Stations	Field Measurements					Samples Collected for Laboratory Analysis				
	Water Temp.	Salinity	pH	Dissolved Oxygen	Turbidity	Copper	Diquat	Dissolved Ortho PO_4	Nitrate-N	Fecal Coliform
	Pre & Post[2]	Pre & Post[2]	Pre & Post[2]	Pre & Post[2]	Pre & Post[2]	Pre & Post[2]	Pre & Post[2]	Monthly	Monthly	Monthly
Station 1 (R-1)	X	X	X	X	X	X	X	X	X	
Station 2 (R-2)	X	X	X	X	X	X	X	X	X	X
Station 3[3] (R-3)	X	X	X	X	X	X	X	X	X	
Station 4 (R-4)	X	X	X	X	X	X	X	X	X	
Station 5 (R-5)	X	X	X	X	X	X	X	X	X	
Station 6 (R-6)	X	X	X	X	X	X	X	X	X	
Station 7 (R-7)	X	X	X	X	X	X	X	X	X	
Boat Ramp (R-1BR)	X[1]	X[1]								X
Discharge #1 (RSL-4)	X[1]	X[1]		X[1]	X[1]					
Steinberger S.[4] (SS-1U & 1D)	X[1]	X[1]			X[1]					

[1] These stations are only for the general water quality monitoring program and are sampled monthly.

[2] Pre-treatment sampling should occur within 48 hours prior to treatment. Post-treatment should occur 3-5 days following treatment. Pre- and post-treatment sampling occurs once a month between April 1 and September 31.

[3] Sample near high tide to collect inflowing water from Belmont Slough.

[4] Sample 50-100 feet upstream of the discharge plume. Upstream will be determined by the tidal/flow conditions.

NOTE: The nutrient analyses should be reported as Dissolved Ortho-Phosphate as P, and Nitrate as N. Laboratory goals for detection/reporting limits should be: Copper at 0.020 mg/L; Diquat at 0.004 mg/L; Dissolved Ortho-Phosphate as P at 0.01 mg/L; and Nitrate as N at 0.1 mg/L; and Fecal Coliform Bacteria at 50 MLN/100 mL.

Sketches of sample locations, chain of custody forms and other information developed as part of this monitoring program shall be maintained and submitted to the RWQCB upon request.

All monitoring information and copies of all reports and records required by this NPDES General Permit shall be retained for 5 years, unless directed otherwise by the RWQCB.

4.2.7 Aquatic Pesticide Monitoring Reporting

All reports shall be submitted to the Regional Water Quality Control Board. The reports will comply with the provisions stated in "Standard Provisions and Reporting for Waste Discharge Requirements (NPDES)", (Attachment C of the Permit, Section B), "Monitoring and Reporting Requirements". The following reports are required:

1) Monthly Pesticide Usage Reports. Monthly Pesticide Usage reports must be submitted to the RWQCB by no later than the 15th of the following month. Department of Pesticide Regulation (DPR) Pesticide Use Report forms may be used as part of the documentation.

2) Annual Report. A calendar year Annual Report must be submitted to the San Francisco Regional Board and a copy submitted to the SWRCB in Sacramento by January 31 of the following year. The Annual Report shall contain tabular summaries of the pesticide monitoring data obtained during the previous year in a format that satisfies the requirements for inclusion in the Department of Pesticide Regulation's (DPR) surface water database. To meet these DPR format requirements, the data table must include the following: date of treatment; date of sampling; date of analysis; collected by; analyzed by; permit holder; and analysis results. The submittal must also include the analysis laboratory's Quality Assurance Plan. The Annual Report shall also include a summary including but not limited to: 1) objectives of the monitoring program; 2) results; and 3) interpretation of data in relation to frequency, duration, and magnitude of impacts to beneficial uses.

