

CONTROL OF NUISANCE PLANT GROWTH
IN LAKE MERRITT, OAKLAND, CA

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Introduction

Lake Merritt is a 145 acre, shallow, salt water lake in the center of downtown Oakland. The lake has a variety of uses, including flood control, wildlife habitat, and recreation. What is now called Lake Merritt was developed initially in 1869 when a constriction was built across the mouth of San Antonio Slough, the point at which two streams originating in the hills discharged into the Bay. Initial dredging of the lake and construction of an earth fill dam and tidal gates took place in 1893. At that time, natural flushing of the lake occurred by tidal action from the Oakland Estuary.

The watershed contributing storm water runoff into Lake Merritt includes a portion of the City of Oakland and all of the City of Piedmont. The 3960 acre watershed is now highly developed and drains through five major storm drain systems as well as numerous street drains along the perimeter of the lake. In 1970, the Lake Merritt Flood Control Pumping Station was placed in operation, replacing the old manual control gates. Lake level control operations are managed by the Alameda County Flood Control and Water Conservation District. The outlet from Lake Merritt discharges via the pumping station and outfall channel to the Oakland inner harbor.

Public recreation is the major use of the lake. The principal activity on the lake is boating. The lake is surrounded by a park that supports picnicking, hiking, jogging, bicycling, and horticultural and nature activities. Located within the park area is Children's Fairyland, the Natural Science Center, Sailboat House, and Park Place Restaurant. There are five man-made islands located in the Trestle Glen arm of the lake that provide a safe nesting area, as well as a migratory stopover, for birds.

Construction of the pumping station and modification to the tidal gates at Seventh Street have improved the flood control effectiveness, but have reduced the tidal flushing efficiency of the Lake Merritt Channel. Lake Merritt has a long history of water quality problems.

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Water Quality

The fact that Lake Merritt is an urban lake, set in a densely populated metropolitan area with residential and commercial properties within the watershed boundaries, along with tidal flow from the Oakland Estuary, makes it impracticable to implement and enforce traditional watershed management techniques to control inflow quality. Sources of chemical and bacteriological pollution at Lake Merritt include urban runoff, sewage line overflows in wet weather conditions, tidal exchange water from the Estuary which may include industrial discharges, waterfowl feces, and nutrient flux from the transported sediments.

In the past, a variety of scientific testing has been conducted to diagnose the water quality problems of Lake Merritt. Information and data collected are described in the "Lake Merritt Restoration Project - Final Report" dated January 1982, prepared by Alameda County Flood Control and Water Conservation District and CH2M-Hill. That report also summarizes previous scientific and engineering studies of Lake Merritt.

Current water quality objectives for Lake Merritt are addressed by the Regional Water Quality Control Board as part of its San Francisco Bay Basin Plan. The Basin Plan presently classifies Lake Merritt for the following existing and potential beneficial uses:

- o Water Contact Recreation (Rec-1)
- o Non-Contact Water Recreation (Rec-2)
- o Wildlife Habitat (Wild)
- o Fish Spawning (SPWN)
- o Estuarine (EST)

Nuisance Plant Growth

Studies conducted by the Regional Water Quality Control Board and the Alameda County Flood Control and Water Conservation District have concluded that most of the perceptible water quality problems at Lake Merritt are a direct result of excessive nuisance plant growth. Nuisance growth consists of widgeon grass (*Ruppia maritima*) and mats of filamentous algae (*Enteromorpha* and *Cladophora*).

These represent a significant problem associated with the lake in terms of its appearance, odors, and restriction of beneficial uses such as boating and fishing. In the past, excessive growths have produced visual and odor problems, and have affected the enjoyment of the lake. The excessive growths have also had the potential to cause fish kills as a result of localized dissolved oxygen depletions.

The peak growth period for widgeon grass normally occurs in May and June, with die-off and decay occurring in late summer. Algae blooms occur immediately after the first hot days of spring. Mats of algae grow along the shallow shoreline and around the bird refuge islands. A normal bloom lasts 2 to 3 weeks as the mats die off and become submerged. Plant growth during the 1981 season covered over 50% of the lake's surface area, well in excess of what maintenance operations could manage. From 1982 through 1986, control of aquatic plant growth at Lake Merritt had been accomplished by the use of an Aquaquip H10-800 aquatic plant harvester.

