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# LAGUNA LAKE MANAGEMENT PROGRAM


City of San Luis Obispo

Department of Community Development, 990 Palm Street/Post Office Box 321, San Luis Obispo, CA 93406 (805) 541-1000



108-81

# Laguna Lake Management Program

January, 1982

LAGUNA LAKE STUDY COMMITTEE
CITY OF SAN LUIS OBISPO

MDW ASSOCIATES
ENVICOM CORPORATION

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# LAGUNA LAKE MANAGEMENT PLAN

## I. INTRODUCTION

This management program for Laguna Lake is the culmination of many months of combined effort by both professional consultants and citizens in developing the City's strategy for protecting an important resource. Laguna Lake is a prized asset to the City, a valuable source of scenic beauty, recreation, and wildlife habitat. The lake is also, however, a fragile and intricate system of competing forces which could destroy or impair its values unless conscientious action is taken to protect and enhance the lake.

The actions recommended in this program will do much to restore and preserve the natural qualities of the lake. The program does not represent the final solution, however, because there are still many uncertainties which only the future will be able to resolve. This study has identified common objectives for the long-term preservation and enhancement of the lake, and it has focussed upon short-term measures for the City to take in pursuit of those objectives.

### A. Background

The City began serious appraisal of its management options for Laguna Lake when the effects of the 1976-78 drought came to be felt. Laguna Lake almost completely evaporated, an event which still leaves a large impression in the minds of nearby residents. The drought helped to catalyze citizen interest in the lake and to focus public attention on the short-term protection of its unique qualities.

Urged on by a media campaign and the combined efforts of several concerned citizens, the City established the Laguna Lake Study Committee in 1979 and solicited proposals from environmental consultants to prepare a management plan for the lake. The City then selected the team of Envicom Corporation and MDW Associates, and formal consideration of planning options commenced in early 1980.

B. Purpose and Scope of Project Study

The purpose of this management plan is to establish "baseline data" and preferred lake conditions and uses, to analyze the full range of techniques available to the City to protect the preferred lake conditions, and to select the appropriate combination of techniques which can achieve the lake's protection and enhancement for the least environmental and financial cost. This plan will be subject to an environmental impact report before any of the recommended actions are carried out by the City. The City has been soliciting public input and participation throughout the course of this study, and will continue to do so through the EIR review as well as any budget hearings, where the plan calls for a commitment of City funds for implementation.

C. Lake Use and Management Goals

The community of San Luis Obispo, during recent years, has expressed its desire that Laguna Lake continue to be used in much the same manner as it has been for the last decade. Generally, this desire can be capsulized into four essential goals:

WILDLIFE PRESERVATION: Preserve and enhance the existing wildlife habitat in and around the lake. Protect, especially, the wildlife areas that remain relatively undisturbed.

RECREATION ENHANCEMENT: Preserve and enhance the opportunities for boating, fishing and wildlife education in the environs of the lake.

SHORELINE HOME PROTECTION: Protect future and existing housing areas from lake-related nuisances and hazards.

AGRICULTURAL PRESERVATION: Preserve and protect existing agricultural uses around the lake.

There has been a growing perception by the community that the lake is becoming less and less viable as a recreational resource. At the "townhall" meeting held at the onset of developing this management plan, many comments

were made which expressed concern about diminished recreational opportunities in the lake. Participants also stated an overwhelming desire to preserve the unique and valuable wildlife habitat which presently exists.

It was the general consensus that a management plan be prepared which preserves the balanced coexistence of recreational uses and wildlife habitat which has existed since the lake was transformed to its present character in the 1960's; that Laguna Lake be restored to provide the recreational opportunities afforded in the past, while preserving the wildlife habitat which is recognized as an important aesthetic, educational, scientific and recreational resource.

D. Organization of Project Study Team

The primary contractor in preparation of this plan was Envicom, Inc. of Sherman Oaks, California. Principals in charge from Envicom were Joseph Johns, President, and Don Asquith, Executive Vice-President. The principal staff member from Envicom was Dwayne Vander Pluym.

Project management and day-to-day liaison with the City was the responsibility of MDW Associates, in San Luis Obispo. Thomas H. Maple, Vice-President, acted as project manager with assistance from John B. Ashbaugh, AICP, planner (and project manager after December 21, 1980). Graphics was available from the MDW staff, primarily Sharon Groves and Debbie Cox.

Special acknowledgement is due the Laguna Lake Study Committee, chaired by Richard Jordison. The Committee, representing nearby residents and other concerned citizens in the City, provided invaluable comment and expertise throughout the study. Members of the Committee included: Foster Gruber, Robert Pederson, Dr. Aryan Roest, Don Smith, Lee Burkett, George McGinnis, and Ernest Miller. Finally, key members of the City of San Luis Obispo staff included David Romero, Director of Public Services, Jim Stockton, Director of Parks, and Terry Sanville, senior planner in the Community Development Department.

## II. SUMMARY OF RECOMMENDED LAKE MANAGEMENT PLAN

This section of the plan provides an overview of its contents. It is organized in the same manner as the full document. A technical appendix is also available, in addition to this report, for a compilation of the various detailed studies of the lake's water quality, soils, etc.

### A. Existing Lake Characteristics and Uses

Section III of this program provides an overview of the lake, its various functions and uses, and its inherent biological and natural qualities. The lake is now used for a combination of purposes, including wildlife habitat, water recreation, and agriculture and homesites along its shoreline. These uses are rather discreetly organized around the lake, resulting in a distinct set of sub-area boundaries each devoted to a differing use or uses (See Figure 1, "Lake Areas").

Laguna Lake goes through a seasonal limnological cycle which sees wide fluctuations in the water level, oxygen levels, temperature, turbidity and nutrients. During spring, marsh vegetation becomes active and takes up many of the nutrients, reducing turbidity and increasing temperatures (see Figure 2, Vegetation). During summer, these trends continue but high air temperatures accompanied by continuous winds result in significant evaporation, up to about 450 acre-feet of water over a normal year. (An acre-foot comprises about 326,000 gallons of water.) Irrigation by a landowner of part of the lake further depletes the lake by about 100 acre-feet per year, with both factors (evaporation and irrigation) causing a drop in water level of about 3 to 4 feet.

In the fall, the marsh vegetation dies back and oxygen levels drop while nutrients from the detritus increase. Winter rains restore oxygen levels and water clarity as well as raising the lake level. Average depth of the lake at 118 feet Mean Sea Level (MSL) varies according to the lake area: 12 feet at the downstream terminus, 6 to 8 feet in the Central Lake, and 0-4 feet in the various marsh areas and inlets to the north and west (see Figure 4, Lake Depth).

The Southeast Arm is the lake's deepest section at the downstream end near Madonna Road. Its proximity to the road makes it the most visible portion of the lake. This part of the lake is deep enough to permit both shoreline and boat fishing, and non-motorized boats of all variety are often seen in this area. The adjacent City park along the north shore provides a number of recreation uses, including picnicking, duck-feeding, etc. The south shoreline is devoted to single-family homes (see Figure 5, (Existing Land Use).

The Central Area of Laguna Lake is a large unit, but less visible or accessible to the public. Boating is discouraged by the increasing growth of smartweed. Residences along the south shoreline are exposed to strong winds but have fine views across the lake to the undeveloped City parkland on the north shore. This open water area provides a large fish reservoir and habitat for many species of waterfowl, although bird species appear to be shifting from diving varieties to dabbling ducks, due to the weed growth.

The Prefumo Inlet is a man-made feature connecting Prefumo Creek to Laguna Lake. It is surrounded on both sides by development and very little recreational use occurs here due to thick willow stands and little access. The primary function of the inlet is to serve as a sediment basin, collecting sediments deposited from Prefumo Creek before they reach the Central Lake. While the inlet once had a depth of 4 to 6 feet, it has now collected sediments to a height of about 2 feet above the normal high water level of the lake. Sediment is deposited at an average rate estimated to be about 8,000 cubic yards per year (see Figure 6, Lake Sedimentation Rate).

The Peninsula Inlet along the north shore is the most valuable part of the lake for wildlife and birds, due to the large amount of cover, the diversity of vegetation, and isolation (see Figure 3, Wildlife Habitat Value). Access is limited only to a dirt road closed to vehicles along the far northern shore. Very little fishing or boating occurs here, although at one time the Laguna Lake Master Plan envisioned a major marina there. A reminder of this plan is the landfill extending about 500 feet into the peninsula from

the road. If current conditions continue, the open water areas will ultimately fill up with vegetation.

The Northwest Marsh and Inlets units comprise the major portion of the smartweed-bulrush marsh of Laguna Lake. The most northerly part of the marsh is privately-owned, and lies outside the City limits (see Figure 8, Land Ownership). Irrigation water for a reclaimed pasture area in this area is drawn from this part of the lake. A developing tract of homes to the south and east borders the marsh. As with the Peninsula Inlet, continued slow sedimentation of the marsh will result in a decrease in the marsh open areas as vegetation fills them in.

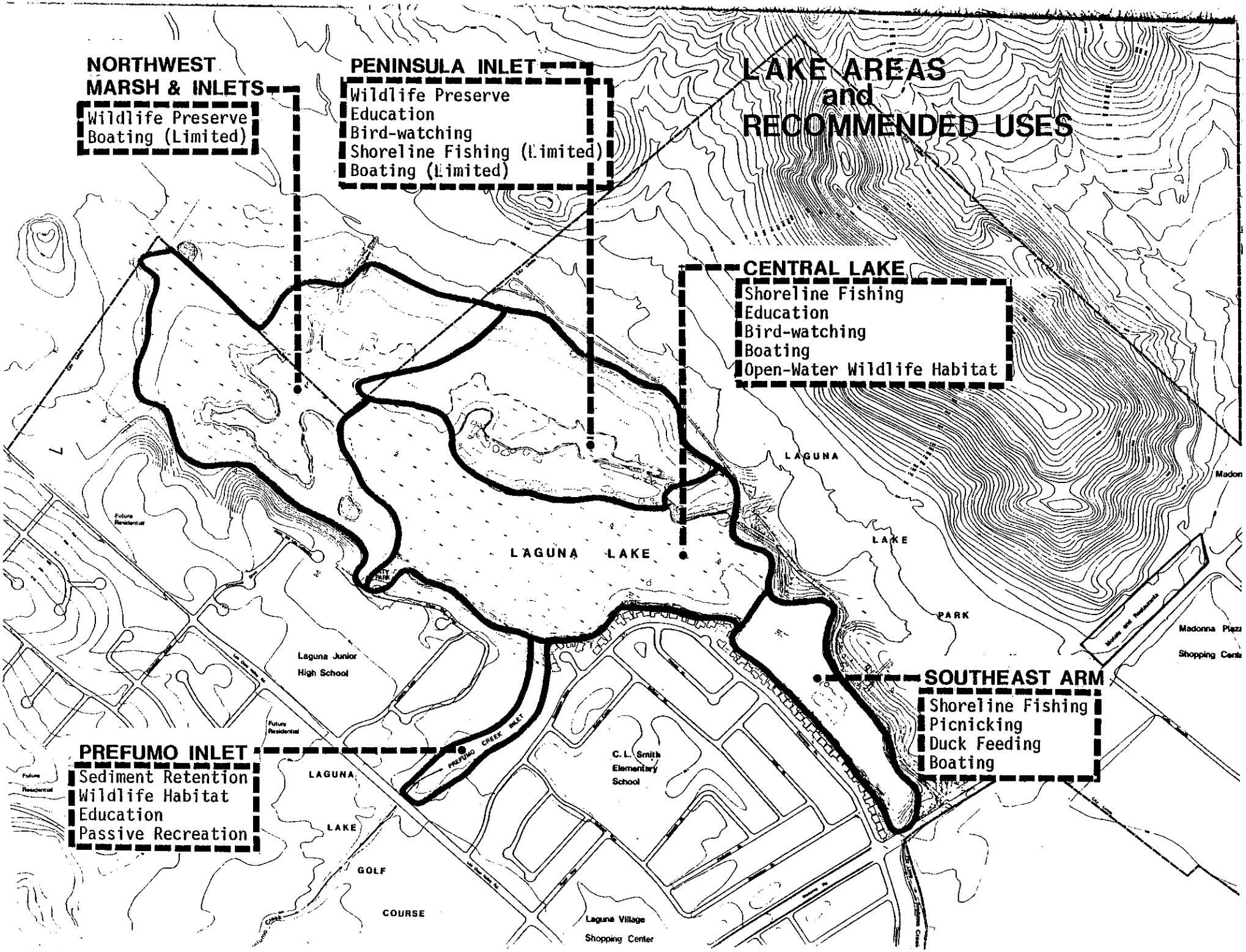
B. Recommended Lake Uses and Required Characteristics

Based on natural environmental conditions, existing uses, and desires or needs expressed by the community, Section IV of the program recommends a variety of uses for each lake area (see diagram, Lake Areas and Recommended Uses). Physical changes to accommodate these uses were recommended in some instances.

The Southeast Arm was recommended for the largest variety of active uses, including shore fishing, boating, picnicking, duck feeding, passive shoreline recreation, and swimming. Swimming would require certain improvements such as sand or gravel shoreline, smartweed reduction, and water buoys to separate swimmers from boats.

For the Central Lake, recommended uses included all of the above, plus open water wildlife habitat and bird-watching. For this area, boat and open-water wildlife both require at least 3-4 feet of water at the seasonal low water level. Smartweed growth would have to be stopped and reduced.

The Prefumo Inlet is recomended for use as a sediment retention basin, for flood control, and riparian habitat suitable for education and passive recreation. To achieve sediment removal, the inlet will have to be excavated to an elevation of 116 to 117 MSL. Willow thickets may be retained in places to prevent erosion and protect some habitat.


LAKE AREAS and RECOMMENDED USES
NORTHWEST MARSH & INLETS
Wildlife Preserve
Boating (Limited)
PENINSULA INLET
Wildlife Preserve
Education
Bird-watching
Shoreline Fishing (Limited)
Boating (Limited)
CENTRAL LAKE
Shoreline Fishing
Education
Bird-watching
Boating
Open-Water Wildlife Habitat
SOUTHEAST ARM
Shoreline Fishing
Picnicking
Duck Feeding
Boating
PREFUMO INLET
Sediment Retention
Wildlife Habitat
Education
Passive Recreation
LAGUNA LAKE
LAGUNA LAKE PARK
LAGUNA LAKE GOLF COURSE
Laguna Junior High School
C. L. Smith Elementary School
Laguna Village Shopping Center
Madonna Plaza Shopping Center
PREFUMO CREEK INLET
Future Residential

The Peninsula Inlet is recommended for wildlife habitat, with limited shore fishing, boating, and bird-watching from the perimeter. No major access improvements are foreseen, and in fact if usage increases some restrictions may need to be considered. The same recommendations apply also to the Northwest Marsh and Inlets.

C. Lake Management Objectives and Alternative Methods for Meeting the Objectives

Based on the recommended uses and required physical conditions for the lake, five management objectives were identified in Section V of the program:

1. Maintain at least 3-4 feet of lake depth at seasonal low water level.
2. Reduce or eliminate existing aquatic weeds.
3. Provide for on-going aquatic weed control.
4. Prevent Prefumo Creek watershed sediment from reaching the lake.
5. Preserve the characteristics of the lake which are important to existing wildlife habitat, flood protection, and recreational opportunity.

Each of the first four objectives listed above is associated with one or more management actions such as dredging, weed harvesting, etc. (The fifth objective is a more general goal of the entire program). The description of these alternative methods and their costs is provided in Section VI of the report.

The first objective relating to minimum lake depth is the most important in the Central Lake and Southeast Arm. Below-normal rainfall years will continue to see lake levels below this minimum depth. Depth may be increased and/or managed year-round either by dredging, by excavation during the dry season, by installing a dam at the culvert under Madonna Road (therby raising the overall lake level), by controlling the amount of irrigation water withdrawn from the lake, or by supplying reclaimed wastewater to the lake.

Weed reduction and long-term maintenance of weed conditions (Objectives 2 and 3) are the essential means for restoring the lake's usability to open-water birds and to boaters. Mechanical harvesting is one means of reducing weeds, with manual harvesting a possible option. Chemicals and biological manipulation are other measures, and the dredging or excavation of the lake for additional lake depth would similarly provide for weed reduction.

Preventing the Prefumo Creek sediment from reaching Laguna Lake is essential in order to avoid expansion of the delta which now threatens to intrude into the Central Lake area. The inlet must be both excavated and dredged in order to meet this objective.

The range of measures which are suitable to meeting the four lake management objectives is illustrated by the following chart. The objectives are listed along the top (objectives 2 and 3 have been combined for ease of reference), and the various management techniques for achieving one or more of the objectives are listed along the left. Where a management technique is suitable to achieving a given objective, the corresponding cell in the chart is indicated by an "X".

SUMMARY OF ALTERNATIVE LAKE MANAGEMENT METHODS

| MANAGEMENT TECHNIQUE/METHOD | OBJECTIVE 1: Lake Depth | 2&3: Weed Reduction/ Maintenance | 4: Prefumo Creek |
|---|---|---|---|
| A. Dredging | X | X | |
| B. Excavation | X | X | |
| C. Raise Water Level | X | X | |
| D. Effluent Recharge | X | | |
| E. Irrigation Control | X | | |
| F. Mechanical Weed Harvest | X | | |
| G. Manual Weed Harvest | | X | |
| H. Chemical Weed Control | | X | |
| I. Biological Manipulation | | X | |
| J. Prefumo Creek Sediment Basin Excavation | | | X |

Among all of the above management methods, four were excluded from further consideration. Excavation was excluded due to the fact that in all but extreme drought conditions it would be infeasible to pump the lake dry in order for heavy equipment to operate on the bottom. Irrigation control was excluded due to the small contribution it would make to lake depth maintenance and due to the legal difficulties surrounding it. Chemical weed control and biological manipulation were excluded due to the uncertainty of environmental impacts and potential high costs.

D. Alternative Lake Management Programs

In Section VII, seven alternative management programs are discussed which involve differing combinations of the management methods which together meet the minimum requirements of the lake management objectives. Each program was then evaluated by use of three criteria: effectiveness, environmental impacts, and cost.

The chart on the following page provides a summary overview of the methods proposed for each of the seven programs. The table also indicates the estimated cost for each of the seven programs.

SUMMARY OF ALTERNATIVE LAKE MANAGEMENT PROGRAMS

| Program | Methods Included | Estimated Cost* |
|---|---|---|
| 1 | Mechanical Weed Harvest, Prefumo Inlet Sediment Basin (Level 1) | $46,000 to $806,000 |
| 2 | Program 1 plus Effluent Water Supply | $84,200 to $844,200 |
| 3 | Program 1 plus Increased Lake Level | $186,000 to $946,000 |
| 4 | Program 1 plus Effluent Water Supply plus Level 2/Prefumo Inlet Basin | $708,200 to $1,128,200 |
| 5 | Program 1 plus Increased Lake Level plus Level 2/Prefumo Inlet Basin | $810,000 to $1,230,000 |
| 6 | Program 1 plus Dredging of Central Lake (50 acres to 109' MSL) | $918,000 to $1,678,000 |
| 7 | Program 1 plus Dredging of Central Lake (25 acres to 106' MSL) | $753,000 to $1,513,000 |

*Costs are expressed in terms of 20-year totals; annual costs would thus be about 1/20th of each figure. The wide ranges are primarily a result of uncertainties regarding the extent to which excavation of the Prefumo Creek Inlet Sediment Basin might be achieved by private contractors, thereby saving the City these costs.

The Comparative Matrix on the following page provides a tool for analyzing the relative costs and benefits of each management program. As the matrix reveals, the most "cost-effective" program at this time is Program 1, combining simplified procedure, ability to attain program objectives, low environmental impact, and the lowest cost.

E. Recommended Lake Management Program

As a result of citizen input through the Laguna Lake Study Committee followed by a Study Session with the City Council and a public hearing, it was decided that Program 1 would be the best management program for Laguna Lake. Recapping the major features of this program, the City will be taking the following actions in order to meet the identified lake management objectives.

| Program | Effectiveness | | | | | | | Environmental Considerations | | | Cost | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | procedure | objectives | | | | | total | natural | cultural | total | | |
| | | 1 | 2 | 3 | 4 | 5 | | | | | | |
| 1 | 1 | 3 | 2 | 2 | 3 | 1 | 13 | 1 | 1 | 2 | 1 | 15 |
| 2 | 1 | 1 | 2 | 2 | 3 | 2 | 11 | 2 | 1 | 3 | 2 | 16 |
| 3 | 3 | 2 | 1 | 1 | 2 | 2 | 11 | 2 | 2 | 4 | 3 | 18 |
| 4 | 2 | 1 | 2 | 2 | 1 | 2 | 10 | 2 | 1 | 3 | 4 | 17 |
| 5 | 3 | 2 | 1 | 1 | 1 | 2 | 10 | 2 | 2 | 4 | 5 | 19 |
| 6 | 2 | 2 | 2 | 2 | 3 | 2 | 13 | 1 | 3 | 4 | 6 | 23 |
| 7 | 2 | 2 | 1 | 1 | 3 | 2 | 11 | 1 | 3 | 4 | 7 | 22 |

1 indicates programs which pose least procedural difficulty, best met objectives, pose lowest environmental impact potential and are lowest cost. Higher numbers indicate greater procedural difficulty, objectives not met as well, greater environmental potential and greater cost. Lower numbers in grand total column indicate programs which have higher benefit-to-cost relationship.



# Alternative Management Programs Comparative Matrix

1. A mechanical weed harvester will be purchased, and City staff will be trained to utilize the equipment to remove aquatic weeds from the most heavily weed-choked areas of the Central Lake. Estimated annual costs for amortization of the equipment and operation by City crews is $1,500 to $4,500 per year (1980 dollars).

2. The Prefumo Creek Inlet will be excavated to "Level 1" and maintained at that point as a sediment basin for the creek before it reaches the Central Lake. Level 1 requires the use of conventional/heavy earth-moving equipment, and a small amount of dredging of the delta of the creek within the Central Lake. The best time for this excavation to occur would be late summer, and it is estimated that 20,000 to 30,000 cubic yards of sand and gravel should be removed every five years. Dredging within the delta will require removal of only about 5,000 yards of silt material every 20 years. Costs for this option range from $800 per year if the City could find users willing to excavate the sand and gravel from the inlet to as high as $36,000 per year if the City had to excavate this material itself.

3. The City will also install a temporary log dam at the downstream end of the Madonna Road culvert which drains the lake. This dam will only be in place over the dry season, and will be removed prior to the onset of heavy winter storms. The effect of this dam will be to raise the lowest lake level during normal years by one foot, but there will be virtually no effect on lake levels during the rainy season. Costs for his log emplacement are minimal, and can be borne by City funds available in the 1980-81 fiscal year.

The combination of these two actions will be sufficient to provide minimum long-term protection for Laguna Lake. It is also recommended, however, that the City continue to consider various alternatives for improvement of lake depth conditions. These alternatives were not recommended as part of the management program at this time due to continuing uncertainties about feasibility or desirability of each option. The methods of improving lake depth include:

- Raising the lake surface level by means of a dam at the culvert under Madonna Road;
- Dredging of the lake bottom by means of a cutterhead dredge;
- Stabilization of the water level by application of wastewater effluent from an upgraded City treatment plant to surrounding lands during dry summer and fall months.

In continuing to consider these other options for improvement of the lake depth, the City should also undertake a monitoring program to collect data about water quality, lake depth, sediment flows, and weed growth throughout the lake. This monitoring program will help to establish the need for additional improvements to the lake depth.

Costs of the weed harvester and Prefumo Creek sediment basin can be borne by the City through general revenues. Should it be necessary in the future to select any of the other lake management measures noted above, it will also be necessary to generate other sources of revenue to finance these measures.