4.3 GENERAL WATER QUALITY MONITORING PROGRAM

The objective of the general water quality monitoring program is to collect the types of water quality data sufficient to document to the Regional Board that the management of Redwood Shores Lagoon is not impacting the water quality and beneficial uses of South San Francisco Bay as well as that of the lagoon itself. For that reason, the types of past analyses conducted included: coliform bacteria, nitrate, dissolved ortho-phosphate, copper, dissolved oxygen, clarity, salinity, pH, temperature, and visual inspections for floatables, scums or oil/grease film, and general appearance in regard to algae and aquatic weed growth plus any dead fish or birds. From March 1 through October 31, with the exceptions of weekly visual inspections and Secchi disk measurements of clarity, the water quality field measurements and sample collections were conducted monthly.

4.3.1 General Water Quality Sampling Locations, Parameters, and Frequency

General water quality measurements of dissolved oxygen, clarity (as turbidity), salinity, pH, temperature will occur during April through September in association with the NPDES General Permit monitoring of pre- and post-treatment conditions for aquatic pesticides. The nutrients, nitrate as N and dissolved ortho-phosphate as P, shall be tested at stations R-1 through R-7 during the period of April 1 through September 30. In addition to turbidity monitoring of R-1 through R-7 as part of the April through September pesticide-related monitoring, turbidity shall also be measured year-round on a monthly basis at RSL-4 and in the receiving waters of Steinberger Slough 50-100 feet upstream (SS-1) of the point of discharge for Discharge Facility #1. Note that the "upstream" direction will vary according to tidal conditions, so the tidal condition shall be recorded when sampling SS-1.

Fecal coliform bacteria shall be measured monthly year-round at two locations: 1) 50 feet offshore of Neptune Beach, and 2) within 50 feet of the boat ramp (R-1BR). Wading and other forms of public water contact occur at these locations. Salinity and temperature shall be included with all of these measurements because they are easy and inexpensive to collect and provide a general sense of water conditions. During each sampling, observations will be recorded regarding floatables, oil/grease films and scum, water discoloration, algae and aquatic plant growth, and any presence of dead birds or fish.

Those components of the general water quality sampling program for April 1 through September 30 are included in Table 4. The general water quality sampling program for October 1 through March 31 is shown in Table 5.

4.3.2 General Water Quality Sampling Methods

Water quality samples shall be collected from a depth of 1 foot below the water's surface. Samples to be analyzed in the laboratory will be stored in suitable containers provided by the laboratory. Field observations of weather conditions, floatables, oil/grease films and scum, water discoloration, algae and aquatic plant growth, and any presence of dead birds or fish shall be recorded on standard field forms (see Appendix A).

4.3.3 General Water Quality Sampling Quality Assurance

To minimize the risk of contamination, the subsequent protocols will be followed:

a) Latex gloves will be worn during sampling of fecal coliform bacteria;
b) Sample container labels will be filled out with permanent ink prior to attachment to the container;
c) Sample labels will include: location, date, and time of sample collection.
d) Sampling equipment such as a Kemmerer bottle will be rinsed with lagoon water from each sampling site prior to retaining the water sample from that site;
e) Water samples for nutrient and bacteria analyses will be stored on ice in a cooler until delivered to the laboratory; and
f) Container type and size, plus sample holding times, will adhere to the analysis laboratory's recommendations.

Table 5
Redwood Shores Lagoon Water Quality Sampling Schedule, October 1 through May 31

Sampling Stations	Field Measurements					Lab
	Water Temp.	Salinity	pH	Dissolved Oxygen	Turbidity	Fecal Coliform
	Monthly	Monthly	Monthly	Monthly	Monthly	Monthly
Station 1 (R-1)	X	X	X	X	X	
Station 2 (R-2)	X	X	X	X	X	X
Station 3[1] (R-3)	X	X	X	X	X	
Station 4 (R-4)	X	X	X	X	X	
Station 5 (R-5)	X	X	X	X	X	
Station 6 (R-6)	X	X	X	X	X	
Station 7 (R-7)	X	X	X	X	X	
Boat Ramp (R-1BR)	X	X				X
Discharge #1 (RSL-4)	X	X		X	X	
Steinberger S.[2] (SS-1)	X	X		X	X	

[1] Sample near high tide to collect inflowing water from Belmont Slough.

[2] Sample 50-100 feet upstream of the discharge plume. Upstream will be determined by tidal/flow condtions.

