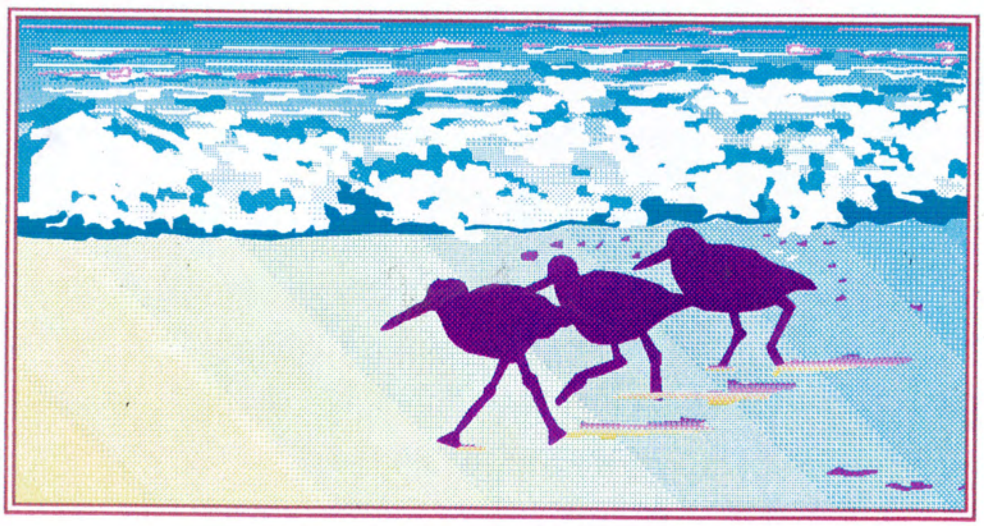
CDM Camp Dresser & McKee

January 1994

Final Report
to
City of Santa Cruz

Water Supply Alternatives Study



Camp Dresser & McKee Inc.

in association with

D.W. Alley & Associates
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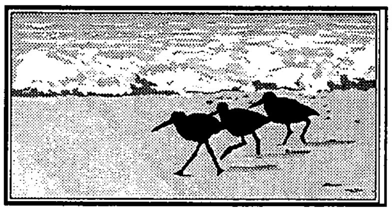

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Summary

1.1 Study Overview

The City of Santa Cruz is investigating the need for increased water supply capability to meet its projected future water demands. The City's 1989 Water Master Plan developed water demand projections and identified alternatives to increase the existing water supply. The purpose of the current study was to build on the 1989 Water Master Plan and evaluate potential water supply projects to meet the City's needs. The results of this study developed recommendations for a project for environmental review and preliminary design.

This study was divided into three phases. The purpose of the Phase I work was to identify and reach consensus on the water supply alternatives to be evaluated in this study. In Phase II, the water supply alternatives identified in Phase I were screened for "fatal flaws" which could preclude their implementation. In Phase III, potential water supply projects were developed from the feasible water supply alternatives that passed the Phase II fatal flaw screening. These projects consist of various combinations of the feasible alternatives that will meet the City's water supply needs. Phase III evaluated and ranked these potential water supply projects and developed a recommended project.

As part of the study, a Technical Advisory Committee was established by the City of Santa Cruz to review project progress and provide input at key project milestones. The Committee is comprised of the members of the Santa Cruz Water Commission, two members of the Santa Cruz City Council and two members of the Santa Cruz Water Department.

In Phase III, nine projects were identified and evaluated. The nine projects consisted of:

- Four new reservoir projects in the Santa Cruz area, two in the San Lorenzo River watershed and two on North Coast creeks,
- Three projects involving the expansion of Loch Lomond and treatment of brackish groundwater in the Majors Creek area;
- One all-groundwater project including new groundwater wells at Thurber Lane and treatment of brackish groundwater in the Majors Creek area; and
- One smaller reservoir project with groundwater wells at Thurber Lane and reclaimed water from the Scotts Valley Wastewater Treatment Plant.

The evaluation recommended the all-groundwater project (brackish groundwater and groundwater at Thurber Lane) to be carried forward for environmental review and preliminary design. This recommendation was adopted by the Technical Advisory Committee.

1.2 Water Demands

The water supply evaluation used a projected year 2005 water demand during droughts of 4,500 million gallons per year (MG/year). This demand was based on the 1989 Water Master Plan projection of 5,175 MG/year for year 2005, which assumed a 15,000 enrollment at U.C. Santa

Cruz in 2005 and development of the greenbelt areas within the City of Santa Cruz in accordance with their zoning. The Water Master Plan demand was adjusted to account for permanent water conservation savings of 180 MG/year from existing customers. In addition, it was assumed that there would be a 10 percent annual reduction in demand due to drought restrictions, which is equivalent to a 15 percent summertime reduction. The projected Water Master Plan growth scenario and resulting demand will be subject to review in the project EIR.

1.3 Existing Water Supply System

The existing City water supply system is comprised of four main production elements: the North Coast; the San Lorenzo River (Tait Street Diversion and Felton Diversion); Loch Lomond on Newell Creek; and the Beltz Wells. These facilities are indicated on Figure 1-1.

The North Coast supply system consists of surface diversions from three coastal streams and a natural spring located approximately six to eight miles northwest of downtown Santa Cruz. These sources are Liddell Spring, Laguna Creek, Reggiardo Creek, and Majors Creek.

San Lorenzo River flows are diverted at the Tait Street Diversion just north of Highway 1. The Tait Street Diversion also includes three wells located on the east side of the river, which are hydraulically connected to the river and tied to the City's appropriative rights for river flows.

The Felton Diversion is located on the San Lorenzo River just downstream of the Zayante Creek confluence, which is approximately five miles north of the Tait Street Diversion. Diverted flows are pumped through the Felton Booster Station to Loch Lomond for storage via the Newell Creek Pipeline.

Loch Lomond is located on Newell Creek. Loch Lomond is the only major reservoir in the San Lorenzo River watershed, and has a maximum capacity of 2,810 MG. In addition to inflows from the Newell Creek watershed, Loch Lomond inflows can be supplemented in drier years by water pumped from the Felton Diversion.

The Beltz well system consists of five groundwater wells located in the southeastern portion of the City water service area.

1.4 Safe Annual Yield of Existing Water Supply System

The annual yield of the existing water supply system was estimated for both a short-term (2-year) critically dry period similar to the 1976-1977 conditions and for a long-term (5-year) extended dry period similar to the 1987-1991 conditions. The yield estimates include existing storage in Loch Lomond, and assume that 1,000 MG of carryover reservoir storage will be available in reserve at the end of the drought period. The annual yield of the existing water supply system was estimated to be 3,510 MG/year, for the short-term critical drought conditions, and 3,910 MG/year for the long-term extended drought conditions. The annual yield during the critically dry period (1976-77) is less than during the extended dry period (1987-91). Therefore, 3,510 MG/year is the safe annual yield of the existing water supply system.

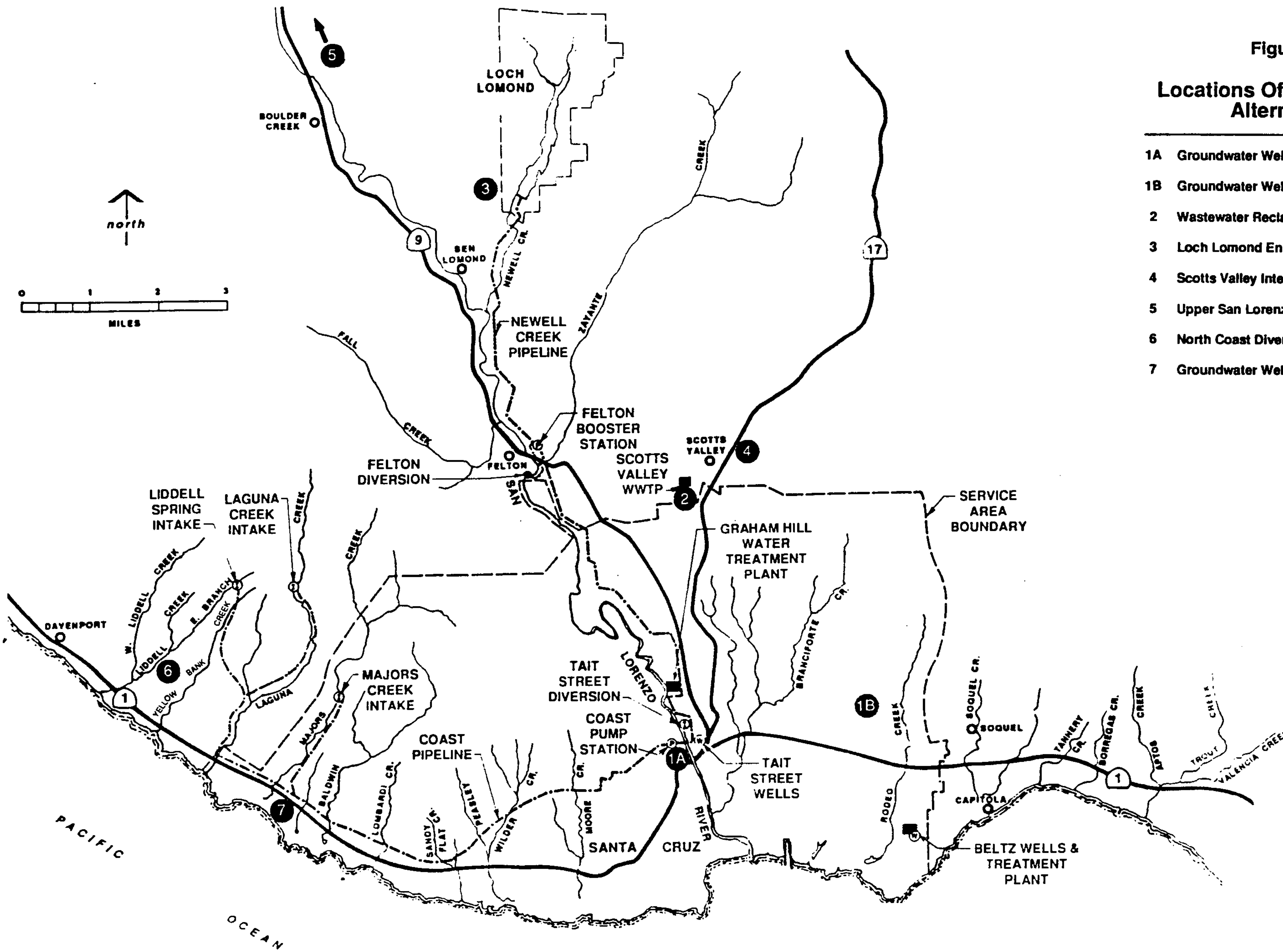


Figure 1-1

Locations Of Water Supply Alternatives

1A	Groundwater Wells - Harvey West Area
1B	Groundwater Wells - Thurber Lane Wells
2	Wastewater Reclamation
3	Loch Lomond Enlargement
4	Scotts Valley Intertie
5	Upper San Lorenzo River Storage
6	North Coast Diversion And Storage
7	Groundwater Wells with Reverse Osmosis

1.5 Water Supply Requirements

There is a shortfall between the safe yield of the existing water supply system and the projected year 2005 water demands. Therefore, additional supply will be needed to meet future demands.

The shortfall ranges from 590 MG/year for an extended drought similar to 1987-91 conditions, to 990 MG/year for a short-term critical drought similar to 1976-77 conditions. Potential projects were evaluated for both the critical 1976-1977 and the extended 1987-1991 drought periods. This was done because the amount of storage included for each project will determine which hydrologic period controls facility sizing. For projects with little or no storage, the 1976-1977 period is the controlling drought period. For projects with storage as the main project element, the extended 1987-1991 drought period is the most controlling drought period. Sizing of facilities for the projects was based on the controlling drought period to ensure that adequate supply would be available during all types of drought years.

The table below summarizes the future water supply requirements.

Water Supply Shortfall

	Short-Term (2-year) Critical Drought (MG/year)	Long-Term (5-year) Extended Drought (MG/year)
Adjusted Year 2005 Water Demands[1]	4,500	4,500
Existing Water Supply[2]		
Annual Yield From Existing Stream Diversions, Wells	3,030	3,390
Existing Reservoir Operation (Loch Lomond)[3]	480	520
Total Annual Supply	3,510	3,910
Water Supply Shortfall	990	590

(1) 1989 Water Master Plan demands were reduced by 180 MG/year to account for water conservation savings from existing customers, and a 10 percent annual reduction in demand due to drought restrictions (equivalent to a 15 percent summertime reduction).
(2) See Table 5-1 for detailed information on existing water supply.
(3) Assumes 1,000 MG reserve carryover storage at the end of the drought period.

The shortfall could be met by developing additional yield from water supply sources, by constructing additional reservoir storage, or by a combination of additional yield and additional storage.

1.6 Development of Water Supply Alternatives

In Phase I, water supply alternatives were developed that could be used to supplement the City's existing supply in order to meet the projected water supply shortfall.

Potential water supply alternatives identified in the 1989 Water Master Plan were reviewed to determine their suitability for inclusion in this study. In addition, possible new alternatives were formulated based on new information available since the Master Plan.

Consensus was reached with the City on the water supply alternatives to be evaluated in this study. Facilities requirements and incremental safe yield estimates were prepared for these alternatives.

Table 1-1 summarizes the agreed-upon water supply alternatives developed in Phase I. Figure 1-1 indicates the general locations of the alternatives.

Table 1-1
Phase I Water Supply Alternatives

Alt. No.	Description of Alternative
1A	Harvey West Groundwater Well
1B	Thurber Lane Groundwater Wells
2	Wastewater Reclamation
3A	Enlarge Loch Lomond by 260 to 500 MG
3B	Enlarge Loch Lomond by 1,010 MG
4	Scotts Valley Intertie
5	Alternate sites for an Upper San Lorenzo River Reservoir (Kings Creek; Waterman Gap)
6	North Coast Diversion and Storage
7	Brackish Groundwater Wells with Reverse Osmosis Treatment

1.7 Fatal Flaw Screening of Alternatives

In Phase II, the agreed-upon water supply alternatives from Phase I were screened for fatal flaws which could preclude their implementation. The existence of fatal flaws was determined by screening the alternatives for the presence of specific exclusionary criteria which would cause them to be excluded from further evaluation. These criteria, which were reviewed by the City, included:

- Regulatory and institutional issues: These criteria included permitting requirements and the time required to obtain permits (implementation schedule); jurisdictional or political constraints; and land use planning constraints.

- Geologic and hydrogeologic concerns: These criteria included geologic concerns regarding seismicity and landslides, which primarily affected the reservoir alternatives; and hydrogeologic concerns regarding groundwater safe yield and aquifer characteristics, which primarily affected groundwater alternatives.

- Environmental issues: This criterion focused on the presence of federal or state rare and endangered species, which primarily affected alternatives in undeveloped areas.

The fatal flaw analysis involved collecting data about the exclusionary criteria in relation to each of the alternatives. Much of this effort involved review of existing records, and the information developed during Phase I of this study.

Field work was performed as necessary to supplement existing information. This field work included characterizing fisheries habitat; performing surficial and photogeological reconnaissance at proposed reservoir/dam sites; visiting proposed reservoir and diversion sites to check information in the California Natural Diversity Data Base (CNDDB) and to identify any additional biological issues of concern; and identification of applicable regulations and contact with local, state, and federal agencies with jurisdiction.

For the fatal flaw screening, the information developed for each alternative was compared with the exclusionary criteria. If any of the exclusionary criteria were present for an alternative, then a fatal flaw was identified.

Fatal flaws were identified for the following two alternatives. Therefore, it was recommended that these two alternatives be excluded from further evaluation in Phase III of this study.

- Alternative 1A - Harvey West Groundwater Well

  This alternative was screened out due to its low yield and potential conflict with planned development in the area.

- Alternative 4 - Scotts Valley Intertie

  This alternative was screened out due to opposition of the Scotts Valley Water District.

The rest of the alternatives were considered feasible alternatives and were recommended for further evaluation in Phase III.

1.8 Development of Potential Water Supply Projects

The purpose of Phase III of this study was to evaluate and rank potential water supply projects developed from the feasible alternatives which passed the fatal flaw screening in Phase II. The primary criterion for developing potential water supply projects was to select projects which meet the City's projected year 2005 water supply requirement during droughts. This water supply requirement is 4,500 MG/year. Potential projects were formulated to have yield sufficient to make up the difference between the safe annual yield of the existing system, and the projected water supply requirement.

The following combinations of alternatives were considered in formulating potential projects:

- A new reservoir at a location in the Upper San Lorenzo River watershed or the North Coast area which would be sized to provide for the full amount of the shortfall.

- Enlarging Loch Lomond in conjunction with non-storage sources, such as groundwater wells, brackish groundwater wells with reverse osmosis treatment, and/or wastewater reclamation.

- Non-storage sources only, such as groundwater wells, brackish groundwater wells with reverse osmosis treatment, and wastewater reclamation, with no new reservoir and no modifications to Loch Lomond. The non-storage sources do not have sufficient yield to meet the shortfall individually, but can meet it when combined as a project.

- A smaller new reservoir at a location in the Upper San Lorenzo River watershed or North Coast area, in conjunction with non-storage sources such as groundwater wells, brackish groundwater wells with reverse osmosis treatment, and/or wastewater reclamation.

Based on these groupings, nine potential water supply projects were formulated from the feasible alternatives:

Project Identifier	Project Description
P-A	Waterman Gap Reservoir (Upper San Lorenzo River)
P-B	Kings Creek Reservoir (Upper San Lorenzo River)
P-C	East Branch Liddell Creek Reservoir and Scott Creek Diversion (North Coast)
P-D	Yellow Bank Creek Reservoir and Scott Creek Diversion (North Coast)
P-E	Loch Lomond 260 MG Enlargement and Brackish Groundwater Wells with Reverse Osmosis Treatment Plant
P-F	Loch Lomond 500 MG Enlargement and Brackish Groundwater Wells with Reverse Osmosis Treatment Plant
P-G	Loch Lomond 1,010 MG Enlargement and Brackish Groundwater Wells with Reverse Osmosis Treatment Plant
P-H	"No Reservoir" Project (Thurber Lane Groundwater Wells and Brackish Groundwater with Reverse Osmosis Treatment)
P-I	Smaller New Reservoir with Thurber Lane Groundwater Wells and Wastewater Reclamation

These nine projects were presented to the Technical Advisory Committee for review and approval to include in the Phase III evaluation. The nine projects were approved for inclusion in Phase III at the July 1993 Water Commission meeting.

As part of the Phase III analysis, engineering and environmental evaluations were performed for each of the projects. The purpose of these evaluations was to identify significant engineering or environmental constraints for each of the projects.

Phase III engineering evaluations focused on identifying the principal design elements of each project, determining the engineering and construction viability of each project; preparing feasibility level construction cost estimates for budgeting and alternative comparison purposes and, identifying significant engineering or construction constraints.

Phase III environmental evaluations included the following tasks: Additional field work to gather specific information on project impacts; identifying potential significant issues and impacts; determining the feasibility of mitigation measures that could be required for projects;

and, assessing the limitations or constraints that could be imposed on a project as a result of the environmental process.

1.9 Discussion of Potential Water Supply Projects

Project summaries were developed to summarize the evaluation findings for each of the projects. The following table presents the significant engineering and environmental constraints identified for each project.

Project	Project Description	Significant Engineering and Environmental Constraints from Phase III Evaluation
P-A	Waterman Gap Reservoir	. The reservoir could take 11 years to fill under average hydrologic conditions. . The re-location of Highway 9 could cause scheduling delays. . The reservoir would inundate portions of the historic Saratoga Toll Road, which could not be mitigated. . Mitigation for fisheries impacts could involve re-negotiation of fishery bypass releases at the City's existing diversions. Reservoir releases would provide some additional bypass flows at the existing diversions. . The estimated capital cost of this project is $54 million. . Land acquisition for this project could cause scheduling delays
P-B	Kings Creek Reservoir	. The reservoir could take 18 years to fill under average hydrologic conditions, which is considered a technical fatal flaw. . Mitigation for fisheries impacts could involve re-negotiation of fishery bypass releases at the City's existing diversions. Reservoir releases would provide some additional bypass flows at the existing diversions. . The estimated capital cost of this project is $58 million. . Land acquisition for this project would be time consuming and difficult due to the large number of landowners in the reservoir area.
P-C	East Branch Liddell Creek Reservoir and Scott Creek Diversion	. An earth dam could not be built because the native material is unsuitable. A roller-compacted concrete (RCC) dam concept was used. . The cost of this project is $117 million. The extremely high cost of this project is due to the high cost of the larger volume RCC dam. . The reservoir could take 12 years to fill under average hydrologic conditions. Additional subsurface flow could possibly be diverted to reduce the reservoir filling time. . Diversion from the Scott Creek basin has the potential to impact coho salmon and tidewater goby in Scott Creek, which could be mitigated. . This project has the potential to impact cultural resources along the Coast pipeline alignment, which could be mitigated.

Project	Project Description	Significant Engineering and Environmental Constraints from Phase III Evaluation
P-D	Yellow Bank Creek Reservoir and Scott Creek Diversion	. An earth dam could not be built because the native material is unsuitable. A roller-compacted concrete (RCC) dam was used. . The cost of this project is $79 million. The high cost of this project is due to the high cost of the RCC dam. . The reservoir could take 8 years to fill under average hydrologic conditions. Additional subsurface flow could possibly be diverted to reduce the reservoir filling time. . Diversion from the Scott Creek basin has the potential to impact coho salmon and tidewater goby in Scott Creek, which could be mitigated. . This project has the potential to impact cultural resources along the Coast pipeline alignment, which could be mitigated.
P-E	Loch Lomond 260 MG Enlargement and Brackish Groundwater wells w/Reverse Osmosis Treatment	. Mitigation for fisheries impacts could involve re-negotiation of fishery bypass releases at the City's existing diversions. This project would not provide any additional bypass flows at the existing diversions. . This project has the potential to impact cultural resources along the Coast pipeline alignment, which could be mitigated. . Brine disposal in the National Marine Sanctuary will require a Regional Board permit and NOAA permit review. . The cost of this project is $38 million.
P-F	Loch Lomond 500 MG Enlargement and Brackish Groundwater Wells with Reverse Osmosis Treatment Plant	. Mitigation for fisheries impacts could involve re-negotiation of fishery bypass releases at the City's existing diversions. This project would not provide any additional bypass flows at the existing diversions. . Brine disposal in the National Marine Sanctuary will require a Regional Board permit and NOAA permit review. . The cost of this project is $34 million.
P-G	Loch Lomond 1,010 MG Enlargement and Brackish Groundwater Wells with Reverse Osmosis Treatment Plant	. Mitigation for fisheries impacts could involve re-negotiation of fishery bypass releases at the City's existing diversions. This project would not provide any additional bypass flows at the existing diversions. . Brine disposal in the National Marine Sanctuary will require a Regional Board permit and NOAA permit review. . The cost of this project is $30 million.
P-H	Brackish Groundwater Wells with Reverse Osmosis Treatment and Thurber Lane Groundwater Wells	. Brine disposal in the National Marine Sanctuary will require a Regional Board permit and NOAA permit review. . This project has the potential to impact cultural resources along the Coast pipeline alignment, which could be mitigated. . The cost of this project is $40 million.

Project	Project Description	Significant Engineering and Environmental Constraints from Phase III Evaluation
P-I	Smaller Yellow Bank Reservoir with Thurber Lane Groundwater Wells and Wastewater Reclamation	. An earth dam could not be built because the native material is unsuitable. A roller-compacted concrete (RCC) dam was used. . The cost of this project is $74 million. The high cost of this project is due to the high cost of the RCC dam. . The reservoir could take 5 years to fill under average hydrologic conditions. Additional subsurface flow could possibly be diverted to reduce the reservoir filling time. . Diversion from the Scott Creek basin has the potential to impact coho salmon and tidewater goby in Scott Creek, which could be mitigated. . This project has the potential to impact cultural resources along the Coast pipeline alignment, which could be mitigated.

In the Phase III evaluation, the Kings Creek Reservoir Project was found to have an initial fill time of 18 years, which constitutes a technical fatal flaw for this project. However, the project was carried through the Phase III evaluation for comparative purposes.

1.10 Weighted Evaluation Criteria for Potential Projects

In June 1993, a workshop was held with the Technical Advisory Committee to select the criteria to be used in evaluating water supply projects and to develop relative weights for the criteria. At the workshop, the Committee first identified project "stakeholders", or those who would have an interest in the potential projects. The Committee then developed a list of issues that would be important to the project stakeholders. Similar issues were then grouped into similar categories or criteria. Using the issues identified, the Committee selected five criteria: Environmental; Cost; Operations/Reliability; Implementability; and Political/Institutional/Public. Once the Committee established the criteria, relative weights were assigned to each of the criteria. Each of the Committee members was asked to compare each of the criteria and assign a relative importance to each of the criteria. Individual scores were then compared and a group weighting was developed through discussion. The Committee-developed criteria and relative weights are:

Criterion	Relative Weight
Environmental	24
Cost	22
Operations/Reliability	19
Implementability	15
Political/Institutional/Public	20
	100

1.11 Comparison and Ranking of Potential Projects

Once detailed evaluations were completed for each of the projects, the projects were compared and scored for each of the evaluation criteria developed by the Technical Advisory Committee. Projects were rated for each of the key issues identified for a given criterion and from these ratings, an overall score was developed for each of the criteria. The criteria weights, along with the criteria scores, were then used to develop a total score for each project. A higher overall score indicates a better project. The project ratings are shown in Figure 1-2.

Project P-H, which includes brackish groundwater with reverse osmosis treatment and Thurber Lane wells, was the best rated project overall. This project ranked highest for the Environmental, Implementability, Operations/Reliability, and Political/Institutional/Public criterion. It also ranked high for the Cost criterion. The most significant issue identified for this project is the potential problem of brine disposal. However, brine disposal is consistent with the Central Coast Water Quality Control Plan, and several possible disposal options were identified.

Projects P-E through P-G, which include brackish groundwater with reverse osmosis treatment and enlargement of Loch Lomond were rated highly, although they have scores well below Project P-H. These projects were rated lower primarily because of concerns that these projects do not provide for maintenance of fishery habitat on the San Lorenzo River and have the potential to open negotiations of bypass flows at the City's existing diversions on the San Lorenzo River. In fact, depending on California Department of Fish and Game requirements, the yields from Loch Lomond could be reduced to the point of making the projects infeasible.

All of the stand-alone reservoir projects (Projects P-A through P-D) and the smaller Yellow Bank reservoir with Thurber Lane groundwater wells and reclaimed water rated below the other projects. This was due to a number of factors, including: their lower reliability due to lengthy construction and fill times; higher potential for environmental impacts, particularly to fishery resources; higher cost; and, greater potential for institutional and political impacts.

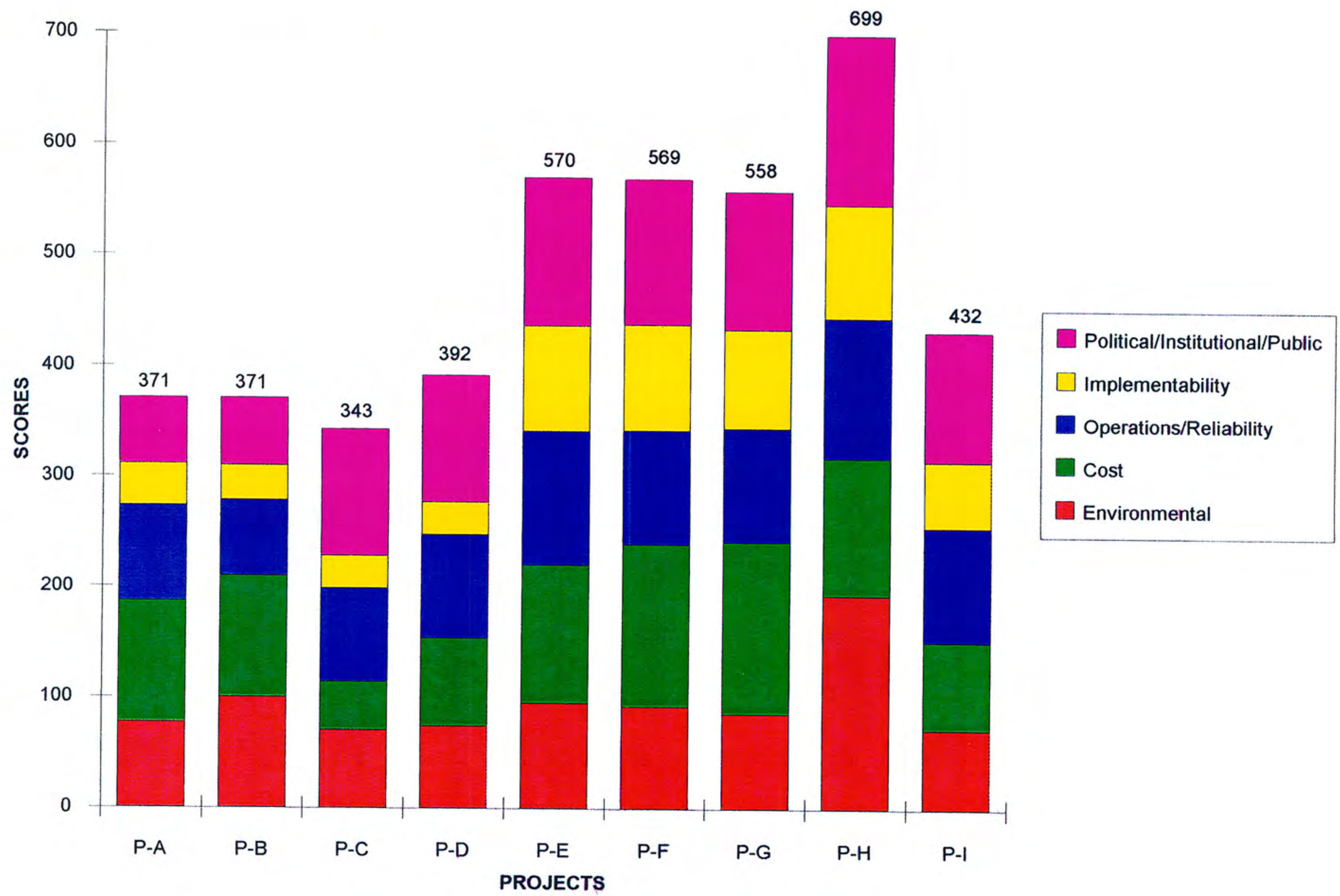
The Technical Advisory selected the criteria for evaluating projects at a workshop, held in June 1993. At the workshop, the Committee also developed relative weights for each of the criteria, based on the relative importance of the criteria. Each of the workshop participants developed relative weights for the criteria and then the group developed a group weight through discussion.

A sensitivity analysis was performed using the individual criteria weightings developed by the participants in the June 1993 workshop. Each of the projects was scored using the individual weightings to see what impact individual scores had on the overall rankings. In all cases, Project P-H remained the highest ranked project. Project P-H had the highest score overall and the highest score in each category except cost.

1.12 Conclusions and Discussion of Recommended Project

Based on the comparison and ranking of the alternatives the following conclusions have been developed:

Figure 1-2
Comparison of Projects for Group Evaluation Criteria Weights



Project P-H, which consists of groundwater wells at Thurber Lane and Brackish Groundwater wells with Reverse Osmosis Treatment, was the highest ranking project. The project has the highest ranking for the Environmental, Operations/Reliability, Implementability, and Political/ Institutional/Public criteria. The project ranked third for the Cost criterion. The project was also the highest ranking project when criteria weighting factors developed by each individual on the Committee were used.

The results of the project evaluation and scoring were presented at a second workshop with the Technical Advisory Committee in September 1993, and the project results were adopted by the Committee.

The proposed project facilities for the recommended project are shown in Figure 1-3 and on the table below. A schematic diagram showing the key components for the recommended project treatment processes is shown in Figure 1-4. For this feasibility study, low pressure reverse osmosis was selected for the general comparison of alternatives because it has been used successfully in many facilities and has proven cost effective. As part of the preliminary design of any treatment facility, a more detailed comparison of alternatives should be prepared to determine technologies appropriate for this installation.

Recommended Project Facilities and Yields

Project Identifier	Project Description	Formulation of Project	Project Yield (MG/yr)	
		Major Features	Critical (2-Year) Drought	Extended (5-Year) Drought
P-H	"No Reservoir" Project (Brackish Groundwater w/RO Treatment and Thurber Lane Groundwater Wells)			
	■ Thurber Lane Groundwater Wells	■ Two 0.35 MGD wells. ■ 0.7 MGD iron and manganese water treatment plant at upper site. ■ 3,500 feet of new pipeline.	120	120
	■ Brackish Groundwater with Reverse Osmosis Treatment	■ Two 2.9 MGD well fields in Davenport and Majors Creek areas. ■ 20,000 feet pipeline from Davenport to Majors. ■ 4.9 MGD reverse osmosis treatment plant at Majors producing 3.9 MGD of treated water and 1.0 MGD brine. ■ 0.9 MGD brackish water bypass which would be blended with 3.9 MGD of treated water to produce a 4.8 MGD blended supply. ■ 320 HP pump station at treatment plant. ■ Parallel Coast pipeline. ■ 36,000 feet of brine disposal pipeline.	870	470

The construction cost estimate for this project is $40 million in 1993 dollars. This includes an estimated $25 million in base construction costs, $7 million for contingencies, and $8 million for engineering, legal, administration, environmental documentation and environmental mitigation and monitoring.

The estimated present worth cost of the project, including capital, operating and maintenance costs is $58 million in 1993 dollars. Operating and maintenance costs were estimated assuming operation of the facility once every ten years, on average. Based on this operation, the breakdown of the $58 million is $48 million for amortization of capital facilities and $10 million for operating and maintenance costs, or about 17 percent of the total present worth cost. Operating the facility more frequently would affect the operating and maintenance cost proportionally. For example, operating the facility once in five years at the same production rate would raise the present worth cost to $20 million for operation and maintenance and $68 million overall. The City will need to consider the benefits and costs of operating the facility on a more frequent basis.

The estimated uniform annual cost of the project is $4.4 million, which includes $3.9 million for amortized capital costs and $0.5 million for annual operating costs. Annualized capital costs were computed assuming a 50-year project life and an 8 percent bond rate. Components with a shorter life were assumed to be replaced, as needed. Annual operating and maintenance costs were computed assuming a 4 percent inflation rate.