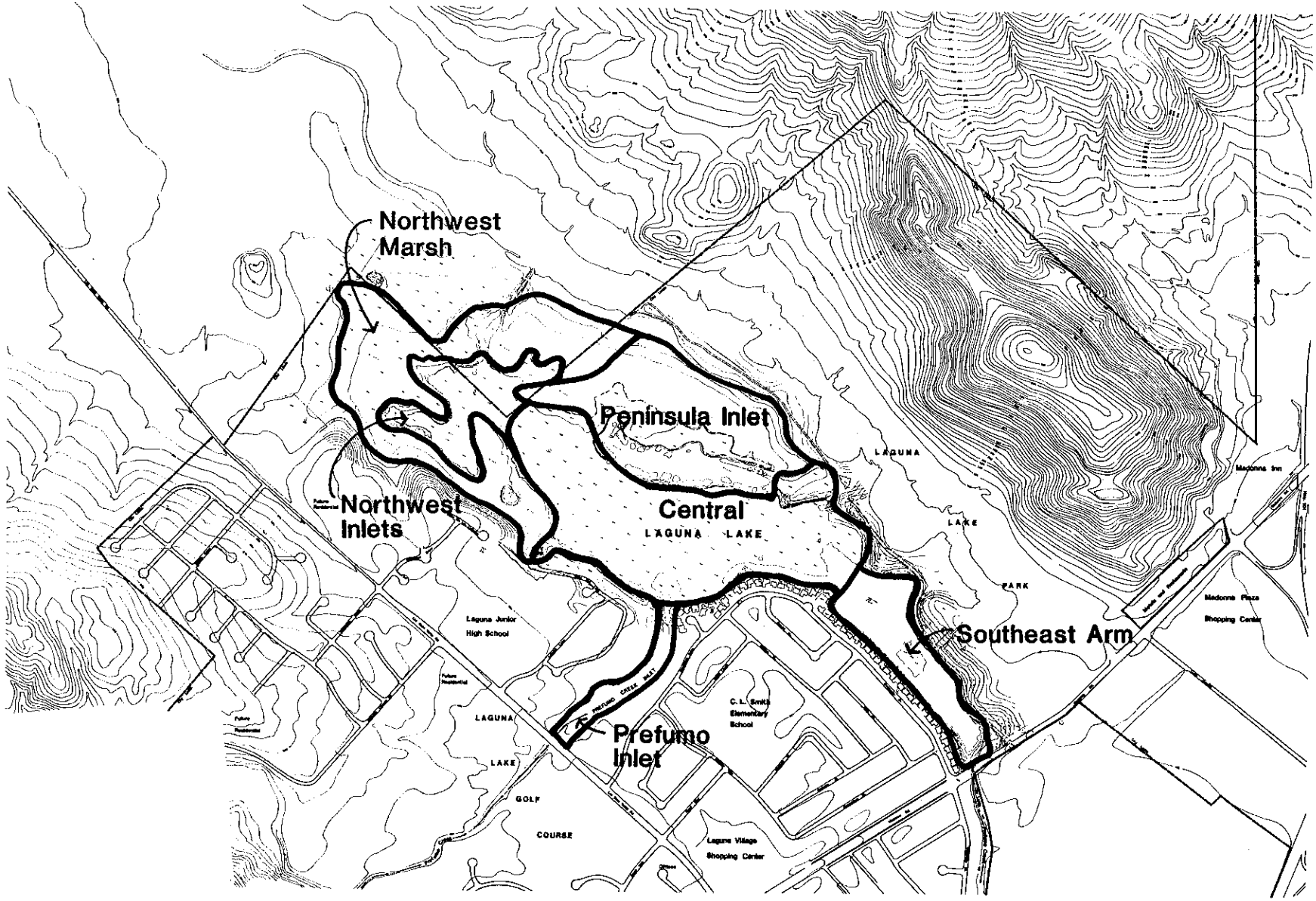



figure 1

# Lake Areas

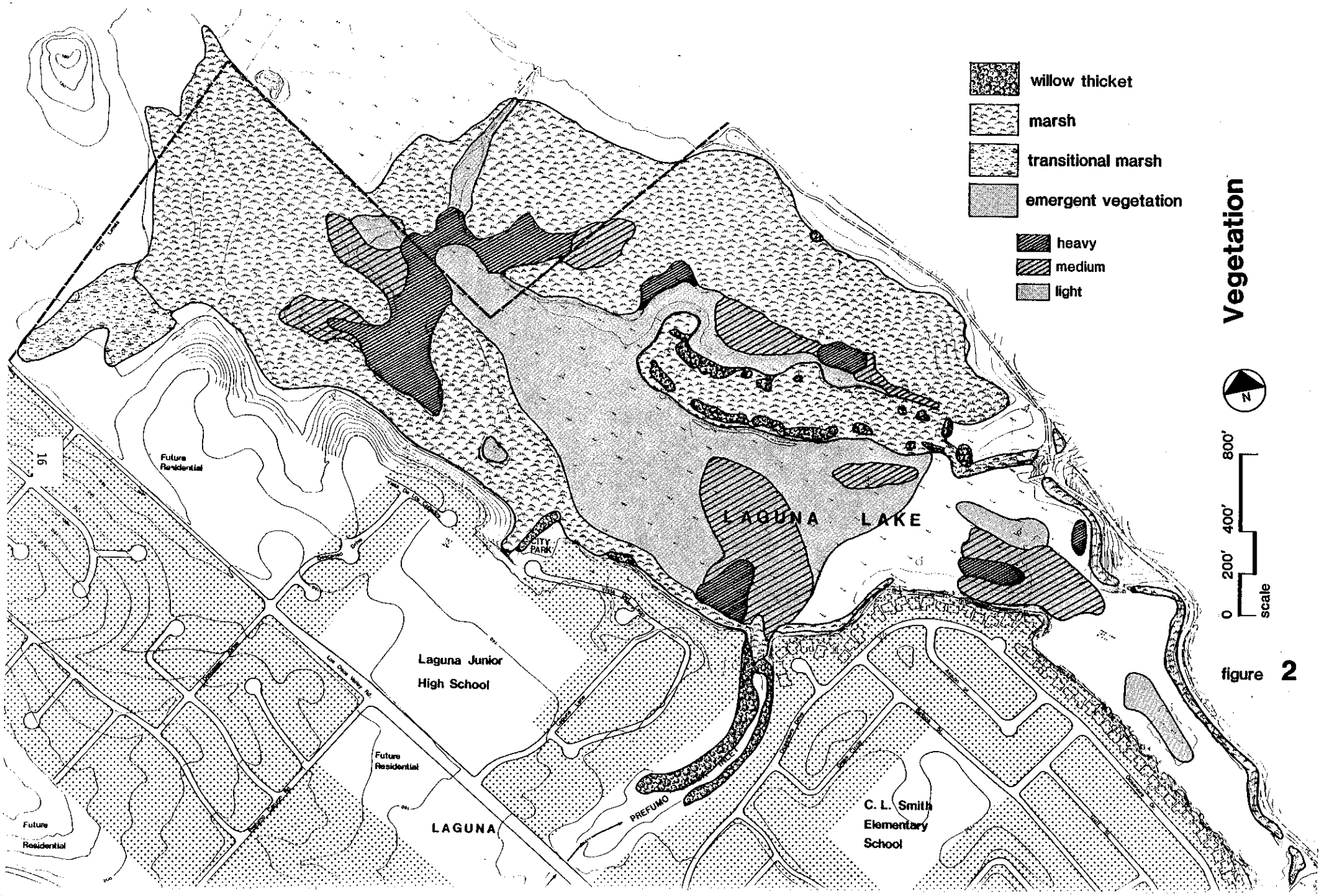
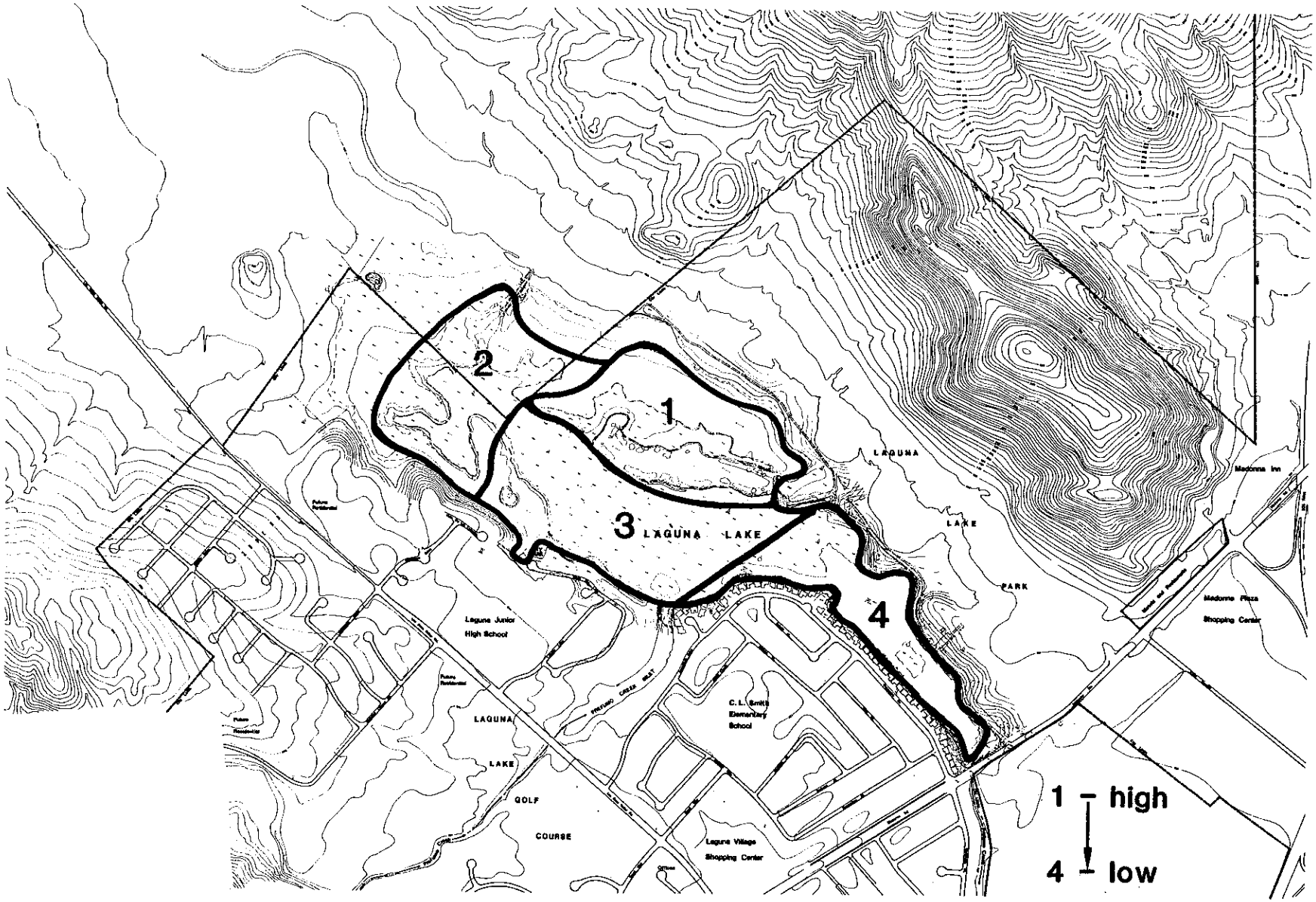

willow thicket
marsh
transitional marsh
emergent vegetation
heavy
medium
light
Vegetation
N
0 200' 400' 800'
scale
LAGUNA LAKE
CITY PARK
Laguna Junior
High School
C. L. Smith
Elementary
School
LAGUNA
PREFUMO
Future
Residential
Future
Residential
Future
Residential
16

figure 2




0 600′ 1200′ 2400′

scale

N

# Wildlife Habitat Value

figure 3

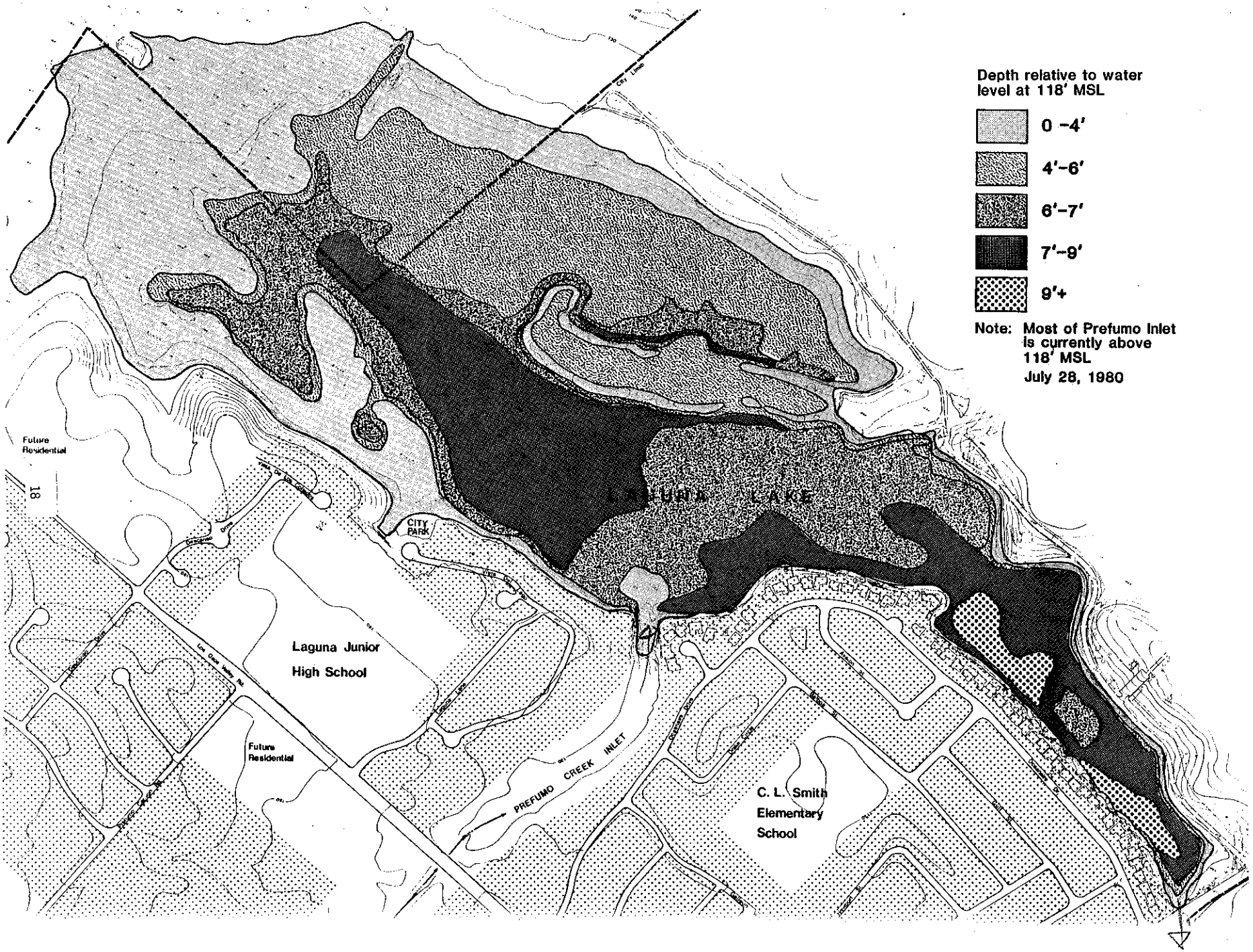
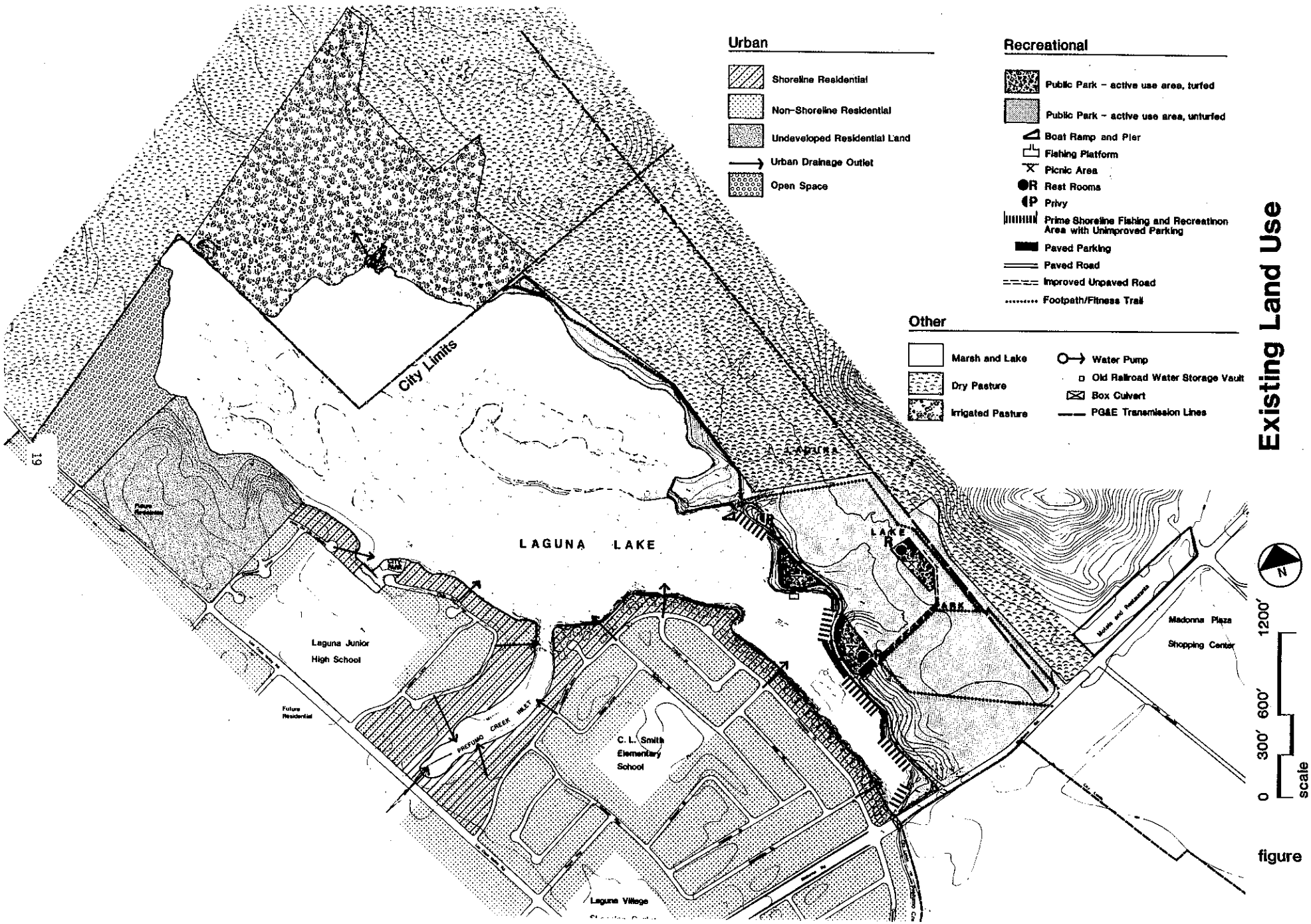
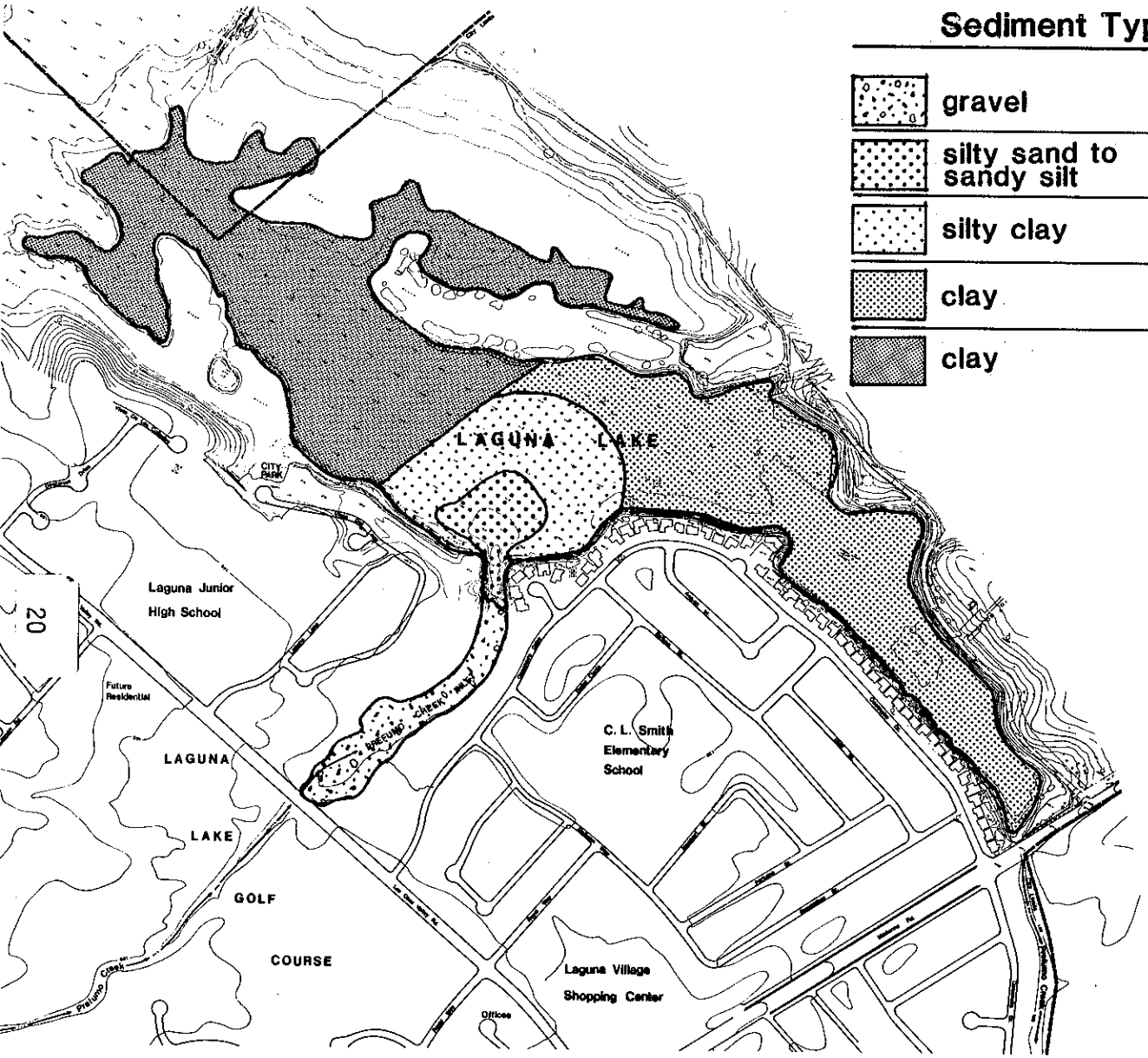

Depth relative to water level at 118' MSL
0 -4'
4'-6'
6'-7'
7'-9'
9'+
Note: Most of Prefumo Inlet is currently above 118' MSL July 28, 1980
Lake Depth
LAGUNA LAKE
CITY PARK
Laguna Junior High School
Future Residential
Future Residential
PREFUMO CREEK INLET
C. L. Smith Elementary School
18
N
0 200' 400' 800'
scale

figure 4




Existing Land Use

figure 5




| Sediment Type | Relative Rate of Accumulation | Lake Areas |
|---|---|---|
| gravel | rapid 0.5 ft./yr. avg. 2–3 ft. single season peak year | Prefumo Inlet |
| silty sand to sandy silt | moderate .25 ft./yr. | Central |
| silty clay | slow .06–.25 ft./yr. | Central |
| clay | very slow .06 ft./yr. | Central and Southeast Arm |
| clay | extremely slow .02 ft./yr. | Central, Peninsula Inlet and Northwest Inlets |

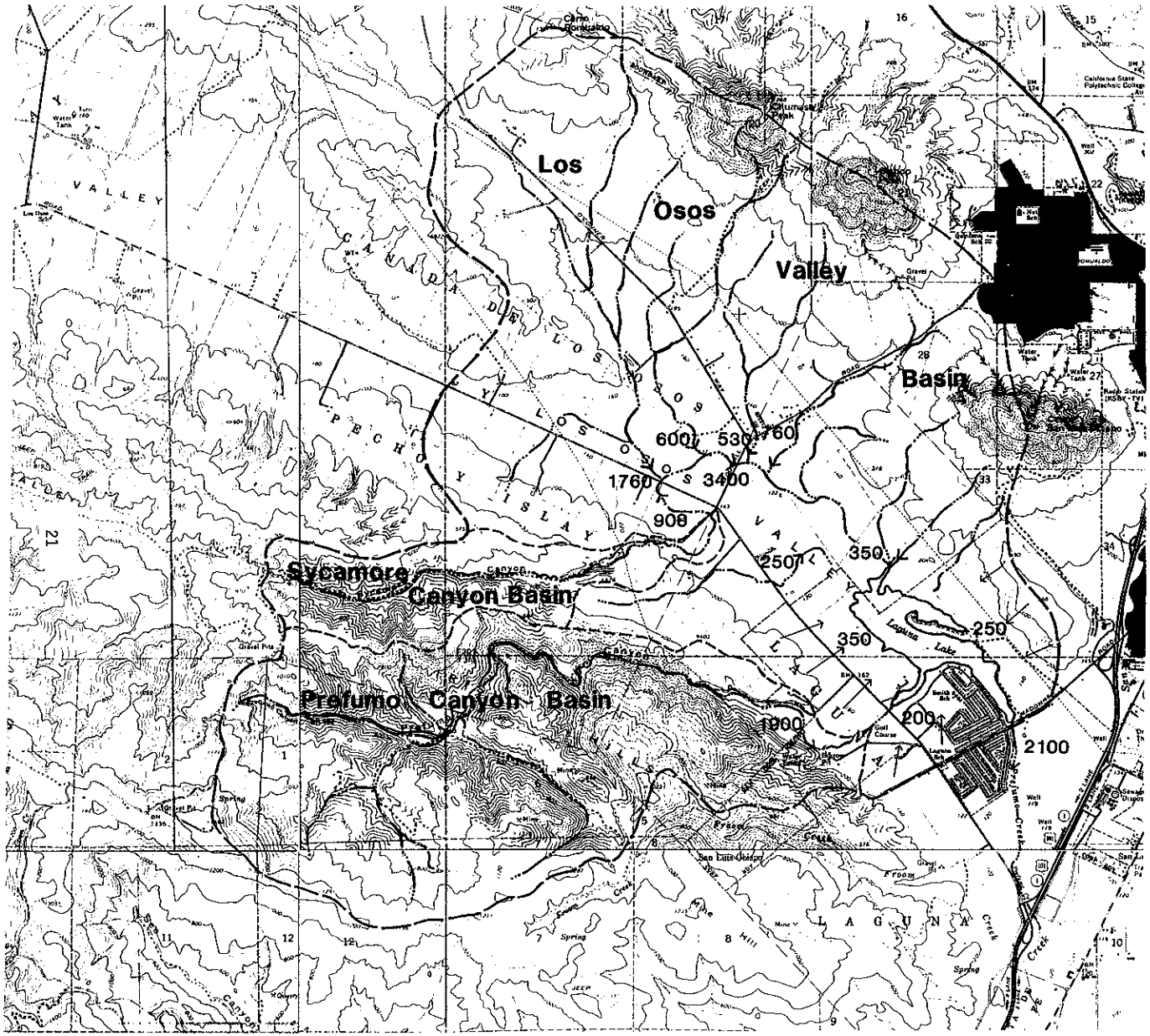
0 400′ 800′ 1600′

scale

N

figure 6

# Lake Sedimentation Rate




000 – 100 year storm runoff in cubic feet per second (cfs)

– general flow of urban runoff

– primary tributary drainage

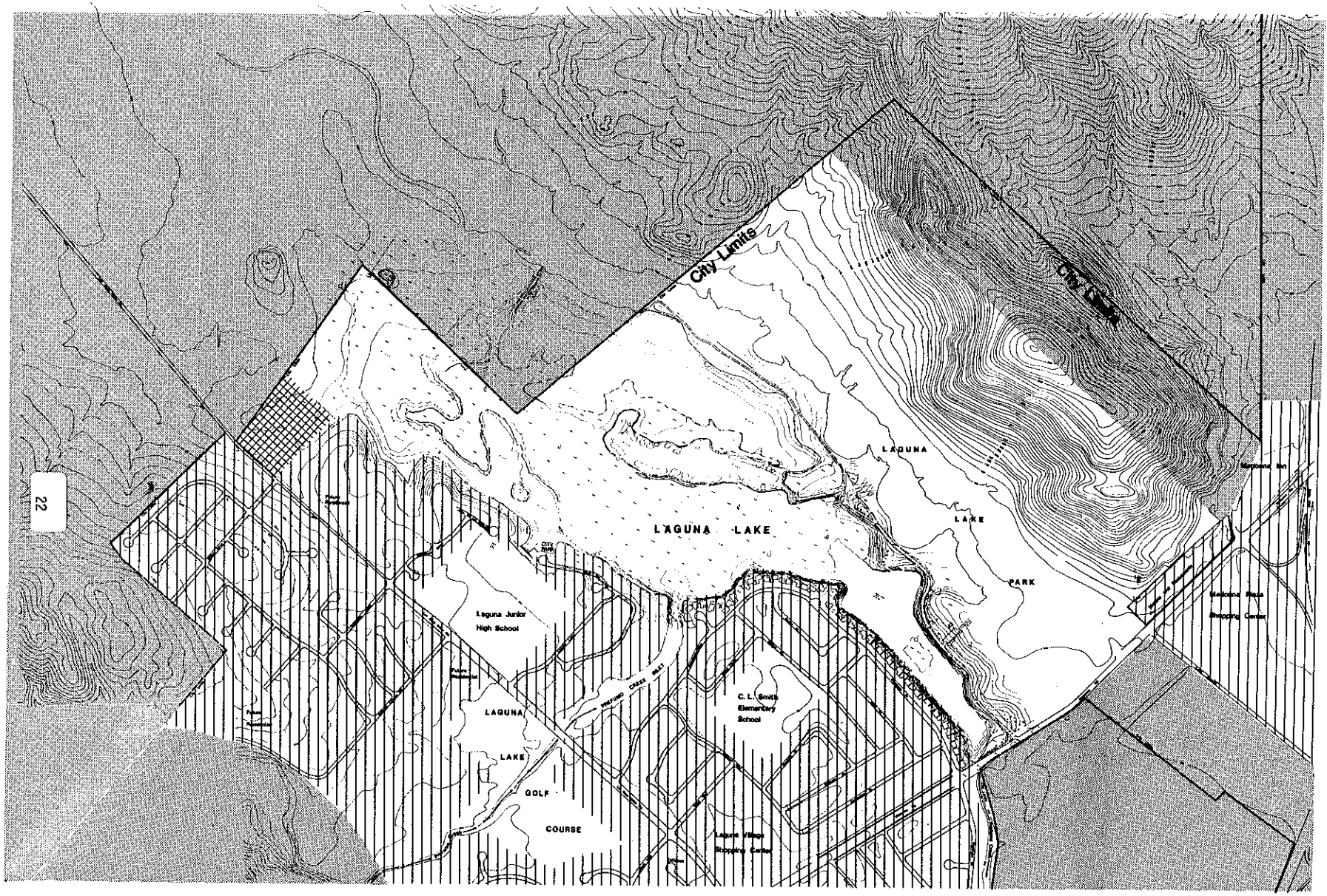
– Laguna Lake watershed boundary

– sub-watershed boundary

**Watershed**

0 1500' 3000' 4500'
scale

figure **7**




# Land Ownership

Public Ownership

Private Ownership in Open Space Easement

Private Ownership – Small Urban Parcels

Private Ownership – Large Agricultural Parcels

figure 8

# III. EXISTING LAKE CHARACTERISTICS AND USES

## INTRODUCTION

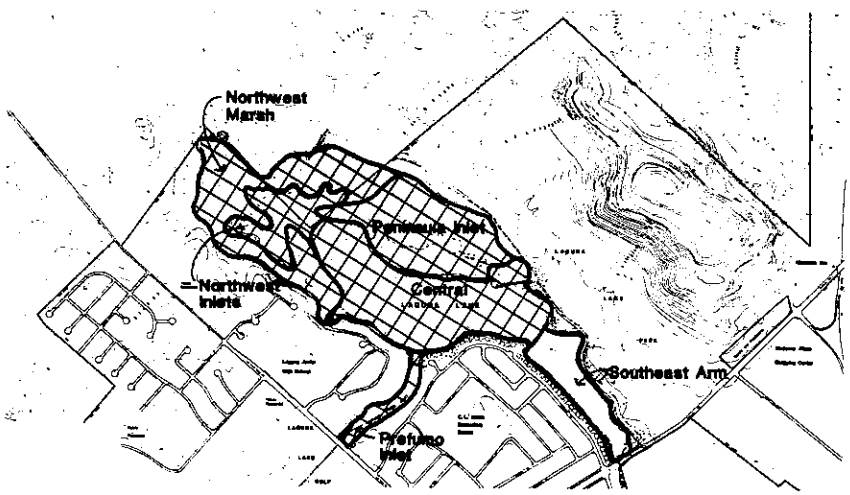
For most of its history, Laguna Lake has served primarily as a wildlife habitat. Even up through the first half of the twentieth century, human interference with its natural environment was relatively minor. It was, of course, used for occasional human cultural purposes such as hunting and other recreational or food-gathering activities. A small area of the lake bottom was dredged and pumps installed to serve as a water supply for the railroad and the city. Ranchers attempted to dike and reclaim small portions of the lake and marsh for farming. However, its value as a wildlife preserve remained relatively undiminished in spite of these foreign incursions.