4.3.4 General Water Quality Monitoring Record Keeping and Reporting

The contractor responsible for mechanical harvesting of aquatic weeds and the application of aquatic pesticides shall keep a record of each month's harvesting and chemical application and provide a copy to the City. The weed removal record shall include information on the time spent weed harvesting, the location of this effort, and the volume of weeds removed. The monthly record of aquatic pesticide application shall include the types of pesticides applied, their application rate and total volume applied, plus the locations of the applications.

The San Francisco Regional Board requires that it be sent an annual report, and this report should also be sent to the San Mateo Countywide Stormwater Pollution Prevention Program. By combining the general water quality field data collected during October 1 through March 31 with the pre- and post-treatment pesticide monitoring data of April 1 through September 30, one annual report can be submitted that will satisfy the General Water Quality reporting requirements and the General Permit requirements. This report should include a letter of transmittal, a tabular summary of the laboratory analysis results, a tabular summary of the general water quality field measurements, and a map showing the locations of the sampling stations. Note that in order to meet requirements for incorporation into the state's water quality database, the tables must include the following information: pesticide application date; sampling date; analysis date; detection limits, the name of the sample collector; and the name of the laboratory performing the analyses.

5.0 INCORPORATION OF BEST MANAGEMENT PRACTICES

5.1 PURPOSE

Best Management Practices (BMPs) are methods of practice that eliminate or reduce the discharge of pollutants, that minimize the areal extent and duration of impacts caused by the discharge of pollutants, and that identify and implement non-toxic or less toxic alternatives. The following are BMPs for management of Redwood Shores Lagoon and its local watershed that are required as a condition of: the San Mateo County-wide Municipal Stormwater NPDES Permit, and the State Water Resources Control Board's NPDES General Permit. The City's requirements for the application of aquatic pesticide in the lagoon are also included. These requirements must be followed by City staff and its contractors when conducting management, repair, or improvement activities associated with Redwood Shores Lagoon and its local watershed.

5.2 STORMWATER MANAGEMENT PLAN PERFORMANCE STANDARDS

The primary guide for managing the lagoon's watershed and storm drain system shall be the San Mateo County-wide Stormwater Management Plan Performance Standards for Management of Lagoons, Municipal Stormwater NPDES Permit No. CAS0029921. These performance standards apply to all lagoon management activities undertaken by the City using its own staff or contractors. The objective of these performance standards is to manage the lagoon in such a manner and by such means as to provide reasonable protection of beneficial uses, as defined in the Water Quality Control Plan for the San Francisco Bay Basin (Basin Plan).

5.2.1 Lagoon Design and Improvements

The City staff and/or contractors will comply with the following requirements when making repairs, alterations, or improvements to Redwood Shores Lagoon.

1. Comply with all applicable local, state, and federal requirements in connection with lagoon dredging, shoreline alteration, or other applicable construction projects.

2. Utilize natural materials for bank protection that provide habitat for terrestrial and aquatic life in addition to effectively preventing erosion whenever possible.

3. For new construction, use only non-chemically treated in-water support structures, such as piers made of metal, concrete, or synthetic wood.

4. Use STOPPP approved best management practices (BMPs) in connection with construction activities.

5. Future redevelopment of a lagoon should incorporate design measures that help support estuarine (bay-like) conditions to the maximum extent possible and minimization of

potential future maintenance, which include, but are not limited to, source water supply, water exchange rates, circulation, bank slope and bank stability, siltation control, and other measures that support aesthetic and ecological values.

5.2.2 Water Quality Monitoring and Source Control

The City staff and/or contractors will comply with the following requirements when managing the water quality of Redwood Shores Lagoon.

1. Develop and implement a monitoring program for aquatic pesticides, consistent with monitoring plan requirements of the Statewide General NPDES Permit for Discharges of Aquatic Pesticides to Waters of the United States.

2. Minimize sediment and nutrient inputs through implementation of STOPPP Performance Standards for Commercial/industrial Discharges, Illicit Discharge Elimination, Municipal Maintenance, New Development and Construction Site Controls, and informing residents through venues described in Section 5.2.6 of these performance standards.

3. Minimize potential of pathogens by following Performance Standards for Storm Drain Facilities, promoting compliance with pet waste control methods through public education and code compliance efforts, and investigating and implementing methods to discourage high concentrations of waterfowl in public beach areas.