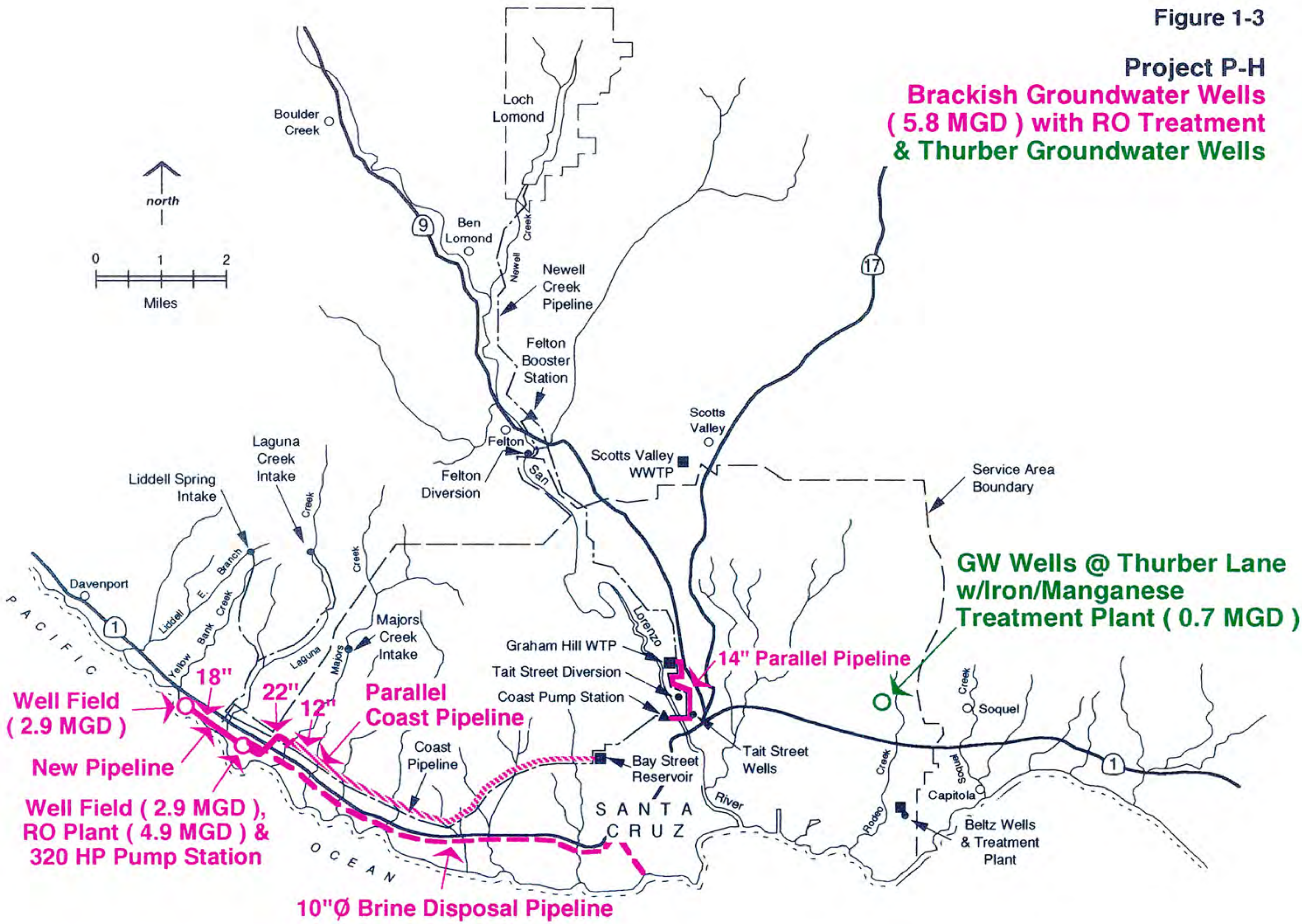
With the selection of a project in this study, the next steps in the planning process are the preliminary design and project environmental review phases. Several key issues will need to be addressed in the preliminary design phase of the project. Some of these issues include:

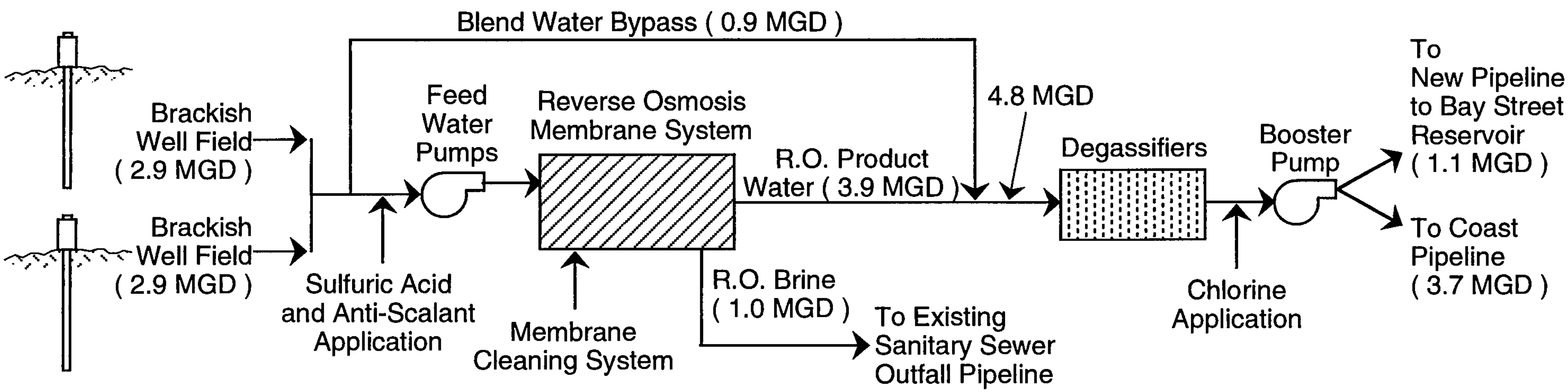
- the testing of proposed pumping rates for the brackish groundwater resources;
- the location of brackish groundwater wells and reverse osmosis treatment plant;
- the method of brine disposal; and
- the location for the reverse osmosis treatment facilities.

Specific tasks to address these issues may include the geophysical explorations and the installation of deep test wells to assess aquifer water quality and production; studies to assess brine disposal options; and discussions with the Regional Board regarding permitting requirements. These tasks would be performed during the preliminary design phase of the project. It may be possible to perform some of the environmental review and preliminary design concurrently. However, project elements will need to be well defined before the environmental review can be conducted. A timeline to implement the project is shown on Figure 1-5.

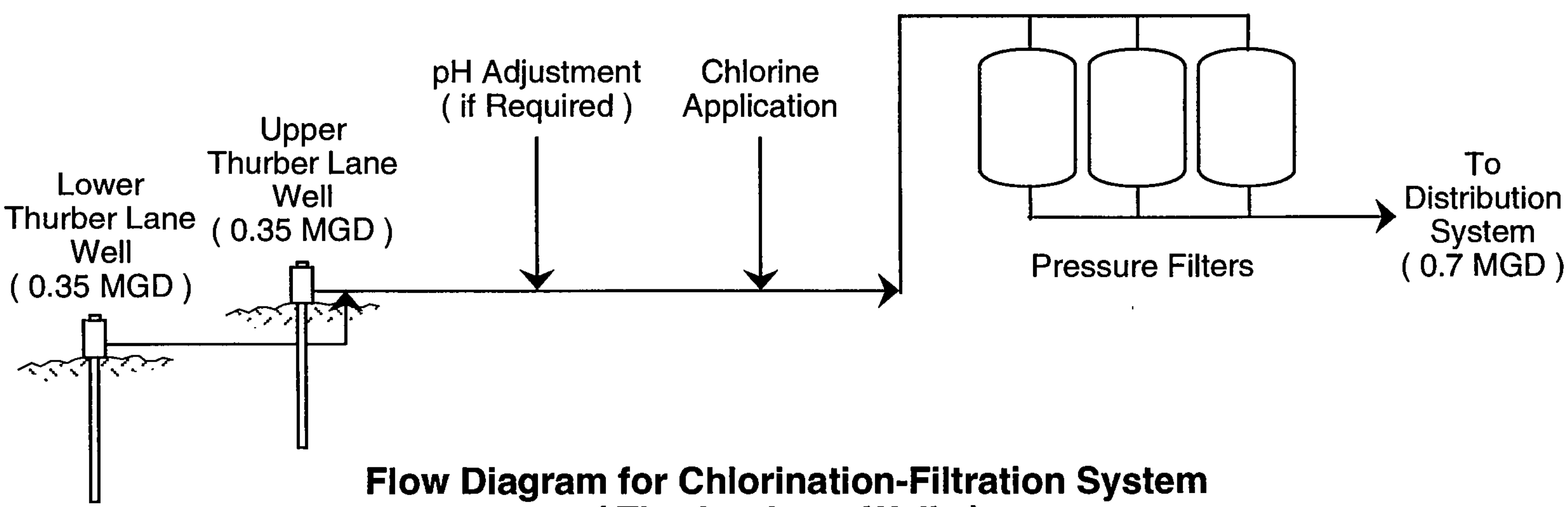
Figure 1-3

Project P-H
Brackish Groundwater Wells (5.8 MGD) with RO Treatment & Thurber Groundwater Wells





Flow Diagram for Reverse Osmosis System (Brackish Groundwater)

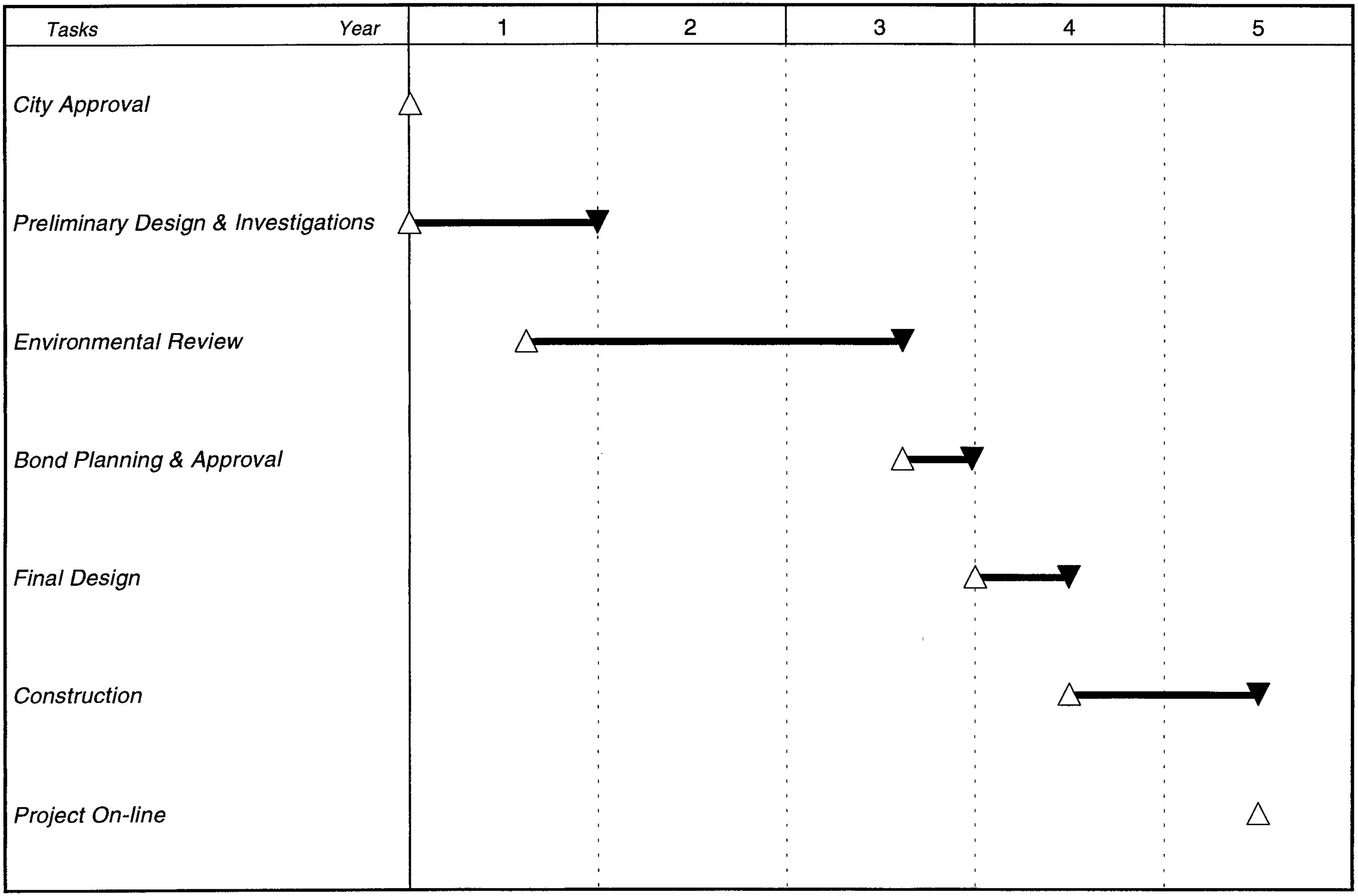


Flow Diagram for Chlorination-Filtration System (Thurber Lane Wells)

Figure 1-4

Treatment Flow Diagrams for Recommended Project

Figure 1-5
Proposed Project Timeline
Brackish GW Wells with RO Treatment & Thurber Lane GW Wells



Section 2
Study Overview

This section describes the purpose and structure of this study, the interrelationship of the study phases, and the general scope of each phase.

2.1 Introduction and Background

The City of Santa Cruz is investigating the need for increased water supply capability to meet its projected water demands. The City's 1989 Water Master Plan developed water demand projections and identified alternatives to increase the existing water supply.

The purpose of this study is to build on the 1989 Water Master Plan and evaluate potential water supply projects to meet the City's needs. The study included a review of the Water Master Plan alternatives, and the inclusion of two new alternatives. Based on these alternatives, nine projects were formulated which were evaluated and compared to develop a recommended project for environmental review and preliminary design.

The City retained Camp Dresser & McKee (CDM) to perform this study. A team of subconsultants assisted CDM to comprehensively address the diverse aspects of the evaluation. These subconsultants and their specialties are: EIP Associates (Environmental); ESA Consultants (Geotechnical/Seismic, Reservoir); Geoconsultants (Hydrogeology, Groundwater); and D.W. Alley and Associates (Fisheries).

As part of the study, a Technical Advisory Committee (Committee) was established by the City of Santa Cruz to review project progress and provide input at key project milestones. The Committee is comprised of the members of the Santa Cruz Water Commission, two members of the Santa Cruz City Council and two members of the Santa Cruz Water Department. The eleven committee members are: Water Commissioners Bill Cox, Toby Goddard, Charles Keutmann, Judy Myers, Dora Nur, David Pais, and Andrew Schifferin; Council Members Katheryn Beiers and Louis Rittenhouse; and Water Department Director Bill Kocher and Deputy Director/Engineering Manager Nick Ferrari.

This study uses a systematic evaluation process to ensure that critical issues are addressed, and that appropriate decisions can be reached. Potential projects are evaluated with respect to engineering, environmental, institutional, and cost factors. The objectives of the evaluation process are: (1) to help identify the best project(s); (2) to facilitate understanding of the relative merits of each project; and (3) to establish a framework to reach a consensus decision. The working definition of consensus is ". . . a project that all decision makers can understand and support even if it is not their personal favorite."

This study is divided into a three phase evaluation process consisting of:

- Phase I - Alternatives Verification/Data Validation
- Phase II - Fatal Flaw Screening
- Phase III - Detailed Evaluation of Potential Projects

A schematic of this process is shown in Figure 2-1. An overview of the scope of services of each phase is included later in this section.

Phase I reviewed the potential water supply alternatives identified in the 1989 Water Master Plan, developed possible new alternatives since the Master Plan, and prepared current yield estimates for the water supply alternatives. The purpose of the Phase I work was to identify and reach consensus on the water supply alternatives to be evaluated in this study.

In Phase II, the water supply alternatives identified in Phase I were screened for "fatal flaws" which could preclude their implementation. The purpose of the Phase II work was to exclude infeasible alternatives from further analysis.

In Phase III, potential water supply projects were developed from the feasible water supply alternatives that passed the Phase II fatal flaw screening. These projects consist of various combinations of the feasible alternatives that will meet the City's water supply needs. Phase III evaluated and ranked these potential water supply projects. Based on the results of the evaluation and scoring of projects, a project was recommended by the consulting team for carrying forward to the environmental review and preliminary design. This recommendation was adopted by the Technical Advisory Committee.

2.2 Phase I Scope - Alternatives Verification/Data Validation

Phase I focused on identifying and reaching consensus on the water supply alternatives that would undergo the evaluation process. A significant amount of work was done on potential water supply alternatives as part of the 1989 Water Master Plan. This study used the alternatives identified in the 1989 Master Plan as its starting point in order to avoid duplication of effort.

Refinements to the previously developed alternatives and possible new alternatives were identified that considered new information available since the 1989 Master Plan (April 1989). This new information included better defining possible reservoir alternatives, assessing the possible impacts of the October 1989 Loma Prieta earthquake, and investigating possible new technologies such as reverse osmosis treatment of brackish groundwater.

Phase I identified appropriate water supply alternatives for this study based on review and refinement of the 1989 Master Plan alternatives, as well as formulation of new alternatives. The facilities requirements and incremental yield estimates were determined for each Phase I water supply alternative.

Phase I - Alternatives Verification/ Data Validation

- Task I.1 Review Available Data and Previous Alternatives
- Task I.2 Identify Other Possible Alternatives
- Task I.3 Compile Facilities and Operational Features of Preliminary Alternatives
- Task I.4 Prepare Draft Technical Memorandum on Preliminary Alternatives
- Task I.5 Meet with SCWD to Verify Alternatives for Further Analysis
- Task I.6 Finalize Technical Memorandum on Phase I

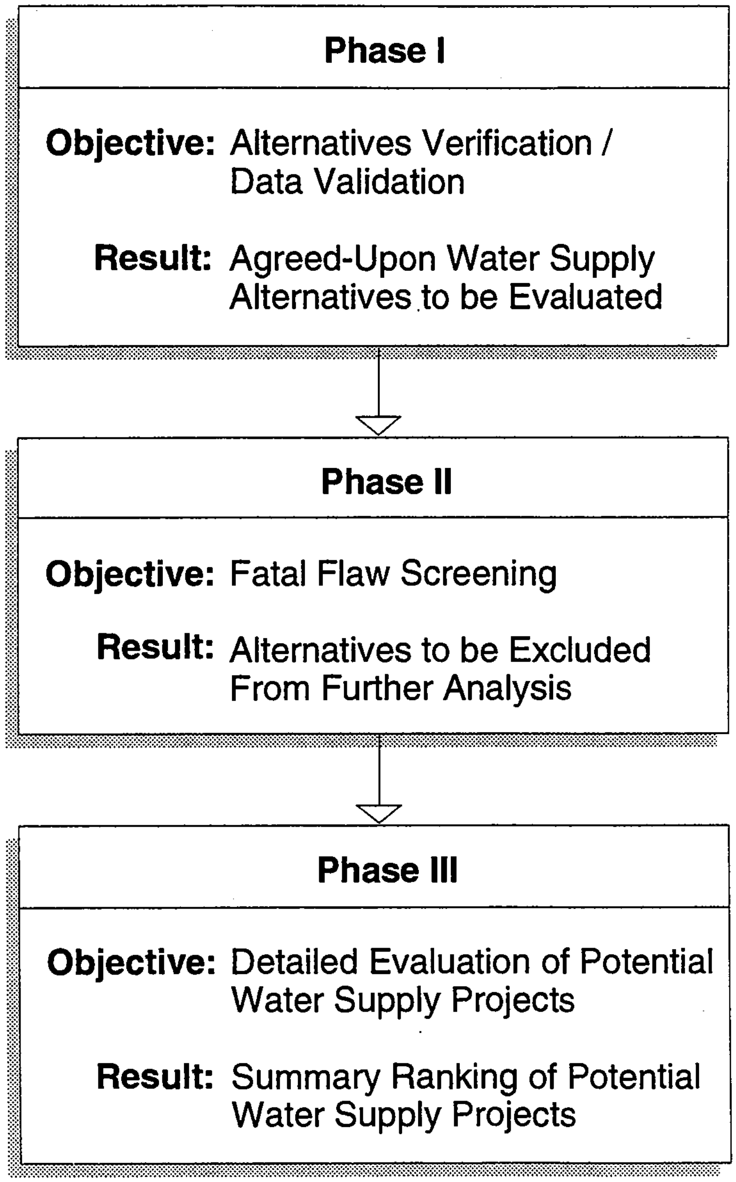


Figure 2-1

**Study Phases -
Schematic of Evaluation Process**

2.3 Phase II Scope - Fatal Flaw Screening

The purpose of the Phase II fatal flaw screening was to detect any environmental or engineering conditions that would make implementation of an agreed-upon Phase I water supply alternative impossible or very difficult. The fatal flaw screening identified those alternatives which were not feasible, and focused the subsequent, more detailed, Phase III evaluation only on feasible alternatives.

Specific "exclusionary criteria" were developed for the fatal flaw screening. These exclusionary criteria were significant engineering and environmental short-comings that would make an alternative infeasible and effectively prohibit its implementation, including: engineering constraints that would make the project not implementable; the presence of significant regulatory or institutional constraints that would prevent timely development and operation; the presence of unmitigatable geologic, seismic, and hydrologic hazards; and the presence of threatened, rare, or endangered plant or animal species. A meeting was held with SCWD to discuss and reach agreement on the proposed exclusionary criteria.

The fatal flaw analysis involved collecting data about the exclusionary criteria in relation to each of the alternatives. Much of this effort involved review of existing records and the information developed during Phase I. Field work was performed as necessary to supplement existing information. This field work included characterizing fisheries habitat; performing surficial and photogeological reconnaissance at proposed reservoir/dam sites; visiting proposed reservoir and diversion sites to check information in the California Natural Diversity Data Base (CNDDB) and to identify any additional biological issues of concern; and identifying and contacting local, state, and federal agencies with jurisdiction over the projects and applicable regulations.

The information about the alternatives developed in Phase I was supplemented with the new information. For the fatal flaw screening, the information for each alternative was compared with the exclusionary criteria to determine if a fatal flaw existed. If any of the exclusionary criteria were present for an alternative, then a fatal flaw was identified. Any alternative with a fatal flaw was recommended for exclusion from the Phase III analysis.

The Phase II evaluation also identified issues which would have a significant impact on implementation and/or cost of alternatives, even though not fatal flaws. These issues were also considered in the subsequent detailed evaluation in Phase III.

Phase II - Fatal Flaw Screening

- Task II.1 Develop Exclusionary Criteria
- Task II.2 Perform Analysis for Fatal Flaws
- Task II.3 Screen Alternatives for Fatal Flaws
- Task II.4 Prepare Draft Technical Memorandum on Fatal Flaw Screening Results
- Task II.5 Meet with SCWD to Discuss Screening Results
- Task II.6 Finalize Technical Memorandum on Phase II

2.4 Phase III Scope - Detailed Evaluation of Potential Projects

The purpose of the Phase III work was to evaluate potential water supply projects developed from the feasible water supply alternatives (i.e., alternatives without fatal flaws based on the Phase II screening). These projects consisted of various combinations of the feasible alternatives that will meet the City's water supply needs. The potential projects were evaluated and ranked with respect to engineering, environmental, institutional and cost factors.

Evaluation criteria were developed and assigned relative importance at a workshop with the Technical Advisory Committee. These agreed-upon criteria and corresponding weights were used to evaluate the potential water supply projects using a numerical scoring system.

The CDM team prepared the preliminary evaluation of the potential water supply projects based on the agreed-upon weighted evaluation criteria. A second workshop was held with the Technical Advisory Committee to discuss the preliminary evaluation results and reach consensus on the ranking of the projects.

This report presents the Phase III evaluation methodology and findings, the consensus reached on project rankings at the second workshop, and the Phase I and Phase II findings. After submittal of the final report to the City, a presentation will be made to the Water Commission and City Council.

Phase III - Detailed Evaluation of Potential Projects

- Task III.1 Develop Weighted Evaluation Criteria
- Task III.2 Perform Analysis for Ranking Potential Projects
- Task III.3 Evaluate Potential Projects With Weighted Criteria
- Task III.4 Prepare Draft Summary Report on Evaluation Results
- Task III.5 Meet With SCWD on Ranking of Potential Projects
- Task III.6 Finalize Summary Report
- Task III.7 Present Information to Water Commission and City Council

Section 3
Water Demands

This section describes the water demand projections used to determine the adequacy of the existing water supply system to meet future demands. It defines the service area for the demands, gives the basis for the projections, and presents year 2005 water demands, with and without conservation savings.

3.1 Service Area

The service area used for water demand projections in this study consists of the existing SCWD service area as defined in the 1989 Water Master Plan. The boundaries of this service area encompass the area within which the SCWD can currently extend water service without special approval from the City Council. The service area includes some unincorporated areas such as the Pasatiempo-Carbonera area just north of the city limits and the Live Oak area to the east of the city limits. The service area also includes the University of California at Santa Cruz (UCSC), a limited area within the Capitola city limits, and several domestic and agricultural connections along Highway 1 on the North Coast.

3.2 Basis For Demand Projections

As part of the 1989 Water Master Plan, a thorough survey of projected land use, population, and housing was conducted to estimate the potential increase in water demands within the SCWD service area through year 2005.

In recognition of uncertain conditions, different growth scenarios were examined in the 1989 Master Plan to represent the potential range of water supply requirements in year 2005. One scenario was based on a 12,000 enrollment at UCSC in 2005, an assumed irrigation demand for 10 percent of the existing greenbelt acreage (other 90 percent undeveloped), and slower growth in the unincorporated portion of the SCWD service area due to the urban service evaluation criteria (USEC) adopted by the County Board of Supervisors to evaluate housing and commercial projects. A second scenario was based on a 15,000 enrollment at UCSC in 2005 and development of the greenbelt areas within the City in accordance with their zoning. This second scenario was selected as the more appropriate representation of future growth for planning purposes in this study. This projected growth scenario will be subject to review in the project EIR.

Table 3-1 summarizes the key housing, population, and land use forecasts in the 1989 Master Plan for the planning scenario which was the basis for developing the water demand projections used in this study.

3.3 Year 2005 Water Demand Projections

This study used the water demand projections for year 2005 as presented in the 1989 Water Master Plan. These water demand projections are shown on Table 3-2.

Table 3-1
Year 2005 Housing, Population, and Land Use Forecasts from the 1989 Water Master Plan

	Year 2005
Housing Units	
Unincorporated Area and Capitola	16,249
Santa Cruz	23,802
Total Housing Units	40,051
Population	
Unincorporated Area and Capitola	44,162
Santa Cruz Including UCSC	63,586
Total Population	107,748
Enrollment at UCSC	15,000
Nonresidential Land Use	
Commercial Acreage	1,038
Industrial Acreage	319
Other Acreage (primarily irrigated areas such as parks, cemeteries, highway medians)	618
Total Nonresidential Acreage	1,975

Table 3-2
Year 2005 Water Demands[1]

	Year 2005 Demands	
	MG/day	MG/year
SCWD Service Area Without UCSC		
Residential	9.10	3,323
Commercial	1.30	473
Industrial	1.09	398
Other (park, cemeteries, agriculture, greenbelt)	0.88	319
Subtotal - SCWD Without UCSC	12.36	4,513
UCSC	1.27	465
Total	13.63	4,978
Unaccounted-for-Water[2]	0.55	199
GRAND TOTAL	14.18	5,177

[1]Source of Information: 1989 Water Master Plan
[2]Based on 4 percent of total.

These demands were determined by multiplying the housing, population, and land use forecasts by appropriate unit water use factors developed in the 1989 Master Plan. The unit demand factors were developed from historic data and compared with other studies to verify their reasonableness.

The total estimated demand was then increased by 4 percent for unaccounted-for-water due to system losses such as leaks, fire flows, and metering losses. The appropriate percentage for unaccounted-for-water was based on data after 1982 when the SCWD implemented its leak detection program.

3.4 Adjusted Year 2005 Water Demand Projections With Conservation Savings and Demand Reduction Due to Drought Restrictions

In the water demand projections prepared for the Master Plan, the impacts of conservation measures were only included for indoor residential use in future construction. The Master Plan assumed that future residential dwelling units would use approximately 19 percent less indoor water than the current average residential dwelling unit. Other potential conservation impacts such as increased use of low water-using landscape materials were not included in the demand projections because of their uncertain impact on future water demand.

Currently, a retrofit program proposed by the SCWD as part of its water conservation program is anticipated to result in water conservation savings from existing customers of 180 MG/year. This retrofit program includes ultra-low flush toilets as well as low flow showerheads and faucets. In addition, the City is implementing an education program to promote voluntary conversion of turf to xeriscape landscaping. Once the lower water use fixtures are installed, the conservation savings will be permanent.

For this study, a feasible temporary reduction in total water demands during droughts was also estimated for planning purposes. In 1988 through 1992, the City had restrictions on water use with summer demand reductions typically ranging from 20 to 30 percent below 1987 demands. Some individual months were as much as 45 percent below the 1987 demand level. The City also achieved some wintertime demand reduction in these years, typically on the order of 5 to 10 percent. The annual average reduction in demand was 8 percent for 1989, 22 percent for 1990, and 20 percent for 1991.

Approximately 70 percent of the City's demand occurs during the dry season from April through October. The City must supplement its supply with withdrawals from reservoir storage during that period. However, the City can typically meet rainy season demands with its river diversions. Therefore, in considering demand reductions, it was recognized that reductions would occur primarily during the dry season. A 15 percent summertime reduction (which would be equivalent to a 10 percent annual reduction) was established for planning purposes. The Water Commission established this level of reduction as reasonable, since it can generally be achieved with voluntary conservation measures.

Based on the anticipated reductions in demand, the water demand projections in Table 3-2 were adjusted. Table 3-3 summarizes the year 2005 water demand projections with conservation savings and with demand reductions due to drought restrictions.

Table 3-3
Adjusted Year 2005 Water Demands With Conservation Savings and Drought Restrictions

	Year 2005 Adjusted Demands	
	(MG/day)	(MG/year)
Total Demand for SCWD Service Area With UCSC[1]	14.18	5,177
Permanent Conservation Savings due to Retrofit and Education Programs	(0.49)	(180)
Subtotal	13.69	4,997
Temporary Demand Reduction due to Drought Restrictions[2]	(1.37)	(500)
Total Adjusted Demand with Conservation Savings and Drought Restrictions	12.32	4,497

[1]Source of Information: 1989 Water Master Plan (as shown in Table 3-2 herein)
[2]Calculated as a 15 percent reduction in summertime demand, which is equivalent to a 10 percent annual reduction.

Section 4
Existing Water Supply System

This section describes the existing water supply system and operations, presents estimates of the safe annual yield of the existing system, and describes the methodology to determine yields.

4.1 Existing Water Supply System

The existing SCWD water supply system was described in detail in the 1989 Water Master Plan. The SCWD supply system is comprised of the following four main production elements: the North Coast; the San Lorenzo River (Tait Street Diversion and Felton Diversion); Loch Lomond on Newell Creek; and the Beltz wells. The existing water supply facilities are shown on Figure 4-1.

4.1.1 North Coast

The North Coast water supply system consists of surface diversions from three coastal streams and one natural spring located approximately six to eight miles northwest of downtown Santa Cruz. These sources are Liddell Spring, Laguna Creek, Reggiardo Creek, and Majors Creek.

Liddell Spring is a natural spring used for water supply and was developed in 1913. The spring "diversion" is located at elevation 584 feet. Water from the spring is directed through a 10-inch steel pipeline into the Coast Pipeline for transmission to the SCWD service area.

Flows from Reggiardo Creek are captured at a diversion dam located at elevation 630 feet. Diversions from Reggiardo Creek are diverted through about 850 feet of pipeline to Laguna Creek. Flows from Laguna Creek and diversions from Reggiardo Creek are captured at a concrete and limestone dam located at elevation 623 feet on Laguna Creek. The original dam constructed in 1890 is still in use today. These diversions are sent through 12,400 feet of 14-inch steel pipeline to the junction with the transmission pipeline from Liddell Spring (the Laguna-Liddell "Y").

Flow from Majors Creek is diverted from a concrete dam located at elevation 352 feet, which was built in the late 1800's. Diversions from Majors Creek are conveyed through 11,300 feet of pipeline varying between 10 and 16 inches in diameter before joining the main Coast Pipeline along Highway 1. Because the Majors Creek diversion is located at a much lower elevation than the other North Coast sources, a check valve is located at the lower end of the Majors Creek transmission pipeline to prevent backflow from the other sources. Thus, use of the Majors Creek Diversion is presently limited by the hydraulic loading from the other North Coast sources.

Water from the North Coast diversions flows by gravity to the northwest portion of the SCWD system via the Coast Pipeline, which varies from 16 inches in diameter between the Laguna-Liddell "Y" and Majors Creek up to 24 inches in diameter near Bay Street Reservoir. Several sections of this pipeline have been replaced over the years due to deterioration and excessive headlosses. According to SCWD staff, the Coast Pipeline has a minimum design pressure rating of 150 pounds per square inch (psi).

Water from the Coast Pipeline is boosted at the Coast Pump Station to the Graham Hill Water Treatment Plant for complete treatment. In the past, North Coast diversions have also been made directly into the SCWD distribution system at Bay Street Reservoir during certain periods, but this practice has been discontinued due to new drinking water regulations.

4.1.2 San Lorenzo River - Tait Street Diversion

San Lorenzo River (SLR) flows are diverted for use at the Tait Street Diversion just north of Highway 1. Water is diverted at a concrete check dam into a screened intake sump where three vertical turbine pumps are used to pump the water to the Graham Hill Water Treatment Plant. These pumps are located in the same building as the pumps for the North Coast diversions. Due to severe flood damage potential, the Tait Street surface diversion intake was relocated to the west side of the river. This relocation is expected to withstand major flood events with only minor damage.

The Tait Street Diversion also includes three wells located on the east side of the river, ranging in depth from 85 to 104 feet, which are tied to the City's appropriative rights for San Lorenzo River flows. The wells are extremely old and are in need of rehabilitation. Based on prior study, the Tait wells are believed to be at least partially hydraulically connected to the river. Thus, withdrawals from the wells may decrease the flows in the river and little long-term storage is obtained from the aquifer.