However, during the last several decades, as the City of San Luis Obispo has expanded, the lake has rapidly undergone a transition. It now is used for a combination of purposes, including wildlife habitat, water recreation, agriculture and homes. The northerly shore at its eastern end is used for relatively intense recreational activity. The remaining west half of the northerly shore is a relatively undisturbed wildlife habitat area. The northwest end, which is primarily marsh, is a wildlife habitat area only slightly disturbed by coexisting cattle grazing. Until very recently the lake was frequently used for sailboating, row boating, windsurfing, etc. A boat launch ramp and pier were installed some years ago by the City. Water is pumped from the lake by adjacent ranchers to irrigate pasture land during summer months.

While the array and diversity of uses around the lake are indeed broad, including urban residential, rural agricultural, sensitive wildlife habitat, and recreational, there is also relatively strong segregation between the uses. This segregation has resulted in relatively discrete units or areas wherein compatible uses and common characteristics occur together with little or no adverse effect on adjacent units. The map on the following page illustrates the boundaries of each area or management unit. The

character of each management unit will be described in the remainder of this section in terms of its recreational use, shoreline land use, biotic community and water body and lake bottom conditions. Present conditions and future trends, as well as predictable problems, will be discussed.

SOUTHEAST ARM




This area of Laguna Lake has about 16 acres of water surface area at normal high water. It is long and narrow in shape; about 1,800 feet long and generally about 300 feet wide. At its widest point, it is approximately 600 feet and at its narrowest, 200 feet.

The southeast arm is the lake's downstream terminus, emptying into Prefumo Creek through a large culvert under Madonna Road. Its southerly shoreline has been developed with homes whose back yards extend to the water's edge. Its northerly shoreline is bounded by the main access road serving Laguna Lake Park from Madonna Road, and by various other park improvements.

The discussion which follows will describe in greater detail the types of recreational activities and land uses along the shoreline, and the vegetation, wildlife, and other physical characteristics of the lake water body.

## Recreational Use

This part of the lake is the area most visible to the public, and it is the most popular area in terms of recreation as well. The view of the lake from Madonna Road provides a scenic vista for travellers along this heavily-used arterial. Recreational use along the shoreline of Laguna Lake Park in this area involves the following activities (see Figure 5).

Fishing: Shoreline fishing for freshwater fish occurs along several open stretches of the north lakeshore, in those spots where the tules have been unable to grow thickly enough to prevent access, and where shoreline mud is not prevalent. The close proximity of the access road enhances the convenience of this shore for fishing. Fishermen commonly park their vehicles along the shoulders of the road and other open areas immediately adjacent to the shoreline and fish next to their automobile. There are no other improvements directly related to public fishing activity, except for a small fishing platform extending about 6 feet into the lake. This platform is located about 2,300 feet from the Madonna Road entrance of the access road, on the shoreline of the small, turfed, scenic knoll which serves as a picnic area. Residents on the south shore use their back yard shoreline and docks for fishing.

Fishing from boats is also popular in the Southeast Arm. The lake is deep enough to permit small boat launching from shore as well as from the launch ramp at the end of the access road. Trolling from boats is not particularly effective due to the shallow bottom, however, and most fishing from boats is done while anchored or adrift.

Boating: As noted above, the deep Southeast Arm has been a popular area for boating. Sailboats, canoes, kayaks, and rowboats (as well as an occasional wind surfer) have all been seen on this arm of the lake. Boats are launched from the shoreline, from the fishing platform discussed above or from a dock and launch ramp located on the central lake area shoreline at the end of the main park access road. Private docks on the south shoreline also provide for launching and mooring of small boats. No motorized craft, except electric motors, are permitted on the lake. Boating on the lake has become less popular as pond weed growth has become heavier. The strong prevailing winds also make row boating difficult at times.

Picnicking: Part of the intrinsic value of the lake is the attraction it holds for picnics. The Park provides 18 improved tables with concrete pads, but only four of these directly adjoin the lake on a 1-1/2 acre, turfed scenic knoll between the Southeast Arm and the Central area. A wind screen

and several trees help to shelter this site from the strong westerly winds. Two other picnic areas are available with restrooms and improved parking north of the Southeast Arm, one of which is immediately adjacent to the main park access road and separated from the lake shore by a distance of 150 feet. This area also offers children's playground facilities and 1.5 acres of open turf for passive recreation. The other is about 600 feet away at the end of a dirt road on the opposite side of the park from the lakeshore. These two areas are occasionally used for group functions by organizations.

Duck feeding, walking, etc.: Many visitors to Laguna Lake Park are there merely to stroll along the shoreline and enjoy the views. An activity popular with visitors is feeding the large flock of ducks which frequents the shoreline. These uses of the lakeshore occur for the most part immediately adjacent to the access road and near the entrance to the park. Frequently, motorists will pull directly off the access road to use the shoreline for these purposes instead of parking in designated spots.

Other uses: Several park activities are not directly related to the lake itself, but may be enhanced by its proximity. These include bicycling; use of the fitness trail (2-1/2 miles of jogging path plus assorted exercise stops); group camping (allowed in the grove of trees north of the group picnic facilities) and hiking into the leased grazing land on the steep hill overlooking the lake, along the northerly boundary of the Park. The latter uses are facilitated by the dirt road leading north from the main access road, although a locked gate controls vehicle access onto the road. No motorcycles or other vehicles are allowed beyond the improved park roads.

## Shoreline Land Use

In addition to the recreational activities along the north shore described above, the south shoreline of the Southeast Arm is used for homes and a portion of the City property north of the improved Park area is leased for grazing.

Residential Use: The south shoreline of the lake's Southeast Arm is occupied by about thirty single-family homes fronting on Oceanaire Drive. These 30 homes are part of a single-family neighborhood extending from the lake to Los Osos Valley Road, comprising about 116 acres (including C.L. Smith Elementary School). Laguna Village Shopping Center, at the south end of this neighborhood, occupies about 9 acres. Along the shoreline itself, there are approximately fourteen private docks which have been constructed by residents. Most of these are non-floating docks. Each dock serves two residential lots.

Residential lots on the shoreline drain directly into the lake. The remainder of the neighborhood drains to the lake via street gutters and culverts which discharge to the lake at the locations shown on figure 5. Flood hazard and the possibility of land subsidence and slippage are concerns of these homeowners. Flooding has occurred during the recent winter storms of 1969 and 1973. Since that time the culvert at Madonna Road has been increased in capacity by about seventy percent so that the lake will not rise above an elevation of 126.0 feet in a 100 year storm.[1] Both 1969 and 1973 storms were generally smaller than a 100 year storm.[2] Although most of the homes are above the 126.0 foot elevation, about eighteen are two to seven inches below. Some homes in this neighborhood have also been the victims of land settlement in the immediate shoreline area.

As the neighborhood has been almost completely built-out, there will be little significant future change in land use character in the lake's south shore area. In the park area on the northerly shore, no long term plans have been made for additional public uses. However, there are large amounts of open area remaining in the park and it is expected that significant changes in land use characteristics will occur in the future.

## Biotic Community

The Southeast Arm of the lake is relatively lacking in natural elements of the lake ecosystem. The biotic community here is dominated by the urban

1U.S. Army Corps of Engineers Department of Housing and Urban Development, Federal Insurance Administratrion, Flood Insurance Rate Map, City of San Luis Obispo.

2However, in the Laguna Lake area, runoff from the 1973 storm may have exceeded the 100-year storm flow as that storm was centered over the Irish Hills. At its center over the nearby Irish Hills, the 1973 storm is considered as greater than a 100 year storm.

influences of the residences along the southerly shore and park uses on the northerly shore. Natural vegetation is limited to a strip of bulrushes, water smartweed, and some coyote brush and willows on the north shore (Figure 2). The open water portion of the lake is fairly clear of emergent growths of water smartweed and sago pondweed because of the generally deeper water in this area.

This section of the lake is populated primarily by a large flock of domestic ducks, whose numbers fluctuate between 50 and 100. American coots, ruddy ducks, and ring-billed gulls also use this area in fairly large numbers (Appendix A). Other species more typical of the marshlands farther to the west can be found here as individuals.

Fish populations in the southeast arm fluctuate continually due to the greater amount of fishing activity; however, removal of these fish does not appear to be depleting the resource of warm water fish in the lake, and trout populations are maintained by a stocking program conducted by California Fish and Game.

Future conditions in the Southeast Arm are expected to remain similar to existing conditions. Increased use of the northerly shore for fishing may substantially decrease shoreline vegetation and fishing success in this area. Smartweed growth in the lake here is limited by the relatively deeper water and is not expected to become much denser than it is now.

## Lake Water and Bottom Conditions

Monitoring of Laguna Lake's water quality indicates that the lake is not significantly different in any location and is highly mixed by the prevailing westerly winds (Appendix B). The lake does have an annual limnological cycle that corresponds with the four seasons. Starting in fall, the marsh vegetation, particularly the sago pondweed, dies back and decomposes, resulting in high nutrient levels in the waters. During this decomposition, oxygen levels are significantly reduced as bacteria

use oxygen while breaking down the vegetation. Oxygen levels during fall and early winter are below the level generally considered adequate for a good fishery (5.0 ppm). The winter season is marked by an increase in oxygen levels, temperatures and turbidity as inflowing rainwater fills the lake. In the spring, the plants become active again and there is a marked decrease in nutrient levels and a continuing increase in oxygen consentration and temperature. Although samples were not taken by this project during the summer, previous research indicates continuing trends of increased temperature, water clarity, plant growth, and depletion of available nutrients (Appendix B).

An important feature of the lake is that it responds rapidly to changes in the physical environment. As the air temperature increases during the day, the surface and bottom waters of the lake respond quickly to this increase, aided by the wind which promotes mixing of the lake waters. Another characterisitc of this daily pattern is the depression of oxygen levels in the bottom waters during the night. This is due to plant uptake of oxygen as well, as well as the decrease in oxygen supply because the plants are not producing oxygen during the night.

Other parameters measured in the lake included turbidity, conductivity, and pH. Turbidity, the measurement of water clarity, changes abruptly due to the input of silty rain water into the lake during the winter, wind-mixing which resuspends bottom materials, and the increase in population density of phyto plankton. Conductivity is a general measure of the salinity of of the water, and changes primarily with the inflow of rainwater carrying dissolved salts from the Laguna Lake watershed. Neither turbidity nor conductivity have a strong effect on the annual cycling of the lake; however, pH is a strong indicator of lake cycling. In addition, the growth of phytoplankton and correspondingly, the size of midge populations, is strongly dependent on pH, with levels above 8.6 limiting the growth of midge populations.

The environmental effect of various water quality parameters and their relationship to the management plan are described in further detail in Appendix B.

The Southeast Arm is the deepest portion of the lake, ranging from about 6.5 feet deep (water level at elevation 118 feet MSL) at a raised area in the central part of the arm to about 12 feet deep in a trough lying along the southerly shore. The average depth of the arm is about 9 feet (Figure 4). The shoreline steeply slopes to the bottom, so fluctuations in water level do not significantly change the water surface area.

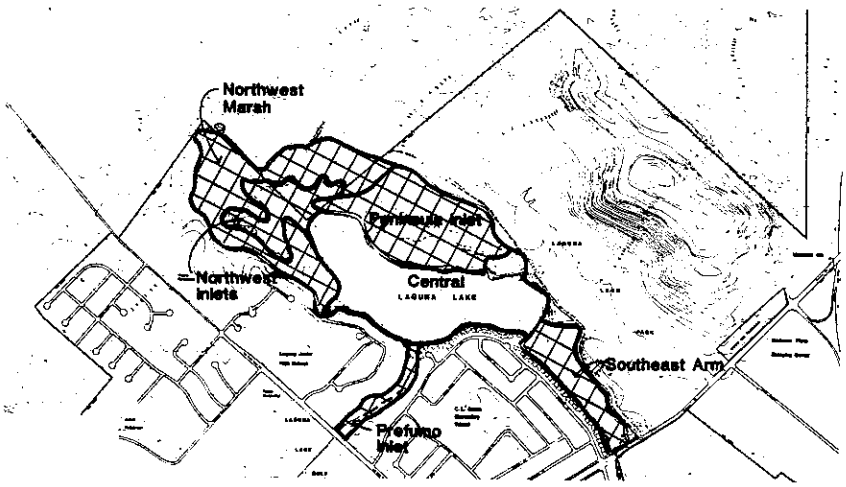
The lake bottom soil in the arm is the same as throughout most of the lake; 90% unconsolidated clay with a thin upper layer of decomposing organic matter. In the past, the lake bottom was slowly built up by the decomposition of organics and the gradual inflow of fine clay particles from the Los Osos Valley via Sycamore Creek. The addition of the Prefumo Creek drainage to the lake brought in more sedimenting material to this area, approximately tripling the very slow rate of sedimentation (increasing from 0.02 ft/yr to 0.06 ft/yr), but not substantially altering the type of material.

The urban area southwesterly of the arm drains into the lake here via several small culverts. This possibly creates temporary local degradations in water quality caused by the runoff of urban pollutants, particularly oil and grease, heavy metals, and organic material. However, given the small amount of urban area, the amount of organic pollutants potentially transported to the lake are within the lake ecosystem's ability to degrade them and does not cause a substantial impact. While heavy metals occur at higher concentrations in this area (H.D. Heinz, 1980, unpublished data), they do not appear to be significantly great enough to cause major impacts.

The largest single factor affecting the recreational and wildlife habitat viability within the Southeast Arm and, more importantly, the entire lake, is the fluctuation of water level during the summer and fall seasons. During these months there is no significant water source to recharge the lake and losses from evaporation and pasture irrigation can cause the water level to drop by 3 to 4 feet. It is estimated that on the average 100 acre-feet is lost to consumptive use by irrigation during this period and up to 450 acre-feet is lost through evaporation from the lake's surface area.

Substantial changes in water quality and bottom conditions are not expected to occur in the southeast arm if current conditions continue into the future. Should large areas of impermeable surfaces and additional parking areas be created in Laguna Lake Park, additional localized runoff and urban pollutants could be generated in amounts significant enough to affect water quality.

CENTRAL LAKE




The Central Lake is approximately 1,000 feet wide and 3,000 feet long. At 59 acres, it is the largest management unit in Laguna Lake (see figure 1). It is bounded by the Peninsula Inlet area and a portion of Laguna Lake Park on the north, the Southeast Arm on the east, the Laguna Lake residential neighborhood on the south, and the Marsh and Northwest Inlet areas on the west. Public access around the shoreline of the Central Lake is more restricted than for the Southeast Arm, in spite of its larger size and greater shore length. The primary public access point on the northerly shoreline is at the end of the Laguna Lake Park access road. Other areas of the north shore are accessible only with some difficulty due to heavy marsh vegetation growth. One other public access point is provided by the small City park on the south shore between Vista del Rio and Vista de los Collados. Except for this park the entire south shore is privately owned.

## Recreational Use

Boating: The Central Lake offers boaters a larger expanse of open water than the Southeast Arm, although the water is generally shallower. A public boat launch ramp and pier is available at the end of the Laguna Lake Park access road. Only non-motorized and electric-motorized boating is allowed on the lake by the City. Small rowboats, skiffs, canoes, kayaks, and sailboats are launched from the public ramp or from the private docks on the south shore. The lake is occasionally used for windsurfing also.

None of the boats on the lake require more than three to four feet of water depth. However, toward the end of the dry summer and fall season the lake level drops, due to evaporation, so that water depth is commonly less than four feet and, during drier years, less than three feet. Smartweed growth has become much heavier in the last several years. The hazard and inconvenience posed by the smartweed and shallow water depth has discouraged boating activity in the Central Lake area.

Fishing: Shoreline fishing is much more limited in the Central Lake than in the Southeast Arm due to the lack of convenient shoreline access. Some fishing does occur off the short pier nearby the boat ramp and along the small length of shoreline near the ramp. A major portion of northern shore of the Central Lake is formed by the Peninsula. This shore is almost entirely overgrown and is not suitable for heavy fishing use. A path along the Central Lake shoreline of the peninsula which, in the past, has provided convenient access for fishing in this area is no longer maintained by the City. Fishing occurs along the southerly shoreline from private docks and yards of residents and from the small City park between Vista del Lago and Vista de los Callados.

Education and Bird-watching: The Central Lake shoreline, particularly along the peninsula, has been infrequently used for school biology class field trips. While it was maintained, the path along the peninsula offered convenient access to view the open-water birds which frequent the Central Lake area. Junior high school classes have also used the small City park area on the south shore for wildlife field study.

Other Uses: There is no other known recreation activity in or around the Central Lake at this time, except for occasional duck-feeding and picnics (without the use of improved tables sometimes) at the end of the paved road into Laguna Lake Park. A restroom (temporary) has been erected here to recognize this use. Organized group recreation occurs at Laguna Junior High School, of course, just to the south of the small City park bordering the south shore of the Central Lake. These sports fields bear no relationship to Laguna Lake, however. Joggers also use the fitness trail

which extends into the area near the boat ramp and beyond the terminus of the paved road.

## Shoreline Land Use

Land use along the Central lake's shoreline is shown in figure 5. Along the south shore of the Central Lake, 18 homes along Oceanaire Drive overlook the lake between the Southeast Arm and Prefumo Creek Inlet. Many of these homes have private piers and other structures on their shoreline frontage. West of Prefumo Creek Inlet there are about 18 home sites along Vista del Lago, but only a few have homes on them. Easement restrictions prohibit any man-made structures along the shoreline frontage of these homes. A City park occupies about 200 feet of shoreline just north of the High School at the end of Vista del Lago.

Beyond this small City park noted above, another neighborhood of homes abuts the lake along Vista de Los Collados. Most of these homes adjoin the Marsh area.

Homes along Oceanaire Drive are more exposed than other shoreline homes to the strong easterly winds crossing Laguna Lake. These homes have fine views in all cases, however. Some of these homes have also been the subject of concern over soil stability and subsidence. None have experienced flooding, as they are generally 1 to 2 feet above the 100 year flood stage level.

Laguna Lake Park, on the northerly shore of the Central area, is largely in a natural state. The fitness trail extends through this area and facilities for fishing and boating (described above) are provided. The inland portion of the park is used occasionally for hiking, but it is primarily used for cattle grazing.

## Biotic Community

The Central Lake area is the major open water portion of Laguna Lake. Shoreline vegetation in this area is concentrated on the southerly shore

between the City Park and Prefumo Inlet and also along the Peninsula. A weedy field habitat that is dominated by coyote brush and located on fill land at the east end of the peninsula is included in this portion of the lake. In the last few years, the open water has become increasingly congested, with deep-rooted smartweed emerging onto the water surface. This growth is heaviest at the mouth of the Prefumo Inlet, with moderate amounts occurring at the constriction in the lake that divides the Central area from the Southeast Arm.

The Central area has provided habitat for waterfowl species that require large open expanses rather than cover for security. When they are present, up to 550 canvasback ducks have used this portion of the lake. Ruddy ducks and coots are also common to abundant here, while ring-billed and mew gull numbers fluctuate from one or two to several hundred as they flock to this area to bathe. Double-crested cormorants also bathe and fish in this area. Other types of waterfowl occur in small numbers in the open water, while in the shoreline vegetation great blue herons, great egrets, and snowy egrets occasionally forage. Nesting birds in the southerly shore vegetation are limited to two to three pairs of pied-billed grebes; birds nesting on the northerly shore will be discussed in the Peninsula Inlet section.

The Central portion of the lake serves as the main fish reservoir in late summer and early fall if and when the water level drops such that the marshlands to the north and west are left dry. Because of the steepness of the banks in this area, only minor warmwater fish breeding is expected to occur here.

The growth of water smartweed has caused a shift in the composition of bird species away from open-water forms to those species of dabbling ducks that prefer cover and feed at the surface in the smartweed mats. As the vegetative growth continues, diving species like canvasback, scaup, bufflehead, and merganser will occur in fewer numbers or not at all, while the dabbling ducks will increase their use of this area. The gulls and cormorants will probably shift their activities to the Southeast Arm where

smartweed growth is less, but because of the smaller surface acreage, they will occur at the lake in fewer numbers.

## Lake Water and Bottom Conditions

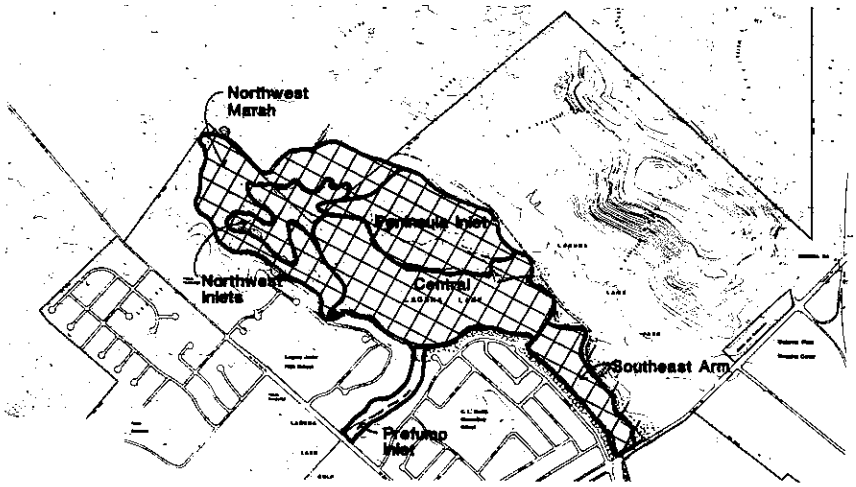
The Central area is highly intermixed by the action of the prevailing wind (Appendix B). During the winter, this area receives large amounts of clean water from the Prefumo Creek drainage, tainted with some pollutants from the urban area southwesterly of the lake. Summer flow into the lake is small and consists of irrigation water runoff from the golf course and urban areas. As in the case of the Southeast Arm, any urban-related pollutants are expected to cause only minor temporary, localized impacts to the lake, and would be adequately diluted and degraded within the Central area.

The lake bottom here averages about 6.5 feet deep (from water elevation at 118 feet MSL) and is fairly level (varying only 6 to 12 inches), except for the delta formation at the Prefumo Creek Inlet and a shallow trough along the north shore. The delta area ranges from 1 to 2 feet deep. Because of the generally flat bottom, fluctuations in water level do not greatly change the surface acreage of the lake except in the delta region; however, if the water level falls drastically, the entire central area drains and dries up as a unit. Also, because smartweed growth is greater at shallower depths, as the water level falls it appears that the lake surface acreage is decreasing rapidly as more vegetation emerges at the surface and the open water becomes more congested.

Soil type over most of the Central Lake bottom is expected to be the same as for most of the lake, 90% clay. However, the delta on which the marsh plants have become established is composed of sandy silt and silty sands. This sediment has been building relatively rapidly (0.25 ft/yr) and the area of the delta expanding with most deposition occurring in years when there are rapid transport of large loads of material. If current conditions continue, the delta region will continue to grow rapidly in high transport years, probably more rapidly now as the inlet has been silted in and most of the debris will now be carried to the lake instead of depositing in the

inlet. As these sediments provide a good substrate and shallower depths more suited to marsh vegetation growth, the open water area will be cut in half by marsh growth, with the eastern half of the Central area becoming similar to the Northwest Marsh and Inlets area.

PREFUMO INLET




The Prefumo Creek Inlet into Laguna Lake extends from Los Osos Valley Road to the Central area of the lake (see figure 1). In length, this unit is about 1,500 feet, and in width about 150 feet on the average. Total size is about 6 acres. It is bounded on both sides of its length by built-out or developing residential uses. Across Los Osos Valley Road to the south lies Laguna Lake Golf Course.

This inlet is a man made feature created in 1963 when the lower end of Prefumo Creek was rerouted so it would empty into the lake. Previously Prefumo Creek circumvented the lake.