4. When monitoring indicates poor water quality conditions from sources other than the Bay intake water, attempt to identify the cause of the water quality problem through surveying potential locations, such as shoreline areas, storm drain inlets, side streams, and identifying potential sources using principles of illicit discharge investigation, including water sampling and testing if needed.

5.2.3 Plant Nuisance Management

The City staff and/or contractors will comply with the following requirements when managing the rooted aquatic plants and algae of Redwood Shores Lagoon.

1. Incorporate principles of integrated pest management into lagoon plant nuisance prevention and control strategies by employing one or more of the following control measures prior to use of herbicides, where practicable: water exchange and circulation rates, non-toxic dyes, mechanical harvesting and/or other practical mechanical methods, growth target thresholds for herbicide application, and using hydraulic controls to enhance herbicide contact and contact time.

2. Set growth thresholds that establish action levels for plant nuisance control. Thresholds shall be set so as to ensure that community values are protected while ensuring that use of herbicides is minimized. An appropriate threshold ensures that herbicides will not be used prior to there being visual evidence of growth, but at the same time ensuring that projected growth rates do not result in routine exceedance of the threshold. (Note: There are

currently no pre-emergent herbicides licensed for aquatic use in brackish water lagoons. Should a properly licensed pre-emergent product become available in the future, an alternate type of threshold may be warranted.)

3. In cooperation with and approval of all regulatory agencies, support research and development efforts on use of experimental technologies for lagoon plant nuisance management.

4. Use approved herbicides that have the most potential to provide the most effective nuisance control and have the least impact on beneficial uses.

5. Encourage City staff and their agents to attend professional training for continuing education in lagoon management.

6. Conduct visual observations by boat or from shore, at a frequency deemed prudent to help identify emerging nuisance conditions. Such observations may include, but are not limited to, looking for accumulation of bottom or floating algae, and spot "raking" for evidence of weed growth if not otherwise visible.

5.2.4 Litter and Debris Control

The City staff and/or contractors will comply with the following requirements to restrict litter and debris from entering Redwood Shores Lagoon.

1. Minimize debris entering the lagoon by providing a sufficient number of proper litter control receptacles in public areas, and service receptacles at a frequency that minimizes potential for overflow, as well as protect aesthetic values.

2. Promote compliance with local ordinances and policies in connection with littering, dock maintenance, disposal of yard waste, recycling, and other potential sources of litter and debris. This may be accomplished through venues described in Section 5.2.6.

3. Inspect, service, and maintain structural litter and debris controls, such as debris curtains, trash racks, and storm drain outfalls, at a frequency sufficient to assure effective unit operation and efficiency.

5.2.5 Communication and Training

The City will comply with the following requirements to ensure adequate communication and training for its staff responsible for managing Redwood Shores Lagoon.

1. Representatives from City staff will meet periodically to share information on lagoon management issues, as well as to evaluate these performance standards for effectiveness, and submit proposed changes to the Municipal Maintenance Subcommittee for comment.

2. New employees involved with lagoon maintenance, and aquatic plant nuisance control activities in particular, will be trained on use of these lagoon performance standards and the role of the new employee's position.

5.2.6 Public Education and Outreach

The City staff and/or contractors will comply with the following requirements to educate the public in ways that they can help improve the water quality of Redwood Shores Lagoon, and to keep the public informed of the City's efforts to improve water quality.

1. At public facilities located near the lagoon, make information available about current lagoon issues which may include, but are not limited to, how to reduce sources of pathogens, nutrients, herbicides, litter and debris.

2. Conduct targeted newsletter/mailings or public service announcements promoting water pollution prevention within the first year of the effective date of these performance standards, and biannually thereafter.

3. Participate in community outreach activities coordinated by STOPPP for the purpose of communicating STOPPP's water quality protection message.

4. Encourage public participation in stewardship of the lagoon, including promotion of volunteer community cleanup events.