Water produced by the Tait wells is delivered to a separate sump on the west side of the river through a 16-inch diameter pipeline crossing under the river. The groundwater is then pumped into a common 24-inch diameter transmission pipeline used to convey water from both the North Coast and San Lorenzo River sources to the Graham Hill Water Treatment Plant, approximately one mile north of the San Lorenzo River-Tait Street Diversion.

4.1.3 San Lorenzo River - Felton Diversion

The Felton Diversion is located on the San Lorenzo River just downstream of the Zayante Creek confluence, which is approximately five river miles north of the Tait Street Diversion. The diversion structure consists of an inflatable rubber dam to divert flows into a screened intake sump. Flows are then pumped through the Felton Booster Station into Loch Lomond for storage via the Newell Creek Pipeline. The desired diversion rate is regulated by using different combinations of the three pumps at the Felton Diversion and the six pumps at the Felton Booster Station. The SCWD plans to improve the Felton Booster Station as recommended in the 1989 Master Plan.

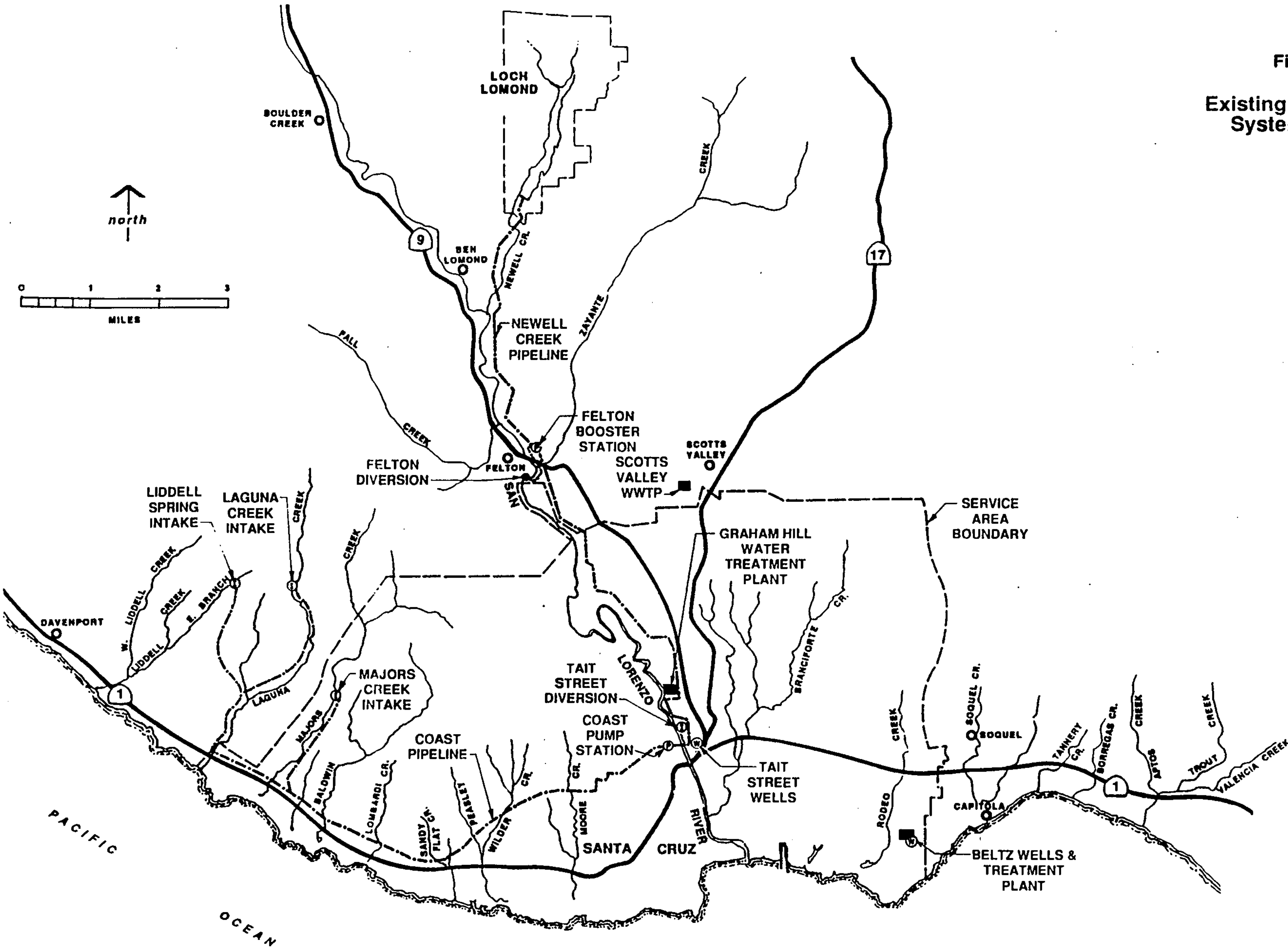
4.1.4 Loch Lomond on Newell Creek

Loch Lomond was created by the construction of Newell Creek Dam, located about ten miles north of Santa Cruz near the town of Ben Lomond. The reservoir was constructed in 1960 to store up to 2,810 MG (8,500 AF) for use by SCWD. Loch Lomond is the only major reservoir in the San Lorenzo River watershed.

Newell Creek Dam is an earthfill dam, 190 feet high and 750 long at the crest. The spillway crest is at elevation 577 feet. Releases from the reservoir are made through outlet works on the upstream face of the dam. The lowest outlet is at elevation 470 feet. At maximum capacity of 2,810 MG, Loch Lomond covers an area of 180 acres.

Figure 4-1

Existing Water Supply System Facilities



Loch Lomond is relatively undersized for its watershed. The average annual inflow is about 1,825 MG/year. Therefore, because only 2,810 MG of storage capacity is available, the reservoir frequently spills. In fact, except for very dry years, the reservoir is normally completely full by late Spring.

In drier years, Loch Lomond inflow can be supplemented by water from Felton Diversion. The diversion is located on the San Lorenzo River approximately five river miles north of the Tait Street Diversion just downstream of the Zayante Creek confluence. The diversion structure consists of an inflatable rubber dam to divert flows into a screened intake sump. Flows are then pumped through the Felton Booster Station and into Loch Lomond for storage via the Newell Creek Pipeline, a steel concrete cylinder pipeline which varies from 18 to 27 inches in diameter. The desired diversion rate is regulated by using different combinations of the three pumps at the Felton Diversion and the six pumps at the Felton Booster Station.

Water released from Loch Lomond for use by SCWD is conveyed to the Graham Hill Water Treatment Plant through the Newell Creek Pipeline. The water flows by gravity from the reservoir to the Felton Booster Station, approximately 4.3 miles downstream of the dam. The water is then pumped at Felton Booster Station to clear a ridge in Henry Cowell State Park at an elevation of about 580 feet. In order to meet fluctuating head-flow conditions, six pumps and alternative valving configurations are available at the Felton Booster Station.

4.1.5 Beltz Wells

The Beltz well system consists of five groundwater wells located in the southeastern portion of the SCWD service area. The wells were incorporated into the SCWD system in 1967 after the City purchased the system from the Beltz Water Company. Water pumped from the wells is treated for iron and manganese removal at the Beltz Water Treatment Plant and is delivered directly into the distribution system.

4.2 Water Rights

In the 1989 Water Master Plan, all available water rights documents for the SCWD sources were collected and reviewed. The water rights currently held by SCWD are shown below. Limitations caused by these rights, which have an influence on the yield of the water supply system, were included in the analysis of the system's operation.

Summary of Water Rights From 1989 Water Master Plan

Source	Period	Maximum Diversion Rate (cfs)	Fish Flow Requirement (cfs)	Annual Diversion Limit (MG/year)
North Coast[1]	Year-round	No limit	None	None
San Lorenzo River				
Tait Street Diversion and Wells	Year-round	12.2	None	None
Felton Diversion to Loch Lomond Reservoir	October	20.0	25	977
	November-May	20.0	20	
	June-August	---	---	
Loch Lomond Reservoir on Newell Creek				
Collection	September-June	No limit	---	1,825
Withdrawal	Year-round	---	1	1,042

(1) Water rights for City of Santa Cruz North Coast Sources are pre-1914 rights with all downstream rights purchased by City; therefore, City may divert up to the full natural flow of each stream.

4.3 Key Hydraulic Constraints of Existing Water Supply System

In the 1989 Water Master Plan, the hydraulic capacities of the SCWD water supply facilities were determined for use in hydrologic and operations studies of the entire supply system. The key hydraulic constraints are noted below. These constraints also apply to the work performed for this study.

4.3.1 North Coast

Water supply from the North Coast including Laguna, Reggiardo, Majors, and Liddell Springs is pumped by the Coast Pump Station to the Graham Hill Water Treatment Plant for treatment prior to distribution. The capacity of the North Coast system is affected by the operation of the San Lorenzo River-Tait Street pumps. The maximum flow capacity from the North Coast System ranges from 9.4 cfs when the Tait Street pumps are not operating to less than 9 cfs when these pumps are operating.

4.3.2 San Lorenzo River (Tait Street Diversion)

The San Lorenzo surface diversion pumps are impacted by the operation of the Tait Street wells and the Coast Pump Station. When the surface diversion pumps are operating alone, they have an estimated delivery capacity of 11.2 cfs. The Tait Street wells operating alone have a capacity of 1.9 cfs. When both the wells and the diversion pumps are operated together, the capacity is approximately 12.9 cfs. When the Coast Pump Station is operating the combined flow from the Tait Street wells and the surface diversion pumps drops to approximately 10.9 cfs. The Coast Pump Station normally operates at maximum capacity during the high runoff months during the winter.

4.3.3 San Lorenzo River (Felton Diversion)

Although adequate pumping capacity is available for diversions up to about 14 cfs, production from Felton Diversion is limited by the internal design pressure of the pipeline between the Felton Booster Station and Loch Lomond. This pipeline was originally designed to convey water from Loch Lomond to Felton Booster Station. At the critical segment on the reservoir side of Felton Booster Station, the maximum pressure (under static conditions) would be about 135 psi (577 feet at reservoir less ground elevation at Felton Booster of about 260 feet). Hence, the pipeline was designed for a maximum operating pressure of 150 psi at this point. Although a factor of safety is typically included for surge protection, operation at pressures well above the design pressure is not prudent.

Based on the design pressure of the pipeline, the maximum capacity of Felton Diversion is restricted to about 8.6 cfs when Loch Lomond is nearly full in order to maintain an operating pressure of 150 psi. Slightly higher diversion rates could be used if the reservoir is considerably lower than its maximum elevation. Based on a review of daily records, diversions well above 9 cfs have occurred in the past with no apparent adverse effects.

4.3.4 Newell Creek (Felton Booster Station)

With all six pumps operating, Felton Booster Station is able to pump a maximum of between 11.2 and 14.4 cfs from Loch Lomond depending on the water level at the reservoir. With only the three large pumps (1, 3, 5) operating, the capacity is between 7.8 and 11.2 cfs depending on the reservoir level.

4.3.5 Beltz Wells

The City has experienced operating problems with the wells in the last few years due primarily to their age. A study is currently underway to evaluate the Beltz wells and to recommend a rehabilitation plan. Based on discussions with the City, the Beltz wells can operate at a sustained capacity of 1 MG/day.

4.4 Current Water Supply System Operations

This section provides an overview of the current operations of the City's existing water supply system. It updates the information in the 1989 Water Master Plan to reflect current conditions. The SCWD uses numerous procedures and informal rules to operate the water supply system. In general, the SCWD supply system is operated to use the better quality and less expensive sources first while maintaining a reasonable reserve in Loch Lomond.

Due to excellent water quality and the lowest production cost of the City's water sources, SCWD uses the North Coast sources to the greatest extent possible. North Coast water is used year-round, except during periods of high surface runoff during and immediately after rainfall events when turbidity is high. SCWD must "turn out" the North Coast diversions, whenever turbidity levels rise, in order to provide acceptable drinking water quality for domestic services which are served directly from the Coast Pipeline. However, this condition will change when the parallel North Coast pipeline along Highway 1 from Bay Street Reservoir to Laguna Creek is constructed to serve the domestic customers along the Coast Pipeline. The planned construction of the pipeline is currently in the permitting stage.

If diversions from the North Coast are insufficient to meet demands, either the San Lorenzo River-Tait Street diversion or the Newell Creek system (Loch Lomond) is operated. However, during heavy rainfall, both the North Coast sources and the San Lorenzo River-Tait Street diversion become inoperable due to excessive turbidity. Although the San Lorenzo River water is not delivered directly to customers, potential complications in treating water with high turbidity make diversions from the river undesirable. In such instances, withdrawals from Loch Lomond are made to meet the entire demand.

Due to a number of operational problems, the Beltz Water Treatment Plant has rarely operated at or near its design capacity. Due to the high production costs and less desirable water quality, the Beltz source is generally not utilized to full capacity.

4.5 Historic Hydrology

As part of the 1989 Water Master Plan analysis, a spreadsheet-style model of the water supply system operations was developed to estimate the yield of the water supply system. The spreadsheet model requires historic hydrologic data to estimate available surface runoff. For the Water Master Plan analysis, the 1921 through 1986 hydrologic period was used. As part of this study, the spreadsheet model was updated to include the 1987 through 1991 hydrologic period. The methodology and results of the yield estimates of the existing water supply system are discussed in Section 5.

Updates to the Master Plan hydrology were made for the existing San Lorenzo River diversions at Tait Street and at Felton, North Coast diversions (Liddell Spring, Laguna Creek, and Majors Creek intakes), and Newell Creek inflow (Loch Lomond).

For the Water Master Plan, monthly diversions at the San Lorenzo River were estimated based on the total monthly runoff at the Big Trees gage, with adjustments for channel infiltration losses, turbidity constraints, and the hydraulic capacity of the diversion structure. However, in October 1987, the United States Geological Survey (USGS) re-activated a gaging station just downstream of the San Lorenzo River diversion. Estimates for available diversions at the San Lorenzo River prior to this date were made using the Water Master Plan methodology. Estimates after this date were made using the daily USGS gage data.

Actual production records from the San Lorenzo River Diversion were obtained from the City for 1987 through 1991. The production data was added to the USGS gage data to develop an estimate of total streamflow upstream of the diversion. Monthly estimates of available diversions for 1988 to 1991 were made using the gage data based on the daily flows at the diversion and the hydraulic capacity of the diversion. The Water Master Plan methodology was also used for this period to compare the methodology with computations based on gage data. The results of the comparison indicated that the estimating method used in the Water Master Plan provides a reasonable approximation of available flow.

Section 5
Safe Yield of Existing Water Supply System

5.1 Definition of Safe Yield

The yield of a water supply is the amount of water that can be supplied in a specified interval of time. The "annual safe yield " of a project is the maximum amount of water that can be reliably provided during the most severe hydrologic period. Over the last 70 years there have been several dry periods which have affected the availability of water supply in the Santa Cruz area. The most severe of these periods included the extended dry period of 1928 to 1935, the short critically dry period of 1976 and 1977, and the extended dry period of 1987 through 1991. The periods which have had the most severe impacts on the City of Santa Cruz water supply are the 1976 to 1977, and 1987 to 1991 periods. The safe yield of the existing system is based on 1976-1977 conditions. However, it is important to calculate the yield for both periods, due to the impact of future projects.

The City of Santa Cruz water supply system is composed of many different components including supplies which react differently, and have different yields, depending on the hydrologic conditions. These supplies can be broken into three types; relatively constant yield supplies such as the Beltz wells; supplies which are extremely sensitive to the changes in hydrology - San Lorenzo River, North Coast Diversions, Felton Diversions, and inflow into Loch Lomond; and Loch Lomond reservoir storage, whose yield is dependent on the duration of the period of drought.

The Beltz wells are relatively insensitive to the difference between the 1976-1977 and the 1987-1991 periods as they do not directly respond to surface water runoff, or rainfall. Their long term recharge and water elevation are impacted by the duration of the drought. However, based on the analysis provided in the 1989 Master Plan and review of other studies, it is assumed that the yield will be the same for the critically dry period, and extended dry periods.

Unlike the Beltz wells, the river flows and diversions are extremely sensitive to the differences between the critically dry and extended dry periods. Figure 5-1 indicates the available diversions for the San Lorenzo River at Tait Street, and the existing North Coast supplies. Figure 5-2 indicates inflow to Loch Lomond from Newell Creek and from the Felton Diversion. The Felton diversion flows are all pumped into Loch Lomond. Newell Creek inflows are not gaged; the values are estimated by comparing seasonal changes in reservoir volume versus measured inflows/outflows at other sources. As indicated in the figure, the available flows during 1976 and 1977 are significantly less than those for 1987 through 1991.

5.2 Procedure for Determining Yields

The spreadsheet-type operational model of the water supply system, developed in the 1989 Water Master Plan, was updated and used to calculate system yields in this study. The spreadsheet model is a monthly water accounting model which uses historic hydrologic data and specified operating conditions to estimate the yield of the City's water supply system.

The storage in Loch Lomond at the beginning of a dry period is based on the demands during the previous summer. For both the 1976-77 and 1987-1991 periods, full storage was assumed in

May of the preceding year. Normal demands were assumed from May to January with a reservoir starting storage at 1835 MG in January.

The Operations Model incorporates the following:

- Total runoff at each streamflow diversion adjusted to "available diversions" by including limitations due to water rights, hydraulic capacities of pumps and pipelines, excessive turbidity during rainy periods, and "down times" (percentage of time a facility is assumed to be inoperable).
- Seepage losses between the streamflow gage at the San Lorenzo River at Big Trees and the Tait Street Diversion.
- Hydraulic interactions between the Coast and San Lorenzo River Pump Stations.
- Available production capacity from the Beltz well system.
- Operating rules to determine when to use Tait Wells and/or Loch Lomond during periods of excessive turbidity in surface runoff which renders the North Coast and San Lorenzo River sources inoperable.
- Operating rules to determine if diversions should be made from Felton.
- Operating rules to determine the priority of use for all sources (i.e., which source is used first, second, etc., under various conditions).
- All elements of the water balance at Loch Lomond including storage changes, natural inflows, precipitation, evaporation losses, fish releases, diversions from Felton, releases to SCWD, and spills.

5.3 Reservoir Storage Depletion and Carryover Storage

Typically, reservoir storage is depleted during the dry season and replenished during the rainy season. However, during drought conditions, reservoir storage generally remains depleted for extended periods due to low inflows and the need to supplement reduced flows available from other sources. The amount and duration of the depletion is dependent on the drought conditions.

It is advisable to have some storage available in reserve at the end of the anticipated "worst case" drought, in case of additional years of below normal rainfall. This carryover storage provides a factor of safety in the event of a more severe drought than has been experienced in the historic record. Based on discussions with staff, a carryover storage of 1,000 MG at the end of the drought period was used in calculating the yield. With 1,000 MG carryover storage, the City could supply water for two additional drought years with hydrologic conditions similar to 1976-1977, assuming that rationing was instituted to reduce annual demand by 25 percent.

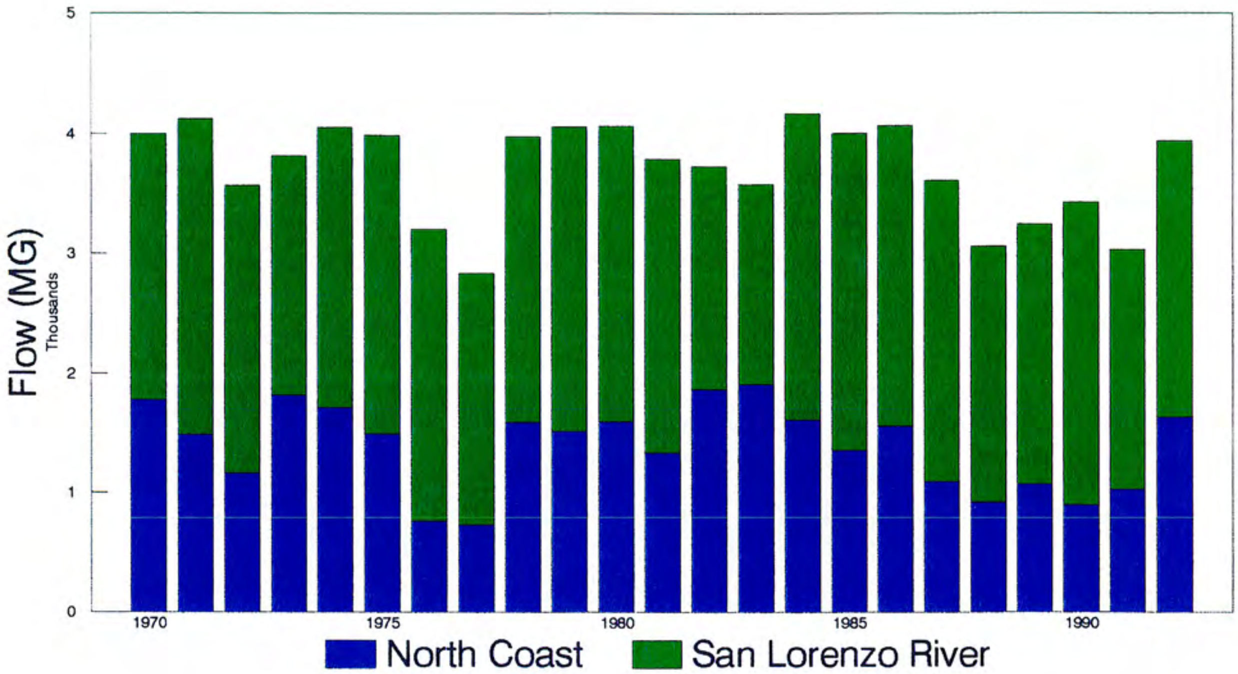


Figure 5-1

Annual Available Diversions from North Coast and San Lorenzo River at Tait Street

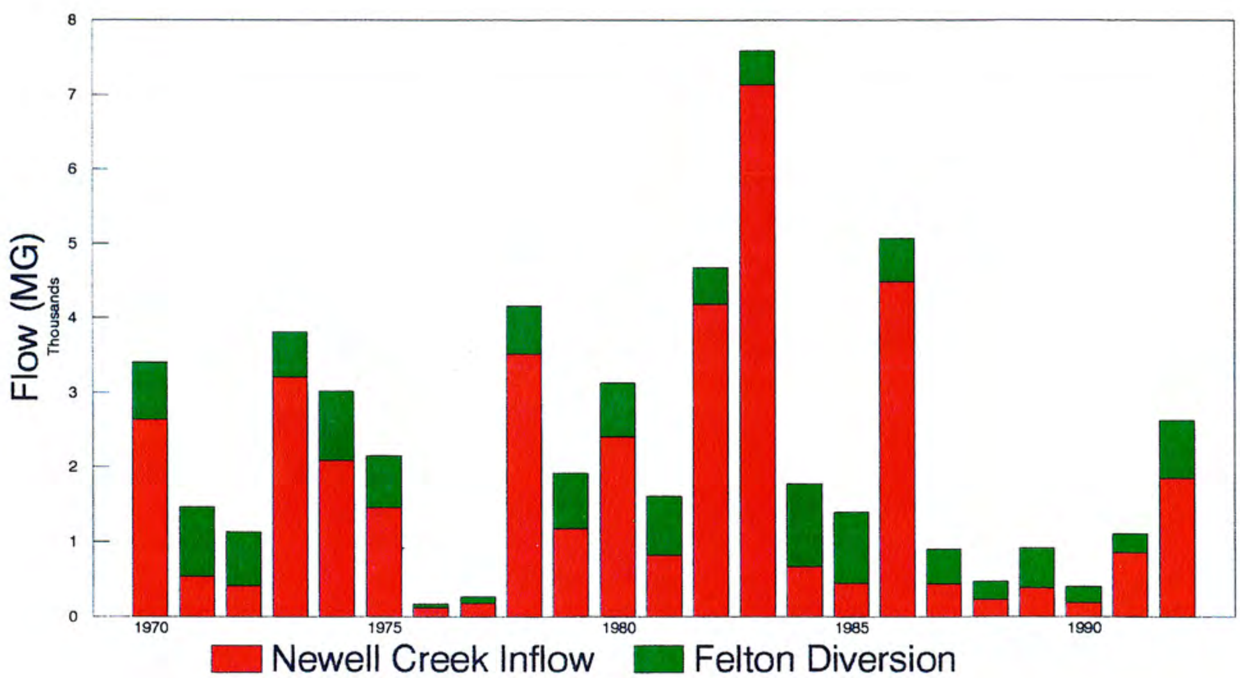


Figure 5-2

Annual Inflows to Loch Lomond

5.4 Verification of Modelled Estimates

Initial model estimates of production from each of the supply sources were compared with actual production records during the 1976-77 and 1987-91 drought periods to see whether there was any obvious bias in the estimating method. The comparison was made by running the operation model for the drought period using actual monthly demands and comparing the estimates of production from each of the sources of supply with actual production records. Loch Lomond inflow estimates were also compared with inflow computed using actual production records. The following was found:

- The estimated available flows at the North Coast diversions were high, and at the San Lorenzo River diversion were low for the 1987-91 drought period, but the combined supply was similar to actual production from these sources. The estimates were closer to actual production data for the 1976-77 period. Because the bias could not be accounted for, actual production estimates were used for both periods.

- The City has, in the last few years, experienced operating problems with the wells, due primarily to their age. Based on discussions with the City, it was assumed that Beltz wells would be able to operate at a sustained capacity of 1 MG/day. A downtime allowance of 2 percent for emergency maintenance and repair was used in calculating the annual yield. It is also assumed that these wells could peak at 2 MG/day during two summer months, and could operate at 1 MG/day for eight additional months. Operating the wells in this manner would provide a total yield of 365 MG/year, which is equivalent to a sustained capacity of 1 MG/day.

- The estimated production from the Felton diversion was higher than observed. Where significant differences were found, City staff reviewed the records to determine the reason for the discrepancies. Part of the difference was attributed to a City water quality policy formalized in 1990 which calls for inflating Felton diversion dam only after the first storm which produces a stream flow of 100 cubic feet per second (cfs) at the diversion. Other differences were attributed primarily to periods of high turbidity in the San Lorenzo River, where Felton diversion cannot be operated because water must be withdrawn from Loch Lomond rather than the San Lorenzo River diversion. Based on the review, actual production from Felton diversion was used in place of estimated values.

- Loch Lomond inflows are not measured. In the operational model, inflows were estimated based on correlation with Zayante Creek. As a check of this correlation, inflows were calculated using storage and production records for Loch Lomond. The estimates for Loch Lomond inflow were found to be slightly lower than flows calculated from operation records. Based on the comparison, minor adjustments were made to the inflow estimates so that the calculated end-of-month storage matched the historic production records.

After making the adjustments, the yield estimates were obtained and are considered reasonable approximations for the system. The operations model, therefore, is also appropriate for calculating the yields of the water supply alternatives which are discussed in Section 7.

5.5 Yield Estimates for Existing Water Supply System

Table 5-1 indicates the annual yield estimates for the existing water supply system for both a short-term critically dry (2-year), and an extended period (5-year) drought. These estimates assume that 1,000 MG of carryover reservoir storage will be available in reserve at the end of the drought period. The storage depletion is calculated by estimating the storage at the beginning of the dry period and withdrawing a constant flow over the period of the drought down to the carryover storage level of 1,000 MG. The starting storage in January 1977 and January 1987 is assumed to be approximately 1,835 MG. This storage level is based on the anticipated normal demand from May of the previous year when the reservoir was full. This same information is presented graphically in Figures 5-3 and 5-4.

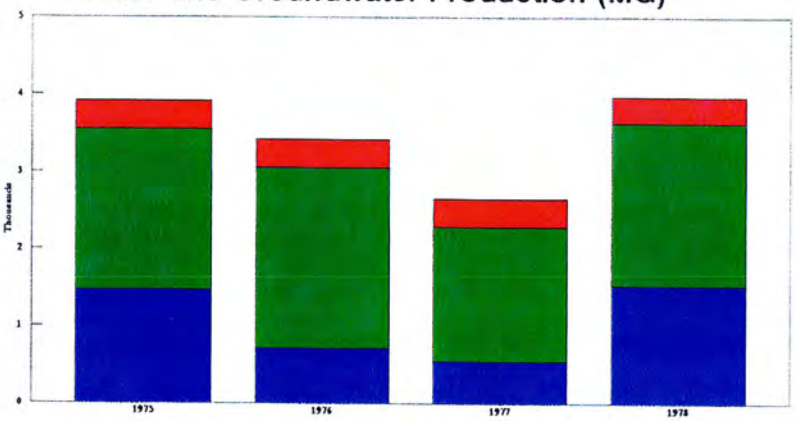
Table 5-1
Yield Estimates
Existing Water Supply System

Supply	Annual Yield	
	Critically Dry Period 1976-77 (MG/yr)	Extended Dry Period 1987-91 (MG/yr)
River and Groundwater Production		
Beltz Wells	360	360
San Lorenzo River	2,050	2,300
North Coast Creeks	620	730
Subtotal	3,030	3,390
Loch Lomond Reservoir Operation		
Inflow		
Felton Diversion	144	292
Newell Creek Inflow	145	284
Subtotal	289	576
Loch Lomond Storage Depletion(1)	418	167
Other - Gains (Losses)		
Rainfall/Evap	7	11
Fisheries Release	(234)	(234)
Subtotal	(227)	(223)
Total Supply from Loch Lomond	480	520
TOTAL YIELD	3,510	3,910

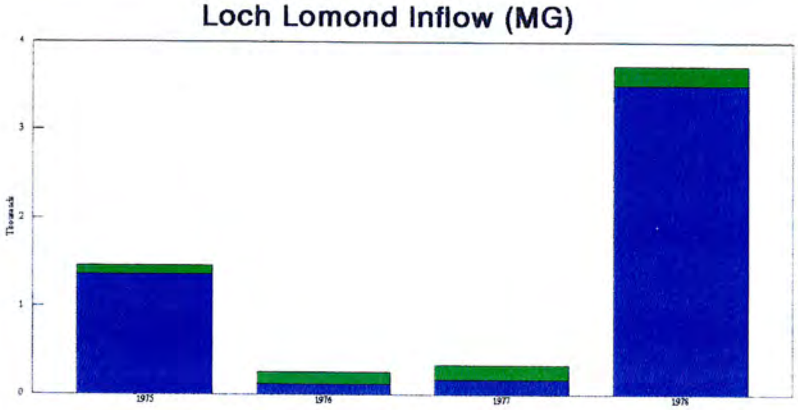
(1) Storage levels at beginning of drought are based on a full reservoir in May of the preceding year, and normal demands through December. Reservoir level in January = 1835 MG. Maintain 1000 MG in reserve at end of dry period.
1976-77 Depletion: (1835-1000)/2 = 418 MG
1987-91 Depletion: (1835-1000)/5 = 167 MG

FIGURE 5-3
YIELD OF EXISTING WATER SUPPLY SYSTEM
1976-1977 CRITICALLY DRY PERIOD

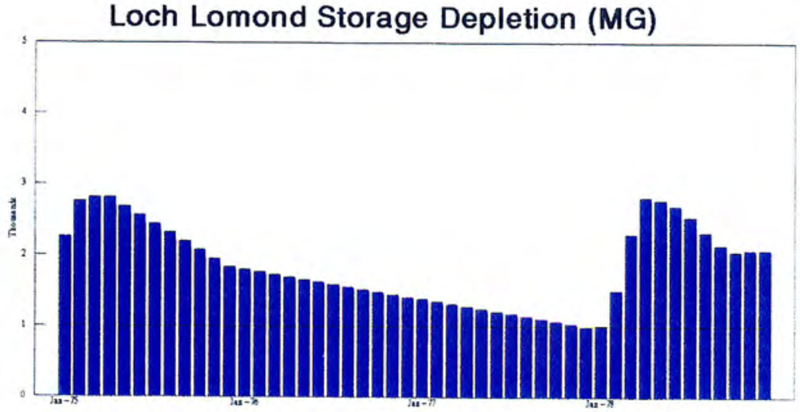
River and Groundwater Production (MG)



Loch Lomond Inflow (MG)



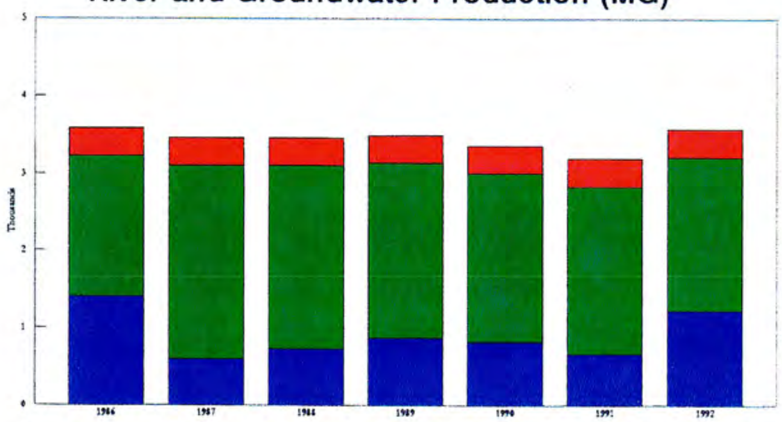
Loch Lomond Storage Depletion (MG)



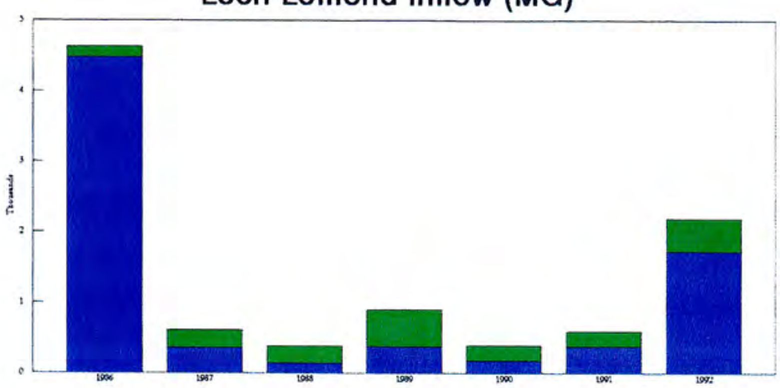
SOURCE OF SUPPLY	ANNUAL YIELD (MG/YR)
Beltz Wells	360
San Lorenzo River	2050
North Coast	620
Subtotal	3030
Felton Diversion	144
Newell Creek Inflow	145
Subtotal	289
Depletion	418
Rainfall/Evap	7
Fisheries Releases	(234)
TOTAL YIELD	3510

FIGURE 5-4
YIELD OF EXISTING WATER SUPPLY SYSTEM
1987-1991 EXTENDED DRY PERIOD

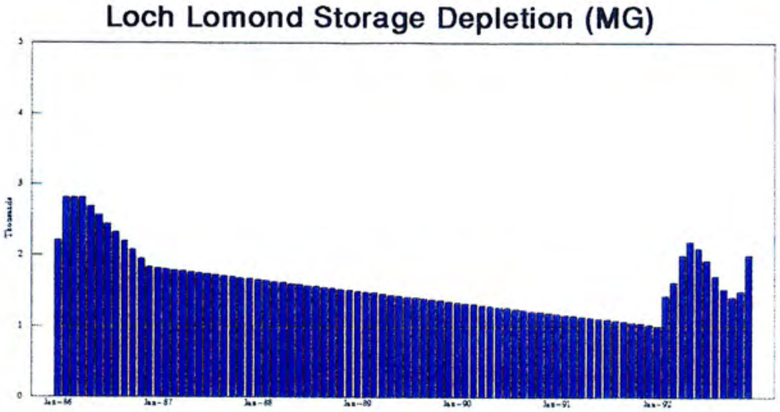
River and Groundwater Production (MG)



Loch Lomond Inflow (MG)



Loch Lomond Storage Depletion (MG)



SOURCE OF SUPPLY	ANNUAL YIELD (MG/YR)
Beltz Wells	360
San Lorenzo River	2300
North Coast	730
Subtotal	3390
Felton Diversion	292
Newell Creek Inflow	284
Subtotal	576
Depletion	167
Rainfall/Evap	13
Fisheries Releases	(234)
TOTAL YIELD	3910

As indicated in the table and figures, the critically dry period of 1976-1977 has a lower yield for the river/groundwater and Loch Lomond inflow components. In the case of the Felton Diversion and Newell Creek inflow, the yield in 1976-1977 is approximately one-half of that during the 1987-1991 period. At the same time the storage depletion component of yield for Loch Lomond is significantly less due to the extended period of drought.