## Recreational Use

Very little recreational use takes place in this area due to the almost exclusively privately-owned frontage here, and to the growth of willows inhibiting foot traffic and other lateral access. The City controls an access way from Los Osos Valley Road down into the inlet. The mouth of the inlet into Laguna Lake is one of the shallowest parts of the lake. The terrain and heavy vegetation makes it difficult or impossible to fish or launch boats in this area. Hiking, bird-watching, and scenic recreational enjoyment are thus the most important recreational uses of this unit.

Other Uses: Prefumo Inlet is the major depository area for sediment carried from Prefumo Canyon in winter storms. Because this sediment material is

good for structural fill for roads and homes and because the channel must be kept clear, so it can adequately carry storm runoff, the City, County, and private contractors have periodically excavated in the bottom of the channel.

## Shoreline Land Use

Shoreline land use along the Prefumo Creek Inlet is shown in figure 5. Residential land uses occur on both sides of the inlet. The homes adjacent to the inlet are enhanced by the open space buffer in their backyards. The degree of enhancement is certainly not as high as that available to the homes along the lakeshore, but the attraction is there. Unfortunately, the hazard of flooding from peak flows of Prefumo Creek is also present to a limited degree, and it is increased by the buildup in sediment deposits on the stream bottom.

## Biotic Community

The biotic community of the Prefumo Inlet is basically riparian (having to do with running water) rather than lentic (standing water like lakes and ponds). Vegetation at the northern end of the inlet is dominated by a heavy growth of willow thickets standing up to twenty feet in height. The southern portion is essentially devoid of vegetation, due in part to the different substrate, greater human activity in this area, and removal of the substrate material for fill. However, several adventive plants, particularly lupines, occur on the sandy, gravelly and cobbled soils. When the creek is running, algal growths attached to rocks are the dominant immersed vegetation.

Wildlife in the Prefumo Inlet is that typical of riparian areas adjacent to urban areas; the avifaunal elements of the community are still present, but most of the ground-dwelling animals are missing. The most conspicuous of the birds are the many warblers that feed on foliage insects in the willows and migrate in large numbers during fall and spring, though some also overwinter in the willows. Orange-crowned warblers and yellow warblers also

probably nest in the willows during the summer. Other bird species found in the willows include various flycatchers, vireos, blackbirds, orioles, and sparrows, particularly white-crowned sparrows in the winter.

The flowing creek offers several habitats to various aquatic insects that breed in the running water during the spring and are the food source for several fish and terrestrial vertebrates. Steelhead trout also move through the inlet during their migration from the sea to breeding sites further upstream in Prefumo Creek. Other organisms attracted to the inlet include shorebirds, especially killdeer, which forage in the sandy areas.

If prevailing conditions continue, the biotic community of the Prefumo Inlet is not likely to change substantially. Some debris will continue to be removed from the southern portion of the inlet, and little vegetation will be established there. However, if excavation for sediment removal were to cease, the willow thickets would tend to expand from the banks of the inlet, eventually covering the bottom of the channel. Excessive sedimentation within the inlet and at the inlet mouth to the lake may create a barrier to trout migration unless this debris is cleared by man or the scouring action of flood waters.

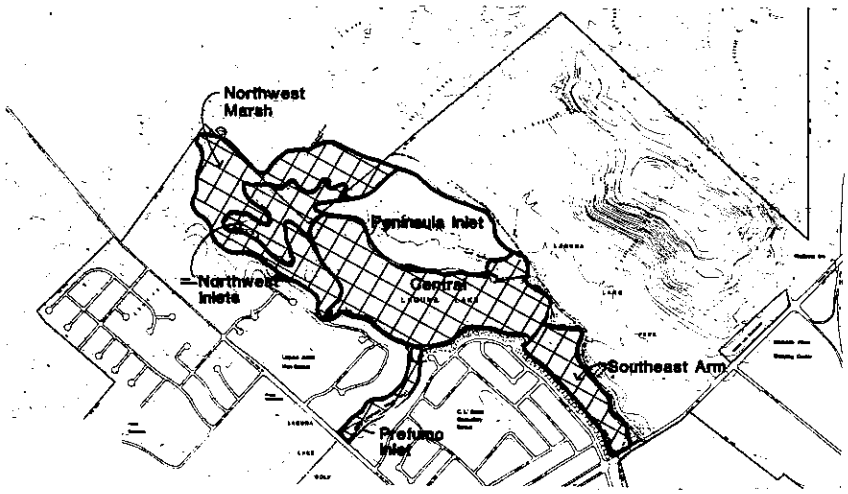
## Lake Water and Bottom Conditions

Prefumo Inlet formerly had a depth of 4 to 6 feet, but it now has been filled with sediment to an elevation of about two feet above the normal high water level (elevation 118 feet MSL) of the lake and is flooded with lake water only during winter storms. During spring and early winter, runoff from the watershed maintains a shallow creek in the inlet, while summer flow through the inlet is largely subterranean, supplied by runoff from golf course and urban irrigation. Though the summer runoff may be laden with various urban pollutants at its point of origin, the water is cleansed by its travel through the gravels and water entering the lake from this source is presumed to be unpolluted.

The sedimented material in the Prefumo Inlet ranges from rocks and cobbles to sandy silts, the material size decreasing from the culvert under Los Osos Valley Road to the lake. This material has been deposited at an average rate of about 8,000 cubic yards per year (depth increasing at a rate of about 0.5 ft/yr); however, the majority of material was deposited in only a few years when heavy winter rains and high watershed runoff caused high debris flow. Some of this material has been periodically removed over the years for use as structural fill in construction projects. This removal has been sporadic, on an as-needed basis, the largest operation occurring in 1979 when 16,000 to 20,000 cubic yards of material was removed for an adjacent housing project.

Prefumo Creek Inlet is not expected to change substantially provided that enough material is removed to maintain use of the inlet as a debris basin. If the material is not removed, a flow containing large volumes of debris may create flooding problems by decreasing the flow capacity of the inlet and blocking the culverts that drain into the inlet. The delta at the mouth of the inlet will grow at an accelerated rate.

PENINSULA INLET




This management unit lies north of the Central Lake (see figure 1). The total unit is about 40 acres in size, consisting of a peninsula (1,500 feet long and 250 feet wide), a small inlet (7 acres of water surface area) and a marsh area of about 24 acres. Beside the Central Lake, this unit is bounded by the Marsh to the northwest and Laguna Lake Park to the northeast. Access to the peninsula from land is possible only by an unmaintained foot trail leading off the dirt road west of the boat launch.

## Recreational Use

The shoreline of the peninsula has not been developed with any activity areas or improved trails, but a small path had been created by anglers, bird-watchers, and hikers using the peninsula. This path is no longer passable, however, due to overgrowth of vegetation. The marsh area is bounded by the park fitness trail on its northerly side.

Fishing: Most fishing is directed south from the peninsula toward the Central Lake due to the shallower condition of the Inlet. Fishing in the inlet north of the peninsula historically was very good, but has apparently diminshed due to the extreme pondweed growth here. Lack of a maintained trail on the peninsula has also inhibited fishing.

Bird-watching and Education: Besides its limited fishing use, the peninsula serves as a good promontory for observing birds and other wildlife, and the

tules along the shore of the peninsula also provide shelter for a variety of waterbirds. The closure of this area to vehicles several years ago may have enhanced the habitat value. (More discussion about the types of birds and wildlife to be found in this area is provided below.)

Boating: Very few boats venture into the Peninsula Inlet, except perhaps to aid in bird-watching activities. The narrowness of the inlet and smartweed growth appear to inhibit boaters or fishing from boats in this unit.

## Shoreline Land Use

Shoreline land use is shown in Figure 5, for the Peninsula Inlet. The shoreline of the Peninsula Inlet is within City ownership, but has not been developed for significant public use. A dirt road about 2,300 feet in length runs along the northerly shoreline beginning at a gate near the boat launch. The road is part of the City's Fitness Trail, and is frequently used for jogging and hiking. There are no public tables or restrooms in this area. The land on the north side of the dirt road is fenced and used for grazing.

Landfill was once planned for the entire peninsula to build it up and raise the central area of the peninsula to create an active use area. Part of the peninsula extending about 500 feet from the end of the road was filled, largely with pavement debris and lake bottom dredge spoil. This area is now barren and covered with ruderal vegetation. No additional land fill activity is planned for this area, and the remaining unfilled area is expected to remain in a "natural" state.

Above the dirt road along the northern boundary of the unit, the City leases a large area of grassland for grazing. The total leased area includes 160+ acres, between the Madonna Inn and Laguna Lake, but only about 40 acres of this area is reasonably flat; most of this flatter area lies above and drains into the Peninsula Inlet area. A few springs occur along the base of the hill and are available to cattle, but have not been developed with stock ponds.

## Biotic Community

Vegetation of the Peninsula Inlet consists of willow thickets along the raised portions of the peninsula, while the lower areas are dominated by extensive mats of water smartweed with occasional dense stands of bulrush. Much of the area is flooded by water two to three feet deep during the winter and spring, this land then drying during the summer and fall. As the land dries, other vegetative species tolerant of wet soil conditions, but not immersed conditions, begin to grow (Appendix C ), but bulrush and smartweed comprise over 95% of the vegetative growth in the marsh. Moderate to heavy amounts of smartweed are also currently becoming established in the open water portion of the inlet.

The Peninsula Inlet is the most important wildlife habitat area within the lake boundaries (Appendix A). This is due to the large amount of cover, the slightly greater diversity of biotic communities, and the greater isolation from human disturbances and grazing. On the peninsula proper the willow thickets and marshland provides nesting habitat for dense populations of common yellowthroat, long-billed marsh wren, song sparrow, and sora. Yellow warblers nest in the willows, which are also a roosting site for black-crowned night herons, whose major roost is in the dense stand of bulrush northwestward of the end of the peninsula. The shoreline of the peninsula is a major foraging area of large wading birds (herons and egrets).

The flooded interior of the peninsula provides foraging habitat for several species of dabbling ducks, but more importantly the heavy cover of smartweed is a major night roosting site, containing up to 300 ducks (mostly northern shovelers, green-winged teal, and pintails). Many of these birds spend the daytime foraging in the sheltered waters of the adjacent inlet, generally in small ponds completely surrounded by large mats of smartweed.

The northeast side of the Peninsula Inlet area provides prime nesting habitat for pied-billed grebes, which occur here more densely than in any other location reported in avian literature. Coots, soras, blackbirds,

song sparrows, and common yellowthroats nest in the bulrushes and smartweed in this area. White-tailed kites also frequent this area in unpredictable numbers. During the winter of 1974-1975, thirty kites roosted in this part of the marsh.

The Peninsula Inlet area provides suitable habitat to many other marsh-related animals besides birds. Muskrats, raccoon, western pond turtle, garter snakes, bullfrog, treefrog, red-legged frog, and several other amphibians commonly occur here. The shallower open portions of the ponds provide breeding sites for warmwater fishes, several of which find their major food sources within the smartweed mats and also cover from predators.

If current environmental conditions continue, the peninsula inlet area will eventually become almost completely filled with marsh vegetation and have little open water. As the smartweed mats close up the small ponds and the inlet, the area declines in value to dabbling ducks, though it potentially increases in value to species that can utilize that habitat for nesting and to the more terrestrial forms of marsh inhabitants.

## Lake Water and Bottom Conditions

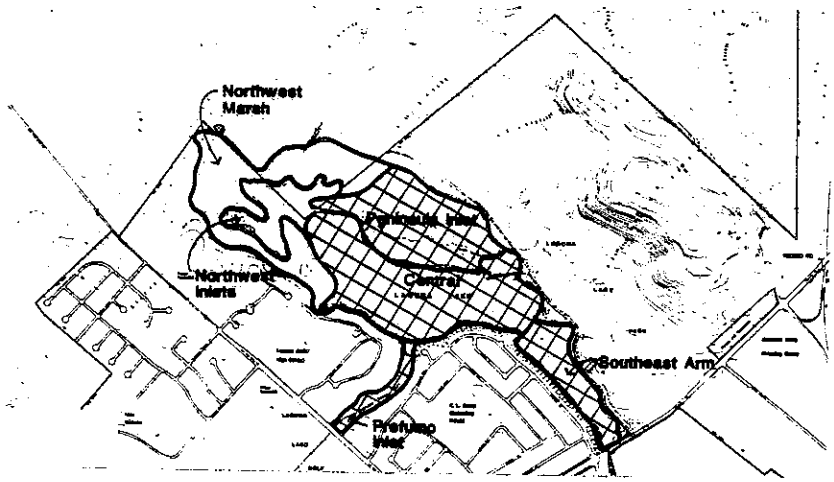
Waters within the Peninsula Inlet are somewhat isolated from the other waters of the lake because of the narrow entrance, but the steady winds keep this water mixed from top to bottom within the inlet and also creates a current that moves bottom waters out toward the Central portion of the lake. Runoff water inflow to this area is limited to sheet flow from the parklands and is expected to be of high quality.

The small ponds that occur throughout the Peninsula Inlet have greatly fluctuating environmental conditions as the lake water level falls. As these become isolated from the main portions of the lake, nutrients and physical parameters can vary greatly, particularly oxygen as the ponds are sheltered from the mixing action of the wind. These changing conditions are not adverse to the normal interactions of the marsh and different species

are especially adapted to these conditions. However, if poor quality water were introduced to this area, significant water quality problems might occur.

The open water portion of the inlet averages about 6 feet deep, being deepest in a trough along the north side of the peninsula. Most of the smartweed mats in the northern portion of this area are rooted in water averaging 4 feet deep. Because of the shallow slope in this area, small changes in water surface.

NORTHWEST MARSH AND INLETS




The Northwest Arm of Laguna Lake is occupied by a shallow marsh penetrated by meandering sloughs which drain to the Central Lake. The marsh and inlets together comprise about 67 acres, but only 13 acres, in the inlets, are generally covered with open water. To the north is irrigated pasture land. To the east lies the Central Lake and Peninsula Inlet. To the south is a developing neighborhood along Vista del Collados and to the west are dry rangeland areas.

## Recreation Areas

There is little boating activity in this unit due to the shallow depth and distance from launch areas. An occasional activity in this unit is birdwatching from boats, or from limited areas of accessible shoreline east and west. No trails have been developed within or near the marsh, and none are planned by the City.

## Shoreline Land Use

The marsh lies just northeast of a developing tract about 8 acres in size. Many of these homes have fine views overlooking the marsh. Next to this neighborhood, a large area of land is planned for future residential use, about 20 acres between the existing tract and the City limits.

The north boundary of the marsh is occupied by irrigated pasture, part of which was recently "reclaimed," although the soil is still capable of supporting the marsh vegetation. The most northerly portion of the marsh (about 17 acres) is privately-owned, and lies outside of the City limits. A trench has been excavated from the irrigated pasture into the inlets within the privately-owned marsh area in order to obtain water for the pasture. A small pump beside this trench distributes water from the lake to the 60 acres of pasture. (See Figure 5). At the northeastern edge of the marsh, just within the City limits, the dirt road/jogging path from the developed park area terminates. Cars are not allowed on this road, and access into the marsh from this point is prevented by fencing between private land and the park.

## Biotic Community

This area comprises the major portion of the smartweed-bulrush marsh of Laguna Lake. While other freshwater elements occur here (Appendix C), these two species account for the vast majority of vegetative growth in this area. This marsh produces a major portion of the food supply used by the wildlife populations throughout the remainder of the lake.

Wildlife in this area is a mixture of the types that occur in the Peninsula Inlet and Central Lake areas (Appendix A). The open water here attracts diving ducks like the canvasback, ruddy duck, and bufflehead and also coots and grebes. Double-crested cormorants use this area more than anywhere else on the lake. The sheltered water areas contained the greatest number of foraging dabbling ducks, with the southwestern inlet being the most heavily used. The shallower shoreline areas are used moderately by the large wading birds, including herons, egrets, and bitterns. Soras and Virginia rails commonly occur in the emergent vegetation of the north section of this area. While the nesting habitat here is not as prime as that in the Peninsula inlet, several marsh species do nest here in good numbers.

The shallow waters of the marsh area are used extensively for breeding by the warmwater fish in the lake. This attracts many predatory bird species (waders, pelicans, grebes, and cormorants) to this area, as well as the larger predatory fish.

Smartweed growth into the inlets has become very dense, causing a decline in the number of waterfowl using the area. Smartweed growth in the southwestern inlet and possibly the increase in human disturbance from the residential development adjacent to the marsh has caused a major shift in bird use from this area to the northerly inlets. If smartweed growth continues unabated within the inlets, it will eventually fill them and wildlife use of this area will shift from essentially aquatic types to semi-aquatic and terrestrial oriented species.

## Lake Water and Bottom Conditions

Though the inlet and marsh area waters are somewhat sheltered from the action of the wind by vegetation, the strong currents and mixing action created in the Central Lake area extend into this part and environmental conditions here are not significantly different than in other parts of the lake. This area does contain greater amounts of suspended organic materials, especially immediately after initial runoff of storm waters from the pasturelands to the north and west, but the strong mixing of the wind distributes these materials rapidly and effectively throughout the lake waters.

The lake depth within the inlets and the bottom configuration is the same as for the Central Lake area, averaging 6 to 6.5 feet deep. The major portion of the marsh is abruptly elevated 3 to 4 feet above the inlets, and normally contains water only about two feet deep. Because of the gradual slope of the marsh area, slight changes in lake water level cause large changes in

the lake's surface area. This effect is mostly hidden by the marsh vegetation for water levels below 118 ft. MSL, but at higher levels that occur during winter storms, intermittent flooding only a few inches deep occurs in large areas west of the marsh.

The bottom soils in this area are expected to be 90% clay intermixed with a thick layer of decomposing organic material. Sedimentation within this part of the marsh occurs slowly, at a rate of 0.02 ft/yr or less.

If current environmental conditions continue, no substantial changes are expected to occur to the lake bottom or water quality in this area in the near future.

# IV. RECOMMENDED LAKE USES AND REQUIRED CHARACTERISTICS

## INTRODUCTION

This section identifies the appropriate uses in each lake area (i.e. existing uses which should be preserved or enhanced and new uses for which the community has indicated a need or desire). The criteria as to the appropriateness of a use were based on natural environmental conditions, existing uses, and desires or needs expressed by the community.

The shoreline and lake conditions required to establish and/or continue the uses defined as appropriate in each lake area will also be identified in this section. Physical changes in the lake or along the shoreline, as well as management programs needed to accommodate the defined uses will be described.

SOUTHEAST ARM

The Southeast Arm is the most intensively used lake area for recreation, and is the least sensitive wildlife area. Consequently the most appropriate uses are recreational in nature. Protection of wildlife and shoreline vegetation is a function of preserving the unique visual, recreational and leisure-time ambiance afforded by the lake.

## Appropriate Uses

Shore Fishing
Boating
Picnicking
Duck Feeding
Passive Shoreline Recreation
Swimming (marginally appropriate)

## Physical Condition and Management Requirements

Generally, the existing conditions in the Southeast Arm are adequate to accommodate the uses listed above. However, there are some essential and some optional improvements to conditions which are discussed below:

Swimming: Health Department standards for water quality must be met. Generally the existing water quality is above the standards required. However, during certain seasons, water quality can drop below standards acceptable for water-contact recreation. If swimming is permitted, water quality should be monitored for coliform.

If swimming is permitted, areas should be specifically marked for such use. If swimming is to be encouraged, the shoreline could be improved by replacing muds with other soil materials (sand, gravel) more acceptable to the public. Water areas should also be demarcated to restrict boats where swimming is permitted. Localized annual harvesting of smartweed and other water vegetation would be required in swimming-permitted areas. This use does not require any

significant or unique programs which need to be addressed in this management plan. Facilities and programs to accommodate swimming should be further addressed in a Laguna Lake Park Master Plan.

Shoreline Fishing, Picnicking, Duck Feeding, Etc.: Existing conditions are acceptable. However, improvements such as benches, parking pullouts, tables, topographic recontouring and surfacing, and other amenities could be considered along the shoreline as part of a Laguna Lake Park Master Plan. Planning for these amenities should address preservation of existing marsh vegetation and erosion control.

Boating: Existing lake depth is acceptable and smartweed growth is generally low to non-existent. During summers following below-normal rainfall years the lake level could drop below the minimum depth of 3 feet for boating in certain areas where the lake bottom is not as deep. Smartweed growth has not occurred in significant proportions, but could in the future if it is able to spread from shallower portions of the Southeast Arm to the deeper areas.

CENTRAL LAKE

The Central area offers the largest expanse of open water in the lakes. It has value as both an important shoreline and water recreation amenity and wildlife habitat. This mix is reflected in the list of uses which follows:

Appropriate Uses

Boating
Shore Fishing
Swimming
Open-Water Wildlife Habitat
Education/Bird-Watching

Physical Condition and Management Requirements

Boating and Wildlife: To provide adequate open-water wildlife habitat and boating recreation amenity, the following conditions should be maintained:

- Water depth must be a minimum of 3 to 4 feet at the seasonal low water surface elevation (i.e. lake surface level in late fall) to provide suitable boating conditions.

- Existing smartweed must be reduced or eliminated.

- Future smartweed blooms must be inhibited or harvested.

The seasonal low water level of the lake, in late fall, is normally at elevation 114' to 115' mean sea level (MSL) following normal to above-normal rainfall in the previous winter season. Thus, during normal rainfall years an adequate minimum depth of 3 to 4 feet is maintained throughout the year. However, following a severely below-normal rainfall season, the water level can drop as far as elevation 112' MSL, and the lake will dry up (except in the Southeast Arm) after one or two severely below-normal rainfall (drought) seasons.

In the area of the delta at the mouth of the Prefumo  nlet, lake depth is inadequate even during the seasonal high lake level (elevation 118') in the spring.

Smartweed growth in the majority of the Central area is generally unacceptable for boating and open-water wildlife species. It is expected that this growth will continue and become heavier in the future. Existing smartweed must be removed and clear water maintained in the future. If a minimum of 8 to 10 feet can be maintained year-round, especially through summer and early all, new aquatic weed growth will not occur. The normal turbidity of the lake decreases light penetration at this depth to below the level needed to germinate new plant growth on the lake bottom. If this minimum lake depth cannot be maintained, periodic harvesting of aquatic weeds or chemical treatment to kill new growth will be required.

Shore Fishing, Education and Bird-Watching: Existing conditions are adequate for these uses. However, the City may wish to consider improvements in a Laguna Lake Park Master Plan. In the small City park on the south shore, improved facilities to permit boat launching and fishing should be addressed in a park plan. Access to the Central area shore formed by the peninsula should be limited. More discussion of limitations occurs in the Peninsula Inlet section.

Swimming: The same conditions as those described for the Southeast Arm are required.

PREFUMO INLET

The primary importance of the Prefumo Inlet is in its capacity as a major storm runoff channel and a sediment catchment basin. Other uses listed below are secondary and of much lower importance.

## Appropriate Uses

Sediment Retention
Flood Control
Riparian Wildlife Habitat
Education
Passive Recreation

## Physical Condition and Management Requirements

Sediment Retention and Flood Control: The inlet channel should be developed and maintained so as to adequately carry flood waters and capture sediment material before it reaches the lake. Sediment must be removed on a periodic basis and the channel bottom maintained at an elevation of 116 to 117 feet MSL. Convenient access into the channel for heavy excavating machinery will be required. Sites for disposal of excavation material will have to be located on an as-needed basis.

Willow thickets at the banks of the channel should be maintained to prevent bank erosion. Willow thickets within the channel bottom should be removed except in the last few hundred feet of the channel mouth. Willow thickets here will help to slow water velocity in the upper reach of the inlet and thus aid in the sediment retention function. However, if the entire inlet is returned to its original design, all willow thickets on the bottom must be removed.

Wildlife, Education and Recreation: Sediment retention and removal must be conducted so as to minimize impacts to wildlife. Excavation should be done such that a channel for trout migration is maintained. Willow thickets, especially at the northern end of the inlet and along the inlet banks should be retained.

PENINSULA INLET

This is the most important wildlife habitat area on the lake and wildlife preservation should be the primary objective in this area. Other uses are of secondary importance and are appropriate only so long as they do not significantly affect wildlife.

## Appropriate Uses

Wildlife Habitat
Shore Fishing
Boating
Education
Science
Bird-watching

## Physical Condition and Management Requirements

Wildlife Habitat: Existing conditions are adequate. Human use of this area should be limited. Conditions regarding smartweed growth are changing. Smartweed is becoming more intense in the inlet area. As this growth becomes heavier, the avifaunal and fish species using this water body will change to those preferring a more marsh-like environment. If it is desirable to maintain a more open-water condition in the inlet, maintenance of smartweed growth will be required.

Education, Scientific, Bird-Watching: This area has great value as an educational resource. However, to maintain its value, human intrusion into the area should be controlled and limited. The existing path system on the periphery of the peninsula and the fitness trail on the northerly boundary of the Peninsula Inlet should continue to be the only means of accessing the area. The area along the fitness trail should be developed to facilitate wildlife viewing. The path along the southern shore of the peninsula should be minimally maintained (minor vegetation trimming) to allow passage, for serious fishermen, biologic investigation and education, but not so as to encourage

casual use. The path along the north shore of the peninsula should be allowed to deteriorate and access to it prohibited. Should human intrusion become more popular than at present, some means of restricting access (posting, fencing, etc.) should be considered as a part of Laguna Lake Park Master Plan.

Shore Fishing: Shore fishing should be prohibited in all areas except the south shore of the peninsula. Fishing from this shore should be permitted, but not encouraged. If shore fishing in this area becomes more popular than at present, some means of restricting access should be considered.

Boating: Boating within the area may be permitted. However, no effort should be made to improve conditions for boating or to encourage this use.

NORTHWEST INLETS AND MARSH

This area of the lake is an important wildlife habitat. Other uses listed below are appropriate only if they do not significantly affect wildlife.

## Appropriate Uses

Wildlife Habitat
Boating

## Physical Condition and Management Requirements

Wildlife Habitat: Existing conditions are adequate. However, grazing within the marsh area has had moderately adverse effects on the vegetation and wildlife habitat. If possible, grazing in areas supporting marsh vegetation should be prohibited in the future.

Boating: Boating within the inlets should be a continued use. However, no effort should be made to improve conditions for boating or to encourage this use.

# V. LAKE MANAGEMENT OBJECTIVES

The discussion of required conditions in the preceeding section identifies a series of objectives for lake management. These may be summarized as follows:

- MAINTAIN 3 TO 4 FEET OF LAKE DEPTH AT SEASONAL LOW WATER LEVEL (i.e. level of lake surface in late fall).

- REDUCE OR ELIMINATE EXISTING AQUATIC WEEDS.

- PROVIDE FOR ON-GOING AQUATIC WEED CONTROL.

- PREVENT PREFUMO CREEK WATERSHED SEDIMENT FROM REACHING LAGUNA LAKE.

- PRESERVE THE CHARACTERISTICS OF THE LAKE WHICH ARE IMPORTANT TO EXISTING WILDLIFE HABITAT, THE EXISTING LEVEL OF FLOOD PROTECTION AND EXISTING RECREATIONAL OPPORTUNITY.

These objectives are the nucleus of the management plan for Laguna Lake. Attainment of each objective in appropriate areas of the lake will result in a lake environment which provides good recreational opportunities balanced with sensitive wildlife habitat preservation. The following pages identify: (1) those lake areas where attainment of each objective is most important; (2) a summary of the existing lake conditions and effects which pertain to each objective; and (3) a list of alternative methods to use in implementing or attaining each objective.