5.3 BMPs FOR AQUATIC PESTICIDE APPLICATIONS

5.3.1 STOPPP Guidelines for Handling Aquatic Pesticides

The following guidelines for the application of aquatic pesticides are from the San Mateo County-wide Stormwater Management Plan Performance Standards for Management of Lagoons, Municipal Stormwater NPDES Permit No. CAS0029921. These performance standards apply to all lagoon management activities undertaken by the City using its own staff or contractors.

1. City staff and their agents will follow federal, state, and local laws and regulations with respect to herbicide handling, use, and disposal.

2. Apply herbicides at the optimal time and conditions to maximize their effectiveness and minimize amount applied.

3. Mix or load herbicides in a safe and prudent manner so as to minimize potential for spillage of raw or mixed product.

4. Calibrate application equipment as needed to assure the desired application rate.

5. Mix only as much material as is necessary for treatment.

6. Ensure that applicators practice herbicide use safety and that applicator equipment is properly inspected to prevent accidental leaks, spills, and hazards to applicators and the environment.

7. Herbicides shall be applied when it is found that non-herbicide control options, such as use of dyes, water exchange, and mechanical methods, are unable to maintain plant or algae growth beneath growth thresholds.

8. When copper based herbicides are called for, a chelated form of copper that offers the greatest affinity for adherence to the target and least likelihood of settling to the bottom shall be used.

9. Implement herbicide storage and disposal performance standards as identified in Municipal Maintenance Performance Standards for Pesticide Usage and Integrated Pest Management.

10. Maintain a record of all herbicide treatments, including herbicides used, general location on the lagoon and acres treated, and application rate. At the end of each calendar year, report to the Regional Board the total quantity of each aquatic pesticide used during the reporting year.

5.3.2 NPDES Permit Guidelines for Applying Aquatic Pesticides

The following guidelines for the application of aquatic pesticides are to modify and improve existing practices of aquatic pesticide application over time, consistent with Provision D of the lagoon's NPDES General Permit:

a) Dischargers must be licensed by DPR or DHS if such licensing is required for the aquatic pesticide application project. The pesticide use must be consistent with the pesticide label instructions and any Use Permits issued by CACs.

b) Prior to initial discharge under this General Permit the Discharger shall take steps to notify potentially affected public and governmental agencies.

c) The dischargers will follow BMPs that are designed to maximize efficacy of control efforts and minimize adverse impacts to the environment. The steps that will be followed to identify appropriate BMPs include:

1. *Preliminary site evaluations*. The discharger will conduct a site inspection to verify the need for treatment, options to treatment (including non-toxic and less toxic alternatives), and suitability of the site for treatment.

2. *Secondary site evaluations and pre-treatment monitoring*. The discharger will determine the type and intensity of treatment needed. This evaluation will include measurement and analysis of indicators to provide information on potential efficacy and water quality impacts.

3. *Alternative Control Measures.* The discharger will evaluate other available BMPs and alternative control measures to determine if there are feasible alternatives to the selected aquatic pesticide application project that could reduce potential water quality impacts.

4. *Treatment*. Immediately prior to treatment, the discharger will examine a series of indicators and modify treatment plans accordingly. These indicators may include day length, precipitation, recreational activity, sunlight, tidal water exchange, water depth, water flows, water turbidity, and wind. If this examination indicates a potential for reduced control efficacy and/or heightened water quality impacts, the treatment will be rescheduled.

5. *Post-treatment*. The discharger will assess control efficacy and water quality impacts. The results of this assessment will be evaluated by the Discharger to refine project operations through an adaptive management process.

5.3.3 City Guidelines for Applying Aquatic Pesticides

The shallow waters around the shoreline are inaccessible to the mechanical harvester. When weed growth in these shallow waters approach densities of about 0.1 kilogram per square meter (wet weight), spot applications of the herbicide REWARD (diquat dibromide) are to be applied at the manufacturer's recommended dosage (label rate). The herbicide application contractor must be a trained technician possessing a Qualified Applicator License Category F (aquatic maintenance). Additionally, the contractor retained to provide this service must be licensed with the California Department of Pesticide Regulation to do pest control applications for hire. This ensures that the contractor has the appropriate insurance for this type of work.