As indicated in Table 5-1, the annual yield of 3,510 MG during the critically dry period of 1976-1977, is less than the yield of 3,910 MG during the extended dry period of 1987-1991. As such, 3,510 MG is the safe yield of the existing system. However, it is important to calculate the yields for both hydrologic conditions due to the impact of future potential projects, and to carry these calculations for both hydrologic periods through the entire analysis. This issue is discussed in more detail in the following sections.

Section 6
Water Supply Requirements

This section compares the water demand projections presented in Section 3 with the yield estimates of the existing water supply system presented in Section 5. The difference between the yield estimates of the existing supply system and future demands determines the amount of additional supply needed by the City.

6.1 Comparison of Supply and Demand

Figure 6-1 graphically compares the yield of the existing water supply system with projected year 2005 water demands. As indicated in Figure 6-1, the total future water supply requirements to meet year 2005 projected water demands will be 5,175 MG/year. With conservation savings and drought restrictions, the total water supply requirement is reduced to 4,500 MG/year.

The yield of the existing water supply system is 3,510 MG/year for a critically dry period (i.e., 1976-1977) (hereinafter called short-term drought) and 3,910 MG/year for an extended dry period (i.e., 1987-1991) (hereinafter called long-term drought). As discussed in Section 5, these yield estimates assume reserve carryover reservoir storage of 1,000 MG at the end of the dry (drought) period.

6.2 Future Water Supply Needs

There is a shortfall between the yield of the existing water supply system and the projected year 2005 water demands. Therefore, additional supply would be needed to meet future demands.

For planning purposes in this study, the following criteria have been used to determine additional supply requirements.

- Adjusted year 2005 water demands of 4,500 MG/year. The adjusted demand includes a 10 percent annual reduction (which is equivalent to a 15 percent summertime reduction) in demand due to drought restrictions, and permanent savings from existing customers of 180 MG/year due to additional conservation measures.

- The yield from the existing water supply system is 3,510 MG for a short-term (2-year) drought period similar to 1976-1977 period, and 3,910 MG for a long-term (5-year) drought similar to the 1987-1991 period. These yields include existing storage in Loch Lomond, and assume reserve carryover reservoir storage of 1,000 MG available at the end of the drought period.

Based on these criteria, the shortfall ranges from 590 MG/year for a long-term drought to 990 MG/year for a short-term critical drought. Table 6-1 summarizes the future water supply requirements.

Table 6-1
Water Supply Shortfall

	Short-Term (2-year) Critical Drought (MG/year)	Long-Term (5-year) Extended Drought (MG/year)
Adjusted Year 2005 Water Demands(1)	4,500	4,500
Existing Water Supply Annual Yield From Existing Stream Diversions, Wells	3,030	3,390
Existing Available Supply (Loch Lomond)(2)	480	520
Total Annual Supply	3,510	3,910
Water Supply Shortfall	990	590

(1) 1989 Water Master Plan demands were reduced by 180 MG/year to account for water conservation savings from existing customers, and a 10 percent annual reduction in demand due to drought restrictions (equivalent to a 15 percent summertime reduction).
(2) Assumes 1,000 MG reserve carryover storage at the end of the drought period.

These water supply requirements could be met by developing additional yield from new non-storage sources, by constructing additional reservoir storage, or by a combination of additional yield and additional storage. However, none of the non-storage alternatives are large enough by themselves to meet the water supply shortfall. Section 10 discusses the development of various combinations of water supply alternatives that will meet the City's water supply needs.

As discussed in the previous section, the safe yield of the existing system is driven by the 1976-1977 hydrology. However, in the future, as additional water supply projects are developed to meet the City's water supply needs, the 1976-1977 and 1987-1991 hydrology sequences need to be evaluated. This is due to the impact of the duration of the drought on storage versus non-storage types of projects. Figure 6-2 indicates the supply requirement for a new non-storage water supply project, such as groundwater and/or reclaimed water, based on the 1976-1977 hydrology with the existing system safe yield of 3,510 MG. For this period, new non-storage water supply of 990 MG would be required during the drought period. Figure 6-3 indicates this same calculation for additional storage. Due to the short duration of the 1976-1977 drought, storage of 3,200 MG is required to provide the necessary annual storage depletion of 1,339 MG. The additional 3,200 MG storage capacity will provide for all the shortfall to meet the projected year 2005 water demand of 4,500 MG/year during a short-term (two-year) critical drought. The required storage includes estimated losses for fisheries releases and evaporation; and assumes there will be no carryover storage in the new reservoir at the end of the dry period.

Figure 6-4 indicates the supply requirement for new non-storage sources based on the 1987-1991 period. As indicated in the figure, the new supply requirement would be only 590 MG, which is less than the 990 MG required for the 1976-1977 period. For a non-storage source, such as

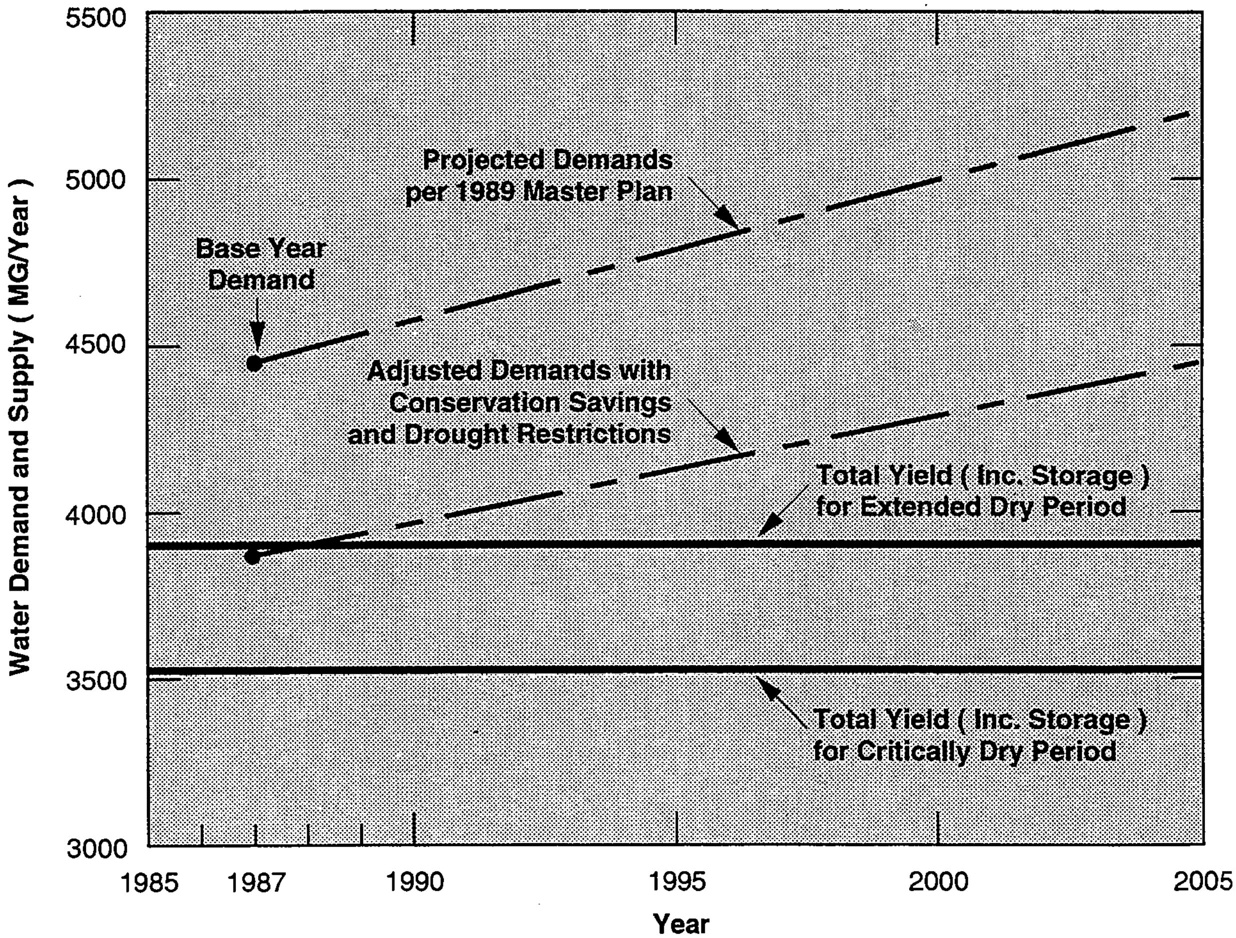
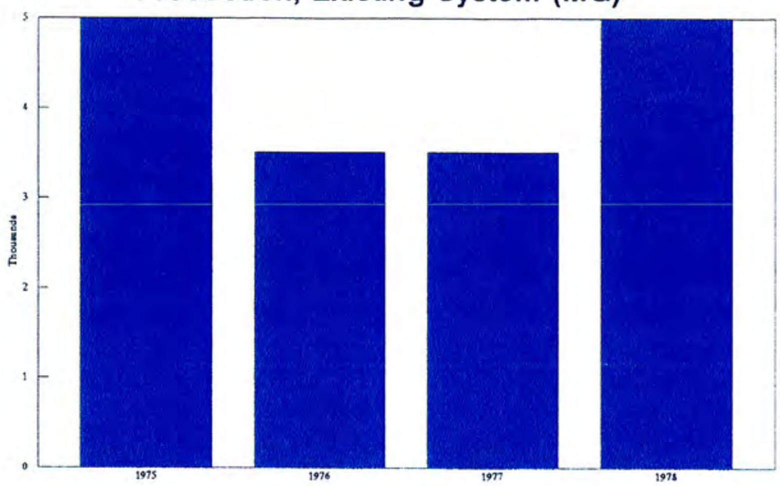


Figure 6-1

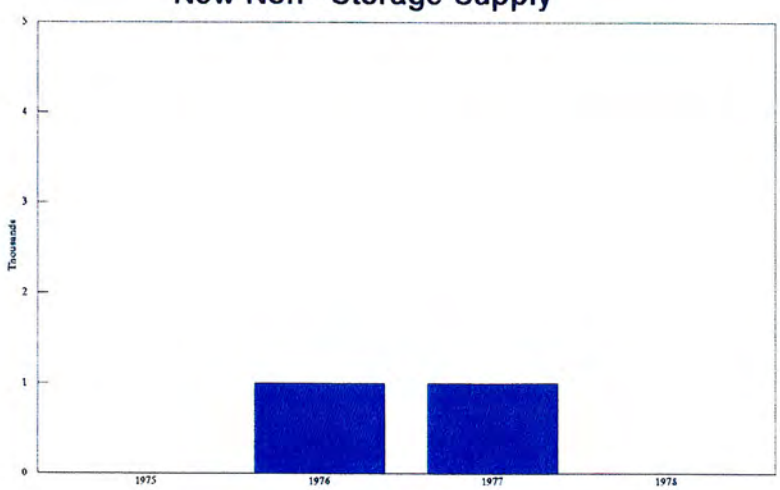
Comparison of Yield of Existing Water Supply with Projected Year 2005 Water Demands

FIGURE 6–2
YIELD, EXISTING WATER SUPPLY SYSTEM + NEW NON–STORAGE SUPPLY 1976–1977 CRITICALLY DRY PERIOD

Production, Existing System (MG)



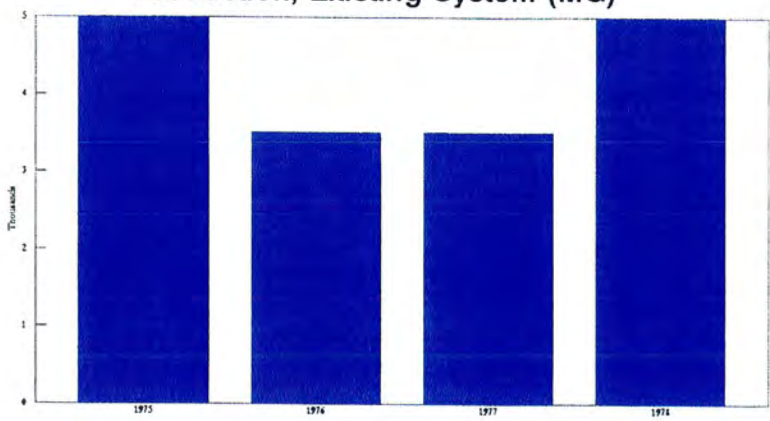
New Non–Storage Supply



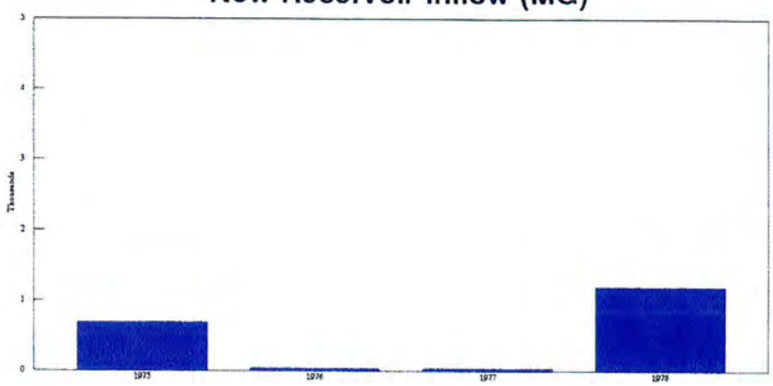
SOURCE OF SUPPLY	ANNUAL YIELD (MG/YR)
Existing System (See Figure 5–3)	**3510**
New Supply Requirement	**990**
YIELD	**4500**

FIGURE 6-3
YIELD, EXISTING WATER SUPPLY SYSTEM + ADDITIONAL STORAGE 1976-1977 CRITICALLY DRY PERIOD

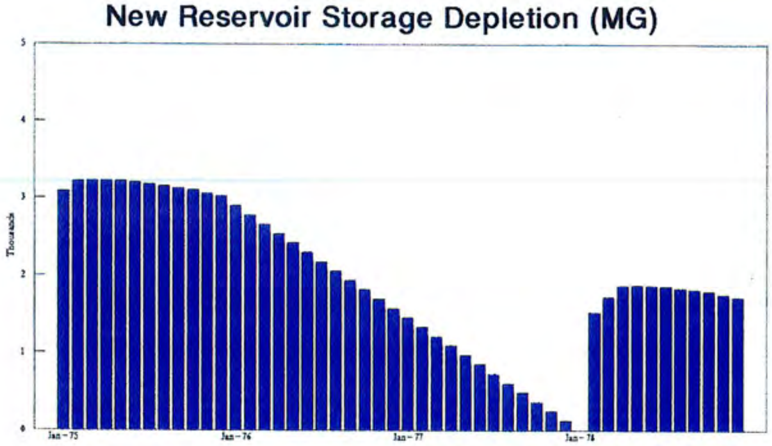
Production, Existing System (MG)



New Reservoir Inflow (MG)



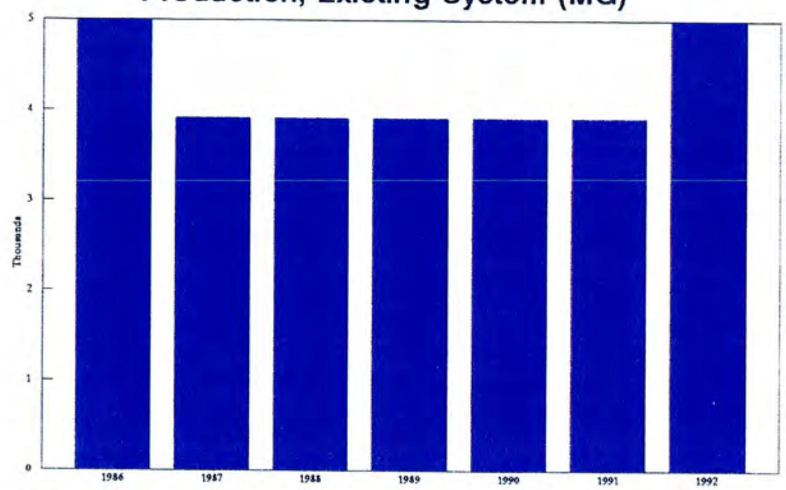
New Reservoir Storage Depletion (MG)



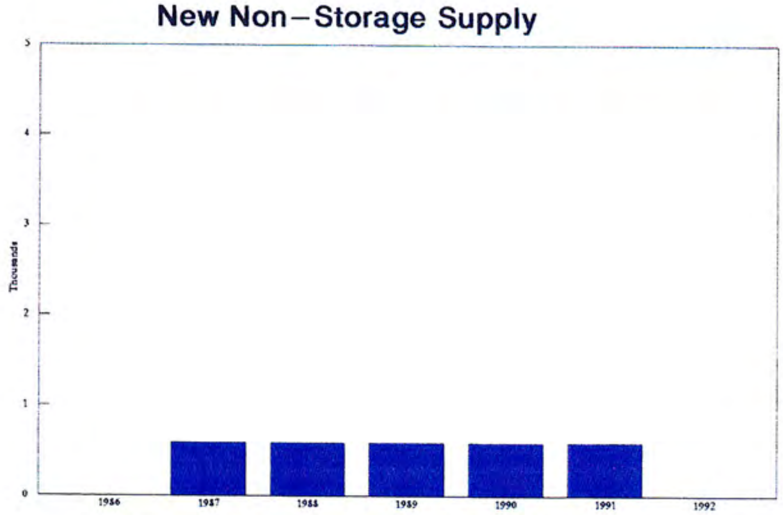
SOURCE OF SUPPLY	ANNUAL YIELD (MG/YR)
Existing System (See Figure 5-4)	**3510**
Inflow	**27**
Storage Depletion (Storage Requirement 3200 MG)	**1339**
Rainfall/Evap	**(23)**
Fisheries Releases	**(353)**
YIELD	**4500**

FIGURE 6-4
YIELD, EXISTING WATER SUPPLY SYSTEM + NEW NON-STORAGE SUPPLY 1987-1991 EXTENDED DRY PERIOD

Production, Existing System (MG)



New Non-Storage Supply

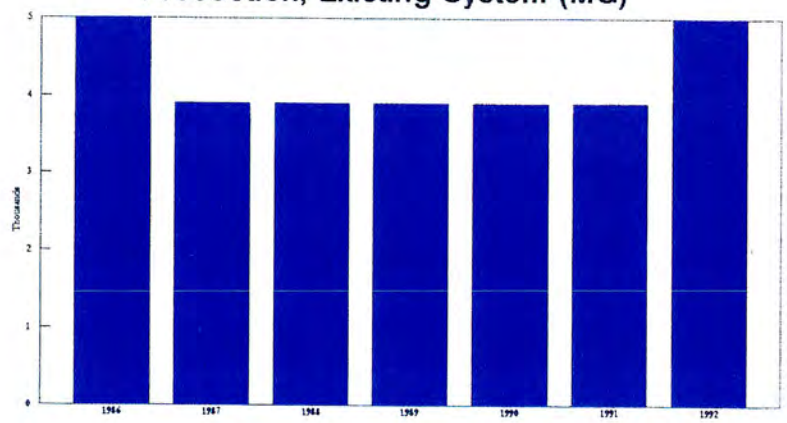


SOURCE OF SUPPLY	ANNUAL YIELD (MG/YR)
Existing System (See Figure 5-4)	**3910**
New Supply Requirement	**590**
YIELD	**4500**

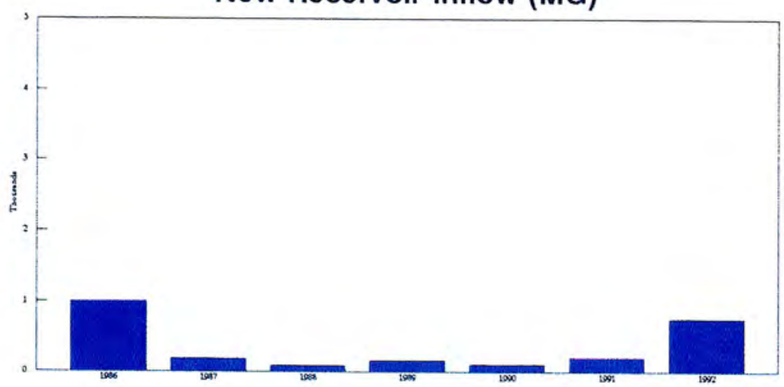
groundwater or reclaimed water, the 1976-1977 period continues to be the most critical hydrologic period. However, during the 1987-1991 hydrologic period, the size required for additional storage would be much greater due to the extended drought period. Figure 6-5 indicates that storage of approximately 4,900 MG is required to provide the necessary annual storage depletion of 863 MG. The additional 4,900 MG storage capacity will provide for all the shortfall to meet the projected year 2005 water demand of 4,500 MG/year during an extended (5-year) drought. The required storage includes estimated losses for fisheries releases and evaporation; and assumes that there will be no carryover shortage in the new reservoir at the end of the dry period. The storage requirement of 4,900 MG for the 1987-91 hydrology is much larger than the storage requirement of 3,200 MG for the 1976-1977 hydrology.

FIGURE 6-5
YIELD, EXISTING WATER SUPPLY SYSTEM + ADDITIONAL STORAGE 1987-1991 EXTENDED DRY PERIOD

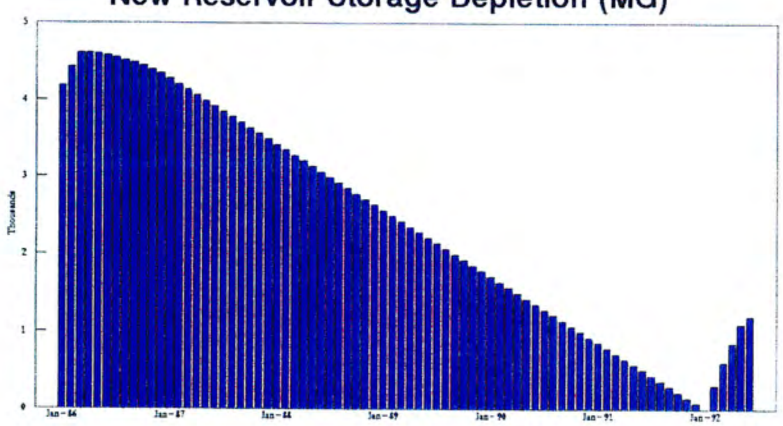
Production, Existing System (MG)



New Reservoir Inflow (MG)



New Reservoir Storage Depletion (MG)



SOURCE OF SUPPLY	ANNUAL YIELD (MG/YR)
Existing System (See Figure 5-4)	**3910**
Inflow	**84**
Storage Depletion (Storage Requirement 4900 MG)	**863**
Rainfall/Evap	**(4)**
Fisheries Releases	**(353)**
YIELD	**4500**

Section 7
Development of Water Supply Alternatives

This section describes the development of the water supply alternatives during Phase I of the study.

7.1 Review of 1989 Water Master Plan Alternatives

A primary element of the Phase I analysis was the review of water supply alternatives identified in the 1989 Water Master Plan. Based on this review and subsequent discussions with City staff, several of the alternatives identified in the Water Master Plan were eliminated from further evaluation. Table 7-1 shows the Water Master Plan alternatives and the results of the review.

As indicated in Table 7-1, five alternatives were identified in the Water Master Plan which have small yields (ranging from 0 to 35 MG/year). While these alternatives may prove to be cost effective, they will not significantly increase the overall system yield. Based on discussions with City staff, these alternatives were removed from this study. The City may choose to pursue these projects as part of its ongoing operation and maintenance program to improve system reliability.

Two North Coast reservoir alternatives were identified in the Water Master Plan: one on Laguna Creek at Bald Mountain School site; and one on Baldwin Creek. Previous studies in the late 1950's concluded that the Bald Mountain School site was a geologically poor site. A review of the hydrology estimates developed as part of the County Master Plan indicated that the Baldwin Creek site has limited water available for a storage reservoir. Based on the County estimates for each of the creeks studied, Baldwin Creek has among the lowest flows available of the North Coast Creeks and, depending on instream flow releases, may not have any water available for a storage reservoir. The Baldwin Creek site is suitable as a reservoir site, but would require pumping water from another stream to replenish storage. Due to their limitations, both these reservoir alternatives were eliminated from further consideration.

7.2 Identification of Other Possible Alternatives

In addition to the review of the 1989 Water Master Plan alternatives, several new alternatives were identified in Phase I. These alternatives considered new information available since the Water Master Plan, as well as appropriate new technologies. Three new alternatives were included in this study: an alternate site for an upper San Lorenzo River reservoir; a North Coast diversion and storage alternative; and a desalination alternative.

An alternate site for an upper San Lorenzo River reservoir was identified at Kings Creek. This alternate site was analyzed in this study, as well as the proposed Waterman Gap site identified in the Water Master Plan.

A new alternative was identified for a diversion facility and storage reservoir in the North Coast area utilizing flow from one of the creeks with higher runoff, and diverting to a storage facility on another creek with lower runoff. A project diverting water from Scott Creek with storage on one of several smaller North Coast creeks appeared feasible.

Table 7-1
Review of 1989 Water Master Plan Alternatives

Water Master Plan Alt. No.	Current Alt. No.	Description of Alternative	Results of Review
2A/2B	--	Felton Diversion Improvements	Small yield. Eliminated from further evaluation in this study, but could be considered as a supplemental source at a later time.
3	--	North Coast Pump Station	Small yield. Eliminated from further evaluation in this study, but could be considered as a supplemental source at a later time.
4	--	Parallel Pipeline, San Lorenzo River	Small yield. Eliminated from further evaluation in this study, but could be considered as a supplemental source at a later time.
5	1A	Additional Groundwater Wells Harvey West Wells	Included in study.
	1B	Thurber Lane Wells	Included in study.
6	2	Wastewater Reclamation	Included in study
7A	3A	Enlarge Loch Lomond by 260 to 500 MG	Included in study.
7B	3B	Enlarge Loch Lomond by 1010 MG	Included in study.
8A	4	Scotts Valley Intertie	Included in study.
8B	--	Soquel Creek Intertie	Project judged not feasible in Water Master Plan. Eliminated from further consideration.
9	--	Zayante Creek Direct Diversion	Project judged not feasible in Water Master Plan. Eliminated from further consideration.
10	--	Parallel Coast Pipeline	Small yield. Eliminated from further evaluation in this study, but could be considered as a supplemental source at a later time.
11A	--	Laguna Creek Reservoir	Poor geology, eliminated from further consideration.
11B	--	Baldwin Creek Reservoir	Potentially limited water supply. Eliminated from further consideration after reviewing revised yield estimates due to low yield.
12A	5	Waterman Gap Reservoir (Upper San Lorenzo River)	Recommended as best San Lorenzo Alternative in Water Master Plan. Included in study.

In addition, a new alternative was identified for desalination of brackish groundwater from wells using reverse osmosis technology. This alternative would involve new well fields in the vicinity of Davenport and Majors Creek.

Table 7-2 summarizes the Water Master Plan alternatives as well as the new alternatives identified in Phase I for evaluation.

Table 7-2
Phase I Water Supply Alternatives

Alt. No.	Description of Alternative
1A	Harvey West Groundwater Well
1B	Thurber Lane Groundwater Wells
2	Wastewater Reclamation
3A	Enlarge Loch Lomond by 260 to 500 MG
3B	Enlarge Loch Lomond by 1,010 MG
4	Scotts Valley Intertie
5	Alternate sites for an Upper San Lorenzo River Reservoir (Kings Creek; Waterman Gap)
6 (New)	North Coast Diversion and Storage
7 (New)	Brackish Groundwater Wells with Reverse Osmosis Treatment

7.3 Incremental Yield Estimates

The methodology described in Section 5 was used to prepare incremental yield estimates for each alternative to be evaluated in this study. The yield estimates were based on the following criteria:

- Adjusted year 2005 water demands of 4,500 MG/year, which includes additional conservation savings from existing customers of 180 MG/year and a 10 percent annual (equivalent to 15 percent summertime) reduction in demand due to drought restrictions.
- Annual yield of the existing water supply system of 3,510 MG/year for a short-term (2-year) critical drought and 3,910 MG/year for a long-term (5-year) extended drought.
- Total reserve carryover reservoir storage of 1,000 MG at the end of the drought period.
- Updated historic hydrology through 1991.
- Preliminary estimates of required instream flow releases from reservoir and diversion alternatives.
- Estimated sustained capacities of proposed wells with a 10 percent downtime allowance.
- Estimated reduction in water demand due to use of reclaimed wastewater.
- Estimated delivery rate from the proposed Scotts Valley Intertie.

Yield estimates were prepared for both types of drought conditions for comparison purposes, and to facilitate formulating potential water supply "projects" from the feasible alternatives. Potential water supply projects would consist of one or more feasible alternatives that would allow the City to meet its projected water supply needs of 4,500 MG/year. Table 7-3 summarizes the incremental yield of the alternatives, as well as the estimated total annual yield of the existing system plus the incremental yield of the alternative.

Table 7-3
Summary of Yield Estimates for Phase I Water Supply Alternatives

Alt. No.	Description of Alternative	Incremental Yield (MG/year)		Estimated Total Annual Yield with Alternative (MG/yr)[1]	
		Critical (2-year) Drought	Extended (5-year) Drought	Critical (2-year) Drought	Extended (5-year) Drought
0	Existing System	3,510	3,910	3,510	3,910
1A	Harvey West Groundwater Well	25	25	3,535	3,935
1B	Thurber Lane Groundwater Wells	120	120	3,630	4,030
2	Wastewater Reclamation	70	70	3,580	3,980
3A	Enlarge Loch Lomond by 260 to 500 MG	110 to 240	60 to 90	3,620 to 3,750	3,970 to 4,000
3B	Enlarge Loch Lomond by 1010 MG	450	200	3,960	4,100
4	Scotts Valley Intertie	250	200	3,760	4,110
5	Upper San Lorenzo River Reservoir at Waterman Gap or Kings Creek (5,500 MG)[2]	990	590	4,500	4,500
6	North Coast Diversion and Storage (3,600-5,200 MG)[2,3]	990	590	4,500	4,500
7	Brackish Groundwater Wells with Reverse Osmosis Treatment	880	880	4,390	4,790

(1) The estimated total annual yield with alternative is the sum of the yield of the existing water supply system plus the incremental yield of the alternative.
(2) Reservoir size based on long-term drought conditions.
(3) 3,600 MG assumes 20 cfs diversion from Scotts Creek; 5,200 MG assumes 10 cfs diversion.

7.4 Facilities Requirements

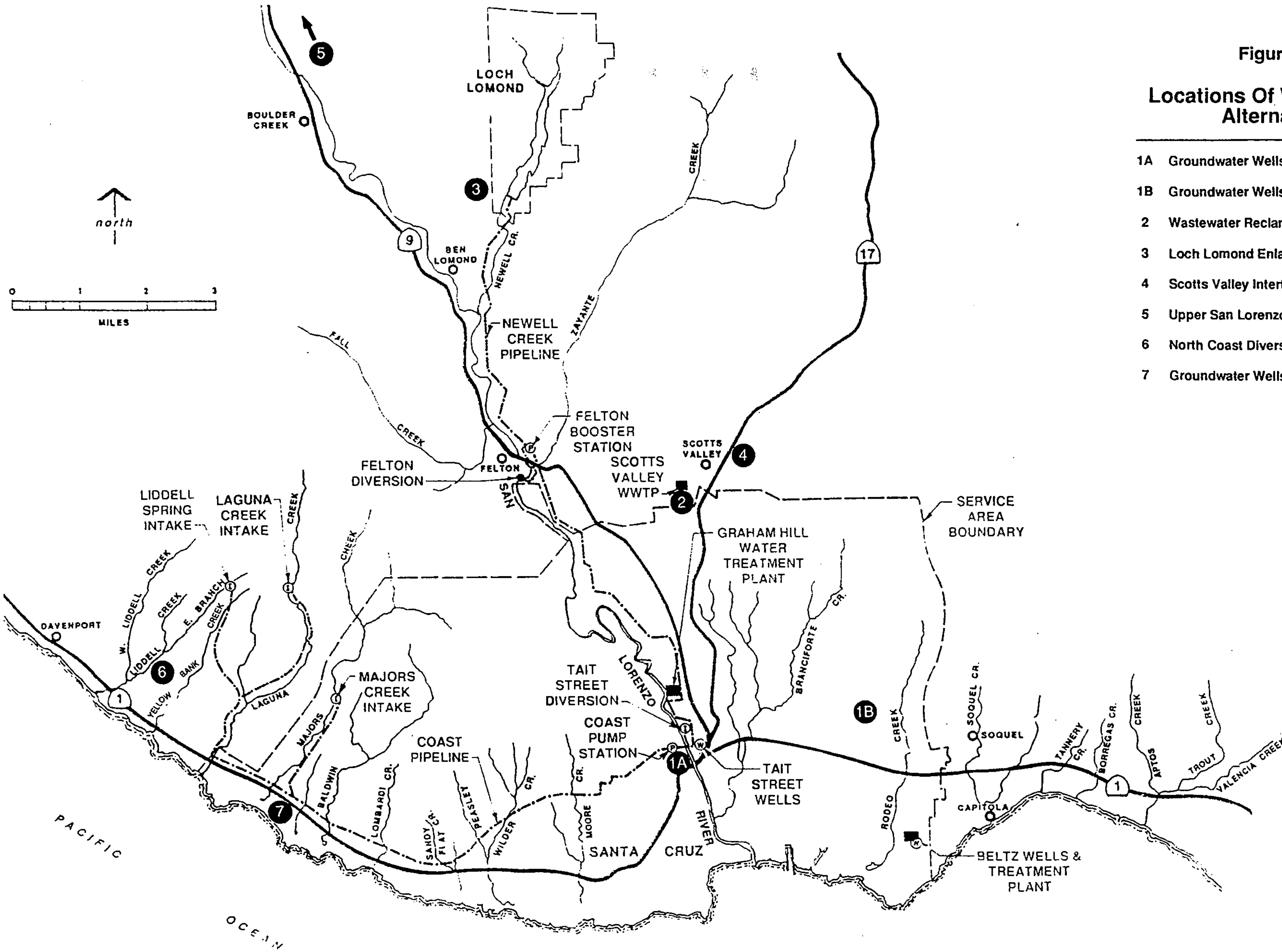
Table 7-4 summarizes the key facilities requirements for the alternatives. Figure 7-1 shows the general locations of the alternatives. A brief summary for the alternatives is given below. Section 10 contains a detailed description of the features and analysis of the projects formulated from feasible alternatives.