The discussion of objectives which is presented below provides an introduction and framework for understanding the two important sections which follow, section V ALTERNATIVE METHODS FOR ACHIEVING OBJECTIVES and section VI ALTERNATIVE MANAGEMENT PROGRAMS.

OBJECTIVE 1 - Maintain 3 to 4 feet of lake depth at seasonal low water level (i.e. level of lake surface in late Fall).

Meeting this objective is most important in the Central and Southeast Arm areas of the lake, as these areas provide the prime features for recreational boating and other water oriented activities.

During the dry season (late spring to late fall) the water surface level of the lake normally drops 3 to 4 feet due to evaporation and irrigation pumping. In normal rainfall years, this decreases lake depth in the Southeast Arm from a maximum average of approximately 8 to 9 feet to about 4 to 6 feet in late fall; and in the Central area, from a maximum of 7 feet to 3 to 4 feet in late fall. In both areas there are localized areas where the lake bottom is higher and thus depths are shallower in late fall. The two most important of these are in the Central Lake area in the delta area at the mouth of the Prefumo Inlet and in the area around the boat launch ramp. Thus, in normal rainfall years (two out of every four years), the existing lake bottom and water level characteristics are adequate to minimally achieve the objective stated above, except in the two localized areas noted.

In these two areas only a relatively minor program must be implemented to reach the objective. On the other hand, to maximize attainment of the objective will require increasing the lake depth across a broader area of the lake, especially in the Central area, or stabilizing the lake water level because there are years when, under existing circumstances, lake depth will not be adequate for water sports in the fall months. In below-normal rainfall years (one out of each four years) water depth may drop below 3 to 4 feet in the fall. In severely below-normal rainfall years (one in each four years) water depth will not be adequate unless actions are taken to increase lake depth or stabilize the lake level.

It is not necessary to increase lake depth or stabilize the lake level in the Peninsula Inlet, Northwest Inlets, Prefumo Inlet or Marsh areas in order to adequately attain the objective. However, if as a result of meeting the objective in the Southeast Arm or Central Lake areas, increased lake depth or a stabilized water level should coincidentally be achieved in the other areas, this would, in most cases, be a desirable additional benefit. Where these

side effects may be undesirable, they are identified in the discussions of environmental consequences in the following section, "Alternative Methods."

There are three primary means of increasing lake depth:

1. Lower the lake bottom by dredging (A)
2. Lower the lake bottom by excavation (B)
3. Raise the normal high water level using a dam near the culvert under Madonna Road (C).

There are two primary means of partially or completely stablilizing the lake's water level:

1. Recharge the lake during the dry season with treated effluent water from the sewage treatment plant (D).
2. Control the amount of water extracted from the lake for irrigation purposes (E).

Each of these methods is discussed in the following section, "Alternative Methods", under sub-sections corresponding to the letter in parentheses () above.

OBJECTIVE 2 - Reduce or eliminate existing aquatic weeds.

Elimination of smartweed and other aquatic weeds is most important in the Central Lake area, as this area provides the prime features for water oriented recreation and the best habitat area for open water bird species. At present, the Central area contains heavy to moderate weed growth over a majority of its area. This is discouraging people from using the lake for boating and is discouraging bird species who prefer an open water environment. In addition, these weeds are a key source of the excessive nutrient load in the lake.

There is little weed growth in the Southeast Area and it appears that natural conditions there will inhibit growth in the future. While weed growth is heavy in the Northwest Inlets and Peninsula Inlet area, this is acceptable. However, it may be desirable to reduce weed growth to some degree in these areas, or to maintain it at its present density in the future.

There are three primary means of eliminating or reducing existing weed growth:

1. Mechanically harvest the weeds with equipment designed for this purpose (F).

2. Manually harvest the weeds using contract employees and equipment fabricated by the City (G).

3. Use chemicals to kill the weeds (H).

4. Manipulate the biological parameters of the lake to "naturally" kill the weeds (I).

Methods used for attainment of other objective will also, as a secondary effect, kill and remove aquatic weeds:

1. Dredging (A)
2. Excavation (B)

Each of these methods, their environmental consequences, costs, etc., is disussed in the "Alternative Methods" section under sub-sections corresponding to the letter in parenthesis () above.

OBJECTIVE 3 - Provide for on-going aquatic weed control.

Removal of existing weed growth must be followed by a program for controlling future growth. The program must be implemented in the Central lake area and may be optional in other areas.

Weed harvesting, chemical treatment and biological manipulation, listed as methods for removing existing weeds under the preceeding objective number 2, are also capable of controlling and maintaining new weed growth in the future. In addition to these, there is a passive control measure that involves maintaining a minimum lake depth. If the depth can be maintained so that it is a minimum of 8 to 10 feet in late fall, this will reduce light penetration such that germination of new growths will be inhibited. This can be achieved by raising the lake level (C), dredging (A) or excavation (B) to a point such that lake depth is at least 12 feet at the normal high water level in late spring immediately after the lake has ceased spilling into Prefumo Creek. During the succeeding dry season the lake level will drop 3 to 4 feet largely due to evaporation, so that lake depth in late fall would be 8 or 9 feet.

2.4m 2.1m

OBJECTIVE 4 - Prevent Prefumo Creek watershed sediment from reaching Laguna Lake .

The Prefumo Creek watershed is the only signficant source of sedimentation in Laguna Lake. The terminus of the creek is in the Prefumo Inlet arm of the lake. Prefumo Inlet, since its creation in the early 1960's, has been functioning as a sediment retention basin. However, it has filled to its capacity with sediment over the years and is not very effective in catching sediment before it reaches Laguna Lake. As a result, a small delta has formed in the lake and it grows each winter. A management program must be implemented to periodically remove sediment from the inlet, restoring its retention function

If a program is not implemented, the delta will eventually expand over a large area of the lake, resulting in significant reduction or even elimination of water recreation opportunities and significant alteration of wildlife habitat.

Re-creation and maintenance of the sediment retention basin in Prefumo Inlet will involve both dredging and excavation. This operation is treated and discussed as a separate "method," J, in the section on Alternative Methods because the sediment retention function and importance of Prefumo Inlet is unique to any other portion of the lake. Decisions as to appropriate management techniques in this area must therefore be made separately from management decisions on other areas of the lake.

There are two methods of maintaining the retention function of the inlet:

1. excavation and minor dredging
2. excavation and major dredging

OBJECTIVE 5 - Preserve the characteristics of the lake which are important to existing wildlife habitat, the existing level of flood protection and existing recreational opportunity.

Implicit in each of the preceding objectives is the objective of preserving wildlife habitat, preserving the level of flood protection to the adjacent man-made environment and preserving the existing recreational opportunities in Laguna Lake Park. The lake modification methods and management programs discussed in the following sections are evaluated as to their potential for adversely affecting achievement of this goal. In comparing one alternative modification method or management program to another to arrive at a selection decision, these environmental evaluations, along with others such as cost, must play a key role.

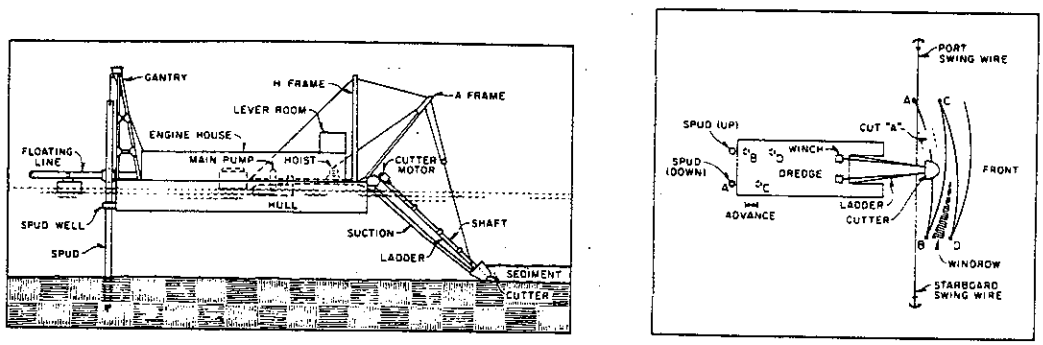
# VI. ALTERNATIVE METHODS FOR ACHIEVING OBJECTIVES

For each of the five objectives indicated in the previous section there are various means of attainment. In the following discussion these alternative methods, their environmental consequences, costs and effectiveness will be identified (each method is lettered for easier reference in the text).

## DREDGING (A)

### Description of Method

There are several varieties of dredges, but the kind most commonly used and available is the hydraulic cutterhead dredge. It is generally the least costly and poses the lowest potential for adverse environmental consequences. Its configuration is typically a rotating auger or cutterhead on the end of a ladder that is lowered to the sediment-water surface. Material excavated by the cutterhead is pumped in a slurry of 10 to 20 percent solids by a centrifugal pump to a floating discharge pipe which leads to a (1/2 mile limit) disposal area. The cutterhead and pickup device swing from side to side on the "cut path" by pulling alternately on port and starboard swing wires at the bow of the dredge. The dredge advances by alternatively lowering and raising spuds, one on each side of the stern of the craft (see illustration below).




Typical configuration of a cutterhead dredge and the stabbing method for advancing it

Sizes vary, of course, but the size most suitable for Laguna Lake would be a 6 inch to 12 inch dredge (size of slurry intake pipe). Generally, dredge machinery is powered by diesel engines. However, if conditions warrant, electric motors can also be used. A dredge of the size noted above can excavate about 100 cubic yards of sediment per hour; about 600 cubic yards per day (assumes 75 percent actual daily production time).

Aquatic vegetation growing from the lake-bottom will be uprooted during the dredging process. Some of this material will be sucked in with the slurry, However, much will be left to float on the lake surface. Collection and disposal of this material as a separate or supplemental aspect of the dredge operation will be required.

The disposal site required for hydraulic dredging is large due to the large volume of slurry produced. The disposal pond is essentially a bathtub formed of earth and will need to be a maximum of eight to ten feet deep. Depth requirements are based on the area available for a disposal site, the amount of dredge material to be disposed. The pond must be 1.5 to 2 times deeper than the desirable depth of dewatered sediment material. The pond should be sized so that a "lift" of dewatered sediment will be no deeper than 5 feet. With a maximum five foot lift, a one acre disposal pond will be required for each 8,000 cubic yards of sediment dredged from Laguna Lake; in other words, one foot of excavation over a one acre area of lake bottom requires 0.2 acres of disposal area.

The pond may be formed by a combination of excavation and formation of a perimeter berm. The slurry is pumped from the dredge via a pipe which discharges the slurry into the upper end of the pond. The slurry runs to its lower end and sediment material drops out on the way. At the lower end the de-sedimented water empties off the top of the pond through a weir and a pipe running back to the lake.

At the completion of the dredge operation after all surface water has been drained from the disposal pond the sediment begins to dry. Periodically, during the drying process the dried crust which forms on top should be

tilled with typical farm machinery so that the lower areas of the "lift" can dry more quickly.

After drying, the sediment material may be transported for use in other areas or left in situ, covered with top soil and seeded. The clay sediment from Laguna Lake has poor drainage qualities and therefore will not adequately support vegetation unless heavily mixed with earth material that has good drainage qualities. This does not seem feasible except in relatively small quantities. Due to cost, it is not considered feasible to transport the material away from the disposal site.

The most reasonable area for a disposal pond lies in the northwesterly portion of Laguna Lake Park adjacent to the Peninsula Inlet area of the lake. Terrain features in this area are suitable and it is furthest distant from the current primary recreation areas of the park. The illustration on the following page outlines that area and indicates the acreage available by a one-acre grid. Using a maximum lift of five feet, the disposal area available can accommodate up to 200,000 cubic yards of sediment material.

## Environmental Consequences

The environmental consequences of dredging can be divided into those that will occur in the lake, in shoreline residential areas and those that will occur at the disposal site. Adverse effects that will occur in the lake are primarily increased turbidity and resuspended nutrients in lake waters resulting from bottom disturbance at the dredge intake and also from residual clay and nutrients suspended in the return water from the disposal site. However, these effects will be temporary, and the overall effect will be a net removal of nutrients so that the long-term effect on nutrient balance will be positive. While highly turbid conditions are common at the lake, the additional turbidity caused by dredging may result in the suffocation of fish due to clogged gills. This adverse effect on the fish population can best be mitigated by accepting the direct effects and cleaning up and restocking after the dredging operation is completed.

Beneficial effects of dredging will be the removal of aquatic weeds in the dredge areas and increased depth. The latter will reduce the rate at which aquatic weeds will reestablish themselves, provide better water circulation and increase useable boating area.

The machinery used in hydraulic dredging typically employ large diesel engines. These can produce relatively high noise levels which could disturb residents near dredging operations. The extent of impact would depend on how long the machinery operates in the lake, the daily operating hours, the kinds of muffling equipment placed on the engines, etc. Alternatively, electric motors could be employed in place of diesel engines. This would reduce noise while increasing cost to an unknown extent.

Adverse effects in the disposal area will primarily be those related to the creation of an area that will not support significant vegetation. Based on sampling to date, the dredge spoils are primarily expansive clay that will not drain well. Specific impacts include: 1) loss of agricultural land; 2) possible visual effects; 3) future increased turbidity in the lake should runoff breach the containment dike; and 4) possible odor nuisance. These potentially adverse effects can be mitigated by removing and stockpiling the topsoil in the disposal area, and replacing it after the dredge spoils have dried. The resulting surface could then support grasses that could be used for agricultural or recreational purposes.

Another possibility is mixing better soils, such as top soil graded from areas of the park or sands and gravels excavated from the Prefumo Inlet (see method J), with the dried lake bottom dredge sediments to produce a mixture which would support grasses and trees. This mixing operation would be a large project if there were very large quantities of dredge material. There is not enough information available at this time to determine the appropriate proportions of the materials which should be mixed.

Another potentially adverse effect is the accidental breaching of the containment dike during the dredging operation. In such a case, the fluid material behind the dike would wash into the Peninsula Inlet area, filling

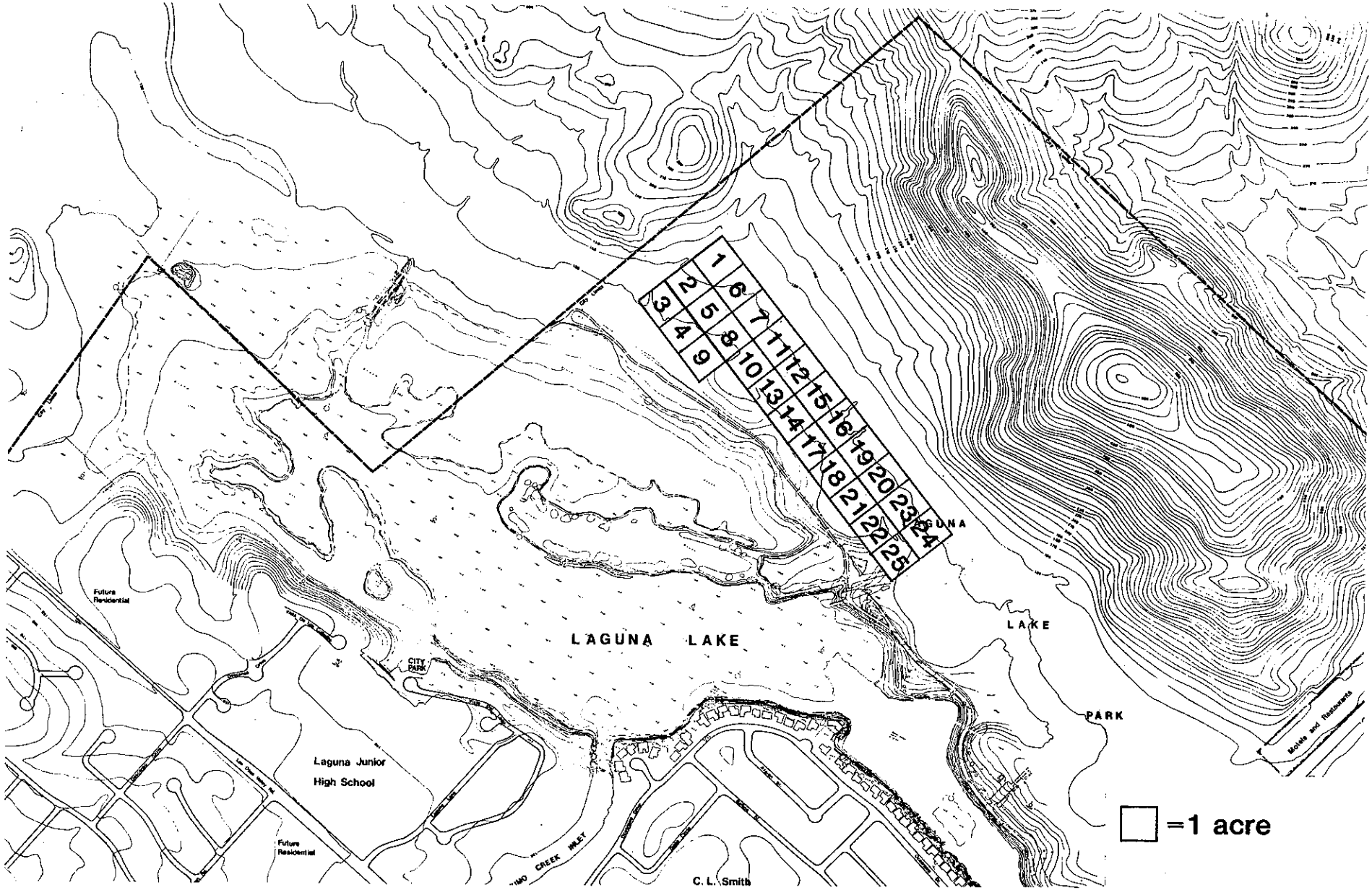



figure 9

# Available Dredge Disposal Area

in and disrupting the area of greatest ecological value within Laguna Lake. Proper engineering design and construction would minimize this potential problem.

A serious, but avoidable, potential impact relates to the stability of shoreline residential building pads. If dredge material is removed in too close proximity of the existing, relatively steep shoreline bank, there is a potential that slippage and subsidance could occur. To avoid this problem, dredging should not take place within 30 feet of the toe of the shoreline bank and the slope of the banks formed along the edge of the dredged area should not be greater than 10 percent (see illustration on following page). These standards are based on relatively limited data. The data and analysis required are complex. If this method is chosen as part of a management program, a comprehensive study of soil shear strength should be conducted prior to establishing specifications or implementing a dredging operation.

## Goal Attainment

Dredging will increase the lake's depth and thus increase its recreational value. Dredging will also remove water vegetation and thus increase open-water wildlife habitat value, recreational value and, by removing a source of nutrients, it will improve the overall water quality in the lake and slow lake eutrophication (the long term process of a lake turning into a marsh).

The degree of effectiveness is of course related to the depth and the amount of area dredged. For this method to be significantly beneficial for boating recreation, the lake bottom should be dredged to a depth of at least elevation 109' MSL (i.e. an average of two feet deeper in the Central Lake area). This depth would be adequate to provide for recreational boating in all but the most severe drought seasons (such as 1976/1977). The area dredged should of course be sizable enough for pleasurable boating (perhaps 25 acres).

Dredging will, as a side effect, remove existing aquatic weed growth and, if the lake bottom is dredged deep enough, this method will also significantly

reduce or eliminate new weed growth. To be effective in this regard the lake bottom must be dredged to elevation 106' MSL. This would provide enough water depth (8 to 10 feet at seasonal low water level) to inhibit plant growth through reduced light penetration. This depth would be effective in most years. However, after severely below-normal rainfall years (like 1970, 1972, 1976 and 1977) it might not.

## Procedure

Dredging of Laguna Lake would involve earthwork in a water course and would cause additional impoundment of water. These two aspects require permit approval from the State Water Resources Control Board, Division of Water Rights as well as the necessity to obtain an agreement with the State Department of Fish and Game. No permit is required from the Corps of Engineers under their "Section 404" program unless material is to be redeposited in the lake or another water body.

Option #1: The dredging operation itself could be accomplished completely by the City using loaned equipment (loan operation). The design of the disposal pond and training of City personnel to operate the dredge and manage the disposal pond would require outside contracting. The California Men's Colony has an 8" dredge which it uses in its El Chorro reservoir. This dredge is available for loan at a nominal charge (see "Cost" below).

Option #2: The City could also rent equipment and manpower from a dredging company on an hourly basis (rental operation). The company would provide for all services directly related to the dredging operation. Design, construction and management of the disposal area would be a City responsibility.

Option #3: The third option is for the City to contract with a dredging company to perform the entire dredging operation (including disposal pond) under an agreement based on the quantity of material to be dredged (contract operation).

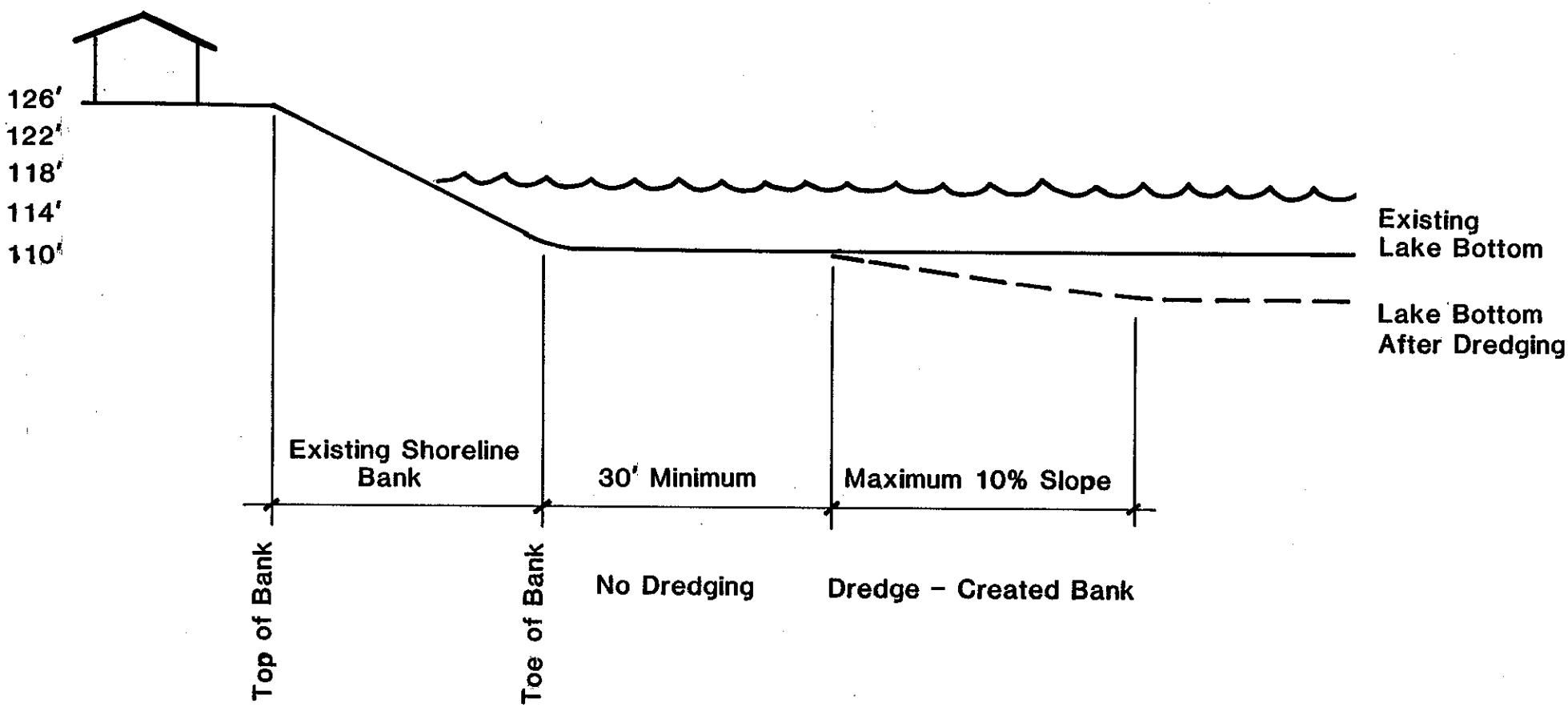



figure 10

# Schematic Standards for Dredging

Any of the above three operations will require some degree of City inspection and administration, and completion of a pre-dredge and post-dredge lake-bottom survey to assure satisfactory completion of work. A summary of unit (cubic yard) cost for each of these operational options is provided in the following section.

Cost

| | |
|---|---|
| Loan Operation:* (Option #1) | $1.60 per cubic yard + $17,000 move-in and move-out cost (assumes no rental cost for dredge) |
| Rental Operation:* (Option #2) | $2.80 per cubic yard + $30,000 move-in and move-out cost |
| Contract Operation: (Option #3) | $4.10 per cubic yard + $50,000 move-in and move-out cost |

*Cost for a loan or rental operation will be uncertain until the job is complete because both are on an hourly basis and would be contingent on the efficiency of the operation. Costs for these two types of operations will therefore increase if the operation is less efficient than assumed in the cost estimate. Thus there is no certainty that a required quantity of dredging will be completed within budget constraints.

Cost for the contract operation is on a cubic yard basis and can only change if more dredging is required. Thus once a contract is negotiated, the total cost for a required quantity of dredging is known.

EXCAVATION (B)

## Description of Method

An alternative to dredging would be to pump out the water in the proposed excavation area, allow the lake bottom to dry, then excavate with conventional equipment. This methodology requires a large, temporary pumping facility, construction of coffer-dams if the entire lake is not drained, a network of drainage channels on the bottom to convey groundwater inflow out of the lake area, and a water rights agreement with adjacent ranchers that pump water for agricultural use.

## Environmental Impacts

As compared to dredging, the impacts of this method would be relatively minor. On the short-term of course, while the lake bed was dry there would be adverse impacts to the water reliant habitats. These would be similar to those experienced during the drought of 1976 and 1977. As soon as the lake water was returned, recovery would be rapid. If the lake bed remained dry for more than one season, however, short-term impacts would increase significantly and recovery would be much slower.

## Goal Attainment and Procedure

This methodology is not considered feasible due to:

1. The long period of time and expense necessary to pump the lake dry.

2. The bottom sediments will probably not dry sufficiently in a reasonable time period to allow using heavy excavating equipment.

3. The time period necessary for pumping and drying will not leave a sufficient period of time for excavating before the next year's rains start.

4. As the clay bottom dries, the soils will shrink substantially, possibly resulting in local shoreline slippage.

This method may be feasible when and if another drought, such as that of 1976/1977, should cause the lake to dry up and groundwater levels to recede. If such a dry period lasted long enough, excavation could be feasible, depending on whether soils were adequately dried to sufficient depth.