Plant growth within the lake is dependent on a number of parameters; nutrients available, sediment thickness, and sunlight penetration to the lake bottom. As concluded in the 1982 CH2M-Hill report, the amount of light reaching the lake bottom was determined to be the primary element in the growth of widgeon grass, and appears to be the key to mitigating growth in the central areas of the lake. The reduction of nuisance plant growth by the control of the other two parameters, nutrients and sediment entering Lake Merritt, was not considered to be feasible. The 1982 report concluded that increasing the lake depth by dredging would provide the greatest effect in reducing nuisance plant growth. Widgeon grass and algae grows aggressively in areas shallower than about 7 feet. As a consequence of the 1982 studies, a major dredging program was completed in October 1985, at a cost of approximately \$2.5 million, deepening the central portion of the lake to an elevation of -10.5 feet. Dredging operations were limited to areas no closer than 25 feet from the shoreline to maintain the stability of perimeter walls. Approximately 400,000 cubic yards of sediments were dredged from the lake. However, filamentous algae continued to grow along the lake's shallow shoreline, during a limited growth season. Widgeon grass has only been visible at the surface of the water in localized areas since the conclusion of the dredging program. Bottom sampling shows widgeon growth to be extremely low in all of the dredged parts of the Trestle Glen arm.

A number of remedial programs have been proposed and investigated to control nuisance plant growth along the shoreline including constructing a hard substrate along the shoreline bottom; introducing a competitive, acceptable plant growth; the use of herbicides; and continued reliance on mechanical harvesting operations.

Algae Treatment Program

During the 1986 spring and summer seasons, it became evident that dredging had been effective in eliminating the nuisance plant growth problem in the central areas of the lake. However, it also was established that continued efforts were required to address the seasonal plant growth that occurs along the shallow shoreline.

Subsequent to the 1986 growing season, the Oakland City Council requested the Office of Public Works to develop a Lake Merritt Management Plan to establish requirements for the coordination of ongoing monitoring, maintenance, and potential capital improvement projects to assure acceptable water quality and beneficial use of the lake. Alternatives directed at the shoreline nuisance plant growth resulted in no acceptable, long term solution to the algae problem. The management plan concluded that a test program of algaecide treatment should be implemented for the 1988 growing season.

A test program of herbicide treatment of the shoreline areas within the Glen Echo arm of Lake Merritt with the product Aquazine was approved by the City Council and the California Regional Water Quality Control Board (CRWQCB) in March, 1988. Aquazine is a product used successfully as an algaecide at a variety of lakes and lagoons in the Bay Area. The focus of the proposed herbicide treatment was to control algae growth along the shoreline. By treating the shoreline for algae growth only, concentrations of Aquazine were minimized and water retention periods were reduced to only one day for each application. Investigations as to the safety of the product concluded that its use was appropriate for Lake Merritt.

In 1988, the Glen Echo shoreline was treated each month from April to August, for a total of five applications. Application of the herbicide was performed by American Lake and Canal, Inc., an aquatic weed control specialist. Each application was followed by a sampling of water, sediment, or mussel tissue to determine concentrations of simazine, the active ingredient in Aquazine. For each application, 230 pounds of Aquazine was applied in a 100 foot wide band along the shoreline, targeted to attain a concentration in water of about 1.5 milligrams/liter.

The dosage was recommended by the manufacturer and approved by the CRWQCB for the control of the net-like algae. During the applications, tidal circulation in the lake was cut off for 24 hours and the lake water held at a high level to minimize the spread and dilution of the Aquazine. Coordination of lake levels, water retention, and tidal flushing was maintained between OPW and Alameda County Flood Control.

Immediately following each application of Aquazine, a die-off of the algae bloom was observed. At no time were simazine concentrations measured in Lake Merritt above 0.028 mg/l. This measured dosage was considerably lower than the manufacturer's recommended dosage of 1.5 mg/l, but was still somewhat effective in controlling the algae. Aquazine was found to dilute quickly throughout the body of water in the lake, making the attempt of localized treatment of algae within the Glen Echo arm less than optimal. Sampling and testing indicated that concentrations of simazine were equalized throughout the lake within hours to levels that were too low to be fully effective against algae growth. Regrowth of algae generally occurred within 3-5 weeks, depending on weather conditions. The monthly application was scheduled and coordinated by the OPW Department of Engineering and Design Services, and was based on the visual inspection of shoreline conditions and the scheduling of special lake events.

Records kept by OPW Maintenance of weed harvester usage and truckloads of aquatic weeds hauled away from the lake provides a good indication of the effectiveness of the algaecide treatment. During the three growing seasons following the completion of lake dredging in 1985, nuisance aquatic plant growth had been limited to shoreline algae only. Maintenance crew time budgeted and expended for surface harvesting during those three growing seasons had been focused on the collection and removal of algae only. The amount of algae removed by mechanical harvesting during the 1988 growing season was reduced by 80% from the previous year. 58 cubic yards of algae were removed in 1988 compared to 276 cubic yards of algae removed the previous year. Only 7 crew-days of labor were used in 1988 to clear the lake of algae by mechanical harvesting, compared to 33 crew-days used the previous year.