7.4.1 Reservoir Alternatives

Eight potential reservoir sites were evaluated: two sites in the upper San Lorenzo River watershed; and six sites on North Coast streams. Topographic maps were reviewed to identify potential reservoir sites, and area-capacity curves were developed. Each of the creeks where sites were identified were also walked to review habitat and develop estimates of fishery bypass flow requirements. Four sites were selected for further evaluation: two sites in the Upper San Lorenzo River watershed—at Waterman Gap and at Kings Creek; and two sites on North Coast streams—at East Branch Liddell Creek and at Yellow Bank Creek. Sites were selected based on having adequate available storage capacity and less potential to adversely impact fishery resources.

Figure 7-1

Locations Of Water Supply Alternatives



1A	Groundwater Wells - Harvey West Area
1B	Groundwater Wells - Thurber Lane Wells
2	Wastewater Reclamation
3	Loch Lomond Enlargement
4	Scotts Valley Intertie
5	Upper San Lorenzo River Storage
6	North Coast Diversion And Storage
7	Groundwater Wells with Reverse Osmosis

Table 7-4
Key Facilities Requirements for Phase I Water Supply Alternatives

Alt. No.	Description of Alternative	Facilities Requirements
1A	Harvey West Groundwater Well	■ 1 MGD well
1B	Thurber Lane Groundwater Wells	■ Two 0.4 MGD wells ■ Iron and manganese water treatment plant
2	Wastewater Reclamation	■ 0.3 MGD treatment facilities at Scotts Valley Wastewater Treatment Plant ■ 9,500 feet of reclaimed water pipeline at Pasatiempo Golf Course and Oddfellow Cemetery
3A	Enlarge Loch Lomond by 260 to 500 MG (4-foot to 8-foot wall and spillway raise)	■ 4-foot to 8-foot parapet wall across top of dam and spillway raise
3B	Enlarge Loch Lomond by 1,010 MG (14-foot dam raise)	■ 14-foot raise of zoned fill embankment and spillway
4	Scotts Valley Intertie	■ Two 1.2 MGD wells in the Lompico aquifer ■ 13,000 feet of intertie pipeline to City of Santa Cruz
5	Upper San Lorenzo River Reservoir	■ 240-foot to 260-foot high zoned earth embankment dam on the San Lorenzo River at Waterman Gap or on Kings Creek
6	North Coast Diversion and Storage	■ 6.5 MGD to 13 MGD diversion facility on Scott Creek ■ 230-foot to 250-foot high zoned earth embankment dam on Yellow Bank Creek or the East Branch of Liddell Creek ■ 32,000-33,000 feet of pipeline from diversion to storage ■ 14,000-16,000 feet of pipeline from storage to existing Coast pipeline
7	Brackish Groundwater Wells with Reverse Osmosis Treatment	■ Two 2.9 MGD well fields (in Davenport and Majors Creek areas) ■ 20,000 feet of new pipeline from Davenport to Majors ■ 4.9 MGD reverse osmosis treatment plant in Majors area (4.9 MGD + 0.9 MGD bypass) ■ Outfall or injection wells for brine disposal ■ Parallel Coast pipeline

Reservoir sizing was based on the amount of supply required for a drought period, evaporative losses, fishery bypass flow releases, and inflow to the reservoir. A monthly spreadsheet-style water accounting model was developed to estimate reservoir sizes. The model included hydrology for both the short-term (2-year) and long-term (5-year) droughts.

The reservoir alternatives were sized to provide for all the shortfall to meet the projected year 2005 water demand of 4,500 MG/year. Only one reservoir alternative would need to be implemented to meet the City's requirement for additional supply capability.

7.4.2 Well Alternatives

Over the last several years, the City has conducted a number of studies to develop additional groundwater supplies. Available hydrogeologic information was reviewed to evaluate proposed well locations and estimate well capacities.

- One well in the San Lorenzo River alluvium near Harvey West Park with a sustained capacity of about 100 gallons per minute (gpm). The well would likely divert water directly into the Coast Pipeline for delivery to the Graham Hill Water Treatment Plant (WTP).

- Two wells in the Purisima formation in the vicinity of the Thurber Lane Pump Station, each with a sustained capacity of 250 gpm. The wells would likely require iron and manganese removal. The wells would connect into the distribution system in the northern portion of the Live Oak area.

The estimated incremental yields of well alternatives are based on the estimated sustained capacities of the wells and a 10 percent downtime allowance. During drought conditions, the wells would be operated during peak summer periods and during some winter months, depending upon rainy season runoff conditions. During non-drought years, the wells would be used as a supplemental supply during peak summer months only.

7.4.3 Wastewater Reclamation

The wastewater reclamation alternative would make use of reclaimed water from the Scotts Valley Wastewater Treatment Plant (WWTP) to serve the Pasatiempo Golf Course and the Oddfellow Cemetery. Due to the proximity of residences, tertiary treatment facilities and a separate reclaimed water pipeline would be required for this alternative to meet Department of Health Services concerns. The Scotts Valley WWTP treats about 20 MG/month. Estimated demands for both the golf course and the cemetery are about 12 MG/month in peak months, for a total of about 70 MG/year.

7.4.4 Scotts Valley Intertie

This alternative would involve developing a conjunctive use intertie program with the Scotts Valley Water District (SVWD). The City would provide treated water to SVWD on a regular basis for use in-lieu of SVWD withdrawals from its groundwater basin. In return, the SVWD would pump and deliver water to the City to alleviate potential supply deficiencies in a severe drought. It was assumed that the City would deliver 20 MG/month to SVWD from November to May in non-drought years. In return, the City would receive a maximum of 70 MG/month from April to October during critical drought years.

7.4.5 Brackish Groundwater Wells With Reverse Osmosis Treatment

Deep groundwater resources exist along the North Coast from Laguna Creek to the vicinity of Davenport. However, water quality data indicate that the water is brackish, with total dissolved solids (TDS) levels range from 800 milligrams/liter (mg/l) to 5,000 mg/l, which exceeds the drinking water standards. Brackish water typically means water with a TDS level between 1,000 mg/l and 5,000 mg/l. For comparison, Title 22 of the California Administrative Code has a secondary goal for TDS levels in drinking water of 500 mg/l. On the other extreme is seawater which has a TDS level of 35,000 mg/l.

For this alternative, several deep wells would be installed, along with a brackish water reverse osmosis (RO) system to reduce the TDS of the raw water to drinking water levels. For this alternative, it was assumed that two well fields would be installed, one in the Majors area and one in the Davenport area. The well fields could produce 2,000 gpm per well field (4,000 gpm total) at peak operation during summer months for delivery to the treatment facility. The well fields have an estimated sustained delivery capacity of 1,000 gpm per well field (2,000 gpm total).

Section 8
Fatal Flaw Screening of Alternatives

This section describes the methodology and results of the Phase II fatal flaw screening of the water supply alternatives developed in Phase I.

8.1 Exclusionary Criteria

The Phase I water supply alternatives shown in Table 7-2 were evaluated for fatal flaws which could preclude their development. The existence of fatal flaws was determined by screening the alternatives for the presence of specific exclusionary criteria which would cause them to be excluded from further evaluation. These criteria were reviewed with the City.

Exclusionary criteria are significant factors which could prohibit a proposed alternative from being implemented. The criteria are divided into three categories:

- *Regulatory and institutional issues:* These criteria include permitting requirements and the time required to obtain permits, and jurisdictional or political constraints. Most of the permits and/or jurisdictions identified affect specific alternatives.
- *Geologic and hydrogeologic concerns:* These criteria focus on seismicity and landslide issues, which primarily impact the reservoir alternatives, and hydrogeologic considerations, which impact groundwater wells.
- *Environmental issues:* These concerns center on the presence of federal and state rare and endangered species, which primarily affect alternatives in undeveloped areas.

The categories and the specific criteria are presented in Table 8-1. The alternatives affected by each criteria are also noted.

The issues identified for each category are only those which have the potential to prohibit development of a project. As part of the detailed evaluation in Phase III, a broader group of issues was identified and considered. For example, environmental considerations in the detailed evaluation might include construction and temporary impacts, cultural resources impacts, potential for growth inducement, water quality considerations, and resource impacts, as well as consideration of listed rare and endangered species. These issues were not included in the Phase II exclusionary criteria list because they can either be mitigated or cannot be evaluated in sufficient detail at this point in the planning process to determine that they would represent fatal flaws.

Cost was initially included as an exclusionary criterion with specific issues focusing on capital costs, operation and maintenance costs, and the funding capability and bonding capacity of the City. Based on discussions with the City, cost was removed as a fatal flaw category, since there is no definitive measure of the point at which the cost of a project would become prohibitive. However, the cost criterion was included in the Phase III detailed evaluation.

Table 8-1
Exclusionary Criteria for Fatal Flaw Screening

Exclusionary Criteria	Affected Alternatives
Regulatory/ Institutional	
Permitting Requirements/Implementation Schedule	
■ Instream Flow Release Requirements (Department of Fish and Game)	All reservoir projects
■ Wastewater Reclamation (Department of Health Services)	Wastewater reclamation
■ Outfall/Brine Disposal (Regional Water Quality Control Board), Monterey Bay National Marine Sanctuary (National Oceanic & Atmospheric Administration)	Brackish groundwater wells with reverse osmosis
■ 404 Permit (U.S. Army Corps of Engineers) and Streambed Alteration Agreement (Dept. of Fish and Game)	All reservoir projects
■ Take Permits (Dept. of Fish & Game, U.S. Fish & Wildlife Service)	All reservoir projects
■ Dam Construction Feasibility	All reservoir projects
Jurisdictional/Political (Scotts Valley/San Lorenzo Valley Water District)	Scotts Valley Intertie
Land Use Planning (County Planning Dept/Coastal Commission Local Program)	North Coast Diversion and Storage
Geologic/ Hydrogeologic	
Geologic	
■ Active Faults	All reservoir projects
■ Landslides	All reservoir projects
Hydrogeologic	
■ Groundwater Safe Yield and Underflow/Pumping/ Transmissivity	Groundwater wells, North Coast diversion and storage, brackish groundwater wells with reverse osmosis
Environmental	
Federal, State, or California Native Plant Society listed rare or endangered species	All alternatives

8.2 Fatal Flaw Analysis

The fatal flaw analysis involved collecting data about the exclusionary criteria in relation to each of the alternatives. Much of this effort involved review of existing records, and the information developed during Phase I, which is described in preceding sections.

Field work was performed as necessary to supplement existing information. This field work included characterizing fisheries habitat; performing surficial and photogeological reconnaissance at proposed reservoir/dam sites; visiting proposed reservoir and diversion sites to check information in the California Natural Diversity Data Base (CNDDB) and to identify any additional biological issues of concern; and identification of and contact with local, state, and federal agencies with jurisdiction over the projects and applicable regulations.

This section contains a description of the fatal flaw analysis performed for each exclusionary criteria.

8.2.1 Regulatory/Institutional Analysis

8.2.1.1 Permitting Requirements/Implementation Schedule

Six permits and requirements were identified which could significantly impact the time required to implement an alternative. For the permits or requirements identified, available data and regulations were reviewed and field reconnaissance was performed, as needed, to assess the presence or absence of fatal flaws. Each is discussed below.

Instream Flow Release Requirements. The reservoir and diversion alternatives would require instream releases for the protection and enhancement of fisheries and maintenance of riparian habitat below the dam. Implementation of these alternatives would require negotiation of instream releases with the State Department of Fish and Game (Fish and Game).

Fish and Game has the authority to protect and enhance fishery resources through the Fish and Game Code. As part of the broader resource protection, the Fish and Game Code also calls for specific measures to protect and enhance anadromous fisheries (fish which migrate up rivers from the ocean to spawn). Section 6202 of the Fish and Game Code declares that the production of salmon and steelhead trout shall be significantly increased by the end of this century, and that existing natural salmon and steelhead trout habitat shall not be diminished further without offsetting the impacts of the lost habitat. Although the code does not provide quantitative measures for compliance, it explicitly requires that the project proponent contact and coordinate closely with Fish and Game for protection of these species.

Where anadromous species are concerned, Fish and Game typically requires that an Instream Flow Incremental Methodology (IFIM) study be performed to assess the stream's habitat and determine what streamflows are required to maintain sufficient fishery habitat to support the fishery. This type of study is generally performed once a specific project has been identified as part of the environmental review process to satisfy requirements of the California Environmental Quality Act (CEQA).

In order to develop preliminary estimates of instream flows for alternatives and to identify potential issues of concern to Fish and Game, fisheries analyses were performed. This work was performed during the Phase I development of alternatives, since information on instream flow releases was needed to determine anticipated sizing and yields of reservoir and diversion alternatives.

Available reports documenting previous studies on creeks of interest were reviewed and field reconnaissance was performed for each of the creeks, including one time fish sampling to determine resident species and determination of the types and extent of habitat. Projects were then informally reviewed with local Fish and Game personnel to obtain insight on potential concerns and requirements. Preliminary instream flow estimates were developed based on visual observations during the field reconnaissance, and limited IFIM modeling of fish habitat on the San Lorenzo River drainage. Instream flow release estimates were then compared with hydrologic estimates for the creeks to determine whether a creek had sufficient streamflow available to provide water for a project and to satisfy estimated instream flow release requirements.

The North Coast Diversion and Storage Alternative would involve diverting water during the rainy season from Scott Creek to a reservoir on either Yellow Bank or the East Branch of Liddell Creek. Fishery resources at Scott Creek include both steelhead and coho salmon. Informal discussions with Fish and Game staff indicate that they would oppose a surface diversion and would require a subsurface diversion. Minimum bypass flows would need to be established, below which no water could be diverted from Scott Creek. Instream releases would also be required from a reservoir on either Yellow Bank Creek or the East Branch of Liddell Creek. Yellow Bank Creek has a small resident rainbow trout population. The East Branch of Liddell Creek has steelhead habitat in the lower reaches of the creek, although the habitat is poor.

Fishery resources in the San Lorenzo River watershed include steelhead trout and coho salmon. Bypass flows would be required at a reservoir to maintain steelhead habitat downstream of the reservoir. A new reservoir in the upper reaches of the San Lorenzo or a tributary or enlarging Loch Lomond would require modification of SCWD's current water rights to allow for increased storage. The current water rights could be subject to revision which might re-open the issues of bypass flows for fisheries for the full reach of the San Lorenzo River below the project. If this were the case, instream releases at Felton Diversion and San Lorenzo River diversion at Tait Street could be subject to re-evaluation as part of a project on the San Lorenzo River. Reservoirs at the Waterman Gap site and the Kings Creek site were sized to allow for both project releases and for instream flow releases. For the Loch Lomond enlargement alternatives, it was found that preliminary estimates of instream flow releases were higher than the incremental yield realized by the project. For this project, alternative mitigation instead of higher instream flow releases would need to be developed to make the project viable.

Based on the preliminary instream flow release estimates and Fish and Game concerns, no fatal flaws were identified. With the exception of enlarging Loch Lomond, it was found that projects could be sized to accommodate both project releases and preliminary instream releases. Enlargement of Loch Lomond could require mitigation other than increased instream flow releases to be viable. An IFIM study will be required to identify instream flow release requirements of Fish and Game during the environmental review phase of final project planning and approval.

Wastewater Reclamation Use. The Wastewater Reclamation Alternative would make use of reclaimed wastewater from Scotts Valley Wastewater Treatment Plant. Water would be used to irrigate the Pasatiempo Golf Course and Oddfellow Cemetery. Regulations regarding use of reclaimed water were reviewed to determine whether there are any restrictions in the use of reclaimed water which could preclude development of this project.

The California Water Code establishes the State Water Resources Control Board (State Board) as the agency with primary authority for water reclamation. The nine Regional Water Quality Control Boards (Regional Boards) administer this authority. The State Board provides reuse plans and policy guidelines. The Regional Boards establish regulations for specific projects.

In addition, the California Department of Health Services (DOHS) has regulatory authority for reclaimed water use. The DOHS is authorized by the Porter-Cologne Act to "establish statewide reclamation criteria for each type of reclaimed water use where such use involves the protection of public health." These criteria appear in Title 22 of the California Code of Regulations. The Regional Board must consult with DOHS before setting project requirements, issuing permits, and monitoring compliance. Any proposed reclaimed water project must meet all applicable health standards. The DOHS assesses proposals and makes recommendations to the Regional Board, which applies and enforces the reclamation criteria.

The Title 22 reclamation criteria establish treatment requirements and bacteriological limitations for reclaimed water. These criteria are currently under revision. The proposed regulations call for different levels of treatment and reclaimed water quality depending upon the type of use. While cemetery irrigation would likely require use of a disinfected secondary effluent with a median number of total coliform bacteria not exceeding 23 per 100 milliliters, irrigation of unrestricted access golf courses associated with residences would likely require use of a filtered effluent disinfected to achieve a median number of total coliform bacteria not exceeding 2.2 per 100 milliliters.

The treatment level required will impact costs but is not considered a fatal flaw, since it would not preclude development of the alternative. No regulations were identified which are considered fatal flaws.

Outfall/Brine Disposal - Monterey Bay National Marine Sanctuary. The alternative for Brackish Groundwater Wells with Reverse Osmosis Treatment includes a reverse osmosis (RO) system which would result in 20 to 25 percent of the RO feedwater being discharged as concentrated brine. The 1972 amendments to the Federal Clean Water Act prohibit the discharge of pollutants to navigable waters from a point source unless the discharge is authorized by the National Pollutant Discharge Elimination System (NPDES) permit. An NPDES permit would be required for brine discharge under this alternative. The NPDES permit would be issued and enforced by the Central Coast Regional Board.

The Regional Board would evaluate the NPDES permit application for brine discharge to determine whether it is consistent with the Regional Board's adopted water quality objectives and the Basin Plan. Consultation with the Regional Board on a similar project involving brine discharge indicates that their main concern is that the discharge be adequately modeled and that the model include all the appropriate parameters. No prohibition to brine discharge was identified.

In addition, any discharge of brine into the Monterey Bay National Marine Sanctuary (Sanctuary) would require review of permit conditions by the National Oceanic and Atmospheric Administration (NOAA). The Sanctuary was recently established and includes all of the ocean waters adjacent to Santa Cruz County. The Final Environmental Impact Statement/Management Plan for the Sanctuary was reviewed and NOAA was consulted about the potential discharge of brine into the Sanctuary. NOAA has a Memorandum of Understanding with the Regional Board to review NPDES permits for discharges into the waters of the Sanctuary but there is no indication at this time that such discharges would be precluded.

Brine discharge has a limited potential for creating a fatal flaw. However, because of the new status afforded the ocean waters adjacent to Santa Cruz County with the establishment of the Sanctuary, there is always the possibility that policy changes or stringent requirements could be established in the future that would limit the amount or quality of brine that could be released.

U.S. Army Corps of Engineers 404 Permit and Department of Fish and Game Streambed Alteration Agreement. A 404 permit is required of any person or public agency proposing to locate a structure, excavate, or discharge dredged or fill material into waters of the United States or to transport dredged material for the purpose of dumping it into ocean waters. The Corps permit authority derives from the Federal Rivers and Harbors Act of 1899, Section 404 of the Clean Water Act, and Section 103 of the Marine Protection, Research, and Sanctuaries Act. The development of new dams and reservoirs is considered to be fill because they inundate existing wetlands and riparian areas. Construction of any facilities within Scott Creek would also require a 404 permit.

The Corps issues two types of permits for filling waters of the U.S. including wetlands: nationwide permits and individual permits. A nationwide permit is a type of "blanket" permit issued for certain specified types of projects that require only minor amounts of fill and comply with a list of special conditions and management practices specified in the Corps regulations.

The nationwide permit authorizes the filling of 10 acres or less of "isolated" wetlands or streams above their "headwaters". The Corps, at its discretion, may require an individual permit for such projects; individual permits are more likely to be required when the amount of fill exceeds one acre. Though no permit application is required if a project qualifies under a nationwide permit, project proponents are required to submit a pre-discharge notification to the Corps if the fill would be between 1 to 10 acres. The Corps then must consult with selected federal and state agencies before deciding whether to require an individual permit. If the fill would be less than 1 acre, no pre-discharge notification is required, but project proponents may ask the Corps to verify that the permit is applicable to their project.

If an individual Corps permit is required for fill in wetlands, as would be the case for any of the new reservoir sites, an alternatives analysis pursuant to the 404(b)(1) Guidelines of the EPA would be required. This analysis must demonstrate that the proposed project is the least environmentally damaging practicable alternative for achieving its purpose. Both off-site and on-site alternatives must be considered. A mitigation plan to compensate for unavoidable impacts would also be required. Mitigation generally must create new wetlands to replace filled wetlands on at least a 1 to 1 acreage basis. For some specialized habitats, the replacement ratio may be considerably greater than 1 to 1, due to the lack of demonstrated long-term success of some wetlands creation projects. The replacement ratio would be identified through consultation with the Corps after a proposed project is selected.

The Corps evaluates a 404 permit application based on achieving a balance between the benefits and detriments of a project, considering effects on such items as conservation, economics, wetlands, fish and wildlife values, flood hazards, navigation, water quality, and the needs and welfare of the people. A permit is granted unless it is determined that a project that involves fill would be contrary to public interest or fails to comply with specific guidelines. The Corps is required by federal law to consult with state and federal wildlife agencies regarding any project that impacts aquatic habitats.

Sections 1601 through 1606 of the State Fish and Game Code require a Streambed Alteration Agreement from Fish and Game for any activity that might substantially divert or obstruct the natural flow or substantially change the bed, channel, or bank of any river, stream, or lake, or for the use of any material from the streambed. This requirement applies to altered drainages as well as natural streams, at least if fish and wildlife habitat would be affected. Full mitigation may be required, typically including replacement of streambed and riparian vegetation on a 1 to 1 acreage basis. A detailed mitigation plan may be required as part of the agreement.

Based on the field studies described later in this section under the environmental criterion, construction of a reservoir on the East Branch of Liddell Creek, Yellow Bank Creek, Kings Creek, or the San Lorenzo River at Waterman Gap would result in inundating wetland areas and impacting aquatic habitats and would require a 404 permit from the Corps and a Streambed Alteration Agreement from the Department of Fish and Game. Consultation with the agencies would be necessary to determine if they would be required for raising the height of the dam at Loch Lomond Reservoir.

The 404 permit and streambed alteration agreement require mitigation of any loss of wetlands. The exact nature and amount of mitigation involves a case-by-case analysis and can become time consuming and expensive. However, there is no indication at this time that they could not be obtained if any of the reservoirs are to be constructed. Therefore, the need to obtain these permits was not viewed as a fatal flaw.

Take Permit. The reservoir alternatives were reviewed to identify the potential for requiring a take permit. The federal Endangered Species Act (ESA) prohibits any taking of species listed by the U.S. Fish and Wildlife Service (Fish and Wildlife) as endangered, and species listed by the state as threatened. Candidate species are not legally protected under this Act. According to the ESA, "taking" is defined as,

> "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct (Section 3[19])"

The Act further states that to "harass" means an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to breeding, feeding, or sheltering. To "harm" is any act which actually kills or injures wildlife. Besides referring to injury or death of an animal, the term "take" would also apply to the disruption of habitat defined as "critical" to that species. If critical habitats are not affected by the proposed project, then federal take permits are not required. Section 9 of the ESA prohibits the removal and collection of endangered and threatened plants from lands under federal jurisdiction. However, the full protection against "take" does not apply to plants as it does to animals.

The endangered species provisions of the California Fish and Game Code (Sections 2050-2098) prohibit the import, export, take, possession, purchase, or sale of species listed by the California Fish and Game Commission. State law also requires state lead agencies as defined by CEQA to consult with Fish and Game regarding any project with potential impacts on a state-listed species. As with the federal process, such consultations conclude with written findings by Fish and Game regarding whether or not the proposed project would jeopardize the species. Fish and Game also coordinates consultations for actions involving species that are federally as well as state-listed and is required, whenever possible, to adopt the federal biological opinion as its finding in such consultations. In addition, under the terms of a memorandum of understanding with Fish and Wildlife, Fish and Game is authorized to enforce the "no take" provision of the federal ESA.

With respect to prohibition of take, the California law differs from the federal ESA in three ways:

- Unlike the federal law, the state law defines "take" simply as "to hunt, pursue, catch, or kill" or attempt the same; the terms "harm" or "harass" are not used in the state code. However, activities that would trigger a jeopardy determination under the state consultation process are similar to those that would constitute "harm" or "harassment" under federal law.

- Unlike the federal law, the state prohibition on take applies to species proposed for listing as well as to species listed as threatened or endangered. When the Fish and Game Commission designates a species as a candidate for listing, that species receives the full protection of the California ESA for the one-year period during which the final decision on listing is made.

- Unlike the federal law, the state ESA does not include provisions for incidental take or preparation of Habitat Conservation Plans. However, Section 2081 of the Fish and Game Code authorizes Fish and Game to approve management agreements and permits that serve a similar purpose. In addition, the newly added Section 2800 of the code authorizes Fish and Game to enter into agreements with other public agencies and private interests to prepare and implement natural communities conservation plans.

Section 2081 of the code allows Fish and Game "to authorize individuals, public agencies, universities, zoological gardens, and scientific or educational institutions to import, export, take, or possess (listed or candidate) species for scientific, educational, or management purposes." However, unlike Section 10(a) of the federal ESA, the state code does not specify required components of such an agreement or permit. However, to be approved, the agreement must be consistent with other parts of the state ESA. This means that Fish and Game must be able to reach a no jeopardy opinion on the proposed agreement. In addition, if federally listed species are involved, Fish and Game approval of the agreement also must be coordinated with a Section 7 consultation with Fish and Wildlife or Fish and Wildlife approval of a 10(a) permit.

The presence of endangered species can constitute a fatal flaw because a project that results in the "take" of a species, or its habitat, requires a "take permit". In order to obtain a take permit, the project proponent must consult with Fish and Wildlife and Fish and Game to reach an agreement on how to reduce impacts to the plant, animal, or habitat. The requirement for a permit can be a potential fatal flaw because it can be very time consuming and mitigation measures can be expensive.

The detailed field studies required to identify listed species and the consultation process are typically done as part of the CEQA environmental review process when a project has been selected. For the purpose of providing a preliminary assessment of projects, the California Natural Diversity Data Base was reviewed, followed by field reconnaissance to review potential sites. Based on these analyses, no fatal flaws were identified. These studies and the results of the analyses are discussed in more detail in the Environmental Analysis section.

Dam Construction Feasibility. Each of the reservoir alternatives was reviewed for dam construction feasibility fatal flaws. The California Division of Safety of Dams (DSOD) is the State agency having jurisdiction over dam construction. DSOD functions as a review agency that evaluates plans and reports submitted to them rather than establishing specific criteria themselves. For a particular dam site, the City of Santa Cruz would present reports with detailed information on the geology and engineering to DSOD who would then either respond favorably to these findings or require additional work. This process would be repeated from the reconnaissance stage through dam construction.

Because specific plans for the reservoir alternatives are not yet defined, DSOD was not contacted. Based on experience with the DSOD review process, alternatives were screened and issues identified for which DSOD would likely have concerns. No fatal flaws were identified.

8.2.1.2 Jurisdictional and Political Criterion

The Scotts Valley Intertie Alternative was reviewed for potential jurisdictional or political constraints. Two entities that would have jurisdiction or political interest are the Scotts Valley Water District (SVWD) and the San Lorenzo Valley Water District (SLVWD). The alternative lies within the boundaries of the SVWD service area and would require an agreement with the SVWD. The presence or absence of fatal flaws for this alternative will be dependent upon: the willingness of SVWD to participate; potential agreement terms; and the ability or desire of the City of Santa Cruz to meet these terms. The SVWD has said they will not participate in implementing this alternative.

Well locations which have been identified are not in the vicinity of existing wells used by the SLVWD, therefore, there is no direct impact from the alternative on the SLVWD.

8.2.1.3 Land Use Planning - County Planning/Coastal Commission

Alternatives in the North Coast are in the Coastal Zone as defined in the Santa Cruz County Coastal Plan and would require a Coastal Development Permit. Santa Cruz County has a state-certified local coastal program which is administered by the County Planning Department. A development permit would be applied for once a project is well defined and the CEQA environmental review is complete. It would also need to be demonstrated that the project is consistent with both the County General Plan and the County Coastal Plan. Although it is likely that the need for a Coastal Development Permit would significantly impact the time required for project review and implementation, no specific issues were identified which would preclude any of the alternatives.

8.2.2 Geologic/Hydrogeologic Analysis

8.2.2.1 Geologic Criteria

Each of the reservoir alternatives was reviewed for geologic fatal flaws. The fatal flaw analysis of the geologic constraints at the reservoir sites was based on a literature search, air photo interpretation, field reconnaissance, and the assumption that DSOD will concur with these findings.

Existing information was reviewed and compiled on the geology and landslides in the vicinity of reservoir alternatives, and on faulting in the entire study region. Existing air photos were analyzed: (1) to map the slopes above each reservoir area and adjacent slopes as well as dam abutments and spillway areas; and (2) to examine post-Loma Prieta earthquake photos on file with Santa Cruz County for signs of recent landslides.

A work map was prepared for each proposed reservoir area and dam site by a Registered Geologist. A 1,000-scale topographic map was used on which existing mapping information was compiled and updated as necessary. A field visit was made of each site led by the geologic mapper to investigate dam site conditions, reservoir terrain, borrow materials and construction access.

Active Faults Fault activity can impact the reservoir alternatives in two primary ways. First, ground rupture along a fault's trace will displace the materials on one side of the fault from those on the other. Unless this displacement is taken into account, failure of structures crossing the fault or along the fractured fault surface can occur. Generally speaking, the presence of an active fault at a dam site is a fatal flaw, but within the reservoir area, it may not be. Secondly, ground shaking caused by distant fault activity can cause failure of natural materials such as landslide deposits, liquefiable soils, or older faults, and failure of improperly engineered structures. Severe ground shaking is usually not a fatal flaw but can greatly increase the expense of a project.

Five active or potentially active faults have particular significance in the study region. These are, from northeast to southwest: the San Andreas, Butano, Zayante, Monterey Bay, and San Gregorio fault zones. Both the San Andreas and San Gregorio fault zones show signs of displacement in the last 10,000 years and can be readily traced on land and, in the case of the San Gregorio, offshore. These faults are considered active by the State and lie within Alquist-Priolo Special Studies Zones. The Monterey Bay fault zone also shows well developed signs of activity in offshore geophysical records within the last 10,000 years. For this project, these traces have been projected northwesterly beyond the original survey and those projections have been included in the analysis. Both the Zayante and Butano faults are older structures that have moved within the past 1.6 million years but do not have constraints on the most recent movements (the timeframe of the most recent movements is not known). These faults traverse the interior of the Santa Cruz Mountains and have neither a well developed topographic expression nor do they cross younger, dateable deposits. Since there is neither evidence that these faults have or have not moved within the past 10,000 years, they are considered potentially active.

No active faults were found to cross any of the proposed dam sites, although splays of the Zayante fault cross Loch Lomond but not Newell Creek Dam. Waterman Gap and Kings Creek dam sites are located within 1,000 feet of splays of the Butano fault but a lack of surface expression and an apparent capping of the fault by 10,000-year-old alluvium suggests this is not a fatal flaw, but is an area that will require additional study. Neither of the coastal sites at Yellow Bank Creek and the East Branch of Liddell Creek is crossed by mapped faults.

The amount of seismic ground shaking experienced at a particular site is related to the distance of an earthquake's epicenter from the site, the magnitude of the earthquake and the foundation materials at the site. Dam analyses are done using the maximum credible earthquake, the largest event a particular fault is capable of producing. Since all sites are located on bedrock, the resulting measure of ground shaking is measured as peak rock acceleration. All dam sites have similar values of highest predicted acceleration, ranging from 0.52 to 0.58 g. While high, these accelerations can be accounted for in design, and, therefore, do not constitute a fatal flaw.

Landslides The active mountain building, weak bedrock formations, and high rainfall of the Santa Cruz Mountains have produced an area very susceptible to landslides. Every drainage examined in this study had some landslides, often in abundance. Landslides can pose a threat to reservoir or dam safety in several ways: (1) movement of an abutment slope can lead to structural failure of the dam, spillway, or other appurtenant structures; (2) blockage of the spillway with landslide debris can cause overtopping of the dam or downstream flooding when the debris washes away; (3) overtopping the dam by waves caused by rapid landslide movement into the reservoir; or (4) a breach of the reservoir rim caused by mass failure into the reservoir or on the adjacent back slope.

Large-scale landslides are often most easily recognized by stereoscopic analysis of aerial photographs. With this technique, an entire hillslope can be viewed and the topography characteristic of landslides, such as scarps at the head or sides, a depressed source area, or an enlarged area where debris has accumulated, can be identified. Often these features are not identified in the field because of constraints by topography or vegetation. Air photo interpretation of landslides in the entire county has been done for the Seismic Safety Element of the Santa Cruz County General Plan in 1975. For the fatal flaw analysis, an independent survey was performed using both pre- and post-Loma Prieta earthquake aerial photographs, and then compared with the published study.