INCREASED LAKE LEVEL (C)

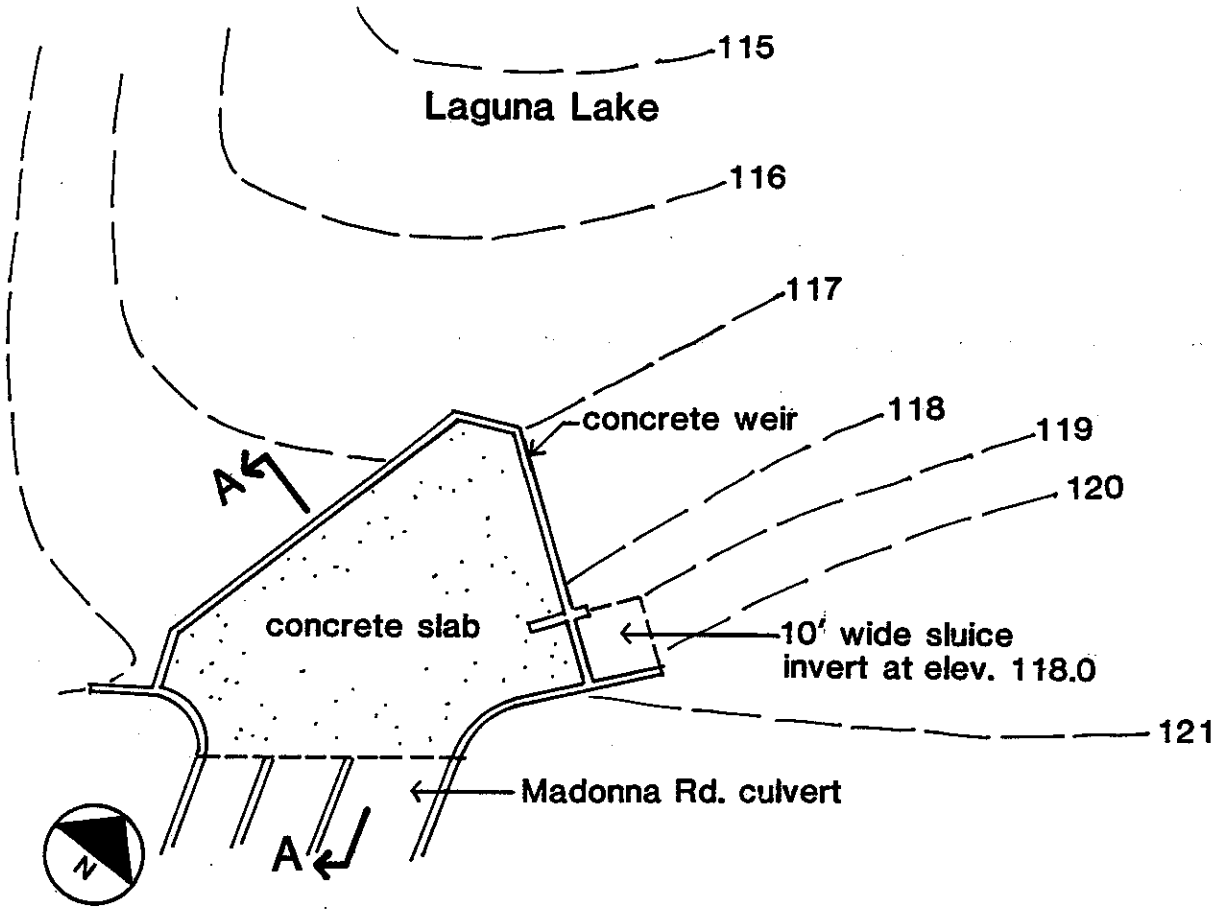
## Description of Method

This method entails the construction of a small reinforced concrete weir immediately up-stream of the Madonna Road culvert (see illustration on following page). The weir could be constructed to a flow line height of 120' MSL. A sluice gate would be provided to allow control of the normal high water level between elevation 118' and 120' MSL.

As a second stage of this operation, "stop logs" could be placed on the top of the weir so that the water level could be temporarily raised an additional two feet to 122' MSL. This second stage would be done in late February of each year. At that time, the major storm season is normally over, but weather conditions would have to be carefully monitored through April. Unless a 100-year storm were predicted during this period the stop logs could remain in place and minor storms and runoff would fill the lake to 122' MSL in preparation for the dry season. The stop logs would be removed gradually as the lake level dropped over the summer and fall and would be completely removed by early November in preparation for the next winter rain season.

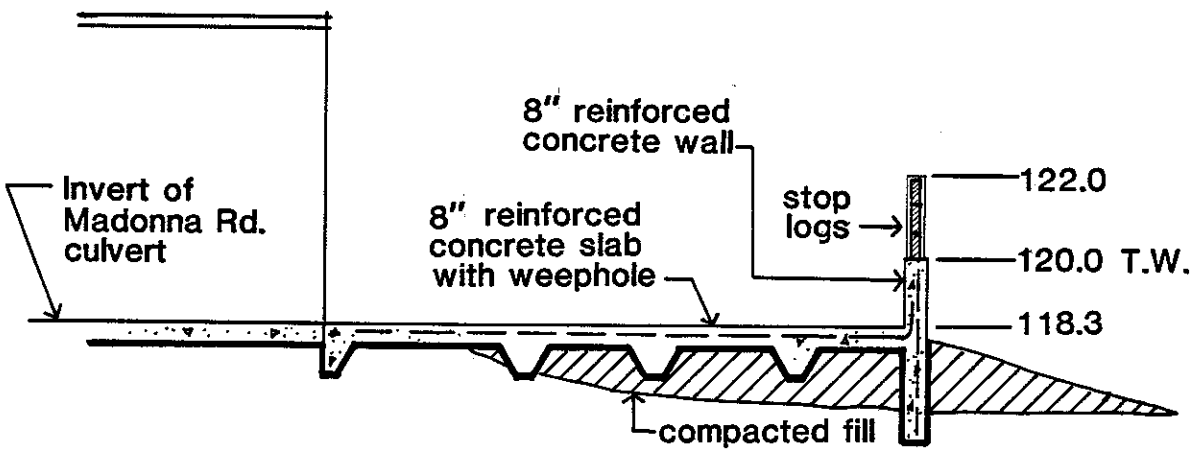
## Environmental Consequences

Impacts to the natural environment would generally be positive over the long term. Additional foraging, breeding and habitat area would be provided for fish life. There will be a temporary short-term loss of wildlife habitat, particularly breeding areas, until the marsh vegetation establishes itself at the new lake level. This loss would occur for about 2-3 years, but could be mitigated by gradually raising the eventual seasonal high water level, at about one foot per year (i.e.: in first year of operation, allow water to come up to 119' MSL, next year increase to 120' MSL, etc.). The timing of the temporary stop log emplacement is also critical; if it is emplaced after the start of the breeding season, it will flood out about 20-30 waterfowl nests. If this practice is continued, it would cause a long term loss in




schematic plan
1" ≈ 25'

## Concrete Weir




section A-A

figure
**11**

available breeding habitat. This effect can be mitigated by emplacing the stop logs no later than the last week of February. Since marsh vegetation will become established in a greater area than that lost through inundation, the long term consequence of this alternative would be increased wildlife habitat for marsh species.

The proposed increased water level would also flood the small perimeter portion of the Peninsula that is normally 1 to 2 feet above the 118' water level. Depending on the extent of immersion, this may eventually lead to the loss of the willow habitat on the peninsula and will cause a major decrease in the minimal public use of this area. This effect could be mitigated by adding 1 to 2 feet of soil on the existing elevated perimeter.

Impacts to cultural (man-made) resources would generally be as follows:

- Raising the seasonal high water elevation above 120' MSL will require that certain park facilities be modified including raising portions of the park access road, extending the boat launch ramp and reconstruction of floating piers.

- Approximately 50 acres at 120' MSL and 100 acres at 122' MSL which is presently grassland used for cattle grazing would be inundated with water. Much of this land is in private ownership on the west end of the lake.

- A seasonal high water level at 120' MSL in the Prefumo Inlet will cause debris to drop nearer to the upper end where it will be easier to excavate. Also, more silt sediment will drop out in the inlet, rather than the lake. When sediment removal is necessary, the lake level can be dropped to elevation 118' MSL by lowering the sluice gate. After a time the sediment in the upper end of the inlet will de-water and can be excavated to 118' or lower.

- Heavy aquatic weed growth could be expected in the Prefumo Inlet, similar to other flooded inlets in the lake, unless measures were taken to control it.

- Private boat docks on the southerly shore would need to be remodeled or reconstructed to accommodate the higher normal water levels.

- This method would impound an additional 400 acre-feet at 120' MSL and an additional 1,000 acre-feet at 122' MSL. Impacts on downstream water users could be considered significant. How significant and what mitigation measures would be required would have to be arrived at through the process of gaining approval from the State Water Resources Control Board, Division of Water Rights to impound additional water in the lake.

- A properly designed and located weir will not increase the 100 year storm flood level of the lake (elevation 126' MSL). The lake level may be increased to any elevation up to 120' MSL without increasing the flood hazard to shoreline property. In addition, this system has appreciable downstream flood reduction potential due to "spillage storage" and can reduce peak outflow rate if the sluice is kept open during the rainy season to elevation 118' MSL.

- Emplacement of the temporary stop logs to raise the lake level to 122' MSL in late February poses a low risk of flooding from a 100 year storm during March and April. With the stop logs in place at 122' MSL the 100 year flood level of the lake would increase from 126.0' MSL to 126.7' MSL . This risk could be minimized or even eliminated if the City monitored conditions with the Santa Maria weather station and removed the stop logs when a major storm were predicted. The probability of major storms that could create flooding with the stop logs in place during March and April is very low (based on monthly precipitation record for the last 25 years).

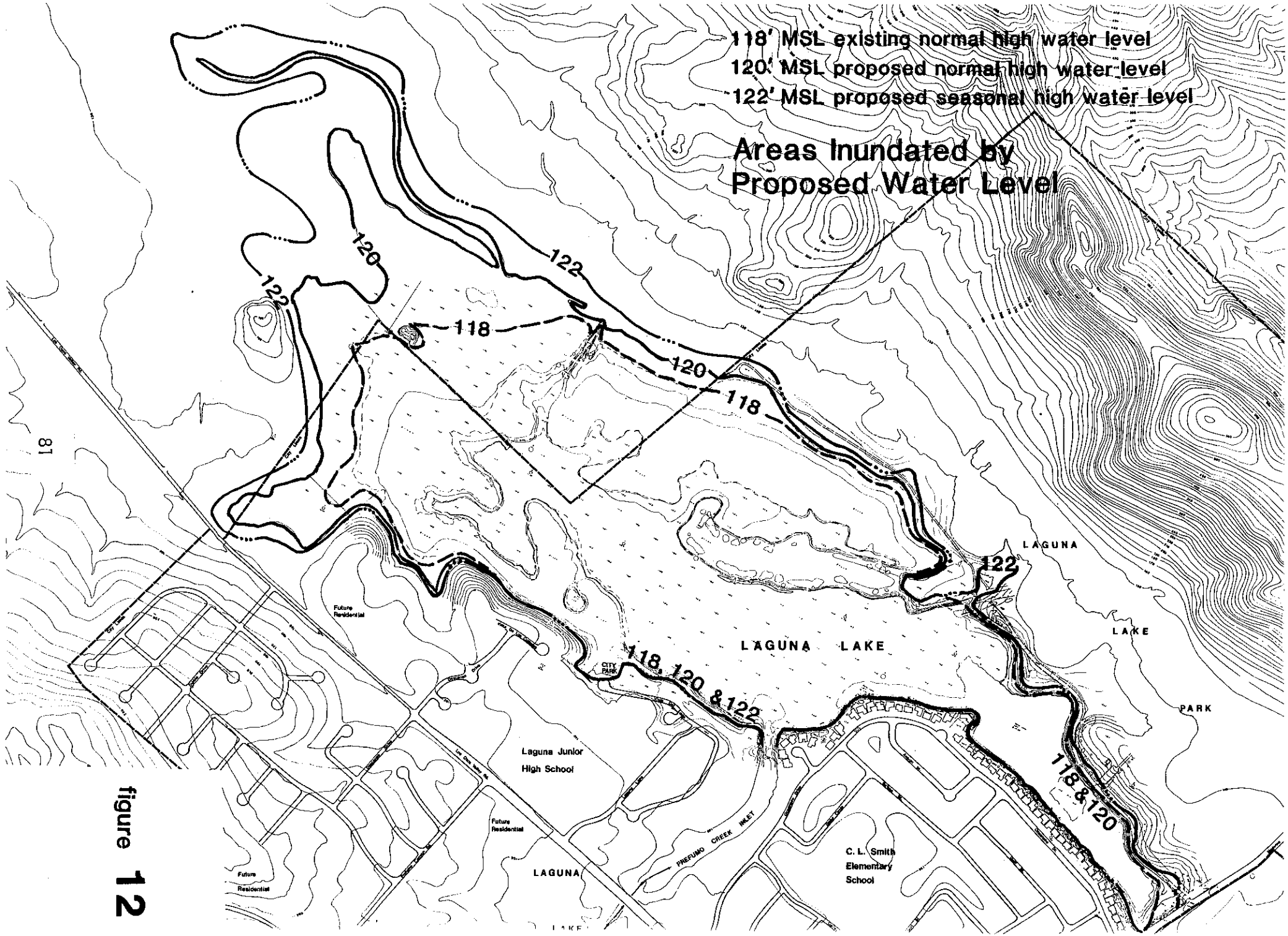

118' MSL existing normal high water level
120' MSL proposed normal high water level
122' MSL proposed seasonal high water level
Areas Inundated by Proposed Water Level
120
122
118
120
118
122
LAGUNA
LAKE
LAGUNA LAKE
118, 120 &122
118 &120
PARK
Future Residential
CITY PARK
Laguna Junior High School
Future Residential
Future Residential
LAGUNA
PREFUMO CREEK INLET
C. L. Smith Elementary School
LAKE

figure 12

- The convenience and value of the Peninsula for educational field trips would be lost during much of the year.

- The general stability of soils under residential pads probably would not be affected by a water rise to elevation 120'. However prior to proceeding with this management method a thorough soils section analysis should be conducted by a soils engineer.

## Goal Attainment

This method would provide an additional permanent two feet of water depth and temporary four feet of depth during the dry season. A two foot increase in the season high water level to elevation 120' MSL would provide adequate depth for recreation in all but the most severe drought seasons (such as 1976/1977). A four foot increase during summer months more than adequate depth in all but severe drought years.

Raising the seasonal high water level to 120' MSL will probably have some effect on inhibiting germination of new aquatic weed growth. However, this effect is not expected to be significant. The temporary seasonal raising of the water level to 122' during later spring through fall would have a sizable inhibitory effect on plant growth during the season when most new growth normally begins.

## Procedure

- Specifications and engineering design documents will be required as well as a soils analysis in the location specified for the dam.

- A permit to impound additional water must be obtained from the State Water Resources Control Board. Prior to approving a permit, the Board

requires that the applicant arrive at acceptable agreements with downstream owners of riparian rights.

- A permit must be approved to construct the weir under the the Corps of Engineers "Section 404" permit program.
- Agreements with landowners whose land or facilities would be inundated would also have to be reached. This could involve reconstruction land acquisition, easement acquisition or damages settlements. Research into deed restrictions and recorded tract maps indicates there are no entitlements which clearly give the City rights to inundate private property above the present normal high water elevation (118.0' MSL) of the lake.
- For elevations above 120' MSL certain park facilities identified above would have to be redesigned and reconstructed.

## Cost

The cost for weir design and construction would be $16,000. Prorated over a 20 year period the annual cost to the City would be $800.00. The above cost estimate covers only dam design and construction. Costs associated with agreements between the City and private landowners or riparian rights owners cannot be accurately estimated. Costs for reconstruction of park facilities are also difficult to estimate without more detailed information. However, for the purposes of this discussion, we will assume costs as follows:

| | |
|---|---|
| Pier inundation: | $3,000 each reconstruction |
| Park Road inundation: | $20/ft. realignment and paving |
| Launch Ramp inundation: | $16/ft. extension |
| Land inundation: | $500/acre |

Based on these assumptions, the total cost is $10,000 or $5,500 per year over a 20 year period for the weir at 120' MSL. To facilitate the additional stage of stop logs and seasonal lake elevation of 122' MSL the total cost would be $140,000 or $7,000 per year over a 20 year period.

EFFLUENT WATER SUPPLY (D)

## Description of Method

The City of San Luis Obispo has applied for federal grants to upgrade the City's water treatment plant to advanced secondary treatment capability. Such treated water could be reclaimed in part by diverting it to Laguna Lake for stabilization of the lake level during the summer months. Water treated at this level meets all standards set by the Regional Water Quality Control Board and public health departments for use in the lake.

The approximate supply available from the treatment plant would be 1.2 million gallons per day (Jenks and Harrison, January 1977), which is considered sufficient to maintain the lake level after daily evaporative and agricultural pumping losses. Three alternative discharge points are feasible, 1) at the far west end of the lake, 2) into Prefumo inlet, and 3) into the Peninsula Inlet.

A pipeline has already been installed in Laguna Lane from Vista del Lago to Laguna Lake. However, its future use should be to deliver water from the lake to the golf course for irrigation. It is located at a place which would not be desirable for discharge of effluent into the lake.

## Environmental Consequences

The advanced secondary treated water would be of high quality, suitable for human contact. However, the treated water would bring an additional supply of nutrients to the lake. In particular, allowable phosphate levels (1.8 mg/l per Regional Water Quality Control Board) would be over four times the current average lake levels (0.43 mg/l). As phosphate is generally the limiting factor to plant growth in freshwater systems, large algal blooms and extensive aquatic weed growth can be expected at the outlet structure(s). This growth can cause localized oxygen depletions during the night due to plant respiration. When the vegetation dies back in the fall, the resultant decomposition of the excessive growth can also cause oxygen

depletion. Both circumstances could cause fish kills and create odor and nuisance problems.

With the increased phosphate supply, nitrogen may become the limiting factor to continued plant growth in the lake. This would cause a switch from green algae species in the phytoplankton to the nitrogen-fixing blue-green algaes. Since blue-green algaes are less desirable food sources, accelerated growth of these species to the detriment of other algaes would result in an overall decrease in species composition and a less stablized lake ecosystem. In addition, several blue-green algaes cause odor problems (though with the strong winds in this vicinity, this is not likely to be a major problem) and some are toxic enough to kill fish and other aquatic animals.

Another potential effect of the increased nutrient supply is an increase in pestiferous midge populations. The abundance of these small insects has been closely related to the abundance of sago pondweed and phytoplankton (Appendix B); as plant populations are increased by the additional nutrients, so would these insect populations. In large numbers, these insects can become a major nuisance to near-by residences.

The environmental effect of increased nutrient supply can be mitigated by locating the outfall such that desirable species utilize the inflowing nutrients and potential problems are isolated from the main portion of the lake. Three alternative outfall locations would serve this function: placing the outfall at the west end of the marsh will filter the nutrients back through the thick rush and smartweed growth first; flow from an outfall in Prefumo Inlet will be filtered through willows and marsh vegetation, and an outfall to the Peninsula Inlet would similarly be filtered through marsh vegetation.

There are potential problems that can occur at each alternative outfall location and the choice of any particular one involves a certain amount of risk that a major environmental impact will occur at that location. Effluent flowing through the Prefumo Inlet may result in overgrowth in riparian vegetation that would cause difficulty in the periodic removal of the accumulated sediment, could decrease the channel's flood water capacity,

and put a potential high density midge population near residences. If the outfall is located in the Peninsula Inlet, environmental impacts such as oxygen depletion would occur in the area of greatest ecological value. Problems associated with a west end outfall location include overgrowth of marsh vegetation that could decrease the amount of fish breeding habitat and sheltered areas.

The problems associated with the effluent inflow and its location can be dealt with by a maintenance program. The program would consist of some form of plant removal, either of riparian vegetation or waterweeds, mechanical aeration of the effluent at the outfall, and monitoring of the receiving waters. A semi-yearly monitoring program is required by the Regional Water Quality Control Board if treated water is diverted to the lake (Appendix I). In addition, the same tests should be done on a semi-monthly basis for the first two years of effluent discharge at two test locations, one in the Central Lake area and one about 400 feet downstream of the outfall. The monitoring program will be necessary to determine if any unexpected long term adverse changes are occurring to the lake. If such changes occur, the monitoring program would provide the data necessary to determine additional mitigation measures. Such additional measures could include chemical removal of phosphate before the effluent is discharged to the lake, monitoring of blue-green algaes and chemical treatment of same before they reach problematic proportions, and manipulation of pH and carbon dioxide concentration at the outlet structure to reduce the potential for blue-green algal dominance. However, it should be noted that additional removal of phosphate from the effluent waters at the sewage treatment plant was deemed too expensive and technically unfeasible during the design of the advanced secondary structures for the treatment plant. In addition, there is a slight chance that no mitigation measures will be adequate enough to allow effluent discharge to the lake without significant problems and in this case, the discharge would have to be stopped.

Another alternative and/or mitigation measure is available if the discharge outlet is located at the west end of the lake or at the Peninsula Inlet. At these locations, it would be possible to divert the discharge waters to

upland slopes that are now grazing lands and develop a transitional marsh (part wetland vegetation, part grassland vegetation). These new wetlands could remove up to 77% of the nutrient load in the water, but would also decrease the potential water supply to the lake. The most significant effect of this alternative is that there might not be enough water to stabilize the lake level and the lake would still decrease in depth albeit slower that it does now. The new transitional marshlands could still be used for grazing.

Beneficial effects of the reclaimed water include a stablized lake level that would preclude the need for dredging, better and more efficient use of water within the City regional area, and overall cleaner lake water during the summer. Site specific beneficial effects would be the enhancement of riparian and freshwater stream habitats in Prefumo Inlet (though this can become a detriment if the growth is not controlled), or an increase in marsh bird nesting habitat at the west end, or possibly better water circulation in the Peninsula Inlet, which would reduce potential adverse effects caused by low circulation during calm weather.

## Goal Attainment

At present, the possibility of the City obtaining funding from the federal government (75% of improvement costs), is unknown. While the State Water Quality Control Board has required that the City's sewage treatment plant provide a high secondary level of sewage treatment, the United States Environmental Protection Agency (EPA) is not so sure that this level of treatment is important enough to justify the costs involved. The EPA has thus delayed funding of the project to study it further.

Notwithstanding the above circumstances, recharge of evaporative and irrigation water losses from Laguna Lake would be the best long term means of providing a consistent water depth suitable for boating and other water recreation.

It is unlikely, however that this method will provide any control on water vegetative growth. In fact it is probable that it would increase algal and water weed growth in the lake. Long-term, effective means of controlling vegetation in the lake must accompany this methodology.

In addition to the five goals described in the previous section, a sixth goal of water recycling and conservation would be attained through this method.

## Procedure

The basic procedures of this method are described in the "Wastewater Treatment, Disposal and Reclamation Facilities Project Report" for the City of San Luis Obispo, January 1977, by Jenks and Harrison, Consulting Sanitary and Civil Engineers.

In addition to the above procedures the City will probably have to obtain a permit from the County Health Department if water contact recreation is permitted in the lake.

## Cost

This cost estimate assumes that recharging Laguna Lake with treated effluent will not be a viable alternative unless EPA approves grant funding for advanced secondary treatment facilities. In this event, the City's share of the costs for pumps and force mains to carry water to Laguna Lake and to the park and golf course for irrigation purposes will be 12.5% of a toal cost of $917,000 (Jenks and Harrison, 1977 cost estimate of $655,000 increased by 40% for 1980 cost equivalent). The portion of this cost which can be attributed to Laguna Lake requirements is 1/3, as park and golf course irrigation would also share the cost. Thus the total cost for Laguna Lake effluent recharge is approximately $38,208 or $1910 per year over a 20 year period.

IRRIGATION CONTROL (E)

## Description of Method

Irrigation accounts for approximately 22 percent of the seasonal water loss from the lake (78% caused by evaporation). The methodology described here is directed toward somehow reducing this loss. There are two alternatives: 1) negotiated water rights limitations; or 2) physical limitations. The first would entail negotiating an agreement with the irrigator to cause him to reduce the amount of water he pumps from the lake. The most likely process would be through some form of adjudication, as this is generally the way that issues of water rights are resolved.

The second would involve some physical barrier which would restrict the amount of water that could be drawn from the City-owned portion of Laguna Lake. This second option would, most likely, result in the same type of legal proceedings described by the first option, but brought by the irrigator.

## Environmental Impacts

The impacts are relatively easy to describe: Positive for the natural system of the lake and cultural resources such as recreation; negative for the rancher if some limits were placed on his irrigation rights.

## Goal Attainment and Procedure

This method would not likely result in any significant degree of maintaining adequate water depth in the lake. Firstly, irrigation accounts for only 22 percent of the total water lost each season. Secondly, and more importantly, it is unlikely that the City could be successful in attempting to limit the water rights of the adjacent land owner who is currently irrigating pasture with lake water.

All owners of lands which lie along the shore of Laguna Lake or along tributary streams have littoral or riparian rights to the water. This means that all owners share an undivided interest in the entire water body of Laguna Lake. There are two ranch owners, the City and numerous homeowners (on the south shore of the lake) who share the littoral rights to Laguna Lake. As long as each does not interfere with the others' rights to the water, no control or division of water is exercised. If one owner or a group contends that other owners' use of the water is interferring with their use, then some division of rights could be arrived at through adjudication.

In the case of the first option, the City could assert that irrigation pumping from the lake lowers the lake level by 8 to 10 inches and thus interferes with recreational use and wildlife habitat. In the second option, the irrigator could assert that physical limitations on the lake water he is able to pump is an illegal division of his interest in the water of Laguna Lake. In either case, it would be difficult to show that irrigation pumping was a key cause of interference with recreational or wildlife habitat requirements, since evaporation accounts for 78 percent of the total water lost. Notwithstanding the above, if this issue were adjudicated, it is likely that, under current precedents of California law, the agricultural use would be favored over recreational use of the water in establishing a division of water rights.

Due to the great likelihood that this method would not achieve the goal intended, it should not be considered further.

MECHANICAL WEED HARVESTING (F)

## Description of Method

At several lakes in Southern California, the lake weed problem is controlled by mowing and removing the cut material. Boats equipped for this purpose are distributed by Aquamarine Corporation of Waukesha, Wisconsin. Big Bear Lake and Spring Valley Lake both use the large "harvester" which cuts to a depth of up to 5 feet and which can operate in water as shallow as about 18 inches. A smaller unit, the "chub," is also available at less cost, and may be adequate to handle the weed problem at Laguna Lake. It can also cut to a depth of 5 feet, and can operate in water as shallow as about 12 inches. Two men are required to operate either machine: one to run the boat, and a second to move the cut weeds into the storage bin (Chub - 1,500 lbs. capacity; Harvester - 10,000 lbs. capacity) near the rear of the boat.

When the boat is full, it proceeds to the shore and the weed material is manually or mechanically transferred to a truck on shore. A conveyor assembly is available with the "harvester."