Listed below are three plans and procedures for chemical treatment of aquatic weeds which can be considered for various conditions. These plans are designed to protect water quality and fish habitats in the lagoon, the sloughs and San Francisco Bay. As such, they should be followed without modification.

Herbicide Application Plan for Shallow Water Problems

In cases where weed growth in shallow water where the mechanical harvester can not operate, REWARD can be used for emergent and submerged weed control. This herbicide is applied at the label rate by framed technicians in the employ of a contractor possessing a Qualified Applicator License Category F.

Procedure:

1. REWARD may be applied at the label rate as a spot treatment to control shallow water growths of emergent or floating weed problems. Application should take place from a motorboat. Applied at the label rate, there is no need to prohibit either swimming or fishing and it is not necessary to restrict the discharge of the treated lagoon water at the pump stations. However, Neptune Beach should be posted against water contact for 24-hours to avoid accidentally dispersing the REWARD before it can be taken up by the aquatic weeds.

2. Prior to applying REWARD to the Neptune Beach , this portion of the lagoon should be posted with signs warning that water contact recreation is prohibited for 24 hours following application for the reason noted above. The signs should contain the warning:

NO SWIMMING PERMITTED FOR 24 HOURS
BETWEEN THE DATES OF ___ AND ___
HERBICIDE (DIQUAT DIBROMIDE) APPLIED TO CONTROL AQUATIC WEEDS

3. Information on the purpose and need for REWARD application, and any beneficial use restrictions should be made available to all homeowners in March of each year through an article in the Homeowners Association newsletter and on the City's web page.

4. At the time of application, it will not be necessary to stop the pumps and hold the lagoon water. Operation of the lagoon's inflow and outflow can continue without interruption.

6.0 CURRENT MANAGEMENT ACTIVITIES IMPLEMENTING BMPs

6.1 MECHANICAL HARVESTING OF AQUATIC WEEDS

The primary method of controlling rooted aquatic weeds in Redwood Shores Lagoon is by mechanical harvesting (see Section 3.4.3). Mechanical harvesting is employed wherever water depth and access permits the harvester to operate.

6.2 NUTRIENT AND BACTERIA MONITORING

The City conducts monthly sampling of nutrients at the seven NPDES monitoring stations during the period of April 1 through September 30. Monitoring of fecal coliform bacteria occurs monthly at Neptune Beach and the Boat Ramp during 12 months of the year (see Section 4.3.1)

6.3 AQUATIC PESTICIDE MONITORING

A pre- and post-treatment pesticide monitoring program for the lagoon has been approved by the State Water Resources Control Board and will be implemented in 2003.

6.4 CITIZEN OUTREACH PROGRAMS

The City regularly participates in public outreach events sponsored by the San Mateo Countywide Stormwater Pollution Prevention Program (STOPPP), such activities include the San Mateo County Fair and the Fair Oaks / Latino Festival. Each year the City contributes an article to the Redwood Shores newsletter, "The Pilot" about lagoon maintenance and BMPs." Additionally, the City distributes brochures and pamphlets designed to encourage residents to manage their use of pesticides, and to be cognizant of the impact of dumping in streams and waterways. These brochures, and other information about stormwater pollution prevention can be found at the SANDPIPER COMMUNITY CENTER (SCC), 797 Redwood Shores Parkway, Redwood City, CA 94065, (650) 780-7323. For additional helpful information pertaining to storm water and lagoon management, residents are encouraged to visit the Countywide STOPPP website at http://www.flowstobay.org/

Currently, the City is developing several informational items specific to the Redwood Shores Lagoon, including notices to homeowners associations about BMPs for maintenance and cleaning of private inlets and catch basins that drain to the Lagoons. Homeowner associations will be encouraged to contact the City Public Works Division, Storm Drains Maintenance Section to discuss proper cleaning and maintenance. At the cost of the cleaning services, the Storm Drains Maintenance Section will complete the annua1 maintenance for homeowner associations.

6.5 WATER CIRCULATION IMPROVEMENTS

The City has contracted with the engineering firm, Camp Dresser & McKee, to model the water circulation of the lagoon, identify the locations of deficiencies, and to recommend improvement measures. This study is currently in progress.