Select landslides were examined in the field reconnaissance phase of this investigation. Due to time and logistic constraints, only the proposed abutment areas were examined in a systematic manner. This field mapping confirmed the air photo interpretation and often enlarged the mapped area of landsliding. The field reconnaissance also identified numerous areas of small, shallow, active landslides within the forested areas which are not visible on the air photos.

These small landslides would be a potential nuisance during construction or reservoir operation, but not a fatal flaw.

Landslides are common in the Loch Lomond area, particularly within the Zayante fault zone and Monterey Formation rocks to the south. Many of these landslides are dormant and few signs of activity that would disturb the present tree cover were identified on the aerial photographs.

Several landslides upstream of Newell Creek Dam were investigated by Earth Sciences Associates for Santa Cruz in 1982. A field investigation was made of these locations in 1992 as part of this study. One landslide on the east reservoir shore about 1,500 feet upstream of the Dam is active and was found to be a potential hazard under severe seismic loading. A second recent landslide involving the access road on the west side of the reservoir about 500 feet upstream of the Dam was found to be the result of a high reservoir level and/or rain. An increase in the reservoir level would tend to decrease stability of the upstream landslides, but their repair is possible so they are not considered fatal flaws. A third, smaller landslide was found to pose a potential hazard if the spillway were modified for the proposed enlargement due to undercutting at the plunge pool; however, repair is possible so it was not considered a fatal flaw.

Landslides are common in the proposed Waterman Gap reservoir area, with air photo mapped deposits covering perhaps one quarter of the land's surface. Most of these landslides appear to be debris flows, often coalescing to fill or form entire local drainage. Landslide deposits that become saturated by reservoir water would have decreased stability and renewed movement could be triggered. Retrogressive failure of these deposits would probably not jeopardize the integrity of the reservoir rim, but rapid movement into the reservoir could produce large waves that would have to be accounted for in dam design.

Several landslides and possible landslides have been mapped in the Kings Creek reservoir area and field reconnaissance suggests many more landslides, particularly smaller debris flows, have altered the site's steep slopes. Two large landslides have developed on either side of the left abutment ridge. These debris flows occupy the central portion of tributary valleys, extending well up on the hillslopes from Kings Creek. The landslides appear to be dormant now but probably have moved within the last several hundred years based on vegetation differences with the adjacent slopes. The upstream landslide would probably be reactivated by reservoir filling, but this would not breach the rim and the resultant reservoir wave could be accommodated in the design. It is unlikely that the downstream landslide would be affected by reservoir filling.

Landslides are prevalent in the downstream half of the Yellow Bank Creek proposed reservoir area. Several massive slump or block-type landslides have been identified in the Santa Cruz Mudstone formation at this site. One of these lies on the left (south) abutment and extends the entire distance from valley floor to ridgetop, a height of about 400 feet. Profiles drawn along this slope indicate a depth to the failure surface may be in the order of 100 feet. Although large diameter trees are growing undisturbed from the landslide mass, the sharpness of features in the head scarp area indicates some movement has occurred relatively recently, probably within the last several hundred years. While not impossible, designing and constructing a dam with this landslide on one abutment would be very difficult. This landslide is not a fatal flaw, but would have a significant impact on construction permitting and cost.

Another landslide of interest at Yellow Bank Creek has developed on the eastern slopes upstream of the dam site near a saddle in the reservoir rim. The recent age of this landslide is suggested by its grass-and-brush-covered surface. This is a debris flow landslide; the occurrence of this type of landslide in Santa Cruz Mudstone, as is mapped at this site, is anomalous and suggests perhaps more complex geologic relationships here than is shown on published maps. The narrowest horizontal flow path of water at maximum reservoir elevation occurs at the saddle above this landslide. Here a 300-foot-wide saddle-section would contain the reservoir. Due to the landslides in this area and uncertain geologic conditions, this site would require a thorough investigation.

Several questionable landslides were mapped in the East Branch of Liddell Creek reservoir area. These could not be verified in the field but several small debris flow landslides were located, particularly near the base of hillslopes. With the water level at maximum reservoir elevation of 560 feet, the horizontal ground-water flow path at the left abutment and for 2200 feet upstream along the reservoir rim ranges from 200- to 500-feet wide. Although landslides are not believed to pose a hazard by breaching this portion of the rim, leakage and/or piping could be a hazard.

8.2.2.2 Hydrogeologic Criteria

Alternatives which include groundwater wells were reviewed for hydrogeologic fatal flaws. The fatal flaw analysis for hydrogeology is based on a review of available literature and data for each of the sites and field reconnaissance. Available hydrogeologic information was reviewed to:

- Investigate options for diversion structure configuration at Scott Creek;
- Evaluate impacts of proposed Scotts Valley wells (intertie) on basin yield and localized drawdown;
- Develop estimates of water quality and recharge for brackish groundwater wells alternative; and
- Develop area of influence curves for Thurber Lane to estimate drawdown area of influence.

In screening alternatives for hydrogeologic fatal flaws, two criteria were identified: the safe yield of the groundwater basin which is being used; and groundwater flow, pumping and transmissivity considerations. The issue of safe yield is regional, relating to the groundwater basin as a whole. Groundwater flow, pumping and transmissivity are more local issues, dealing with the use of individual aquifers and/or the physical capacity of any existing or planned wells.

The safe yield of the groundwater basin is reflected by the current amount of water being pumped and the amount of available recharge from rainfall. Excessive pumping results not only in a rapid decline in groundwater levels, but might also result in sea water intrusion or replacement of potable water by connate water moving laterally or vertically from adjacent aquifers.

On a local scale, factors such as storage capacity and transmissivity of the aquifer, along with physical limitations of existing or future types of well construction are the important considerations, and have been evaluated. Environmental concerns related to the reduction of surface water flow were also evaluated, but only in those cases where aquifers potentially to be developed may have a hydraulic connection to streams and wetlands.

Groundwater well sites at Thurber Lane and in the Harvey West area were both reviewed. Previous studies were conducted at both of these sites by Luhdorff and Scalmanini, which consisted of both test well drilling and hydrogeologic analysis to determine aquifer transmissivity and sustained well capacities. The hydrogeologic analysis by Luhdorff and Scalmanini was reviewed, and a field reconnaissance was made of the proposed locations. No fatal flaws were identified for either of these alternatives, although it was determined that the pump station site for the Thurber Lane wells is not suitable for two wells, because the cones of depression around the wells may interfere with each other at the desired pumping rates. A second site further up Thurber Lane, which was the former location of a hydropneumatic tank, could be used for a second well.

The Scotts Valley Intertie Alternative included both local and regional concerns. The Scotts Valley Intertie alternative is an in-lieu recharge project in which the City of Santa Cruz would distribute treated water to SVWD in lieu of pumping by the SVWD within the Scotts Valley groundwater basin. The SVWD would extract groundwater from the basin and deliver it to the City of Santa Cruz during drought periods to alleviate any water supply deficiencies. During these critical periods, it is estimated that a capacity of about 70 million gallons per month (1600 gpm) will be needed from April through October. Concerns for this project include the amount of drawdown in the immediate vicinity of new wells and the potential to adversely impact existing wells.

The groundwater basin in the Scotts Valley area consists of semi-consolidated sand and sandstone of the Santa Margarita and Lompico aquifers. Both published and unpublished data were reviewed concerning aquifer conditions, particularly on the "deep" Lompico aquifer in the northeastern portion of Scotts Valley. Based on the review, it was concluded that wells completed in the Santa Margarita sandstone, and wells in the El Pueblo or Camp Evers area in both the Santa Margarita and Lompico aquifers do not have the required delivery capacity. However, deep wells (such as existing wells No. 7A and 11) in the Lompico aquifer "fairway," which extends from Scotts Valley Drive northeast to the former Santa's Village, would have the required capacity. Two new wells in this area should not interfere with one another if they are at least 1,500 feet apart, based on known aquifer characteristics. The aquifer properties should not constitute a fatal flaw, provided that the amounts of water pumped do not exceed the quantities of water delivered to the District in lieu of pumping.

Based on Department of Fish and Game concerns, the diversion at Scott Creek for the North Coast Diversion and Storage Alternative was reviewed to determine the feasibility of using subsurface collectors to divert flow from the creek. Informal discussions with a local well driller who has constructed wells in the area indicate that the upper layers of alluvium in the vicinity of Scott Creek contain silts and clays and have a very low transmissivity. This would likely preclude the use of a subsurface infiltration gallery, but deeper wells with laterals may still be feasible. For the analysis, assumptions were made regarding the total available storage capacity of the alluvium, and recharge was calculated based on available stream flow data from the period 1959 through 1974 for the Scotts Creek drainage area. For the November through March period for these years, flows were calculated for low-flow, average-flow and high-flow conditions in Scott Creek. Recharge to the basins was assumed to be 20 percent of the three streamflow quantities.

The evaluation suggests that an average of at least 5,000 gpm may be available from the area for continuous extraction during the rainy season, although recharge would vary considerably and would be substantially less in drier years. During dry years, extractions from alluvial storage may be feasible. Based on the estimated extent of the alluvium, there would be enough storage capacity in the alluvium to yield 3,300 gpm for 5 months. This yield could be developed with no recharge assuming that the basin is initially full. These rates are consistent with the smaller diversion rate used to develop estimated sizes for project facilities.

The alternative for Brackish Groundwater Wells With Reverse Osmosis Treatment involves the construction of several deep wells in the North Coast area at locations ranging from Laguna Creek to the vicinity of Davenport. The hydrogeologic aspects of this alternative have been evaluated based on a review of published and unpublished data, including the logs of deep oil exploratory test holes, and a brief reconnaissance of the area. Two main hydrogeologic factors evaluated in the fatal flaw analysis for this alternative were: a determination of a safe yield for both well fields, and the effect that pumping might have on the base flow of streams in the area. Based on a cursory evaluation of known hydrogeologic conditions, the two dispersed well fields should not exceed the average long-term annual recharge and would not reduce the base flow of the area's streams. Recharge areas and recharge amounts will need to be defined if this project is selected for further evaluation. A third consideration is the disposal of brine from the RO unit into shallow subsurface environments near the well fields. Brines can probably be disposed of in shallow injection wells on the beach, for example near the mouth of Laguna Creek. Thus, there are no hydrogeologic conditions which would be fatal flaws for this alternative.

8.2.3 Environmental Criterion Analysis

8.2.3.1 Federal or State Listed Rare and Endangered Species

The environmental concerns center on the presence of federal and state rare and endangered species which primarily affect alternatives in undeveloped areas. The alternative sites were surveyed for environmental fatal flaws with the principal focus on the North Coast Diversion site at Scott Creek; reservoir sites at the East Branch of Liddell Creek and Yellow Bank Creek; Loch Lomond; and the potential reservoir sites in the upper San Lorenzo River watershed. Existing data bases were examined, aerial photographs and flood plain maps were reviewed, and field surveys were conducted. The data base examination involved review of the California Natural Diversity Data Base (CNDDB) that is maintained by the Department of Fish and Game.

The CNDDB provides a listing of plants, animals, and natural community elements observed within a general geographic area that have been identified as being of federal or state special status. The CNDDB was reviewed for the following U.S. Geological Survey quad sheets: Ano Nuevo, Davenport, Santa Cruz, Felton, Big Basin, and Castle Rock Ridge. The CNDDB listings give the general area of the observations. For example, the Saltmarsh Common Yellowthroat location is given as Scott Creek Marsh, at the mouth of Scott Creek, east of Highway 1, approximately 3 miles northwest of Davenport. The CNDDB listings do not include maps. The purpose of the CNDDB is to provide some direction for field investigation.

The 1987 flood plain maps available at the Santa Cruz County Planning Department were also reviewed as were the 1989 aerial photographs of the county. The flood plain maps and aerial photographs were used to identify potential riparian areas.

Field visits were made to all reservoir and diversion sites. The purpose of the field visits was to compare sites with the general information obtained from the CNDDB and to identify additional biological issues of concern. The focus of the field investigation was on identifying habitat associated with sensitive species.

A number of species were identified in the CNDDB. The field surveys that were conducted did not confirm the presence or absence of the species identified in the data base. Further site analysis would be necessary to confirm the presence or absence of the species or their habitat. The additional work would require conducting detailed field analyses with a team of biologists that would rate the different sites according to habitat values present. This effort would be aided by the use of color and infrared aerial photos at a scale of 1:12,000 or larger. This level of effort would typically be performed as part of the CEQA environmental review process once a specific project has been selected.

Based upon the review of the CNDDB, two birds, the Saltmarsh Common Yellowthroat and the Tricolored Blackbird were identified in the vicinity of the Scott Creek site. In addition, the data base indicates that the Western Snowy Plover, a bird; Tidewater Goby, a fish; Northern Coastal Salt Marsh, a plant community; and the plant species, Santa Cruz Microseris, San Francisco Campion, Screibers Manzanita, and Blasdale's Bent Grass have been recorded in the Scott Creek watershed but, based on the field analysis, would probably not be present in the project area. Additional species of concern that were identified using the CNDDB were the Marbled Murrelet, a bird species, that may be present in either the East Branch of Liddell Creek or Yellow Bank Creek watersheds; the White-rayed Pentachaeta, a plant, that has been sited on the hillsides adjacent to the San Lorenzo river; and the Silver-leaved Manzanita, another plant, that has been observed 1/2 mile east of the northeast arm of Loch Lomond Reservoir. Additional species such as the Santa Cruz long-toed salamander, the red-legged frog, and the San Francisco Garter Snake as well as one or more raptor species which may also be present. Potential sensitive habitats that would need further examination include freshwater marsh, any riparian forest or woodland, and maritime chaparral.

Although the coho salmon is presently not a listed species, the Santa Cruz County Fish and Game Commission recently recommended that Fish and Game evaluate the coho salmon for possible listing.

Based upon the review of available information and a field review of the alternative sites, nothing was established during Phase II that would serve as a fatal flaw to eliminate any alternative from consideration. A description of the findings for each alternative is included in Section 9. Additional information is needed to establish the presence or absence of any of the threatened and endangered species or habitats identified in the CNDDB, but it is assumed that mitigation measures could be worked out for any loss of critical habitat or wetlands.

8.3 Results of Fatal Flaw Screening

Table 8-2 summarizes the key findings from the fatal flaw screening.

For the fatal flaw screening, the information developed for each alternative was compared with the exclusionary criteria. If any of the exclusionary criteria were present for an alternative, then

TABLE 8-2
KEY FINDINGS FROM FATAL FLAW SCREENING OF WATER SUPPLY ALTERNATIVES
(Page 1 of 2)

Exclusionary Criteria	Affected Alternatives	Alternatives With Fatal Flaws	Significant Issues Identified for Consideration in Phase III Evaluation
Regulatory/Institutional			
Permitting Requirements/Implementation Schedule			
- Instream Flow Release Requirements (Department of Fish and Game)	All reservoir projects	None	Alternatives 5 and 6 can be sized to accommodate both project releases and preliminary instream releases. Alternative 3 (A & B) would require mitigation other than increased instream flow releases to be viable. All reservoir projects will require a study to identify instream flow release requirements of Fish and Game during the CEQA review process.
- Wastewater Reclamation (Department of Health Services)	Wastewater reclamation	None	A permit will be required from the Regional Board. The treatment level required by the Title 22 reclamation criteria, which are currently under revision, will affect project costs.
- Outfall/Brine Disposal (Regional Water Quality Control Board) Monterey Bay National Marine Sanctuary (National Oceanic & Atmospheric Administration)	Brackish GW w/RO	None	A permit will be required from the Regional Board, with review by NOAA. There is the possibility of future policy/requirement changes that would limit the amount or quality of brine that could be released into a Bay outfall. A permit for injection wells may be easier to obtain.
- 404 Permit (U.S. Army Corps of Engineers) Streambed Alteration Agreement (Department of Fish and Game)	All reservoir projects	None	A 404 permit and Streambed Alteration Agreement will be required for construction of a reservoir on the East Branch of Liddell Creek, Yellow Bank Creek, Kings Creek, or the San Lorenzo River at Waterman Gap. They may also be required for raising Loch Lomond Dam. Mitigation of any loss of wetlands is required which can be time consuming and expensive. However, both a 404 permit and a streambed Alteration Agreement should be able to be obtained for any of the reservoir projects.
- Take Permits (Dept. of Fish & Game, U.S. Fish & Wildlife Service)	All reservoir projects	None	No endangered species were identified at the project sites based on review of the California Natural Diversity Database and field reconnaissance. A detailed field study must be performed during CEQA review process.
- Dam Construction Feasibility (Division of Safety of Dams)	All reservoir projects	None	No issues were identified that would preclude DSOD approval.
Jurisdictional/Political (Scotts Valley/San Lorenzo Valley Water District)	Scotts Valley Intertie	Scotts Valley Intertie	The Scotts Valley Intertie will not be evaluated in Phase III due to opposition of the Scotts Valley Water District.
Land Use Planning (County Planning Dept./Coastal Commission Local Program)	North Coast Diversion	None	Alternatives within the Coastal Zone will require a Coastal Development Permit, which will significantly impact project implementation time. No issues were identified which would preclude permit approval.

TABLE 8-2
KEY FINDINGS FROM FATAL FLAW SCREENING OF WATER SUPPLY ALTERNATIVES
(Page 2 of 2)

Exclusionary Criteria	Affected Alternatives	Alternatives With Fatal Flaws	Significant Issues Identified for Consideration in Phase III Evaluation
Geologic/Hydrogeologic			
Active Faults	All reservoir projects	None	No active faults cross any proposed reservoir sites. Splays of the Zayante fault cross Loch Lomond but not Newell Creek Dam. Waterman Gap and Kings Creek sites are within 1,000 feet of splays of the Butano fault, which will required additional study. Neither of the coastal sites at Yellow Bank Creek and the East Branch of Liddell Creek is crossed by mapped faults. All dam sites have similar values of highest predicted seismic acceleration, which can be accounted for in the design.
Landslides	All reservoir projects	None	Landslides are common in Loch Lomond area, but repair is possible. Landslides in the form of debris flows are common at Waterman Gap and Kings Creek sites, and could produce large waves that must be accounted for in design. The Yellow Bank Creek area will require additional investigation due to the presence of massive landslides and uncertain geologic conditions; selection of an alternative alignment may decrease capacity. The East Branch of Liddell Creek had questionable evidence of landslides; no major problems are anticipated at that location.
Groundwater safe yield and underflow/pumping/transmissivity	GW wells, North Coast Div., Brackish GW w/RO	Harvey West Wells	The Harvey West well alternative will not be evaluated in Phase III due to its low yield and conflict with the proposed Costco Store planned for the site. The pump station site for Thurber Lane wells is not suitable for two wells due to potential interference during pumping; a second site further up Thurber Lane (former hydro tank) could be used for second well. The North Coast Diversion alternative could probably not have a subsurface infiltration gallery; however, deeper wells with laterals may be feasible and will require further investigation. The brines for the brackish groundwater alternative could probably be disposed of in shallow injection wells on the beach.
Environmental			
Federal, State, or California Native Plant Society listed rare or endangered species.	All alternatives	None	No fatal flaws were found based on review of available information and field reconnaissance. Detailed field analyses would be required during the CEQA review process of specific projects to establish the presence or absence of any threatened or endangered species or habitats identified in the California Natural Diversity Database. It is assumed that any loss of critical habitat or wetlands could be mitigated.

a fatal flaw was identified. Fatal flaws were identified for the following two alternatives. Therefore, these two alternatives were excluded from further evaluation.

- Alternative 1A - Harvey West Groundwater Well

  This alternative was screened out due to its low yield and potential conflict with planned development in the area.

- Alternative 4 - Scotts Valley Intertie

  This alternative was screened out due to opposition of the Scotts Valley Water District.

The rest of the alternatives were included in the Phase III evaluation.

The Phase II evaluation also identified issues which would have significant impact on implementation and/or cost of alternatives, even though not fatal flaws. These issues were considered in the subsequent evaluation in Phase III.

Section 9
Development of Potential Water Supply Projects

The section presents information on the potential water supply projects developed as part of Phase III of the Water Supply Alternatives Study. The section provides an overview of how projects were developed, presents the projects which were selected for Phase III evaluation, and discusses the Phase III evaluations performed to finalize specific facilities sizes.

9.1 Feasible Water Supply Alternatives

Based on the results of the Phase II fatal flaw screening, the following water supply alternatives were recommended for inclusion in the Phase III evaluation. No fatal flaws were identified for these alternatives. Therefore, these alternatives were used in formulating potential water supply projects in Phase III, as described later in this section.

Alt. No.	Description
1B	Groundwater Wells at Thurber Lane
2	Wastewater Reclamation
3A	Enlarge Loch Lomond by 260 to 500 MG
3B	Enlarge Loch Lomond by 1,010 MG
5	Upper San Lorenzo River Reservoir
6	North Coast Diversion and Storage
7	Brackish Groundwater Wells with Reverse Osmosis Treatment

Two alternatives screened in Phase II were not recommended for inclusion in the Phase III evaluation due to fatal flaws. Alternative 1A - Groundwater Well Near Harvey West Park was dropped from further consideration due to its low yield and potential conflict with proposed land use in the area. Alternative 4 - Scotts Valley Intertie was dropped due to opposition from Scotts Valley.

9.2 Criteria for Development of Potential Projects

As part of the Phase III evaluation, several projects were formulated from the feasible alternatives identified in Phase II. These potential projects consist of various combinations of alternatives that will meet the City's water supply needs. The potential projects were evaluated and ranked with respect to engineering, environmental, institutional, and cost factors.

The primary criterion for the development of potential water supply projects is to be able to meet the City's projected year 2005 water supply requirement during droughts of 4,500 MG/year. This demand was based on the 1989 Water Master Plan projection of 5,175 MG/year. The Water Master Plan demand was adjusted to account for permanent water conservation savings from existing customers of 180 MG/year. In addition, it was assumed that there would be a 10 percent annual (which is equivalent to a 15 percent summertime) reduction in demand due to drought restrictions.

Potential water supply projects were formulated to have additional yield sufficient to make up the difference between the safe annual yield of the existing water supply system and the projected water requirement. The safe annual yield of the existing system, including existing storage capacity, is 3,510 MG/year for a short-term (2-year) critical drought similar to 1976-77 conditions, and 3,910 MG/year for a long-term (5-year) extended drought similar to 1987-1991 conditions. The shortfall ranges from 590 MG/year for the extended drought conditions to 990 MG/year for the short-term critical drought conditions. The development of potential projects considered both types of drought conditions, and was based on providing additional water supply capability sufficient for either drought condition. The proposed projects must be capable of meeting both the critical and extended drought conditions.

The following combinations of alternatives were considered in formulating potential projects.

- A new reservoir at a location in the Upper San Lorenzo River watershed or the North Coast area which would be sized to provide for the full amount of the shortfall.
- Enlarging Loch Lomond in conjunction with non-storage sources, such as groundwater wells, brackish groundwater wells with reverse osmosis treatment, and/or wastewater reclamation.
- Non-storage sources only, such as groundwater wells, brackish groundwater wells with reverse osmosis treatment, and wastewater reclamation, with no new reservoir and no modifications to Loch Lomond. The non-storage sources do not have sufficient yield to meet the shortfall individually, but can meet it when combined as a project.
- A smaller new reservoir at a location in the Upper San Lorenzo River watershed or North Coast area, in conjunction with non-storage sources such as groundwater wells, brackish groundwater wells with reverse osmosis treatment, and/or wastewater reclamation.

9.3 Potential Water Supply Projects

Table 9-1 summarizes the nine potential water supply projects formulated from the feasible alternatives. Due to the complexities of implementing a reservoir alternative, the formulation of projects assumed that a project would contain only one reservoir (i.e., a project would not include two small reservoirs). Projects P-A and P-B call for construction of a new reservoir in the Upper San Lorenzo River watershed, which would be sized to provide the full incremental water requirement to meet project demands. Project P-A sites the new reservoir at Waterman Gap, while P-B sites it at Kings Creek. Projects P-C and P-D call for diverting water from Scott Creek to a new reservoir in the North Coast area, which would be sized to provide the full incremental water requirement. Project P-C sites the new reservoir at East Branch Liddell Creek while Project P-D sites it at Yellow Bank Creek.

Table 9-1
Summary of Potential Water Supply Projects

Project Identifier	Project Description
P-A	Waterman Gap Reservoir (Upper San Lorenzo River)
P-B	Kings Creek Reservoir (Upper San Lorenzo River)
P-C	East Branch Liddell Creek Reservoir and Scott Creek Diversion (North Coast)
P-D	Yellow Bank Creek Reservoir and Scott Creek Diversion (North Coast)
P-E	Loch Lomond 260 MG Enlargement and Brackish Groundwater Wells and Reverse Osmosis Treatment Plant
P-F	Loch Lomond 500 MG Enlargement and Brackish Groundwater Wells and Reverse Osmosis Treatment Plant
P-G	Loch Lomond 1,010 MG Enlargement and Brackish Groundwater Wells and Reverse Osmosis Treatment Plant
P-H	Thurber Lane Groundwater Wells and Brackish Groundwater with Reverse Osmosis Treatment
P-I	Smaller New Reservoir with Thurber Lane Groundwater Wells and Wastewater Reclamation

Projects P-E, P-F, and P-G are variations based on enlarging the City's existing Loch Lomond reservoir, but must also include other alternatives. The incremental yields of the Loch Lomond enlargements are not sufficient to provide for all of the shortfall. Project P-E includes enlarging Loch Lomond by 260 MG (4-foot parapet wall and spillway raise) and implementing the alternative for brackish groundwater wells with reverse osmosis treatment (4.9 MGD facility). Project P-F calls for a 500 MG enlargement of Loch Lomond (8-foot parapet wall and spillway raise) and a reverse osmosis treatment facility for brackish groundwater (4.1 MGD). An 8-foot high parapet wall is the maximum allowable for the existing dam. Project P-G calls for a 1,010 MG enlargement of Loch Lomond (14-foot dam and spillway raise) and a smaller facility (2.8 MGD) for reverse osmosis treatment of brackish groundwater. The existing Coast pipeline would be adequate for Projects P-F and P-G. Therefore, a parallel pipeline would not be needed for these projects. A parallel pipeline would be required for Project P-E.

The Loch Lomond enlargement must be implemented with the brackish groundwater/reverse osmosis treatment alternative as part of a project. It is not possible to meet the incremental water requirement with a project consisting of enlarging Loch Lomond by 1,010 MG (which is the maximum allowable enlargement without major modifications to the existing dam) and implementing the Thurber Lane groundwater wells and wastewater reclamation alternatives. The total system yield with such a project (Loch Lomond enlargement with groundwater wells and wastewater reclamation) would be only 4,150 MG/year for a short-term critical drought and 4,300 MG/year for an extended drought.

Project P-H is the only alternative that does not include a new reservoir or enlargement of an existing reservoir. It includes the alternatives for brackish groundwater wells with reverse osmosis treatment and the Thurber Lane groundwater wells. Due to hydrogeologic constraints, the alternative for brackish groundwater wells with reverse osmosis treatment could not be sized large enough to meet the full incremental water supply requirement as a stand-alone project. Project P-H would require a pipeline parallel to the existing Coast pipeline.

Project P-I calls for constructing a smaller new reservoir (one that would not be sized to provide the full incremental water requirement) and implementing non-storage alternatives as part of the project (Thurber Lane Groundwater Wells and Wastewater Reclamation). Based on the Phase III evaluation results, Yellow Bank Creek was selected as the reservoir site. The required size of the smaller reservoir was determined by the incremental supply provided by the other non-reservoir components. The implementation and permitting requirements would be similar for a full size or reduced size new reservoir.

The nine projects selected by CDM were presented to the Technical Advisory Committee for review and approval to include them in the Phase III evaluation. The nine projects were approved for inclusion in Phase III at the July 1993 Water Commission meeting.

9.4 Evaluation of Projects

In Phase III, engineering and environmental evaluations were performed to gather specific information for each project to supplement findings from earlier phases of work. The purpose of these evaluations was to identify significant engineering or environmental constraints for each of the projects.

9.4.1 Engineering Evaluations

Phase III engineering evaluations focused on the following tasks:

- Identifying the principal design elements of each project.
- Determining the engineering and construction viability of each project.
- Identifying significant engineering or construction constraints, if any.
- Preparing feasibility level construction cost estimates for budgeting and alternative comparison purposes.

The Phase III evaluations are summarized below.

9.4.1.1 Final Sizing of Reservoir Projects

Final reservoir sizes were developed based on new information developed in Phase III evaluations. The North Coast Reservoir Projects include diverting water from Scott Creek during the rainy season to a reservoir located on either Yellow Bank Creek or the East Branch of Liddell Creek. An alternative concept using wells to capture creek underflow, which was identified in Phase II, was evaluated further. The reservoir final sizes were developed based on estimates of recharge and pumping from the Scott Creek basin.

The San Lorenzo River Projects include a release into the San Lorenzo River rather than a pipeline to meet drought year demands. An issue raised earlier in the study was whether an allowance for seepage should be included in the releases. The seepage issue was reviewed with people familiar with the hydrology of the San Lorenzo River (phone conversations with Al Haynes, San Lorenzo Valley Water District and Barry Hecht, Balance Hydrologics, June 1993).

Based on these conversations, it was concluded that the San Lorenzo River gains water in the section between the reservoir and Felton Diversion because of the geologic characteristics of the river channel and septic tank inflows. Therefore, no direct allowance was made for seepage. However, total reservoir releases were calculated as the sum of the releases to meet downstream demands and releases to meet estimated fishery requirements. Previously, the release to meet fishery requirements had been included in the release to meet downstream demands.

9.4.1.2 Reservoir Filling Analysis

An analysis was made of the average time to initially fill and to re-fill the reservoirs. The monthly spreadsheet models developed for sizing the reservoirs were expanded to include 70 years of historical hydrology. Consecutive years were evaluated to determine how many years would be required to fill the reservoir, assuming average runoff conditions. Initially filling and re-filling the reservoirs assumed that instream releases would need to be maintained while the reservoir was filling. The reservoirs were found to have fill times ranging from 8 to 18 years.

9.4.1.3 Blending Opportunities for Reverse Osmosis

In earlier phases of the study, reverse osmosis treatment facilities were sized assuming that reverse osmosis treated product water would have the same level of total dissolved solids (TDS) as the City's other sources of supply. Further analysis was performed in Phase III to address the question of whether brackish water could be blended with the City's existing supplies to significantly reduce the size of treatment facilities or eliminate the need for reverse osmosis treatment. Based on discussions with the City, a goal of 300 mg/l was selected, which is slightly higher than the City's existing TDS level of about 260 mg/l. Reverse osmosis facilities were sized to meet this goal. Although the higher TDS goal decreases the treatment facility size, the savings identified were not significant.

Water quality data indicate that the brackish water TDS levels may range from a low of 800 mg/l to as high as 5,000 mg/l. Projects were sized using an assumed TDS level of 1,500 mg/l. A sensitivity analysis was performed to determine the impact of facility sizing for different influent TDS levels and for a goal of 300 mg/l for the total supply. It was found that a reverse osmosis facility would be required for the range of TDS levels evaluated although the treatment plant size would vary. For example, Project P-E, which has a treatment plant sized at 4.9 MGD, would have a plant sized at 5.9 MGD for a brackish water supply with 5,000 mg/l TDS. The plant size would drop to 3.5 mgd for a brackish water supply with 800 mg/l TDS. Additional assessment of brackish water quality and blending opportunities will be needed as part of the preliminary design of such a project.

9.4.1.4 Project Facilities Evaluation and Sizing

For all of the projects, new facilities were sized to be operated in a baseload manner (i.e., a continuous, constant production capability from the new source of supply) with Loch Lomond used to provide short-term peaking capability. The reason for doing this was to reduce the number of new facilities which would be required, including parallel pipelines. This is also consistent with the current operation of the water supply system. For each of the projects, monthly production estimates from existing sources of supply were reviewed for the critically dry and milder drought periods. These were compared with pipeline capacities to determine whether new parallel pipeline facilities would be required. The following criteria were used for sizing specific facilities:

Dams and Reservoirs

- 3:1 (horizontal:vertical) upstream slope and 2.5:1 downstream slopes for new earth embankment dams (Upper San Lorenzo River projects).
- 2:1 upstream slope and 1.5:1 downstream slope for embankment raise at Loch Lomond.
- Vertical upstream face and 0.8:1 downstream slope for roller-compacted concrete dams (North Coast Reservoir projects).
- 15-feet of freeboard for earth embankment dams.
- 0 feet of freeboard for roller compacted concrete dams.
- Multi-level outlet structure to maintain water quality.
- Spillway sized for 1/2 to full Probable Maximum Flood event.
- Relocation of any public roads within reservoir site.
- No public recreation facilities for new projects.

Pump Stations and Pipelines

- Pump stations sized based on hydraulic requirements and a 70 percent efficiency for mechanical and electrical losses.
- Pipelines sized based on a maximum of 2 feet of friction loss per 1,000 feet of pipeline.

9.4.1.5 Project Cost Estimating

Capital costs and annual operating and maintenance costs were developed for each of the projects. Cost estimates were developed using both cost curves and construction bid costs from similar types of projects. Construction cost estimates included the following assumptions:

- 1993 costs based on Engineering News Record Construction Cost index of 6,400 for the San Francisco Bay area.
- Construction costs include base cost, a 30 percent contingency, 20 percent engineering allowance, 5 percent legal and administrative allowance, and a 5 percent environmental mitigation and monitoring allowance.
- Annual operating costs (chemicals, labor and power) were computed using an inflation rate of 4 percent per year.
- A bond rate of 8 percent was used to calculate annual bond repayment requirements.

The contingency takes into account construction items not yet identified, changes in project elements which cannot be defined now, changes in the construction climate, and uncertainty as to the schedule for construction.

9.4.2 Environmental Evaluations

Also, as part of the Phase III work, additional environmental evaluation was performed to better define permit requirements for projects and to better define potential project environmental impacts. The Phase III environmental work focused on the following tasks:

- Performing additional field work to gather information on project impacts.
- Identifying potentially significant issues and impacts.
- Determining the feasibility of mitigation measures that may be required for projects.

- Assessing the limitation or constraints that may be imposed on a project as a result of the environmental process.

The Phase III environmental evaluations are summarized below.

9.4.2.1 Site Visits

Additional field investigations were conducted in Phase III to evaluate vegetation and wildlife habitat at the new reservoir sites and the route identified for re-location of Highway 9. Site visits were also conducted to survey existing land uses at the reservoir sites and along the coast. Preliminary assessments were made of the potential visual impacts of projects and potential traffic and circulation impacts, with an emphasis on disruption related to construction.