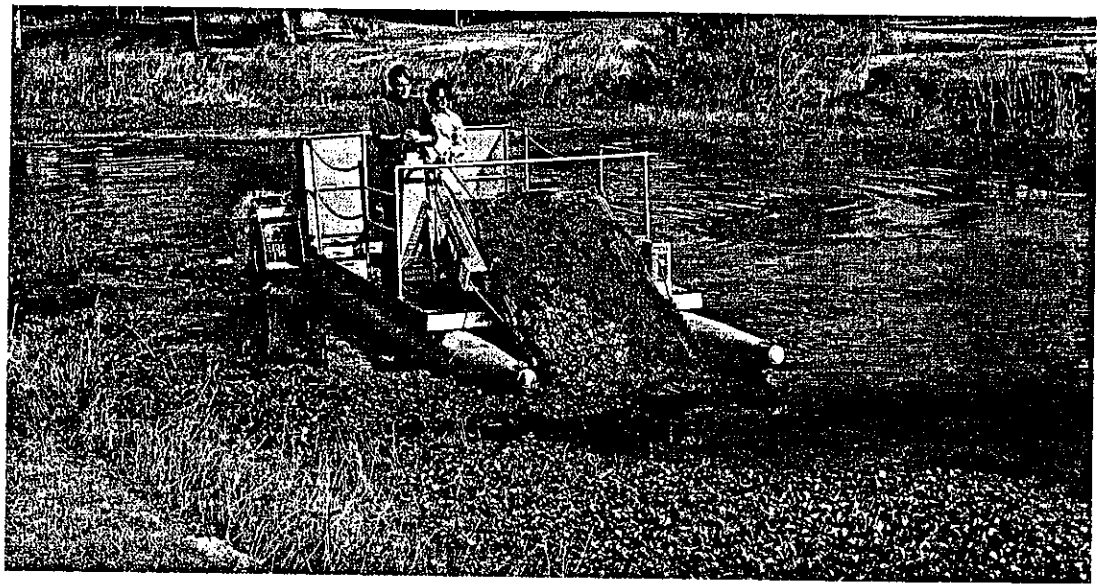
## Environmental Consequences

Weed harvesting has several advantages over other methods of weed control. The primary advantage is that the cut material is removed rather than dying, as with chemical controls, so that there is no build up of rotting material in the lake itself, and unwanted nutrients are removed. Also, there is no build-up of chemicals in the lake water and bottom sediments. The cut material can be used as a mulch, and has been used to retard erosion on the ski slopes at Big Bear. It is also highly nutritious and can be used as animal feed.

Weed removal will have some adverse effects on the biotic community of the lake. In particular, it removes the shelter, food source, and attachment substrate for various invertebrates and vertebrates; however, studies indicate that the aquatic weed growth is so abundant, that it is not a strong limiting factor to invertebrate abundance (Stimac and Leong, August 1977). In this respect, the relatively limited amount of aquatic weeds

# CHUB

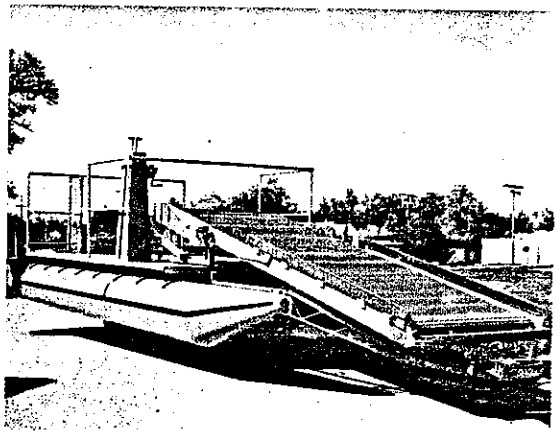
AQUAMARINE



AQUAMARINE's **CHUB — Cutter Harvester Utility Boat** — is the aquatic weed harvester designed to fit even the most conservative budget. As with any good work boat, you use the **CHUB** when you want to. You are completely in control of the situation with your **CHUB.**

The **CHUB** is simply constructed and maintained. There is nothing complicated about the simple V-belt and chain drives. The cutter depth is controlled by a single hand winch. The operator can maneuver the **CHUB** "on a dime" with two levers controlling the patented **Zero-Turn-Radius** transmission, which drives the two aluminum paddle wheels in six inches of water. Operator visibility is unrestricted and all of the controls are designed for easy operation.

Safety is a prime concern in the **CHUB** design, evidenced by the high aluminum handrails and non-skid deck. As a further and important safety feature, the cutter bars and the conveyor stop automatically and **instantly** when the operator's foot leaves the specially-designed clutch pedal.



With the versatile **CHUB** trailer, the **CHUB** can be moved hundreds of miles with ease and any boat ramp allows you to start your next harvest within minutes! A **CHUB** shore conveyor is also available for direct loading of a truck.

# CHUB SPECIFICATIONS



## Operator Console

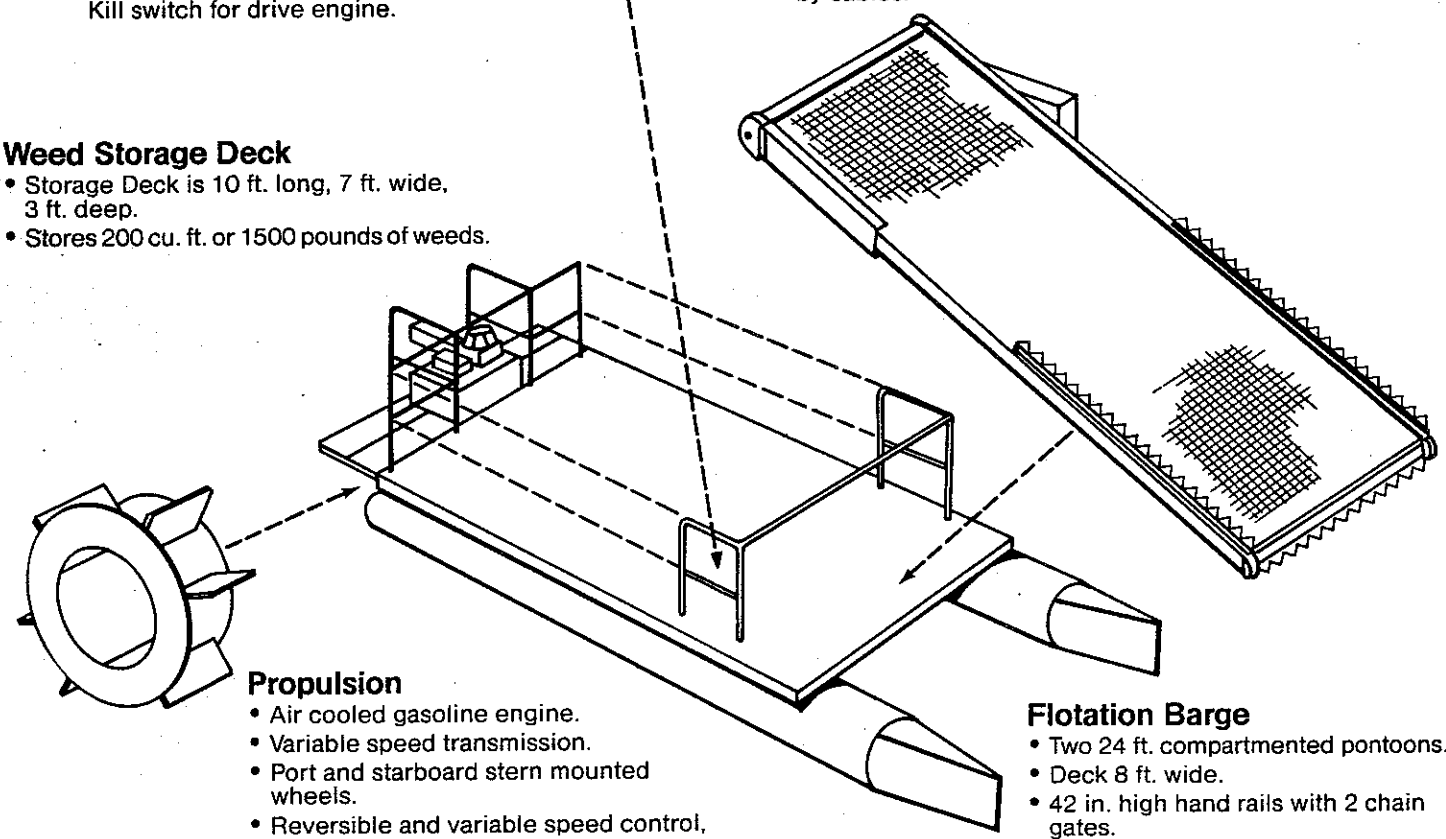
- Console mounted on forward starboard side.
- Controls: Paddle wheels—2 levers, forward, neutral, reverse.
  Cutters and conveyor—left foot clutch pedal must be depressed to operate.
  Left side console—self-locking winch for raising and lowering cutters and conveyor.
  Kill switch for drive engine.

## Cutters and Conveyor

- Two 7 ft. side cutters, one 4 foot. horizontal cutter.
- Conveyor belt 4 ft. wide, 1 x 1 in. flat wire mesh.
- Conveyor driven thru 9 sprockets with 3 in. take-up for belt adjustment.
- Conveyor bed constructed of aluminum and nylatron wear strips.
- Conveyor can be raised to horizontal position or lowered to depth of 5 ft.
- Conveyor raised and lowered by winch.
- Power to the conveyor and cutters is transmitted by a vee belt through a clutch on the main drive shaft.
- Eccentrics on the ends of the main drive shaft power the side cutters which connect to the horizontal cutter by cables.

## Weed Storage Deck

- Storage Deck is 10 ft. long, 7 ft. wide, 3 ft. deep.
- Stores 200 cu. ft. or 1500 pounds of weeds.



## Propulsion

- Air cooled gasoline engine.
- Variable speed transmission.
- Port and starboard stern mounted wheels.
- Reversible and variable speed control, 0-55 RPM.

## Flotation Barge

- Two 24 ft. compartmented pontoons.
- Deck 8 ft. wide.
- 42 in. high hand rails with 2 chain gates.
- Draws 7 in. of water empty, 12 in. full.
- Steel surfaces sandblasted and coated with 8 to 10 mils of epoxy.

**Overall Dimensions:** 31 ft. long, 5 ft. 6 in. high, 10 ft. 10 in. wide, 8 ft. wide with paddle wheels removed.

**Weight:** 1500 lbs.

**Transportation:** Aquamarine CHUB Trailer Model T-110 launches, loads and transports CHUB.

**EACH UNIT INCLUDES:**

- **Parts, Operation, Launch and Maintenance Manuals.**
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removed as compared to the amount preserved in the marsh areas would not be expected to substantially reduce the abundance of animal populations in the lake. The removal of the weeds may also make open water portions of the lake more attractive to waterfowl that require open areas for security.

If effluent water is introduced into the lake, it will probably contain high levels of nitrogen and phosphorus (current limits are set at 4.0 mg/l, 80 kg/day, ammonia + ammonium and 1.8 mg/l, 36 kg/day, of phosphorus; Central California Regional Water Quality Control Board, Order no. 80-04, 13 February 1980). These nutrients will be used by macrophytes, algae, and phytoplankton for continued growth. Harvesting of macrophytes and algal mats will help remove nutrients from the lake system, and also make incoming nutrients more available for phytoplankton growth. As phytoplankton is at the bottom of the food chain for fish in the lake, the net result would be an increase in available fish forge. However, a secondary effect may be that phytoplankton growth would be great enough to cause a green tinge to the lake waters. This may be considered a negative aesthetic effect but would also be a positive impact because light penetration, and thus pond weed growth, would be reduced.

## Goal Attainment

Mechanical weed harvesting will completely remove weed growth in the lake wherever it is used. It is 100% effective without any significant adverse side effects.

To be most effective weeds should be harvested during the fall season. The harvesting machinery has a maximum effective depth of five feet. The lake water level is lowest in late fall so harvesting at that time would have the greatest effectiveness. In addition it is during this season that weeds begin dying and harvesting of the dead or dying material would remove a source of ammonia in the water. Weed harvesting would create a suitable boating environment with current lake depth conditions in any normal-rainfall year. It would also maintain the open-water wildlife habitat that the lake has afforded since modifications to it in the early 1960's.

## Procedure

No permits are required for weed harvesting.

There is no known company which rents harvesting equipment or which contracts for lake weed harvesting jobs. The only known option available would be for the City to purchase the harvesting machinery and allocate sufficient manpower and shore equipment to conduct the weed harvesting.

It is estimated that to harvest the present relatively high level of weed growth in the lake could take six months. To control weed growth thereafter would not take more than two months every three or four years.

In the periods of non-use the City could probably rent the machinery to other lake owners, though the demand is unknown at this time. The "chub" is extremely light in weight (1,500 lbs.) and is easily transportable on a small trailer.

## Cost

The large "harvester," used at Big Bear and Spring Valley Lakes, costs $79,000, including the shore conveyor. However, the "chub," which should be adequate for the needs of Laguna Lake costs $15,150.00 (F.O.B. Wisconsin) with its trailer.

Amortized over 20 years and including labor, maintenance and additional supporting equipment costs, it is estimated that the annual cost of mechanical harvesting could be approximately $4,500.00.

If rental of the equipment became feasible this would offset this cost to some degree. If California Conservation Corps personnel could be contracted to operate the harvesting program this would remove labor costs and the annual cost would drop to $1,500.

MANUAL WEED HARVESTING (G)

## Description of Method

Weed harvesting can be conducted by dragging a "cutting bar" through the water behind a boat. The weeds float to the surface and can be scooped up, loaded into the boat and transported to shore. Labor could be provided by the California Conservation Corps (CCC) under contract with the City or through one of the employment opportunity programs sponsored by the State or federal government.

## Environmental Consequences

The environmental impacts would be the same as for mechanical weed harvesting.

## Goal Attainment

The effectiveness of manual weed harvesting probably would be somewhat lower than the mechanical method because the chance of misses is greater. Otherwise the goal of creating and maintaining clear waters for boating and wildlife would be well achieved.

## Procedure

An efficient "cutting bar" would have to be designed and fashioned by City personnel. Some type of motorized water craft, ideally a small, light barge would have to be fabricated or purchased. Labor would have to be contracted.

The greatest disadvantage to this method is the probable length of time required to complete the initial clearing of lake weed growth. No accurate time estimate can be made, but it is unlikely that it could take less than two seasons to accomplish the task.

## Cost

If the CCC personnel could be used there would be no labor costs. Equipment could be purchased or fabricated for less than $2,000.00. Including shore-support equipment the total annual cost (over a 20 year period) for initial clearing and subsequent annual maintenance would be in the range of $300 to $3,000 (the higher cost includes labor costs at low wage rates).

CHEMICAL WEED CONTROL (H)

## Description of Method

The removal of undesired smartweed and algal mats can be accomplished with the use of toxic chemicals, like copper sulphate, or herbicides. An effective means of using copper sulphate is to spread large cyrstals evenly by hand over the water within major infestation zones while the water is still. Application rates vary with density of growth, but 80 pounds will control about 0.5 acres of growth, if it is not too thick. If the infestation is thick, copper sulphate is not very effective as a control. Herbicides that can be used to control major or thick growths after they occur are highly toxic, particularly to fish (examples: Weedtrine or Paraquat) and are not recommended for use in Laguna Lake.

Pre-emergent herbicides may be used to control aquatic weed growth after its initial removal by some other means. These kinds of chemicals work to inhibit the germination of new water weed. The use of Casoron G-10 at 100 to 150 pounds per acre would control potential outbreaks before they occur when the herbicide is used in areas with historical annual weed infestations

## Environmental Consequences

As the aquatic weeds die off, they return substantial amounts of nutrients to the lake waters, which are then used for growth by other plants. In addition, the decomposition of the drying plants lowers the amount of dissolved oxygen available in the treated area. The low supply of oxygen and, as in the case of copper sulphate, the toxicity of the chemicals can lead to fish kills and result in odor problems. Pre-emergents work before substantial growth occurs, so that there is far less decomposition; however, the vegetation needs to be removed first. After vegetation is removed, there may not be a need to treat an area with pre-emergent herbicides as there has been no history of chronic annual weed infestations at Laguna Lake, and future aquatic weed growths may be controlled by other, natural means (low light transparency, high water turbulence, etc.).

Chemicals will accumulate in the bottom sediments of the lake. The long term consequences of this will be the probable loss of bottom organisms that live in the sediments, and a general decrease in the food supply for bottom-feeding fish. Also, copper sulphate would inhibit the action of decomposing bacteria, which would cause an accumulation of organic debris that is anoxic, creating odor problems and low levels of dissolved oxygen in the treated areas.

## Goal Attainment

In certain areas of the lake, where weed growth is relatively dense, chemical treatment probably would not be effective. Side effects to the lake environment and water quality would probably be acceptable so long as chemical use was carefully controlled and a monitoring program conducted simultaneously. The use of pre-emergent herbicides should be considered only after initial weed removal and if chronic weed infestations occur.

## Procedure

No permits are required, although an agreement with the Department of Fish and Game would have to be reached.

## Cost

The application of copper sulphate would be needed two to three times per year, depending on the growth of the aquatic weeds. If the weeds are sufficiently killed back in the first year, as might be the case at Laguna Lake, re-application in deeper waters may not be necesary for three to four years. Pre-emergents need to be applied once a year, but with accumulation in the bottom sediment, less is needed each year. Estimated costs for chemicals per year would range between $5,000 and $10,000 for those years in which it is used (Costs based on $85 per treatment per acre at Big Bear Lake and an outlay of $11,300 at Westlake in 1976).

Estimated cost over a 20 year period is $2,000.00 to $4,000.00 annually.

BIOLOGICAL MANIPULATION (I)

## Description of Method

This alternative concerns the reduction of pondweed growth on a lake-wide basis and the long term stabilization of the lake ecosystem through the manipulation of physical parameters. In the context of aquatic weed growth, it involves the introduction of large herbivorous fish species, such as channel catfish, to control smartweed growth along the shoreline and through the marsh areas. Manipulation of the physical parameters of the lake can be used to control outbreaks of blue-green algae, reduce nutrient levels, increase oxygen levels in deficient areas, and increase the fish food supply. Blue-green algae can be controlled through increasing the supply of carbon dioxide in waters and subsequent lowering of pH levels, such that the competition balance is switched to be more favorable to green algal species. Nutrient levels can be reduced by the use of alum (aluminum sulphate), which combines with the nutrients and forms an insoluble precipitate that sediments on the bottom of the lake. Oxygen levels can be increased through the use of aeration systems run by low horsepower air pumps. The fish food supply can be increased by balancing the physical parameters such that the major zooplankton species that provide forage for young fish are prevalent.

## Environmental Consequences

The introduction of a new fish into the lake may cause an overall shift in the current species balance, potentially against the more favored angling fish. Large herbivorous fish tend to stir up bottom sediments during their feeding, which generally increases the turbidity of the bottom lake waters. As trout prefer cleaner waters, this introduction would result in a lower carrying capacity for trout in the lake than already exists because of the high water temperature and generally turbid conditions. In addition, the herbivorous fish are not selective in their feeding, preferring to forage where plants are at the highest density. This could result in a long term decrease in important marsh vegetation that serves as shelter for smaller fish species. Without these sheltered areas, the smaller fish would be

substantially reduced, decreasing food supply for larger predaceous game fish and increasing the likelihood of certain invertebrate and zooplankton species dominating lake habitats. In addition, there is no guarantee that aquatic weed growth in areas currently perceived as a problem would be adequately controlled by the new fish. In order to provide definitive answers, this methodology requires extensive knowledge of the interworkings of the lake ecosystem, and such knowledge is generally lacking and sometimes unattainable.

Manipulation of carbon dioxide or other parameters to control blue-green algae is most effective if a continuous monitoring system is used so that the shift in species abundance is noted at the earliest possible time. If the blue-green algaes are allowed to become predominant, control methods will act too slowly to prevent most of the immediate adverse effects of blue-green algal dominance, including lowered fish food supply, and formation of toxic substances.

The application of aluminum sulphate is only effective for a long term if the inflowing supply of nutrients is controlled. At Laguna Lake, the nutrient supply comes from virtually all portions of the lake, and would be increased if effluent water is used. Because of the wide-spread sources of nutrient inputs to the lake, specific control measures cannot be implemented at any one point. Therefore, without control over the nutrient inputs, the application of alum would be effective for only two to three years.

Oxygen levels within the lake sometimes fall below the beneficial criteria of 5.0 ppm, particularly at the bottom of the lake during calm mornings. However, the constant wind pattern generally adequately oxygenates the lake daily and aeration would only be necessary for those rare times that have several consecutive windless days. On these occasions, oxygen levels may drop appreciably, but the biotic community of the lake can generally survive these rare times without major population losses, as long as oxygen levels do not drop below 1.0 ppm. In those severe cases where oxygen is

essentially totally depleted, it is unlikely that sufficient aeration could be achieved without the use of uneconomically large pumps.

## Goal Attainment

Information available to date indicates that the lake is well balanced as long as steady winds occur at the site. Therefore, there currently exists no reason to manipulate basic physical parameters except in response to potential detrimental impacts due to the actions of other alternatives chosen in the lake management plan.

The further consideration and planning for introduction of herbivorous fish to control macrophytes (pond weed) would require much more knowledge of the lake ecology than is available now.

## Procedures and Costs

Procedures and costs for manipulating basic physical lake parameters in response to effects from other alternative actions in this management plan should be considered after selection, from the alternative programs in Section V, of a preferred program(s) for lake management.

PREFUMO INLET SEDIMENT BASIN (J)

The Prefumo Creek watershed has historically produced high quantities of sediment. Before the early 1960's, the sediment dropped out of runoff waters as it flowed through a relatively long, low-slope stretch of creek channel after leaving the steeper grades of Prefumo Canyon. The creek did not, at that time, empty into Laguna Lake. The alignment of Prefumo Creek was altered in the early 1960's so that it would empty into Laguna Lake. What we now call the Prefumo Inlet was created by earth moving machinery and the Prefumo Creek channel was altered to empty into it. This shortened the length of Prefumo Creek across flat land area by about 3,500 feet and created a condition which has caused heavy sediment deposits to accumulate in the Prefumo Inlet. Knowingly or unknowingly, the developers and designers of the inlet created a sediment retention basin which has done a fair job of preventing heavy sedimentation of Laguna Lake for the last sixteen years. Only when the retention capacity of the inlet has been exceeded has there been any significant transport of sediment material into Laguna Lake. This problem began in 1969 and became significant in 1973 and 1980. Runoff from the major storms of 1969 brought large quantities of sediment into the inlet. Its sediment retention capacity was completely filled. However, there was probably little, if any, appreciable deposit in the lake because the inlet still maintained adequate capacity through most of that storm season. Then in 1973, the retention capacity of the inlet having been filled in earlier years, runoff from major storms (some of which exceeded 100 year intensity in the Irish Hills watershed) pushed large quantities of sediment into the lake, forming the precursor of the delta we see today. That original delta was only about two to three feet deep and contained approximately 2,500 cubic yards of sandy silt and silty sand sediment. In 1977 a large quantity of sediment (15,000 to 20,000 cubic yards) was removed from the upper half of the inlet. In 1978, large storms again generated high runoff, but much of the accompanying sediment was trapped in the upper half of the inlet, its capacity having been improved by the 1977

excavation. Then in 1980 large storms brought heavy sedimentation again. The upper half of the inlet had already filled to capacity in 1978. The result was a large growth of the delta. It grew by almost three feet in depth and now contains between 4,000 and 5,000 cubic yards of sediment.

Out of the total sediment volume in the delta, about 30 percent is composed of sand, the deposit of which is directly attributable to inadequate retnetion capacity in the upper end of the inlet. However, about 70% is silt and clay which will settle out slowly only in relatively still water. Thus, about 3,000 to 3,500 cubic yards of the delta has been created by material that will not settle out within the inlet under present lake level conditions (see method H) unless the entire inlet is excavated to a relatively constant grade from the Los Osos Valley Road culvert invert (elevation 120' MSL) to the general lake bottom elevation of 111' MSL.

The historical accounting described above cannot be shown as absolutely true with statistical accuracy, because little monitoring of the inlet has been done over the last 16 years. However, by piecing together the relatively little information that is available it is clear that the account above is reasonably accurate.

Prefumo Inlet has historically acted as a sediment retention basin. It has been successful in stopping the transport of sand and gravel sediment to Laguna Lake when it was not filled to capacity with sediment. Over the last 16 years it has filled up with sediment and lost all of its silt retention capacity and most of its sand and gravel retention capacity. The City, County and private contractors have intermittently removed some relatively small amounts of material, temporarily restoring some of the channel's retention capacity for short periods of time. However, this has not been enough to keep the

delta in the Central Lake area from growing dramatically in some years. Sediment will continue to flow into the Prefumo Inlet for virtually the City's lifetime. It must be retained in the inlet or the delta will eventually fill the Central Lake area, reducing or eliminating recreational boating opportunities and altering the lake's present ecology.

## Description of Method

There are two levels of sediment control to be considered. The first involves only controlling sandy and gravel sediments. The second, and most comprehensive, involves controlling silts as well as sands and gravels.

Level #1: The inlet's sandy sediment retention capacity seems to be exceeded when sediment in its upper half builds to elevations above 120' MSL. To maintain its function as a sand and gravel trap, sediment should be removed before reaching elevation 120' MSL. When sediment is removed, it should be excavated to the water table by heavy earthmoving equipment. The ideal time to do this is in late summer when the lake reaches lower surface levels. This option would require the excavation of 20,000 to 30,000 c.y. of sand and gravel every 4 to 5 years.

To control the delta as a part of this option would require dredging about 5,000 c.y. of silt material from the Prefumo Inlet mouth of the Central Lake area every 20 years (250 c.y. per year, average).

Level #2: To create the maximum silt sediment retention capability will require that the entire inlet be excavated and dredged to the flow line, depth and width characteristics originally created. Initially this will involve both dredging and excavation. Willows

and other vegetation in the north end of the channel will have to be removed as part of a dredging operation (see Method A). It is estimated that there is presently approximately 70,000 cubic yards of sand and silt material lying below the expected water table elevation of 117 to 118' MSL which would have to be dredged. Another 20,000 cubic yards of material on top would have to be excavated by heavy earthmoving equipment. This option would also involve removing an average of 6,500 to 8,500 cubic yards of material per year to maintain the required channel design characteristics. This maintenance operation would require dredging every 5 years.

## Environmental Consequences

Excavation of sand and gravel sediment material will have no long-term adverse environmental consequences. Short term impacts will be noise, dust and minor traffic conflicts while heavy machinery (loaders, bulldozer, etc.) is operating in the inlet channel and transporting the excavated sediment material to suitable disposal sites. So long as controls are placed on excavation such that willow thickets along the inlet channel banks are not removed, and such that a primary fish migration channel is maintained, there will be little impact to natural environmental resources.

Some potentially severe impacts could be generated if disposal sites for the excavated material are not suitable or if disposal activities (i.e. compaction, revegetation, etc.) are not conducted properly. Reasonable site selection and disposal operation specifications and standards can mitigate these potential impacts. The option of not excavating and relocating sediment material is, of course, open. However, environmental impacts to the lake, in this case, would be extreme in the long run.

The relatively heavy dredging operation required to recreate and maintain the inlet as described in level 2 could cause noise problems for residents on each side of the inlet. Maintenance will require that approximately 4 months of dredging be conducted at five year intervals to return the inlet to its optimum design characteristics. Additionally, a minimum of about 6 acres of nearby land must be found for a dredge disposal pond, probably in Laguna Lake Park, every five years. Eventually, land area in Laguna Lake Park which is available for dredge disposal (i.e. not in prime recreation areas) will be used up. The only feasible solution will be to remove dewatered dredge materials from old disposal sites to make room for new dredge material. The dewatered material will have to be excavated and transported to disposal sites outside the park (some material may be used in the park, but this will not likely be a substantial amount). The removal of this material must be considered an integral part of this methodology to avoid significant impacts to recreation in Laguna Lake Park.