The use of Aquazine during the 1988 test season was determined to be a cost effective method of controlling nuisance plant growth along the shallow shoreline shelf. The monitoring program in place during the treatment period also concluded that the Aquazine had not accumulated in bottom sediments or in invertebrates within the lake.

During the 1989 growing season, the algaecide program was expanded to treat the entire shoreline perimeter of the lake, excluding the bird refuge area (a treatment area of approximately 3 miles of shoreline). The bird refuge was excluded to minimize disturbance to the birds. The algaecide program was successful during both the 1989 and 1990 growing seasons in controlling shoreline algae growth. Algae growth was not eliminated altogether by the program, but was reduced to a level that did not degrade any of the beneficial uses of the lake. In particular, the City did not receive any inquiries regarding the odor of decaying plant growth during those seasons.

ANNUAL PROGRAM

In preparation for each year's treatment program there are a number of steps that are followed by the Office of Public Works. A working manual has been produced to assist in the implementation of the algae treatment program. Although treatment only occurs during five months of the year, advance planning and organization are necessary to assure that all required approvals, inter-department and inter-agency coordination, and funding allocations are obtained. The manual contains sections that address the following issues required to implement the program:

- a) Public Relations
- b) City Council Approval
- c) Environmental Permits
- d) Vendor Contracts
- e) ACFC & WCD
- f) Monitoring Program
- g) Treatment Scheduling

Each section includes sample correspondence, recommended lead times, forms, memos, reports, and contact names and phone numbers.

- a) **Public Relations:** Each year a summary report of the previous years program, including the monitoring program results, are distributed to a wide range of interested citizen groups and individuals. The current mailing list numbers 35. In addition, a fact sheet is distributed to the City's Maintenance Department and Park & Recreation Department so that any questions from the public regarding the program can be answered directly or referred to the proper individual.
- b) **City Council Approval:** Each year a staff report is prepared to inform City Council of the results of the previous year's program and to request their authorization to implement the current year's program by entering into a contract with an aquatic weed control specialty vendor.
- c) **Environmental Permits:** Each year the City files a Notice of Exemption to the California Environmental Quality Act (CEQA) with the County Clerk. In addition, the approval of the California State Regional Water Quality Control Board (RWQCB) is requested. The algaecide application contractor obtains the required permit from RWQCB prior to the first treatment.
- d) **Vendor Contracts:** A vendor contract is prepared each year between the City and an algaecide application contractor (Aquatics Unlimited of Martinez.) The contract calls for 5 applications of the herbicide Aquazine on a monthly schedule. Actual timing for applications is determined during the growing season, usually providing less than one week notice as an algae bloom is identified.

- e) Alameda County Flood Control and Water Conservation District: each year ACFC & WCD is requested by the City to participate in the administration and funding of the water quality program at Lake Merritt. ACFC & WCD has provided that support by contracting consulting services with water quality specialists (Engineering Science, Berkeley) and an analytical lab (Sequoia Labs, San Mateo).
- f) Monitoring Program: In conjunction with the algaecide treatment program, a limited water quality monitoring program is implemented each year. In the week following each algaecide treatment, OPW Engineering and Design personnel will sample lake water to measure dissolved oxygen, water temperature, and Secchi depths. In addition, they visually observe the growth or decay of algae at ten pre-set monitoring stations. Photographs are also taken at that time.

Independent of the City's monitoring crew, a contract lab (Sequoia Labs, San Mateo) performs sampling and analysis of simazine concentrations (the active ingredient in Aquazine) in water, sediment, mussels, and fish.

Monitoring and sampling results are reviewed by the water quality consultant (Engineering Science).

- g) Treatment Scheduling: Coordination of treatment scheduling is key to the success of the algaecide treatment program. ACFC & WCD controls the tide gates and holds the water level down when rainfall is predicted in the area. In general, water cannot be held in Lake Merritt without tidal flushing for more than 4 days, due to dissolved oxygen depletion. In addition, the Park and Recreation Department requests lake level to be held high for various special events and the City Maintenance Department requests lake levels to be held high for shoreline cleaning operations. Special event scheduling, shoreline cleaning scheduling, and the algae treatment scheduling are coordinated to maximize effectiveness and minimize conflicts. In addition, ACFC&WCD always attempts to capture a high tide to maintain a high lake level for treatment, minimizing the cost of pumping estuary water into the lake.

Although the use of Aquazine has been successful in controlling the nuisance growth of algae along the shallow shoreline, the City is continuing to investigate alternatives that will cost effectively control or eliminate algae growth. So far, however, the unique conditions at Lake Merritt have precluded the use of any of the suggested alternatives.