9.4.2.2 Review of Existing Information

The following information was reviewed as part of the Phase III investigation: County of Santa Cruz zoning maps, the County General Plan and Coastal Zone Management Program Land Use Plan, the Monterey Bay National Marine Sanctuary Environmental Impact Statement/Management Plan, and other environmental impact reports prepared by EIP Associates regarding proposed reverse osmosis and reservoir projects.

9.4.2.3 Agency Contacts

Several agencies were contacted to better define potential project impacts and identify agency concerns. The following agencies were contacted: the U.S. Environmental Protection Agency (EPA), regarding brine disposal for deep injection wells; the Central Coast Regional Water Quality Control Board (Regional Board), regarding brine disposal options; the National Oceanic and Atmospheric Administration, regarding Monterey Bay National Marine Sanctuary; the California Department of Fish and Game, regarding fisheries and threatened and endangered species issues for reservoir projects; Wilder Ranch State Park, regarding the pipeline alignment through the State Park; and the County of Santa Cruz Planning Department, regarding potential project permit requirements.

The potential for permitting difficulties for brine disposal was identified as an area requiring further investigation in Phase III. As part of the Phase III evaluation, Brad Hagemann, Senior Engineer, Permitting Section, for the Central Coast Regional Water Quality Control Board was contacted to discuss brine disposal options and potential permit issues. Three disposal options were reviewed with the Regional Board: disposal of brine using the City's existing wastewater outfall in downtown Santa Cruz; construction of a new outfall at the reverse osmosis treatment plant site; and, the use of beach injection wells near the treatment plant site. A fourth method identified, the use of deep injection wells, would be regulated by the EPA, not the Regional Board. The Water Quality Control Plan for the Central Coast Basin has provisions for brine disposal so any of the disposal methods would be feasible from a permitting perspective. The Regional Board has also adopted two resolutions regarding desalination discharges. Resolution 90-05 states that: "Desalination discharges do not contribute the type of pollutants which are a concern in the Prohibition Zone" for Monterey Bay (the "Prohibition Zone" is designated from the Salinas River south to Carmel). The resolution also states that "sufficient regulatory mechanisms exist to protect Monterey Bay from desalination and circulating seawater discharges." Resolution 91-9 states: "Discharges to the Monterey Bay Prohibition Zone from desalination units and circulating seawater system discharges may be permitted after each proposal satisfies California Environmental Quality Act requirements and completes the National Pollutant Discharge Elimination System process". The Regional Board's preferred alternative for brine disposal would be use of the existing outfall.

9.4.2.4 Cultural Resources Literature Review

The California Archaeological Inventory at Sonoma State University was contacted to conduct a cultural resources literature review. A written report was provided and the results of the survey have been incorporated into this report as part of the Phase III review.

Section 10
Discussion of Potential Projects

This section presents a summary for each of the projects based on the findings in Phase II and Phase III of this study. The following information is addressed for each project:

- Description of Project
- Estimated Incremental Yield
- Facilities Requirements
- Engineering Analysis
- Regulatory and Institutional Analysis
- Environmental Analysis
- Summary of Significant Project Constraints

A summary of each of the project facilities is presented in Table 10-1.

10.1 Project P-A - Waterman Gap Reservoir

10.1.1 Description of Project

This project would involve developing a storage reservoir at the Waterman Gap site on the San Lorenzo River. Water would be stored at the reservoir and released during summer months of drought periods to supplement existing supplies. Releases would also be made during normal and dry years for fisheries.

10.1.2 Estimated Incremental Yield

The reservoir was sized at 5,900 MG. This provides a yield of 590 MG/year during a long-term (5-year) drought and additional water to make instream releases for fisheries. The storage requirement to meet drought year demands is approximately 50 percent of the total reservoir storage volume. The reservoir could also provide a yield of 990 MG/year for a short-term (2-year) drought. The reservoir was sized to provide for all the shortfall to meet the projected year 2005 water demand of 4,500 MG/year. It was assumed that water to meet demands would be withdrawn from the reservoir between May and October of dry years.

10.1.3 Facilities Requirements

The proposed facilities for this alternative are shown on Figure 10-1, and include:

- Reservoir size of 5,900 MG.
- Zoned earth embankment dam approximately 240 feet high, 830 feet in crest length, with slopes ranging from 2.5:1 to 3:1.
- Outlet works.
- Concrete spillway.
- Construction of approximately 2.4 miles of new road to replace the section of Highway 9 which would be inundated by the reservoir.
- Use of existing Felton Diversion to capture reservoir releases during drought periods.

TABLE 10-1

SUMMARY OF POTENTIAL WATER SUPPLY PROJECT FACILITIES
(Page 1 of 3)

Project Identifier	Project Description	Formulation of Project	Project Yield (MG/yr)	
		Major Features	Critical (2-year) Drought	Extended (5-year) Drought
P-A	Waterman Gap Reservoir	▪ 5,900 MG reservoir at Waterman Gap with a 240-foot high dam. ▪ Relocation of 2.4 miles of Highway 9.	990	590
P-B	Kings Creek Reservoir	▪ 6,000 MG reservoir at Kings Creek with a 260-foot high dam. ▪ Improvement of 4.4 miles of private road to replace Kings Creek Road.	990	590
P-C	East Branch Liddell Creek Reservoir and Scott Creek Diversion	▪ 5-1,000 gpm wells and 1,000 HP pump station at Scott Creek. ▪ 4,100 MG reservoir on East Branch Liddell Creek with 250-foot dam. ▪ 32,000 feet of pipeline from diversion to storage. ▪ 150 HP pump station at reservoir. ▪ 16,000 feet of pipeline from storage to existing Coast pipeline at Majors Creek. ▪ Parallel Coast pipeline.	990	590
P-D	Yellow Bank Creek Reservoir and Scott Creek Diversion	▪ 5-1,000 gpm wells and 700 HP pump station at Scott Creek. ▪ 3,900 MG reservoir on Yellow Bank Creek with 230-foot dam. ▪ 33,000 feet of pipeline from diversion to storage. ▪ 400 HP pump station at reservoir. ▪ 14,000 feet of pipeline from storage to existing Coast pipeline. ▪ Parallel Coast pipeline.	990	590
P-E	Loch Lomond Enlargement (260 MG) and Brackish Groundwater w/RO Treatment			
	▪ Loch Lomond Enlargement (260 MG)	▪ 4-foot parapet wall across top of dam and spillway raise.	110	60
	▪ Brackish Groundwater Wells with Reverse Osmosis Treatment	▪ Two 2.9 MGD well fields in Davenport and Majors Creek areas. ▪ 20,000 feet pipeline from Davenport to Majors. ▪ 4.9 MGD reverse osmosis treatment plant at Majors producing 3.9 MGD of treated water and 1.0 MGD of brine. ▪ 0.9 MGD brackish water bypass which would be blended with 3.9 MGD of treated water to produce a 4.8 MGD blended supply. ▪ 320 HP pump station at treatment plant. ▪ Parallel Coast pipeline. ▪ 36,000 feet of brine disposal pipeline.	880	530

TABLE 10-1

SUMMARY OF POTENTIAL WATER SUPPLY PROJECT FACILITIES
(Page 2 of 3)

Project Identifier	Project Description	Formulation of Project — Major Features	Project Yield (MG/yr) — Critical (2-year) Drought	Project Yield (MG/yr) — Extended (5-year) Drought
P-F	Loch Lomond Enlargement (500 MG) and Brackish Groundwater w/RO Treatment			
	■ Loch Lomond Enlargement (500 MG)	■ 8-foot parapet wall across dam and spillway raise.	240	90
	■ Brackish Groundwater Wells with Reverse Osmosis Treatment	■ Two 2.45 MGD well fields in Davenport and Majors Creek areas. ■ 20,000 feet pipeline from Davenport to Majors. ■ 4.1 MGD reverse osmosis treatment plant at Majors producing 3.3 MGD of treated water and 0.8 MGD of brine. ■ 0.8 MGD brackish water bypass which would be blended with 3.3 MGD of treated water to produce a 4.1 MGD blended supply. ■ 270 HP pump station at treatment plant. ■ 6,000 feet of pipeline to existing Coast pipeline. ■ 36,000 feet of brine disposal pipeline.	750	500
P-G	Loch Lomond Enlargement (1,010 MG) and Brackish Groundwater w/RO Treatment			
	■ Loch Lomond Enlargement (1,010 MG)	■ 14-foot raise of zoned fill embankment and spillway at Loch Lomond.	450	200
	■ Brackish Groundwater Wells with Reverse Osmosis Treatment	■ Two 1.75 MGD well fields in Davenport and Majors Creek areas. ■ 20,000 feet pipeline from Davenport to Majors. ■ 2.8 MGD reverse osmosis treatment plant at Majors producing 2.2 MGD of treated water and 0.6 MGD of brine. ■ 0.7 MGD brackish water bypass which would be blended with 2.2 MGD of treated water to produce a 2.9 MGD blended supply. ■ New 200 HP pump station at treatment plant. ■ 5,000 feet of pipeline to existing Coast pipeline. ■ 36,000 feet of brine disposal pipeline.	540	390

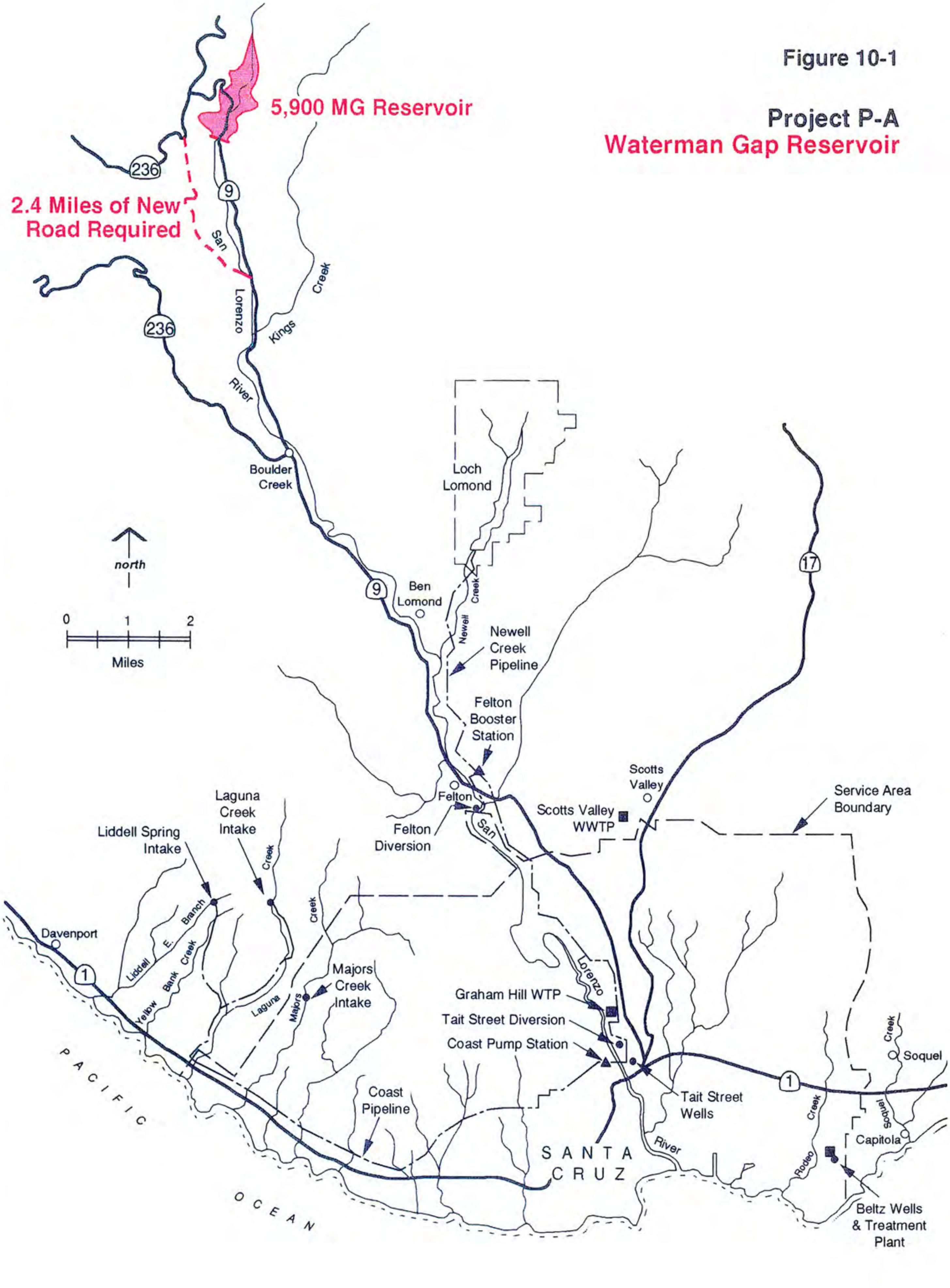
TABLE 10-1

SUMMARY OF POTENTIAL WATER SUPPLY PROJECT FACILITIES
(Page 3 of 3)

Project Identifier	Project Description	Formulation of Project Major Features	Project Yield (MG/yr) Critical (2-year) Drought	 Extended (5-year) Drought
P-H	"No Reservoir" Project (Brackish Groundwater w/RO Treatment and Thurber Lane Groundwater Wells)			
	■ Thurber Lane Groundwater Wells	■ Two 0.35 MGD wells. ■ 0.7 MGD iron and manganese water treatment plant at upper site. ■ 3,500 feet of new pipeline.	120	120
	■ Brackish Groundwater with Reverse Osmosis Treatment	■ Two 2.9 MGD well fields in Davenport and Majors Creek areas. ■ 20,000 feet pipeline from Davenport to Majors. ■ 4.9 MGD reverse osmosis treatment plant at Majors producing 3.9 MGD of treated water and 1.0 MGD of brine. ■ 0.9 MGD brackish water bypass which would be blended with 3.9 MGD of treated water to produce a 4.8 MGD blended supply. ■ 320 HP pump station at treatment plant. ■ Parallel Coast pipeline. ■ 36,000 feet of brine disposal pipeline.	870	470
P-I	Smaller New Reservoir at Yellow Bank Creek with Thurber Lane Groundwater Wells and Wastewater Reclamation			
	■ Reduced Size New Reservoir at Yellow Bank Creek	■ Two 0.35 MGD wells. ■ 0.7 MGD iron and manganese water treatment plant at upper site. ■ 3,500 feet of new pipeline. ■ Five 1,000 gpm wells and 700 HP pump station at Scott Creek. ■ 33,000 feet of pipeline to reservoir. ■ 2,600 MG reservoir, 200 feet high. ■ 320 HP pump station at reservoir. ■ 14,000 feet of pipeline from reservoir to Coast pipeline. ■ Parallel Coast pipeline.	800	400
	■ Thurber Lane Groundwater Wells	■ Two 0.35 MGD wells. ■ 0.7 MGD iron and manganese water treatment plant at upper site. ■ 3,500 feet of new pipeline.	120	120
	■ Wastewater Reclamation	■ 0.55 MGD treatment facility at Scotts Valley Wastewater Treatment Plant. ■ 9,500 feet of reclaimed water pipeline at Pasatiempo Golf Course. ■ Modified service connection at Oddfellow Cemetery.	70	70

Figure 10-1

Project P-A
Waterman Gap Reservoir



- Use of existing pipeline from Felton Diversion to Felton Booster Pump Station.
- Use of existing Felton Booster Pump Station and pipeline to Graham Hill Water Treatment Plant (WTP).

A borrow source for material to construct the embankment would need to be located. The majority of material would likely come from the reservoir site. In addition, the reservoir site would need to be cleared and grubbed.

10.1.4 Engineering Analysis

10.1.4.1 Facilities Sizing

Facilities were sized assuming that a continuous, constant release would be made from the reservoir during summer months of drought years and that the existing Loch Lomond supply would be used to meet short-term peak requirements during this period. If the new reservoir project were to be used to provide higher flows during peak periods, additional parallel pipelines could be required from the Felton Diversion to the Graham Hill WTP.

10.1.4.2 Project Cost Estimate

The estimated capital cost of the Waterman Gap Project is $54 million dollars in 1993 dollars. This high cost is primarily due to the amount of material which would be required for the embankment dam.

10.1.4.3 Pipeline Evaluation

The use of a pipeline to convey flows from the reservoir site to the Felton Booster Station was compared with making a release to the river channel. Approximately 13 miles of 18-inch to 22-inch pipeline would be required to convey water from the reservoir site to the Felton Booster Pump station, the assumed tie-in point. The estimated cost of a pipeline is approximately $12 million to $15 million in 1993 dollars, not including contingencies, engineering, administration, and legal costs. No water quality or seepage issues were identified which would preclude the use of the stream channel for conveying flows to Felton Diversion. Therefore, the use of a pipeline to convey flows to Felton was rejected because of the significant additional cost.

10.1.4.4 Geotechnical Issues

The design of a zoned embankment dam for this facility would be relatively straightforward since no major geologic hazards were identified at the site. The site is ideal for a zoned embankment dam, with competent foundation and abutments, although the need for landslide stabilization within the new reservoir will require special study. The outlet facilities and spillway, however, will pose a major design issue. Also, due to the relatively narrow constraints of the San Lorenzo River downstream of the site, the design of the spillway must include significant energy dissipation and control of discharged stormwater before returning it to the river.

Available geologic information was reviewed and compiled. Existing air photos, both before and after the Loma Prieta earthquake, were reviewed and interpreted to map the slopes above the proposed reservoir site and adjacent slopes, as well as proposed dam abutments and spillway areas. Field reconnaissance was performed to investigate dam site conditions, reservoir terrain, borrow materials, and construction access. A geologic work map for this site is presented in Appendix A.

No active faults have been mapped crossing the proposed dam site. The Waterman Gap dam site is located within 1,000 feet of splays of the potentially active Butano fault. The proposed dam site has a highest predicted acceleration of 0.52 g. While high, these accelerations can be accounted for in design.

Landslides are common in the proposed Waterman Gap reservoir area, with air photo mapped deposits covering perhaps one quarter of the land surface. Most of these landslides appear to be debris flows, often coalescing to fill or form entire local drainages. Landslide deposits that become saturated by reservoir water would have decreased stability and renewed movement could be triggered. Rapid movement into the reservoir could produce large waves that would have to be accounted for in dam design.

An alternative alignment for Highway 9 was developed based on a review of the topography in the vicinity of the dam. The existing road grade was used as a guide to determine the maximum allowable grade for a new road. The alignment was also reviewed in the field to identify potential geologic or environmental constraints. The proposed road location is shown on Figure 10-1.

10.1.4.5 Hydrologic Issues

A monthly spreadsheet-style water accounting model was developed to estimate reservoir sizes. The model included hydrology for both the short-term (2-year) and long-term (5-year droughts. Fishery bypass flows and evaporative losses estimates were included in the model. Area-capacity curves for the reservoir were developed from topographic maps. The analysis assumed there would be no carryover storage in the new reservoir at the end of the dry period. The model was extended to include 70 years of historical hydrology and used to evaluate the time required to fill the reservoir.

For the Waterman Gap site, filling the reservoir was estimated to take 11 years, assuming average hydrologic conditions. Although only one drought period was identified in the 70 years of hydrologic data which would empty the reservoir, the reliability and availability of the supply would be diminished for several years following such an event.

Available geologic information was reviewed and compiled. Existing air photos, both before and after the Loma Prieta earthquake, were reviewed and interpreted to map the slopes above the proposed reservoir site and adjacent slopes, as well as proposed dam abutments and spillway areas. Field reconnaissance was performed to investigate dam site conditions, reservoir terrain, borrow materials, and construction access. A geologic work map for this site is presented in Appendix B.

10.1.5 Regulatory and Institutional Analysis

The following state and federal permits/approvals would be required for this project:

- Permit to Appropriate Water (State Water Resources Control Board)
- Timberland Conversion Permit and Timber Harvesting Plan (State Department of Forestry)

- Encroachment Permit (State Department of Transportation (Caltrans))
- Environmental Impact Report for Re-location of Highway 9 (Caltrans)
- Streambed Alteration Agreement (State Department of Fish and Game)
- Approval of Plans and Specifications and Certificate of Approval to Construct or Enlarge a Dam or Reservoir (State Department of Water Resources, Division of Safety of Dams)
- Section 404 Permit to excavate or discharge dredged material into waters of the United States (Army Corps of Engineers)
- Potential for "Take" Permit (U.S. Fish and Wildlife Service and Army Corps of Engineers)

Approximately 2.4 miles of new road would be needed to replace portions of Highway 9. Phillip Badal, Senior Transportation Planner for Caltrans District 4 Planning Division was contacted to discuss the re-alignment of Highway 9. He stated that Caltrans would be a reviewing agency during the CEQA review phase of project implementation and would also require an encroachment permit. He also noted that the project, if deemed major enough, could require legislation for the project to proceed. For a project of this magnitude, close involvement with Caltrans would be required. This project also has a significant potential for delays due to the re-location of Highway 9.

The majority of the land at the reservoir site is owned by the San Lorenzo Valley Water District, which has expressed its opposition to this project. There is also a potential for scheduling delays due to the need to acquire the land and the district's stated opposition to the project.

The reservoir would also inundate a State Department of Parks and Recreation Trail which connects Castle Rock State Park with Big Basin State Park.

10.1.6 Environmental Analysis

10.1.6.1 Cultural Resources

A cultural resources review for the Waterman Gap site was conducted by the California Archaeological Inventory at Sonoma State University. Only a small percentage of the reservoir area has been mapped. Although no Native American resources were identified at this site, the potential for such resources is considered high based on the site characteristics. The Saratoga Toll Road and the Southern Pacific Railroad Boulder Creek Spur, historic features, run through the site.

10.1.6.2 Vegetation and Wildlife

The California Natural Diversity Database was reviewed to identify species/community information. Floodplain maps and aerial photographs were reviewed to identify potential riparian areas. Field visits were made to compare sites with information from the database, and to identify additional biological issues of concern. The vegetation associated with a potential Waterman Gap dam site in the upper San Lorenzo River watershed is basically redwood forest. The site has some potential for sensitive species or habitat. Intensive field surveys would be required to determine the presence or absence of such species. Likely candidates include the California tiger salamander, Santa Cruz long-toed salamander, red-legged frog, the marbled murrelet, and one or more raptor species. Potential sensitive habitats include freshwater marsh, and riparian forest or woodland.

10.1.6.3 Fisheries and Aquatic Resources

A preliminary fisheries analysis was performed which consisted of: reviewing available information; walking Kings Creek and portions of the San Lorenzo River to characterize fishery habitat; taking discharge measurements to use in developing estimates for potential instream flow releases; performing limited hydraulic modeling for the San Lorenzo River to develop preliminary release estimates; and meeting with the Department of Fish and Game to identify their concerns. This work is documented in Appendix D.

Fishery resources in the San Lorenzo River watershed include steelhead trout and coho salmon. The reservoir site would inundate steelhead trout habitat. Loss of steelhead habitat would be mitigated with flow augmentation to enhance summer rearing habitat below the dam for steelhead and coho salmon. The Department of Fish and Game has stated that mitigation impacts for a new reservoir would be considered along with the impacts on fishery due to existing diversions. Bypass flows at the San Lorenzo River diversions at Tait Street and at Felton could be subject to re-evaluation as part of this project. Bypass flows would also be required for a new reservoir. An Instream Flow Incremental Methodology (IFIM) study will be required to identify instream flow release requirements of the Department of Fish and Game during the CEQA review phase if this project is selected.

10.1.6.4 Threatened and Endangered Species

While it is unlikely that the site contains a federal- or State-listed endangered or threatened species, it is assumed that any loss of critical wetlands or habitat could be mitigated.

10.1.7 Summary of Significant Project Constraints

The following significant constraints were identified for this project:

- The reservoir would take eleven years to fill, based on average hydrology, after a drought similar to the extended drought period used for planning. The reliability of this project would be substantially diminished during filling period.
- The re-location of Highway 9 would involve extensive, close coordination with Caltrans and has the potential to cause scheduling delays.
- The need to acquire land for the reservoir from the San Lorenzo Valley Water District, which has publicly stated its opposition to this project has the potential for scheduling delays.
- Construction of the reservoir would inundate portions of the historic Saratoga Toll Road. This impact could not be mitigated.
- Mitigation for fisheries impacts could potentially involve re-negotiation of fishery bypass releases at the City's existing diversions on the San Lorenzo River. Releases from the reservoir would provide some additional bypass flows at existing diversions.
- The dam's proximity to a potentially active fault could produce a negative perception of the safety of the project.

10.2 Project P-B - Kings Creek Reservoir

10.2.1 Description of Project

This project would involve developing a storage reservoir at the site on Kings Creek, a major tributary to the San Lorenzo River. Water would be stored at the reservoir and released during summer months of drought periods to supplement existing supplies. Releases would also be made during normal and dry years for fisheries.

10.2.2 Estimated Incremental Yield

The reservoir was sized at 6,000 MG. This provides a yield of 590 MG/year during a long-term (5-year) drought and additional water to make instream releases for fisheries. The storage requirement to meet drought year demands is approximately 50 percent of the total reservoir storage volume. The reservoir could also provide a yield of 990 MG/yr for a short-term (2-year) drought. The reservoir was sized to provide for all the shortfall to meet the projected year 2005 water demand of 4,500 MG/year. It was assumed that water to meet demands would be withdrawn from the reservoir between May and October of dry years.

10.2.3 Facilities Requirements

The proposed facilities for this project are shown on Figure 10-2, and include:

- Reservoir size of 6,000 MG.
- Zoned earth embankment dam approximately 260 feet high, 750 feet in length, with slopes ranging from 2.5:1 to 3:1.
- Outlet works.
- Concrete spillway.
- Improvement of approximately 4.4 miles of private road to bypass the section of Kings Creek Road which would be inundated by the reservoir.
- Use of existing Felton Diversion to capture reservoir releases during drought periods.
- Use of existing Felton Booster Pump Station and pipeline to Graham Hill WTP.

A borrow source for material to construct the embankment would need to be located. The majority of material would likely come from the reservoir site. In addition, the reservoir site would need to be cleared and grubbed.

10.2.4 Engineering Analysis

10.2.4.1 Facilities Sizing

Facilities were sized assuming that a continuous, constant release would be made from the reservoir during summer months of drought years and that the existing Loch Lomond supply would be used to meet short-term peak requirements during this period. If the new reservoir project were to be used to provide higher flows during peak periods, additional parallel pipelines could be required from the Felton Diversion to the Graham Hill WTP.

10.2.4.2 Project Cost Estimate

The estimated capital cost of the Kings Creek Project is $58 million dollars in 1993 dollars. The high cost is primarily due to the large amount of material which would be required for construction of an embankment dam.

10.2.4.3 Pipeline Evaluation

The use of a pipeline to convey flows from the reservoir site to the Felton Booster Station was compared with making a release to the river channel. Approximately 13 miles of 18-inch to 22-inch pipeline would be required to convey water from the reservoir site to the Felton Booster Pump station, the assumed tie-in point. The estimated cost of a pipeline is approximately $12 million to $15 million in 1993 dollars, not including contingencies, engineering, administration, and legal costs. No water quality or seepage issues were identified which would preclude the use of the stream channel for conveying flows to Felton Diversion. Therefore, the use of a pipeline to convey flows to Felton was rejected because of the significant additional cost.

10.2.4.4 Geotechnical Issues

The design of a zoned embankment dam for this facility will be similar to that discussed for the Waterman Gap site; however, at this site a detailed investigation of the landslides located in the left abutment area will be required to ensure a safe and adequate structure. Due to a smaller drainage basin, and the fact that this facility would be located on a tributary to the San Lorenzo River, there are no heightened concerns regarding the spillway design as previously described for Waterman Gap.

Available geological information was reviewed and compiled. Field reconnaissance was also performed to investigate dam site conditions, reservoir terrain, borrow materials and construction access. A geological work map prepared for this site is presented in Appendix B.

No active faults were found to cross the Kings Creek dam site. The Kings Creek dam site is located within 1,000 feet of splays of the potentially active Butano fault. The proposed dam site has a highest predicted acceleration of 0.54 g. While high, these accelerations can be accounted for in design.

Several landslides and possible landslides have been mapped in the Kings Creek reservoir area and field reconnaissance suggests many more landslides, particularly smaller debris flows, have altered the site's steep slopes. Debris flow landslides exist on both abutments and would have to be removed for construction. Due to the extent of landslides in the abutment area, no alternate alignment could be identified which would not require landslide mitigation.

10.2.4.5 Hydrologic Issues

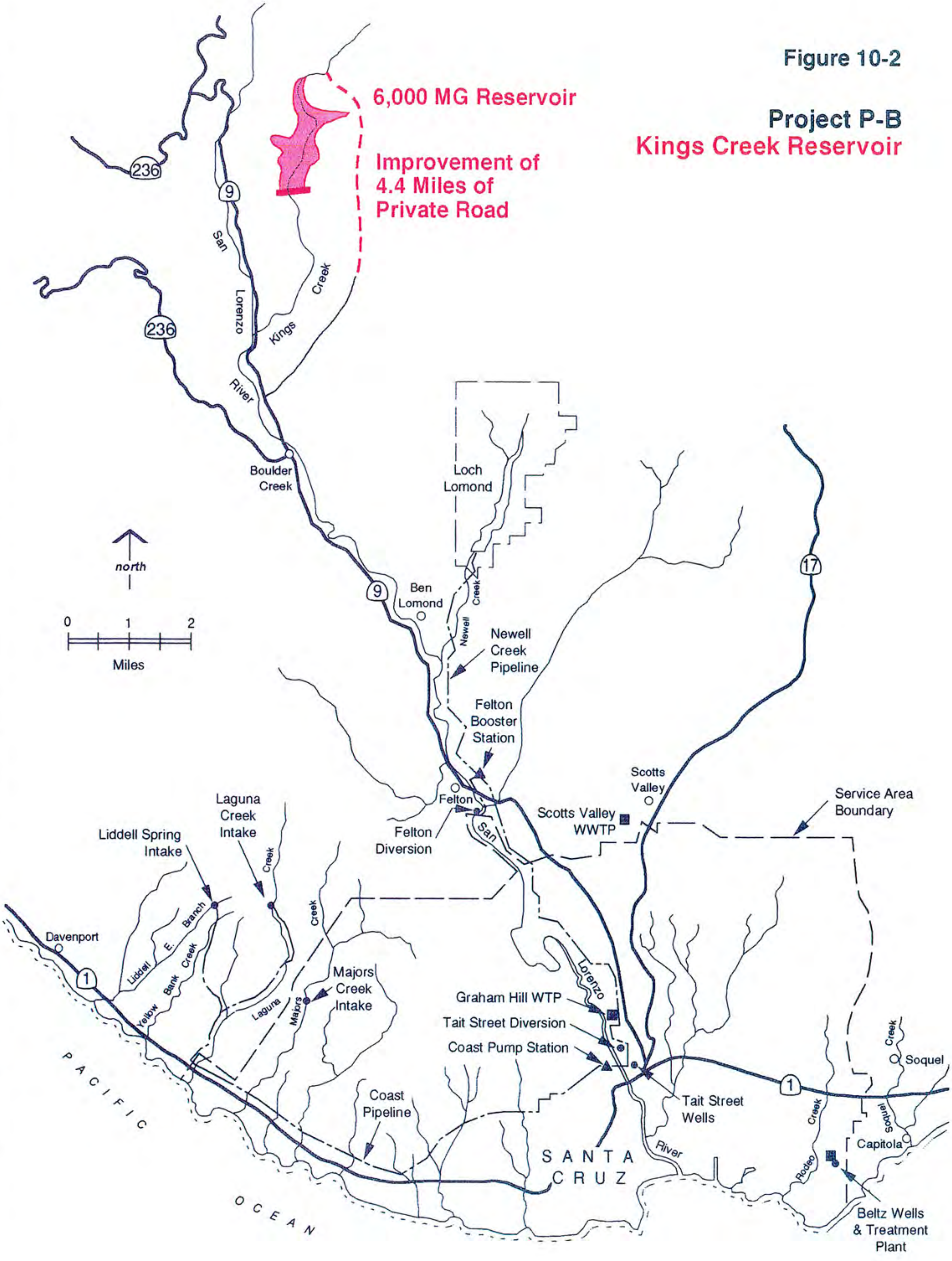
A monthly spreadsheet-style water accounting model was developed to estimate reservoir sizing and to evaluate the time required to fill the reservoir. At the Kings Creek site, filling the reservoir would take an estimated 18 years, based on average hydrologic conditions. Therefore, this watershed does not generate sufficient inflow for a reservoir of this size. In the 70 years of hydrologic data reviewed, only one drought period was identified which would empty the reservoir. However, the reliability and availability of the supply would be poor after such a drought period or during initial filling of the reservoir. Although this issue constitutes a technical fatal flaw, the Kings Creek Project was carried through the Phase III evaluation for comparative purposes.

10.2.5 Regulatory and Institutional Analysis

The following state and federal permits/approvals would be required for this project:

Figure 10-2

Project P-B
Kings Creek Reservoir



- Permit to Appropriate Water (State Water Resources Control Board)
- Timberland Conversion Permit and Timber Harvesting Plan (State Department of Forestry)
- Streambed Alteration Agreement (State Department of Fish and Game)
- Approval of Plans and Specifications and Certificate of Approval to Construct or Enlarge a Dam or Reservoir (State Department of Water Resources, Division of Safety of Dams)
- Section 404 Permit to excavate or discharge dredged material into waters of the United States (Army Corps of Engineers)
- Potential for "Take" Permit (U.S. Fish and Wildlife Service and Army Corps of Engineers)

Twenty-eight property owners were identified in the reservoir area. Construction of the reservoir would displace these property owners. The project would also be very disruptive to local residents due to the need to provide alternative access to the upper reaches of the reservoir.

10.2.6 Environmental Analysis

10.2.6.1 Cultural Resources

A cultural resources review for the Kings Creek site was conducted by the California Archaeological Inventory at Sonoma State University. Although no Native American resources were identified at this site, the potential for such resources is considered high based on the site characteristics. The historical maps depict a trail and a minimum of six buildings within the project area. Building foundations and deposits associated with residential use are anticipated for this study area.