Other environmental consequences and parameters for dredge disposal are discussed in the Section on "Dredging" (method A).

## Goal Attainment

The implementation of level 2 above, will probably eliminate the major source of sedimentation of Laguna Lake. Other sources of sedimentation in the watershed and the suspended clay material from the Prefumo Canyon watershed would continue. However, these sources are causing sedimentation of the lake at a very slow rate (1 foot every 20 to 50 years) and are not considered significant. The only way of dealing with this kind of sediment is through dredging the

lake bottom. There is no other feasible method because the material is very light and stays in suspension for relatively long periods of time.

Implementation of level 1 above, will eliminate part of the source of sedimentation in the delta area but would not eliminate delta formation. Dredging will be a required aspect of this option. Nevertheless, attainment of the goal of controlling sediment in Prefumo Inlet is only slightly less successful than level 2.

## Procedure

Excavation within the inlet involves earthwork within a water channel and thus, an agreement must be reached with the State Department of Fish and Game. No permit is required under the Corps of Engineers "Section 404" program unless material is to be redesposited in other areas of the lake or other water bodies.

Specificiations and excavation and dredging design documents must be prepared. The first step in this process will be to prepare an accurate topographic survey of the inlet channel and its immediate bank areas. Concurrently, a soils analysis should be conducted to ascertain the characteristics and depth of the sediment material and the location of the water table when Laguna Lake is at its high and low seasonal water level. Subsequently, design sections should be prepared showing the desired after-excavation channel characteristics. Monitoring of the sediment elevation in the channel should be conducted annually. Site disposal engineering specificiations and procedures should be prepared on an as-needed, case-by-case basis. When possible, it will be advantageous to allow others who need fill material to conduct excavation activities under City specifications and administration.

Transport and disposal operations and engineering would then not be a City responsibility and excavation costs would not be incurred by the City.

## Cost

Level #1: The management of Prefumo inlet to retain sand and gravel sediment and to remove silty sediment from the delta will require initial excavation of 20,000 c.y. and dredging of approximately 5,000 c.y. Subsequent maintenance will require excavation of approximately 6,000 c.y. (done on a 5 year cycle) and dredging an average of 250 c.y. (done on a 10 year cycle) each year.

If the City could find users willing to excavate the sand and gravel material, the initial re-creation of the basin would cost the City approximately $8,000 for dredging ($400 per year prorated over 20 years). The maintenance operation, if the City could find users for the excavated material, would be approximately $400 per year for dredging. The total cost would be about $16,000 or $800 per year over a 20 year period.

If the City could find no users for the sand and gravel material, the initial cost would be $100,000 ($5,000 per year prorated over 20 years) for excavation and $8,000 for dredging ($400 per year prorated over 20 years). The maintenance cost would be $30,000 per year excavation and $400 per year for dredging. The total cost over a 20 year period would be $716,000 or approximately $36,000 per year.

Level 2: This option requires the initial excavation of 20,000 cubic yards and dredging of 70,000 cubic yards plus dredging approximately

38,000 cubic yards each 5 years thereafter for maintenance.

If the City could find users for material with good structural fill quality, the annual cost would be about $32,000 (assuming a "contract operation" for dredging; see pages 51 & 52 ).

If the City could find no one to excavate and transport dewatered material from the park disposal site or to excavate and transport dry material from the inlet, the total annual cost would be approximately $50,000 (again assuming a "contract operation" for dredging).

It is very likely that there will be contractors who will wish to excavate and transport sand and gravel material out of the inlet. Whether the annual demand will equal the amount of material which must be removed is not known. However, it is a good probability that there will be more material available than is required and the City will have to assume the burden of removing and disposing of the excess in some years. Thus the actual costs to the City will be somewhere between the ranges given above:

Level #1 - $800 to $36,000 per year

Level #2 - $32,000 to $50,000 per year

CONCLUSION - ALTERNATIVE METHODS

An initial review and comparison of the foregoing methods reveals three which should be excluded from further consideration as follows:

EXCAVATION (B): The discussion of this method indicates the reasons for dropping it from consideration at this time. Should natural circumstances occur (i.e. drought) which permit this method to be implemented, the City should at that time conduct tests on bottom soils to determine feasibility of operating heavy excavating machinery in the lake and prepare an excavation plan.

IRRIGATION CONTROL: The discussion on this method indicates the reasons for dropping it from consideration at this time. However, if irrigation pumping increases to a significant proportion of seasonal water loss, the City should consider remedial measures at that time.

CHEMICAL WEED CONTROL: A comparison of this methodology with mechanical or manual harvesting methods indicates it is equal to or higher in cost and has much greater potential for causing adverse environmental impacts. This control tool should be considered as an option of last resort.

BIOLOGICAL MANIPULATION: Too little of this method is known to rely on it as a primary management tool. Manipulation of physical parameters in the lake which could be necessitated by any of the other management methods must be considered in the selection of management programs but cannot be considered as a causative agent of lake management.

It is also recommended that the "Contract Operation" be utilized in dredging operations involving large quantities of material. For small quantities the "Loan Operation" would be appropriate. The "Rental Operation" is not considered a prudent method of employing dredging operators.

# VII. ALTERNATIVE MANAGEMENT PROGRAMS

The preceeding sections have described the broad goals for the long term use and character of Laguna Lake (Secion II), the existing physical characteristics and uses of the lake and its environs (Section III), the objectives which must be met to attain and preserve the uses and characteristics desired for the lake's future (Section IV and V), and finally, a series of alternative methods which may be employed to meet the objectives (Section VI). The steps taken in these sections have been directed toward ultimately arriving at a series of options for the management of Laguna Lake.

The alternative management programs presented in this section are essentially groups or combinations of methods which, together, will meet at least the minimum requirements of all five of the objectives listed in Section V. On the following page is a table which lists each objective and the corresponding methods which may be suitable to its attainment.

From the table it is apparent that there are several methods which are suitable for each objective, and that several methods are suitable to more than one objective.

# LAKE MANAGEMENT OBJECTIVES

| OBJECTIVE | SUITABLE METHOD FOR ATTAINMENT OF OBJECTIVE* |
|---|---|
| 1. Maintain 3 to 4 feet of lake depth at seasonal low water level. | (A) Dredging<br>(C) Increased Lake Level<br>(D) Effluent Water Supply |
| 2. Reduce or eliminate existing aquatic weeds. | (A) Dredging<br>(F) Mechanical Harvest<br>(G) Manual Harvest |
| 3. Provide for on-going aquatic weed control. | (A) Dredging<br>(C) Increased Lake Level<br>(F) Mechanical Harvest<br>(G) Manual Harvest |
| 4. Prevent Prefumo Creek watershed sediment from reaching Laguna Lake. | (J) Prefumo Inlet Sediment Basin<br>Level #1 Maintenance<br>Level #2 Maintenance |
| 5. Preserve the characteristics of the lake which are important to existing wildlife habitat, the existing level of flood protection and existing recreational opportunity. | All methods are suitable to varying degrees and must be evaluated against this over-riding objective. |

*Those methods which were eliminated in the conclusion to Section VI are not included.

It is also apparent that there are many different combinations of methods that could be formulated into management programs. In fact, the management programs that are presented on the following pages represent only a fraction of the possible combinations. Those that were selected for consideration, however, are representative of all the possible combinations, many of which are not significantly different from others.

There are seven program options presented for consideration. Each of the programs has been evaluated in terms of three criteria:

Effectiveness - the extent to which the program meets or exceeds the minimum requirements of the objectives and the degree of difficulty involved in implementing the programs.

Environmental Considerations - the potential for adverse environmental impacts.

Cost - the cost of carrying out the program.

These aspects are briefly summarized in the discussion of each program. More extensive descriptions are contained in the discussions of the alternative methods, Section V I.

To simplify an evaluation of all programs, the reader should refer to the comparative matrix in Section II above (summary). The matrix indicates that Program I is easiest to implement and attains the objectives at the lowest acceptable minimum level; that it has the lowest potential for environmental impacts and will cost the least to carry out. The succeeding programs are increasingly more effective (with the exception of Programs 6 and 7), are more costly and have greater potential for environmental impact.

PROGRAM 1

## Description

MECHANICAL WEED HARVEST (F) - all water areas but focusing on Central.
PREFUMO INLET SEDIMENT BASIN (J) - utilizing Level #1 and a "loan operation" dredging program.

## Effectiveness

- This program will marginally meet the minimum requirements of all five objectives identified in Section IV.

- It will require an agreement with the State Department of Fish and Game for dredging and excavation work.

## Environmental Considerations

- A small disposal pond (less than one acre) will be required in Laguna Lake Park for dredge material.

- A net reduction of nutrients will result from aquatic weed removal.

## Cost*

| | | |
|---|---|---|
| Excavation: | $0 to $35.000/year | ($0 to $700,000) |
| Dredging: | $800/year | ($16,000) |
| Weed Control: | $1,500 to $4,500/year | ($30,000 to $90,000) |
| TOTAL | $2,300 to $40,300/year | ($46,000 to $806,000) |

*All annual costs in this analysis are prorated over a 20 year time span. Cost in parentheses are total cost for 20-year period.

PROGRAM 2

## Description

EFFLUENT WATER SUPPLY (D) - from high secondary sewage treatment.
MECHANICAL WEED HARVEST (F) - concentrating on the Central area but controlling and clearing in all water areas.
PREFUMO INLET SEDIMENT BASIN (J) - utilizing Level #1 and the "contract operation" dredging program.

## Effectiveness

- This program will exceed the minimum requirements for objectives 1, 2 and 3.

- It will meet the minimum requirements for objectives 4 and 5.

- It will achieve an additional objective of water recycling and conservation.

- Possibility of receiving Federal funding (75% of cost) is unknown at this time, but probably won't occur sooner than two years.

- A permit for water contact recreation must be obtained from the County Health Department.

- The program will require an agreement reached with the State Department of Fish and Game for dredging and excavation work.

## Environmental Considerations

- Better and more efficient use of City water will occur.

- The effluent water will contain relatively high phosphate levels which may cause large algal blooms which could result in oxygen depletion, fish kills, odor and nuisance problems. Physical parameters in the lake may have to be manipulated to prevent these problems.

| | Cost | |
|---|---|---|
| Excavation: | $0 to $35,000/year | ($0 to $700,000) |
| Dredging | $800/year | ($16,000) |
| Weed Control: | $1,500 to $4,500/year | ($30,000 to $90,000) |
| Effluent Water Supply: | $1,910/year | ($38,200) |
| | $4,210 to $42,210/yr. | ($84,200 to $844,200) |

PROGRAM 3

## Description

INCREASED LAKE LEVEL: (C)
MECHANICAL WEED HARVEST (F) - concentrating on Central, but clearing and controlling weeds in all water areas.
PREFUMO INLET SEDIMENT BASIN (J) -utilizing Level #1 and a "loan operation" dredging program.

## Effectiveness

- This program will exceed the minimum requirements for objectives 1, 2 and 3.

- It will meet or exceed the minimum requirements for objectives 4 and 5.

- It will require a permit from the Army Corps of Engineers for weir construction and an agreement with the State Department of Fish and Game for dredging and excavation work.

- It will require a permit from the State Water Resources Control Board for additional impoundment of water.

- Agreements with property owners whose land is inundated will have to be reached.

- Agreements with downstream riparian rights owners will have to be reached.

- A soils and water table analysis will be required before proceeding.

## Environmental Considerations

- Some relatively minor man-made structures and facilities will be inundated. Reconstruction will be necessary.

- The area of marsh and water wildlife habitat will be expanded by 100 acres in the most valuable area of the lake.

- The amenity of Prefumo Inlet will be improved as a water body deep enough for boating throughout.

- Flood control conditions will be improved.

- A net reduction in nutrients will result from aquatic weed removal.

- Potential soil stability problems.

## Cost

| | | |
|---|---|---|
| Excavation: | $0 to $35,000/year | ($0 to $700,000) |
| Dredging: | $800/year | ($16,000) |
| Weed Control: | $1,500 to $4,500/year | ($30,000 to $90,000) |
| Water Impoundment | $7,000/year | ($140,000) |
| TOTAL | $9,300 to $47,300/year | ($186,000 to $946,000) |

PROGRAM 4

## Description

EFFLUENT WATER SUPPLY (D) - from high secondary sewage treatment.
MECHANICAL WEED HARVEST (F) - concentrating on the Central area but controlling and clearing in all water areas.
PREFUMO INLET SEDIMENT BASIN (J) - utilizing Level #2 and the "contract operation" dredging program.

## Effectiveness

- This program will exceed the minimum requirements for objectives 1, 2 and 3.

- It will meet or exceed the minimum requirements for objectives 4 and 5.

- It will achieve an additional objective of water recycling and conservation.

- Possibility of receiving Federal funding (75% of cost) is unknown at this time, but probably won't occur sooner than two years.

- A permit for water contact recreation must be obtained from the County Health Department.

- The program will require an agreement reached with the State Department of Fish and Game for dredging and excavation work.

## Environmental Considerations

- Better and more efficient use of City water will occur.

- The effluent water will contain relatively high phosphate levels which may cause large algal blooms which could result in oxygen depletion fish kills, odor and nuisance problems. Physical parameters in the lake may have to be manipulated to prevent these problems.

## Cost

| | | |
|---|---|---|
| Excavation: | $0 to $5,000/year | ($0 to $100,000) |
| Dredging: | $32,000 to $45,000/year | ($640,000 to $900,000) |
| Weed Control | $1,500 to $4,500/year | ($30,000 to $90,000) |
| Effluent Water Supply: | $1,910/year | ($38,200) |
| | $35,410 to $56,410/year | ($708,200 to $1,128,200) |

PROGRAM 5

## Description

INCREASED LAKE LEVEL (C)
MECHANICAL WEED HARVEST (F) - concentrating on Central, but clearing and controlling weeds in all water areas.
PREFUMO INLET SEDIMENT BASIN (J) - utilizing Level #2 and a "contract operation" dredging program.

## Effectiveness

- This program will exceed the minimum requirements for objective 1.

- It will exceed the minimum requirements for objectives 2 and 3.

- It will meet or exceed the minimum requirements for objectives 4 and 5.

- It will require from the Army Corps of Engineers for weir construction and an agreement with the State Department of Fish and Game for dredging and excavation work.

- It will require a permit from the State Water Resources Control Board for additional impoundment of water.

- Agreements with property owners whose land is inundated will have to be reached.

- Agreements with downstream riparian rights owners will have to be reached.

- A soils and water table analysis will be required before proceeding.

## Environmental Considerations

- Some relatively minor man-made structures and facilities will be inundated. Reconstruction will be necessary.

- The amenity of Prefumo Inlet will be improved as a water body, deep enough for boating in large part.

- Flood control conditions will be slightly improved.

- The area of marsh and water wildlife habitat will be expanded by 100 acres in the most valuable area of the lake.

- A net reduction in nutrients will result from aquatic weed removal.

- Localized turbidity could result in minor fish kills.

## Cost

| | | |
|---|---|---|
| Excavation: | $0 to $5,000/year | ($0 to $100,000) |
| Dredging: | $32,000 to $45,000/year | ($640,000 to $900,000) |
| Weed Control: | $1,500 to $4,500/year | ($30,000 to $90,000) |
| Water Impoundment: | $7,000/year | ($140,000) |
| | $40,500 to $61,500/yr. | ($810,000 to $1,230,000) |

PROGRAM 6

## Description

DREDGING (A) - 50 acres in Central to elevation 109' MSL utilizing "contract operation" program.
MECHANICAL WEED HARVEST (F) - concentrating on keeping Central clear after dredging, but clearing and controlling weeds in all other water areas as well.
PREFUMO INLET SEDIMENT BASIN (J) - utilizing Level #1.

## Effectiveness

- This program will meet the minimum requirements of objective 1.

- It will exceed the minimum requirements of objectives 2 and 3.

- It will marginally meet the minimum requirements of objectives 4 and 5.

- It will require an agreement with the State Department of Fish and Game for dredging and excavation.

## Environmental Considerations

- A large disposal pond (20 acres) will be required in Laguna Lake Park for dredge material. This may cause short-term adverse aesthetic effects, loss of some grazing land and odor nuisance.

- Additional turbidity caused by dredging may result in suffocation of fish.

- A net reduction of nutrients will result from aquatic weed removal.

## Cost

| | | |
|---|---|---|
| Excavation: | $0 to $35,000/year | ($0 to $700,000) |
| Dredging: | $36,150/year | ($723,000) |
| Weed Control: | $1,500 to $4,500/year | ($30,000 to $90,000) |
| | $37,650 to $75,650/year | ($753,000 to $1,513,000) |

PROGRAM 7

## Description

DREDGING (A) - 25 acres in Central to elevation 106' MSL utilizing "contract operation" dredging program.
MEHCANICAL WEED HARVEST (F) - concentrating on areas of Central not dredged for weed removal and control.
PREFUMO INLET SEDIMENT BASIN (J) - utilizing Level #1.

## Effectiveness

- This program will exceed the minimum requirements in half the Central area and marginally meet the minimum requirements in the other half for objective 1.

- It will meet the minimum requirements for objectives 2 and 3.

- It will margainally meet the minimum requirements of objectives 4 and 5.

- It will require an agreement with the State Department of Fish and Game for dredging and excavation work.

## Environmental Conditions

- A large disposal pond (25 acres) will be required in Laguna Lake Park for dredge material. This may cause short-term adverse aesthetic effects, loss of grazing land and odor nuisance.

- Additional turbidity caused by dredging may result in suffocation of fish.
- A net reduction in nutrients will result from aquatic weed removal.

| | Cost | |
|---|---|---|
| Excavation: | $0 to $35,000/year | ($0 to $700,000) |
| Dredging: | $44,400/year | ($888,000) |
| Weed Control: | $1,500 to $4,500/year | ($30,000 to $90,000) |
| | $45,900 to $83,900/year | ($918,000 to $1,678,000) |

# VIII. RECOMMENDED LAKE MANAGEMENT PROGRAM

The seven alternative management programs in the previous section were presented to the Laguna Lake Study Committee and to the City Council in fall of 1980. Based upon the desires of these two bodies and the expressed opinions of many local residents at a public hearing in November, the City has selected Program #1 as a preferred alternative for use as a project description in the environmental impact report. When the EIR is completed and funds appropriated, this management program can be formally initiated.

## A. Introduction

Program #1 as described in Section VII above is limited to two measures to be undertaken by the City: the Prefumo Creek sediment basin maintenance, and aquatic weed control by a mechanical harvester. The following sections describe each of these methods generally, although for greater detail the reader is referred back to Section VI which described all of the management measures considered for the lake.

Beside these two measures, it is important to point out that a monitoring program must be undertaken and maintained indefinitely in order to test the effectiveness of these or any other subsequent management efforts for the lake. Subsection C below describes the monitoring program needed for the lake in generalized outline form.

Critical to the success of the management plan is the commitment of sufficient funds to carry it out. The preferred management plan is the least expensive program among the seven identified in Section VII, but costs for implementing this program are still significant. Subsection D discusses these costs and proposed means of financing.

Several of the methods considered in Section VI, but not recommended for implementation at this time, concerned ways to improve lake depth. The primary reasons for rejecting the use of these methods was the higher cost, although other factors entered in as well. Subsection E concludes the

report with a review of these other alternatives for improvement of lake depth conditions, analyzing the potential of each of these measures to contribute to lake enhancement in the future.

B. Lake Management Program

The City will initiate in the 1981-82 fiscal year a two-pronged strategy directed toward the restoration and maintenance of Laguna Lake. The first and most immediate action will be the purchase and operation of a mechanical weed harvester for aquatic weed removal. At about the same time, the City will begin to excavate and dredge the Prefumo Creek Inlet to restore its function as a sediment basin.

Mechanical Weed Removal

The City will purchase a small weed harvester known as a "Chub" from a Wisconsin firm, and begin as early as fall 1981 to remove aquatic weeds from the Central Lake area. The Chub will require about six months to remove the greatest accumulation of weed from the lake, with repeat harvests needed only every two to three years and lasting only about two months. The Chub has a capacity for storing 1,500 pounds of cut weeds; it can operate in as little as 12 inches of water and can cut to as much as five feet of depth.

When full, the cut weeds will be hauled to a shoreline location (probably at the end of the road into Laguna Lake Park where the present pier is located), and a conveyor assembly will be used to haul the weeds into a disposal truck. The weeds are a valuable organic mulch or feed material and will probably not require a permanent disposal site. Temporary storage in a nearby area of undeveloped park property may be necessary until a user can be found.

Prefumo Creek Sediment Basin

The Prefumo Creek sediment basin appears to be able to function to trap sediments from Prefumo Creek when the upper half of the inlet is held to an elevation below 120 feet MSL. The "Level 1" maintenance of the basin which is called for in this management program will require removal of about 20-30,000 c.y. of sand and gravel material to excavate the inlet down to the

water table. When completed (probably within three to six months, depending on the type of removal and the size of equipment which is used), the inlet will once again trap most suspended sediments in the waters of Prefumo Creek before they reach Laguna Lake. Monitoring of the sediment levels in the basin will then establish the degree to which this action has been successful (see below).

In addition to the excavation of the inlet, a minor amount of dredging of the delta of the creek within the Central Lake area is proposed. This dredging will remove about 5,000 c.y. of silt which is otherwise likely to be continuously increased in size and height, encroaching upon the Central Lake area. This dredging could be accomplished with a "loan operation" dredge available from a nearby firm or institution. Disposal of the dredge spoil would require about 1-1/2 acres of land area within Laguna Lake Park (undeveloped portions) for dewatering of the silt materials. A series of small settling ponds would also be needed in order to clarify the runoff from this dredging disposal area. The dredging would need to be repeated only every twenty years in order to meet design criteria for the sediment basin performance.

For a detailed overview of the existing profile of the Prefumo Creek Inlet and how it would function under the "Level 1" excavation and dredging, refer back to Subsection J in Section VI of this report.

Temporary Log Dam

The City will also install a temporary log dam at the downstream end of the Madonna Road culvert which drains the lake. This dam will only be in place over the dry season, and will be removed prior to the onset of heavy winter storms. The dam will consist of five to six heavy timbers installed in a framework of reinforcing bars, designed and constructed so as to permit easy installation and removal.

The effect of this dam will be to raise the lowest lake level during normal years by one foot to 119 feet MSL. There will be virtually no effect on

lake levels during the rainy season. This log dam will require minimal maintenance and can be accomplished by City Public Services crews.

C. Monitoring Program

In order to fulfill the objectives of this management program, the City will need to develop a monitoring program which will periodically review the progress achieved by the weed harvesting and sediment basin excavation. At a minimum, this monitoring will include regular observations by personnel in the City Public Services Department (or Parks and Recreation Department) to determine lake elevations, weed and sediment disposal, recreational use in the Central Lake area, and the approximate sediment configuration of the Prefumo Creek inlet. Even with this very minimal effort at monitoring, it will be necessary for City personnel to utilize a consistent reporting format and that such reports be filed on a fixed-period basis (e.g. semi-monthly or monthly).

A more sophisticated monitoring program would also be more costly, and would include regular water quality testing, lake depth recording, surveying of the Prefumo Creek Inlet, and intensive observation of recreational use patterns. It is not proposed at this time to initiate such a comprehensive monitoring program immediately. In the near future, the City should commit necessary funds and personnel training particularly in order to establish the necessity of exercising any of the other lake depth improvement measures. At a minimum, the City should purchase a small testing kit to record water quality parameters such as turbidity, pH balance, key mineral and organic constituents, etc. Testing should be done on at least a quarterly basis, and lake level and temperature data should also be noted at the same time.

D. Costs and Financing

The costs of implementing the preferred Laguna Lake Management Plan are estimated to be approximately as follows:

| Action | Annual Cost | 20-Year Cost |
|---|---|---|
| Mechanical Weed Harvesting | $1,500 - 4,500* | $30,000- 90,000 |
| Prefumo Creek Sediment Basin | $ 800 - 35,800** | $16,000-716,000 |
| TOTAL | $2,300 - 40,300 | $46,000-806,000 |

*The lower figure represents the possible use of California Conservation Corps personnel to operate the weed harvester. Higher costs represent the use of City personnel.

**Lower costs would be possible if the basin could be excavated entirely by private constractors or others who would desire the sand and gravel for fill materials. Higher costs represent the use of City funds to finance excavation of the sand and gravel.

The installation of the temporary log dam across the culvert at Madonna Road will be a minor cost to the City, and it is anticipated that these heavy timbers will be purchased and installed with incidental funds available in the Public Services Department budget for FY 1980-81.

Financing the above expenditures would be accomplished, at least initially, through the City's normal operating revenues. Special federal or State grant funding is probably neither available nor necessary for the relatively small scale of expenditures estimated above. It is not known at this time where these expenditures would be included within the budget (e.g. Public Works or Parks Department budget units), but the capital costs for purchase of the weed harvester are already included in the City's 1981-82 CIP. In all likelihood, ongoing operating and maintenance costs should be absorbed with relatively little budgetary impact.

## E. Additional Lake Depth Improvement Measures

The above management actions will provide adequate, but marginal achievement of the long-term lake management objectives. There are still, however, a series of management options which deserve serious and continuing consideration because they may result in better long-term improvement of the recreational and ecological values of Laguna Lake. Each of these options would be concerned with improving the depth of the lake and/or maintaining the seasonal variations in the lake level to a more acceptable degree.

The first of these alternative lake depth management measures involves the use of advanced secondary treated effluent from an upgraded City wastewater plant. The effluent water supply alternative is described in detail in Section VI, Subsection D above. Although this alternative is still very promising in terms of providing an excellent long-term solution to lake level fluctuations, there are many uncertainties surrounding the availability of the effluent. Not least among these uncertainties is the cost to the community of upgrading the plant to advanced secondary treatment. The U.S. EPA grant which may be available to the City to fund 75 to 87-1/2% of these costs might itself be unacceptable because of certain conditions imposed on the grant acceptance of the EPA, or by the State or Regional Water Board.

The second method of improving lake depth conditions would be the construction of a concrete weir or dam at the downstream end of the lake to raise the water level of the lake permanently. The weir concept is more fully described under Section VI, Subsection C (Increased Lake Level). The primary obstacle to this method is the uncertainty concerning the legal ramifications of the heightened lake level (to 120 MLS). Additionally, there may be unresolved concerns regarding flood potential and the impacts of inundation upon park land and facilities adjacent to the lake.

The third and final method of improving lake depth conditions is also the most costly: dredging. As a long-term solution to the problems of siltation, weed growth, and degradation of the lake quality, dredging has a

great deal of merit. Due to the substantial costs associated with the dredging process, though, the City should exhaust both of the above options (effluent recharge or the dam) before proceeding to the dredging option.

The "staging" or sequence of decision-making on each of these lake depth improvement measures is illustrated on the following page. The City will continue to consider each of these three actions in the priorities noted above, and as the uncertainties involved in each one are resolved decisions must be made based on the best and most cost-effective solution to the lake's continuing problems.

# RECOMMENDED LAKE MANAGEMENT PLAN