6.6 STORM DRAIN MAINTENANCE

The Public Works Division annually completes maintenance and clearing of all 2,685 catch basins and inlets, the 17 pump stations, and all creeks (lined and unlined) in the City before October 15, the start of the wet season. To discourage dumping of trash, debris and fluids into storm drains and catch basins, the Storm Drains Maintenance Section stencils every catch basin and inlet in the City's storm drain system with ***"No Dumping, Flows To Bay".*** The storm drain catch basins and inlets in Redwood Shores are stenciled with ***"No Dumping, Flows To Lagoon."***

6.7 SEDIMENTATION IMPROVEMENTS

Included in current discussions are the need for accurate bathometric mapping and the feasibility of dredging sediment from the bottom of the lagoon to its original depth.

7.0 EVALUATION OF BMPS EFFECTIVENESS

The objective of an ongoing refinement of BMPs is to increase the effectiveness of aquatic pesticide applications and reduce usage over time. Total annual usage of each pesticide will be compared on a year to year basis to document trends in aquatic pesticide use over time. Due to environmental variables, other data such as tonnage of biomass material harvested, water temperatures and weather conditions should be included in the evaluation. Physical, cultural, biological, and less toxic chemical control alternatives can also be investigated on an ongoing basis and incorporated as appropriate to increase BMPs effectiveness.

The evaluation of BMPs for optimal pesticide application will be derived from the pre- and post-application water quality analyses (see Section 4.2). The finding of harmful levels of pesticide residuals within the treatment area or outside of the target treatment area after a defined period of time will call for modification of pesticide application BMPs.

The data resulting from the monthly monitoring of the lagoon's general water quality characteristics will also be reviewed for water quality trends. Nutrient and fecal coliform bacteria data will be especially useful, and the dissolved oxygen level data will provide an indication of the suitability of the lagoon's waters for sustaining aquatic biota.

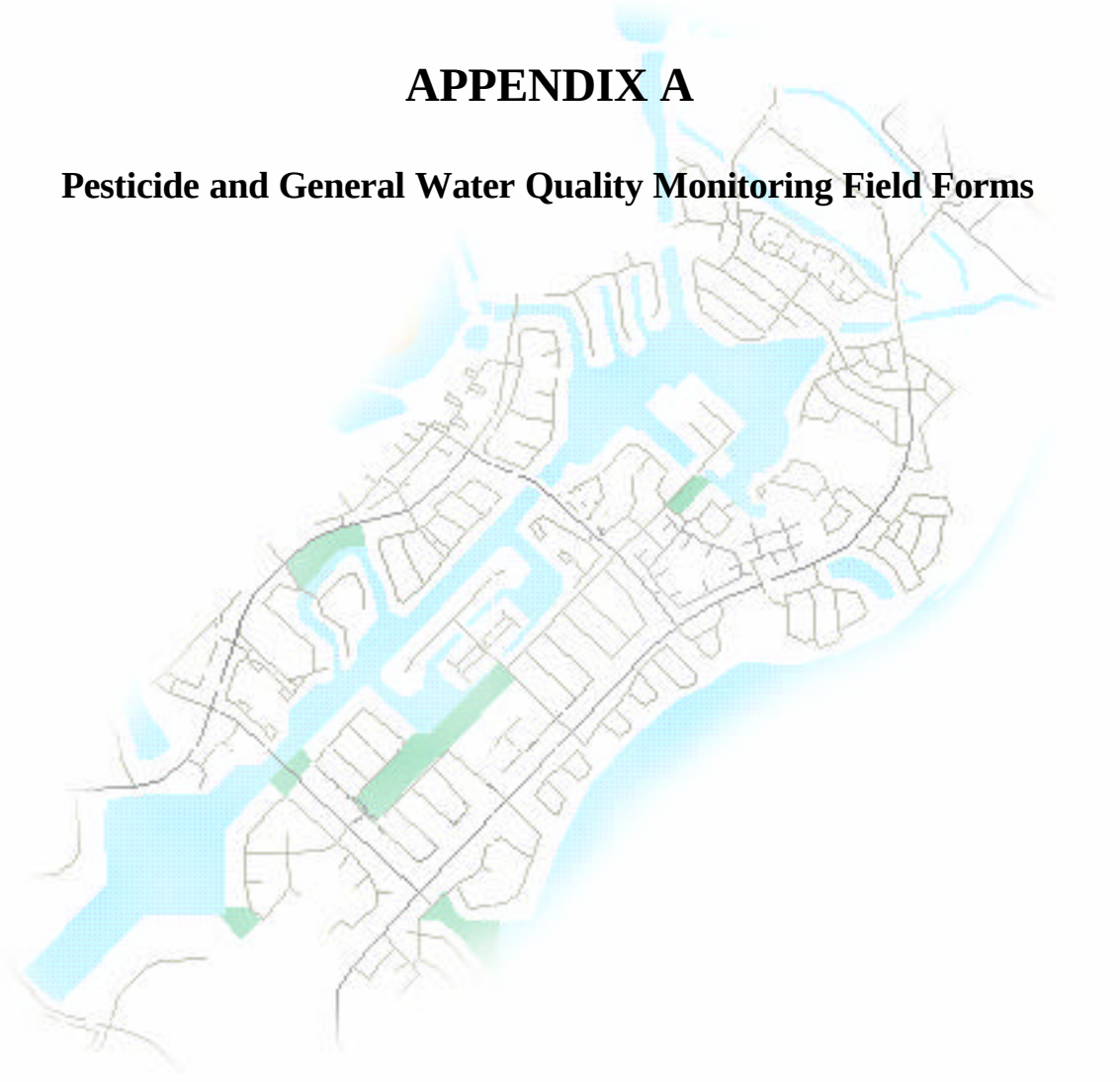
8.0 LAGOON MANAGEMENT PLAN UPDATES

This edition of the management plan makes few changes to the operating procedures of the lagoon but has numerous changes to the past monitoring program. All components of the management plan are subject to review and periodic revision to reflect changes in management goals, permitting requirements, water quality objectives, aquatic macrophyte and algae control methods, and the availability of approved herbicides and algaecides. Years of monitoring the water quality of the lagoon provides further insight to the biochemical and physical characteristics of the lagoon, potentially allowing certain analyses or monitoring schedules to be modified to yield greater or lesser detail. To ensure that this update occurs, the Regional Board requires a revised and updated Lagoon Management Plan be submitted once every three years.

The various reporting and observation forms included with this plan have been designed to provide the lagoon operator and his supervisors with a source of useful information upon which decisions can be based. As experience is gained in using these forms, it may be found that additions or deletions are required or that reformatting may make them more usable. Should this be the case, revised forms should be developed.

APPENDIX A

Pesticide and General Water Quality Monitoring Field Forms



NPDES General Permit
Pesticide Monitoring Field Notes

Date:

Water Sampled: Redwood Shores Lagoon

Name(s) of Field Personnel:

Location (City): Redwood City

Circle One: Pre-Treatment Post-Treatment

Date of Last Treatment:

Treated With:

Weather Conditions

Air Temperature:

Wind Conditions: Light; Moderate; High

Percent Cloudy:

Samples Collected for Pesticide Residue Testing (Collected at mid-depth)

Sample Code	Type of Analyses	Time	Station	Total # of Bottles	Duplicates (Yes / No)	Preserved (Yes / No)	Iced (Yes / No)
R-Blk[1]	Copper & Diquat		Field Blank	2			
R-1	Cu, Diquat Nutrients		Outlet	3			
R-1BR	Fecal Coliform		Boat Ramp	1			
R-2	Cu, Diquat, Nut. & FC		Neptune Beach	4			
R-3	Cu, Diquat Nutrients		Belmont Inlet 1&2	3			
R-4	Cu, Diquat Nutrients		Northeast Basin	3			
R-5	Cu, Diquat Nutrients		Discharge Channel #2	3			
R-6	Cu, Diquat Nutrients		Area 1 Southwest	3			
R-7	Cu, Diquat Nutrients		Area 1 Northeast	3			
Duplicate[1]	Copper & Diquat			2			

Comments or Problems:

[1] The field blank and duplicate are for copper and diquat analyses only (no nutrients). Label the site with duplicate as the site code followed by A or B (eg. R-2A and R-2B).