10.2.6.2 Vegetation and Wildlife

The California Natural Diversity Database was reviewed to identify species/community information in order to focus field reconnaissance efforts. Floodplain maps and aerial photographs were reviewed to identify potential riparian areas. Field visits were made to compare sites with information from the database, and to identify additional biological issues of concern. The vegetation associated with a potential Kings Creek dam site is basically redwood forest. Review of the aerial photos showed that the areas have fairly dense stands of trees which was confirmed with field observation.

The Kings Creek site has some potential for sensitive species or habitat. Intensive field surveys would be required to determine the presence or absence of such species. Likely candidates include the California tiger salamander, Santa Cruz long-toed salamander, red-legged frog, the marbled murrelet, and one or more raptor species. Potential sensitive habitats include freshwater marsh, and riparian forest or woodland.

10.2.6.3 Fisheries and Aquatic Resources

A preliminary fisheries analysis was performed which consisted of: reviewing available information; walking Kings Creek and portions of the San Lorenzo River to characterize fishery habitat; taking discharge measurements to use in developing estimates for potential instream flow releases; performing limited hydraulic modeling for the San Lorenzo River to develop preliminary release estimates; and meeting with the Department of Fish and Game to identify their concerns. This work is documented in Appendix D.

Fishery resources in the San Lorenzo River watershed include steelhead trout and coho salmon. Loss of resident rainbow trout habitat would be mitigated with flow augmentation to enhance summer rearing habitat below the dam for steelhead and coho salmon. The Department of Fish and Game has stated that mitigation of impacts for a new reservoir would be considered along with the impacts on fisheries due to existing diversions. Bypass flows at the San Lorenzo River diversions at Tait Street and at Felton could be subject to re-evaluation as part of this project. Bypass flows would also be required for a new reservoir. An IFIM study will be required to identify instream flow release requirements of the Department of Fish and Game during the CEQA review phase if this project is selected.

10.2.6.4 Threatened and Endangered Species

While it is unlikely that the site contains a federal- or state-listed endangered or threatened species, habitats such as riparian forest and wetlands can be difficult and costly to mitigate. It is assumed that any loss of critical wetlands or habitat could be mitigated.

10.2.7 Summary of Significant Project Constraints:

The following significant constraints were identified for this project:

- The reservoir would take 18 years to fill, based on average hydrology, after a drought similar to the extended drought period used for planning. Therefore, this project could not be counted on as a reliable source of supply, and is considered fatally flawed from this standpoint.
- Landslides are located at the dam site which would require removal during construction. Although costs have been included for landslide mitigation, there could be a negative perception of the safety of this project from both of these landslides and the proximity to a potentially active fault.
- Mitigation for fisheries impacts could potentially involve re-negotiation of fishery bypass releases at the City's existing diversions on the San Lorenzo River. Releases from the reservoir would provide some additional bypass flows at existing diversions.
- This project would displace a large number of landowners. Land acquisition has the potential for delays because of the number of property owners involved.

10.3 Project P-C - East Branch Liddell Creek Reservoir and Scott Creek Diversion

10.3.1 Description of Alternative

The East Branch Liddell Creek Reservoir and Scott Creek Diversion Project would involve diverting water during the rainy season from Scott Creek to a reservoir located on the East Branch of Liddell Creek. Water would be stored in the reservoir to provide additional drought year supply. Releases would also be made during normal and dry years for fisheries.

10.3.2 Estimated Incremental Yield

The reservoir was sized at 4,100 MG. This provides a yield of 590 MG/year during a long-term (5-year) drought and additional water to make instream releases for fisheries. The storage requirement to meet drought year demands is approximately 70 percent of the total reservoir storage volume. The reservoir could also provide a yield of 990 MG/year for a short-term (2-year) critical drought period. It was assumed that water to meet demands would be withdrawn from the reservoir between May and October of dry years.

10.3.3 Facilities Requirements

The proposed facilities for this alternative are shown on Figure 10-3 and include the following:

- Five-1,000 gpm wells to divert Scott Creek underflow, 16-inch diameter, 200-feet deep.
- 1,000 HP pump station at Scott Creek.
- Approximately 32,000 feet of 24-inch diameter pipeline from Scott Creek to the reservoir.
- Reservoir sized at 4,100 MG.
- Roller-compacted concrete dam approximately 250 feet high and 930 feet in length.
- 150 HP pump station at the reservoir site.
- 16,000 feet of 22-inch diameter pipeline from the storage reservoir to the Coast pipeline at Majors Creek.
- Approximately 35,000 feet of 14-inch diameter pipeline from Majors Creek to the existing Coast Pump Station.
- Upgrade of Coast Pump Station by 75 HP.
- Approximately 6,000 feet of 14-inch diameter pipeline from existing Coast Pump Station to Graham Hill WTP.

10.3.4 Engineering Analysis

Facilities were sized assuming that a continuous, constant release would be made from the reservoir during summer months of drought years and that the existing Loch Lomond supply would be used to meet short-term peak requirements during this period. If the new reservoir project were to be used to provide higher flows during peak periods, the new parallel Coast pipeline would need to be sized at a larger diameter.

10.3.4.1 Project Cost Estimate

The estimated capital cost of the Scott Creek Diversion and East Branch Liddell Creek Reservoir is $117 million in 1993 dollars. The extremely high cost of this project is due to the high cost of constructing the dam. The cost of the roller-compacted concrete dam, discussed below under "Geotechnical Issues", is approximately 70 percent of the estimated capital cost for this project.

10.3.4.1 Geotechnical Issues

The roller-compacted concrete (RCC) dam recommended for this north coast site was selected over that of a zoned embankment or rockfill dam because of: (1) the relatively steep topography, (2) the competency of the foundation rock, (3) the difficulty in providing sufficient space for a conventional spillway, and (4) the lack of adequate volumes of competent soil and rock materials. The local bedrock at this site consists of Santa Cruz Mudstones, which have a very low specific gravity (less than 1.5), and is not considered appropriate for use in a zoned embankment. Although extensive excavation will be required to socket the RCC dam into the abutments and foundation, especially to resist strong earthquake shaking, this should not pose a major problem to construction. A favorable aspect to the RCC dam is that the entire crest acts as an overflow spillway, thereby eliminating the need for a separate structure. Unfortunately, however, it will be necessary to import all RCC materials which unfavorably impacts estimated costs. The total cost of this project is also adversely impacted because of the relatively high dam required for the reservoir size.

Available geologic information was reviewed and compiled. Field reconnaissance was also performed to investigate dam site conditions, reservoir terrain, borrow materials and construction access. A geologic work map prepared for this site is presented in Appendix B.

The East Branch of Liddell Creek dam site is not crossed by any mapped faults. The proposed dam site has values of highest predicted acceleration of 0.52 g. While high, these accelerations can be accounted for in design.

Several questionable landslides were mapped in the East Branch of Liddell Creek reservoir area. A questionable landslide was identified on the right abutment of the original dam alignment. The dam was relocated about 500 feet upstream to avoid the landslide.

10.3.4.3 Hydrologic Issues

Monthly diversions from Scott Creek, and inflows to East Branch Liddell Creek were estimated. For Scott Creek, the daily flow records from 1959 through 1973 were used, along with estimated bypass flows to develop factors to estimate monthly flow available. Factors were developed for a range of instream release requirements and diversion rates on Scott Creek. Estimates of monthly flows were developed for East Branch Liddell Creek using the monthly flow estimates for Laguna Creek and Majors Creek and adjusting flows based on the ratio of watershed sizes and mean annual rainfall for the watersheds. A monthly spreadsheet-style water accounting model was developed to estimate reservoir sizing and to evaluate the time required to fill the reservoir.

After completion of the analysis to divert water from Scott Creek, it was determined that Department of Fish and Game would oppose a surface diversion. A cursory analysis was made of the feasibility of extracting water from the deeper alluvium rather than using a surface diversion in Scott Creek. The evaluation suggested that an average of at least 5,000 gpm (11 cfs) may be available from the area for continuous extraction during the rainy season months, although recharge would vary considerably and would be substantially less in drier years. The study also estimated the storage capacity of the alluvium sufficient to yield 3,300 gpm (7 cfs) for 5 months. Based on the analysis, the project was configured with five 1,000 gpm wells assumed to be located in the alluvial basin. The sizing assumed that available recharge could be pumped but that groundwater storage would not be used.

Once pumping rates were established, an analysis was made of the average time to initially fill and to re-fill the reservoir. For the East Branch Liddell Creek site, filling the reservoir was estimated to take 12 years. It may be possible to locate additional high capacity wells along Scott Creek in order to reduce the initial and re-fill time for the project. A larger pipeline and pump station would also be required at Scott Creek to divert the flows to the reservoir. This would add an estimated $2 to $3 million dollars to the capital cost of the project, not including contingencies. Because of the extremely high cost of the project, these additional costs were not included in the project cost estimate.

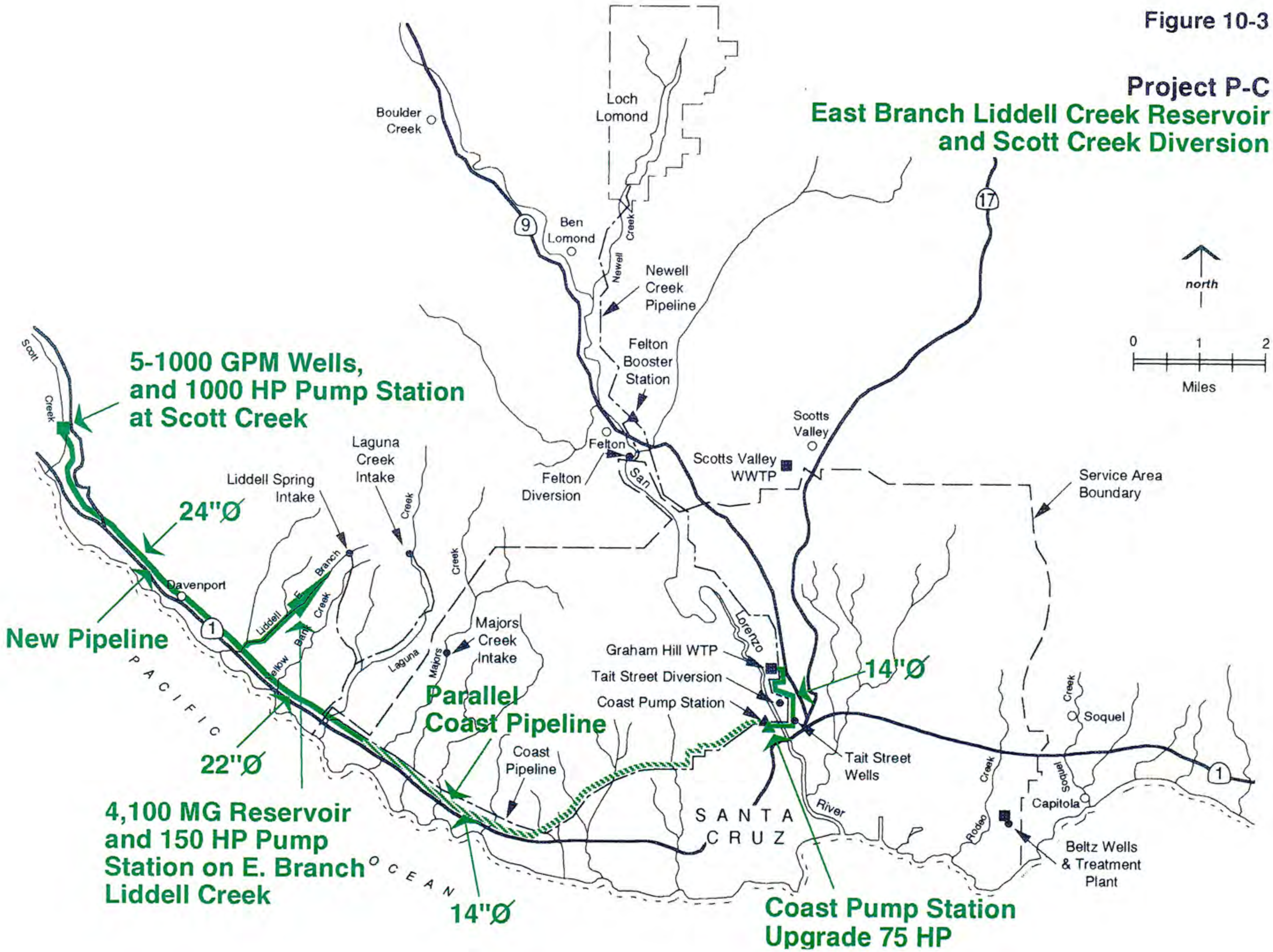


Figure 10-3
Project P-C
East Branch Liddell Creek Reservoir
and Scott Creek Diversion
5-1000 GPM Wells,
and 1000 HP Pump Station
at Scott Creek
24"Ø
New Pipeline
22"Ø
4,100 MG Reservoir
and 150 HP Pump
Station on E. Branch
Liddell Creek
14"Ø
Parallel
Coast Pipeline
14"Ø
Coast Pump Station
Upgrade 75 HP
Boulder Creek
Loch Lomond
Ben Lomond
Newell Creek
Newell Creek Pipeline
Felton Booster Station
Felton
Felton Diversion
Scotts Valley
Scotts Valley WWTP
Service Area Boundary
north
0
1
2
Miles
Scott Creek
Davenport
Liddell Spring Intake
Laguna Creek Intake
Majors Creek Intake
Graham Hill WTP
Tait Street Diversion
Coast Pump Station
Tait Street Wells
Coast Pipeline
San Lorenzo River
SANTA CRUZ
Soquel
Capitola
Beltz Wells & Treatment Plant
PACIFIC OCEAN

10.3.5 Regulatory and Institutional Analysis

The following permits would be required for this project:

- Permit to Appropriate Water (State Water Resources Control Board)
- Timberland Conversion Permit and Timber Harvesting Plan (State Department of Forestry)
- Streambed Alteration Agreement (State Department of Fish and Game)
- Approval of Plans and Specifications and Certificate of Approval to Construct or Enlarge a Dam or Reservoir (State Department of Water Resources, Division of Safety of Dams)
- Section 404 Permit to excavate or discharge dredged material into waters of the United States (Army Corps of Engineers)
- Potential for "Take" Permit (U.S. Fish and Wildlife Service and Army Corps of Engineers)
- Coastal Development Permit (Santa Cruz County Planning Department)
- Encroachment Permit (Caltrans)

This project is in the Coastal Zone as defined in the Santa Cruz County Coastal Plan, and would require a Coastal Development Permit. It would also need to be demonstrated that the project is consistent with both the County General Plan and the County Coastal Plan. Although it is likely that the need for a Coastal Development Permit would impact the time required for project review and implementation, no specific issues were identified which would preclude obtaining the permit.

New pipeline facilities would be located in the Highway 1 right-of-way and would require an Encroachment Permit from Caltrans.

10.3.6 Environmental Analysis

10.3.6.1 Cultural Resources

A cultural resources review for the East Branch of Liddell reservoir site and pipeline alignments was conducted by the California Archaeological Inventory at Sonoma State University. Although no Native American resources were identified at the reservoir site, the potential for such resources is considered high based on the site characteristics. The literature review gave no indications of historical resources within the study area. The project includes new pipelines from Scott Creek to the Majors area and a new pipeline in the existing Coast pipeline corridor. Six archaeological sites have been recorded within this area. Given the environmental features of the pipeline alignments, there is a high possibility of additional Native American resources.

10.3.6.2 Vegetation and Wildlife

The California Natural Diversity Database was reviewed to identify species/biotic community information. In addition to the site reconnaissance, floodplain maps and aerial photographs were reviewed to identify additional biological issues of concern. The vegetation associated with Liddell Creek consists of dense canyon vegetation and forest containing redwoods, Douglas-fir, tanbark-oak, aralia, elderberry, and dogwood and potential chaparral areas. The understory consists of redwood sorrel, western coltsfoot, five-fingered fern, and sword fern. The slopes are heavily wooded.

Vegetation at the Scott Creek site on the property leased to the California State Polytechnic University (Cal Poly) off of Swanton Road consists of red alder riparian forest dominated by red alder, although yellow and arroyo willows are also common. The understory is dense and composed of blackberry, nettle, dogwood, and box elder. Further downstream behind the Cal Poly farm buildings, yellow willow becomes dominant.

The Scott Creek and Liddell Creek sites have some potential for sensitive species or habitat. Intensive field surveys would be required to determine the presence or absence of such species. Likely candidates include the saltmarsh common yellowthroat, California tiger salamander, Santa Cruz long-toed salamander, red-legged frog, the marbled murrelet, and one or more raptor species. Potential sensitive habitats include freshwater marsh, any riparian forest or woodland, maritime chaparral, and maritime coast range ponderosa pine forest.

10.3.6.3 Fisheries and Aquatic Resources

A preliminary fisheries analysis was performed which consisted of: reviewing available information; walking several North Coast creeks to characterize fisheries habitat; and meeting with the Department of Fish and Game. This work is documented in Appendix D.

Aquatic resources in the Scott Creek watershed include tidewater goby, red-legged frog, steelhead trout and coho salmon. The Department of Fish and Game has stated that they would oppose a surface diversion which would present a barrier to fish migration or cause sedimentation upstream of a dam. Minimum bypass flows would need to be established, below which no water could be diverted from Scott Creek. An IFIM study would be required to identify instream flow release requirements of the Department of Fish and Game during the CEQA review phase if this project is selected. The Department of Fish and Game performed some IFIM work on Scott Creek during the 1992-1993 rainy season. A Scott Creek lagoon study analysis of how streamflow is related to sandbar passage and water quality will also be required.

Fishery resources in Liddell Creek includes a steelhead population. Both the East and West Branches are utilized, though there are migrational barriers in the lower sections on the West Branch. The impact of loss of steelhead habitat within the inundation zone on the East Branch could be mitigated. Acceptable mitigation for the Department of Fish and Game would include enhancement of summer pool habitat below the dam and improvement of steelhead access to the West Branch. Augmentation of summer streamflow from dam releases would also be required. An IFIM study would be required to determine bypass flows for steelhead access, spawning, egg incubation, and rearing during winter and spring.

10.3.6.4 Threatened and Endangered Species

It is expected that the Liddell Creek and Scott Creek sites do not support any federal- or state-listed endangered or threatened species. However, site specific surveys would need to occur to determine the presence or absence of rare, threatened, or endangered species. It is assumed that any loss of critical wetlands or habitat could be mitigated.

10.3.7 Summary of Significant Project Constraints

- An earth embankment dam could not be constructed at this site, because the native material is unsuitable for embankment fill. The dam would be RCC.

- The cost of this project is the highest of all of the projects evaluated. This is due to the high cost of RCC construction and the large volume of material which would be required for the dam.
- The reservoir would take twelve years to fill, based on average hydrology, after a drought similar to the extended drought period used for planning. This fill time could be shortened with a supplemental diversion of Scott Creek underflow.
- The diversion adjacent to Scott Creek has the potential to impact fishery resources in Scott Creek. The project would need to provide mitigation to protect fishery habitat.
- This project includes a new pipeline from Scott Creek to Majors and a new pipeline parallel to the existing Coast pipeline. There is a high probability of encountering cultural resources during construction of the pipelines. This could be mitigated.

10.4 Project P-D - Yellow Bank Creek Reservoir and Scott Creek Diversion

10.4.1 Description of Alternative

The Yellow Bank Creek Reservoir and Scott Creek Diversion Project would involve diverting water during the rainy season from Scott Creek to a reservoir located on Yellow Bank Creek. Water would be stored in the reservoir to provide additional drought year supply. Releases would also be made during normal and dry years for fisheries.

10.4.2 Estimated Incremental Yield

The reservoir was sized at 3,900 MG. This provides for all the shortfall to meet the projected year 2005 water demand of 4,500 MG/year. The storage required for an extended (5-year) drought period is greater than the amount needed for a short-term (2-year) drought. Therefore, the reservoir was sized to provide a yield of 590 MG/year during a long-term (5-year) drought period and additional water to make instream releases for fisheries. The storage requirement to meet drought year demands is approximately 75 percent of the total storage volume. A reservoir sized to meet the shortfall during extended drought conditions will also meet the 990 MG/year shortfall for the short-term (2-year) critical drought conditions.

10.4.3 Facilities Requirements

The proposed facilities for this project are shown on Figure 10-4 and include the following:

- Five 1,000 gpm wells to divert Scott Creek underflow, 16-inch diameter, 200-feet deep.
- 700 HP pump station at Scott Creek.
- Approximately 33,000 feet of 24-inch diameter pipeline from Scott Creek to the reservoir.
- Reservoir sized at 3,900 MG.
- Roller-compacted concrete dam approximately 230 feet high and 870 feet in length.
- 14,000 feet of 22-inch diameter pipeline from the reservoir to the Coast pipeline at Majors Creek.
- 400 HP pump station at the reservoir.
- Approximately 35,000 feet of 14-inch diameter pipeline from Majors Creek to the existing Coast Pump Station.
- Upgrade of Coast Pump Station by 75 HP.

- Approximately 6,000 feet of 14-inch diameter pipeline from existing Coast Pump Station to Graham Hill WTP.

10.4.4 Engineering Analysis

10.4.4.1 Facilities Sizing

Facilities were sized assuming that a continuous, constant release would be made from the reservoir during summer months of drought years and that the existing Loch Lomond supply would be used to meet short-term peak requirements during this period. If the reservoir project were to be used to provide higher flows during peak periods, the new parallel Coast pipeline would need to be sized at a larger diameter.

10.4.4.2 Estimated Project Costs

The estimated capital cost of the Scott Creek Diversion and Yellow Bank Creek Reservoir project is $79 million in 1993 dollars. The high cost of this project is due to the high cost of constructing the dam.

10.4.4.3 Geotechnical Issues

The roller-compacted concrete (RCC) dam recommended for this north coast site was selected over that of a zoned embankment or rockfill dam because of: (1) the relatively steep topography, (2) the competency of the foundation rock, (3) the difficulty in providing sufficient space for a conventional spillway, and (4) the lack of adequate volumes of competent soil and rock materials. The local bedrock at this site consists of Santa Cruz Mudstones, which have a very low specific gravity (less than 1.5), and is not considered appropriate for use in a zoned embankment. Although extensive excavation will be required to socket the RCC dam into the abutments and foundation, especially to resist strong earthquake shaking, this should not pose a major problem to construction. A favorable aspect to the RCC dam is that the entire crest acts as an overflow spillway, thereby eliminating the need for a separate structure. Unfortunately, however, it will be necessary to import all RCC materials which unfavorably impacts estimated costs. The total cost of this project is also adversely impacted because of the relatively high dam required for the necessary reservoir size.

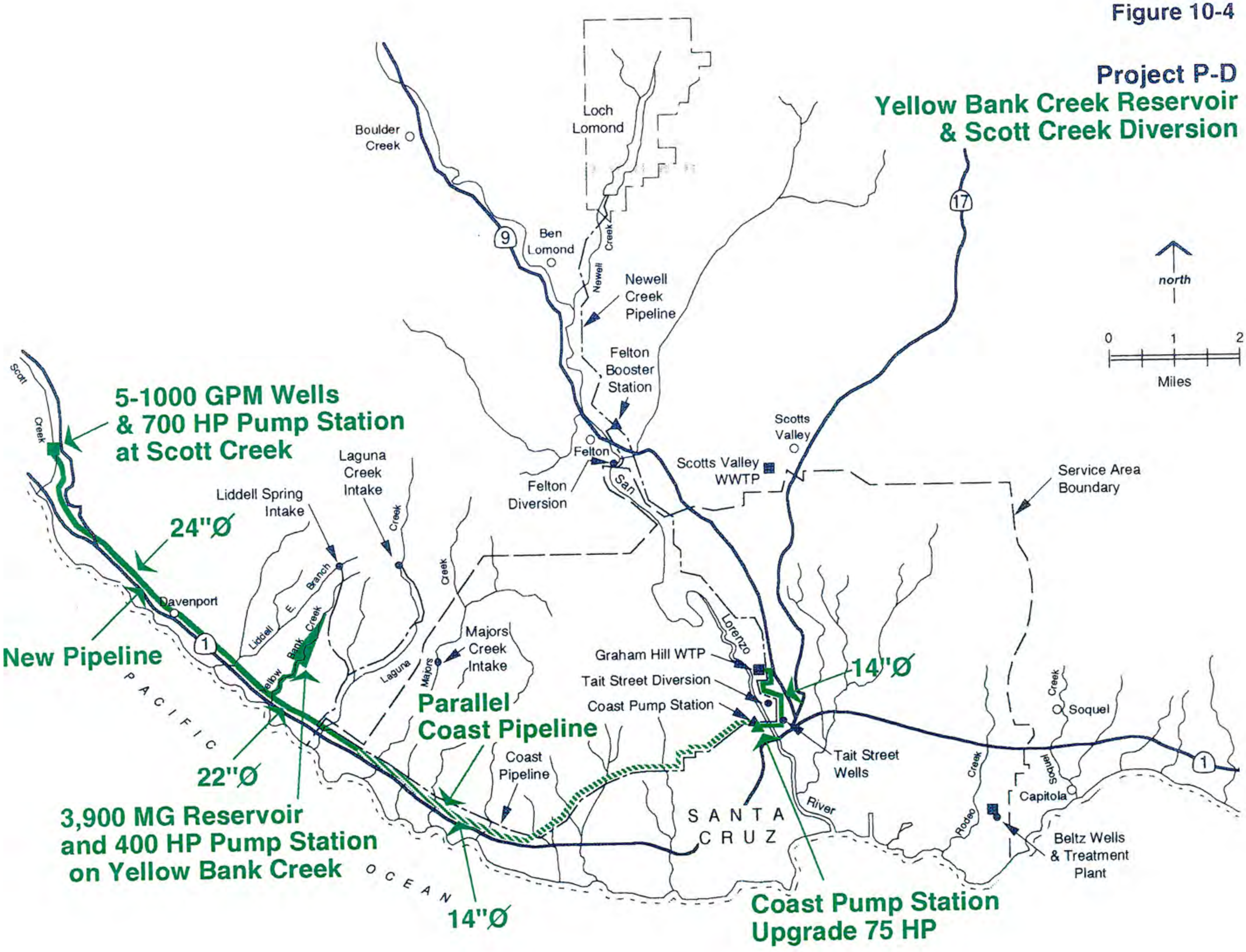
Available geologic information was reviewed and compiled. Field reconnaissance was also performed to investigate dam site conditions, reservoir terrain, borrow materials and construction access. A geologic work map prepared for this site is presented in Appendix B.

The Yellow Bank Creek dam site is not crossed by any mapped faults. The proposed dam site has values of highest predicted acceleration of 0.58 g. While high, these accelerations can be accounted for in design.

Landslides are prevalent in the downstream half of the Yellow Bank Creek reservoir area. Several massive slump or block-type landslides have been identified in the Santa Cruz Mudstone formation at this site. One of these was identified on the left (south) abutment of the initial alignment selected. The slide extends the entire distance from valley floor to ridgetop, a height of about 400 feet. This slide was judged to have a significant impact on construction permitting and cost. An alternative dam alignment was identified just upstream of the original alignment.

Figure 10-4

Project P-D
Yellow Bank Creek Reservoir & Scott Creek Diversion



This alternative alignment would avoid most of the landslide area and would eliminate the landslide mitigation required for the original alignment.

10.4.4.4 Hydrologic Issues

Monthly diversions from Scott Creek, and inflows to Yellow Bank Creek were estimated. For Scott Creek, the daily flow records from 1959 through 1973 were used, along with estimated bypass flows to develop factors to estimate monthly flow available. Factors were developed for a range of instream release requirements and diversion rates on Scott Creek. Estimates of monthly flows were developed for Yellow Bank Creek using the monthly flow estimates for Laguna Creek and Majors Creek and adjusting flows based on the ratio of watershed sizes and mean annual rainfall for the watersheds. A monthly spreadsheet-style water accounting model was developed to estimate reservoir sizing and to evaluate the time required to fill the reservoir.

After completion of the analysis to divert water from Scott Creek, it was determined that Department of Fish and Game would oppose a surface diversion.

A cursory analysis was made of the feasibility of extracting water from the deeper alluvium rather than using a surface diversion in Scott Creek. The evaluation suggested that an average of at least 5,000 gpm (11 cfs) may be available from the area for continuous extraction during the rainy season months, although recharge would vary considerably and would be substantially less in drier years. The study also estimated the storage capacity of the alluvium sufficient to yield 3,300 gpm (7 cfs) for 5 months. Based on the analysis, the project was configured with five 1,000 gpm wells assumed to be located in the alluvial basin. The sizing assumed that available recharge could be pumped but that groundwater storage would not be used.

Once pumping rates were established, an analysis was made of the average time to initially fill and to re-fill the reservoir. For the Yellow Bank Creek site, filling the reservoir was estimated to take 8 years. It may be possible to locate additional high capacity wells along the creek in order to reduce the initial and re-fill time for the project. A larger pipeline and pump station would also be required at Scott Creek to divert the flows to the reservoir. This would add an estimated $2 to $3 million dollars to the capital cost of the project, not including contingencies. Because of the extremely high cost of the project, these additional costs were not included in the project cost estimate.

10.4.5 Regulatory and Institutional Analysis

The following permits would be required for this project:

- Permit to Appropriate Water (State Water Resources Control Board
- Streambed Alteration Agreement (State Department of Fish and Game)
- Approval of Plans and Specifications and Certificate of Approval to Construct or Enlarge a Dam or Reservoir (State Department of Water Resources, Division of Safety of Dams)
- Section 404 Permit to excavate or discharge dredged material into waters of the United States (Army Corps of Engineers)
- Potential for "Take" Permit (U.S. Fish and Wildlife Service and Army Corps of Engineers)
- Coastal Development Permit (Santa Cruz County Planning Department)
- Encroachment Permit (Caltrans)

This project is in the Coastal Zone as defined in the Santa Cruz County Coastal Plan, and would require a Coastal Development Permit. It would also need to be demonstrated that the project is consistent with both the County General Plan and the County Coastal Plan. Although it is likely that the need for a Coastal Development Permit would impact the time required for project review and implementation, no specific issues were identified which would preclude obtaining the permit.

New pipeline facilities would be located in the Highway 1 right-of-way and would require an Encroachment Permit from Caltrans.

10.4.6 Environmental Analysis

10.4.6.1 Cultural Resources

A cultural resources review for the Yellow Bank Creek reservoir site and pipeline alignments was conducted by the California Archaeological Inventory at Sonoma State University. Although no Native American resources were identified at the reservoir site, the potential for such resources is considered high based on the site characteristics. The literature review gave no indications of historical resources within the study area. The project includes new pipelines from Scott Creek to the Majors area and a new pipeline in the existing Coast pipeline corridor. Six archaeological sites have been recorded within this area. Given the environmental features of the pipeline alignments, there is a high possibility of additional Native American resources.

10.4.6.2 Vegetation and Wildlife

The California Natural Diversity Database was reviewed to identify species/biotic community information. In addition to the site reconnaissance, floodplain maps and aerial photographs were reviewed to identify additional biological issues of concern.

The vegetation associated with Yellow Bank Creek consists of an alder riparian forest and willow thickets in the canyon bottoms and coastal scrub and possibly chaparral covering some of the slopes. Knobcone pines occur on the ridges and in the vicinity of the dam site. The site also contains some redwood forest areas.

Vegetation at the Scott Creek site on the property leased to Cal Poly off of Swanton Road consists of red alder riparian forest dominated by red alder, although yellow and arroyo willows are also common. The understory is dense and composed of blackberry, nettle, dogwood, and box elder. Further downstream behind the Cal Poly farm buildings, yellow willow becomes dominant.

The Scott Creek and Yellow Bank Creek sites have some potential for sensitive species or habitat. Intensive field surveys would be required to determine the presence or absence of such species. Potential candidates include the saltmarsh common yellowthroat, California tiger salamander, red-legged frog, the marbled murrelet, and one or more raptor species. Potential sensitive habitats include freshwater marsh, any riparian forest or woodland, maritime chaparral, and maritime coast range ponderosa pine forest.

10.4.6.3 Fisheries and Aquatic Resources

A preliminary fisheries analysis was performed which consisted of: reviewing available information; walking several North Coast creeks to characterize fisheries habitat; and meeting with the Department of Fish and Game. This work is documented in Appendix D.

Aquatic resources in the Scott Creek watershed include tidewater goby, red-legged frog, steelhead trout and coho salmon. The Department of Fish and Game has stated that they would oppose a surface diversion, which would present a barrier to fish migration and cause sedimentation upstream of a dam. Minimum bypass flows would need to be established for Scott Creek. An IFIM study would be required to identify instream flow release requirements of the Department of Fish and Game during the CEQA review phase if this project is selected. The Department of Fish and Game performed some IFIM work on Scott Creek during the 1992-1993 rainy season. A Scott Creek lagoon study to analyze how streamflow is related to sandbar passage and water quality will also be required.

Yellow Bank Creek presumably had a steelhead population before the construction of coastal agricultural dams. A resident trout population now exists in Yellow Bank Creek. Project mitigation could include enhancement of resident rainbow trout habitat below the reservoir, within the reservoir and upstream. Red-legged frogs within the inundation zone may require relocation to perennial stream habitat lacking this species, if a suitable stream can be found. The red-legged frog issue was not included within fishery discussions with the Department of Fish and Game, however. An IFIM study may be required to establish instream flow releases below the reservoir.

10.4.6.4 Threatened and Endangered Species

The Yellow Bank and Scott Creek sites are not expected to support any federal- or state-listed endangered or threatened species. However, site specific surveys would be needed to determine the presence or absence of rare, threatened, or endangered species. It is assumed that any loss of critical wetlands or habitat could be mitigated.

10.4.7 Summary of Significant Project Constraints

- An earth embankment dam could not be constructed at this site, because the native material is unsuitable for embankment fill. The dam would be RCC.
- The cost of this project is the second highest of all the projects. This is due to the high cost of RCC construction and the large volume of material which would be required for the dam.
- The reservoir would take eight years to fill, based on average hydrology, after a drought similar to the extended drought period used for planning. This fill time could be shortened with a supplemental diversion of Scott Creek underflow.
- The diversion adjacent to Scott Creek has the potential to impact fishery resources in Scott Creek. The project would need to provide mitigation to protect fishery habitat.
- This project includes a new pipeline from Scott Creek to Majors and a new pipeline parallel to the existing Coast pipeline. There is a high probability of encountering cultural resources during construction of the pipelines. This could be mitigated.

10.5 Project P-E - Loch Lomond 260 MG Enlargement and Brackish Groundwater Wells With Reverse Osmosis Treatment

10.5.1 Description of Project

This project consists of enlarging the existing Loch Lomond to provide additional storage capacity and extraction of brackish groundwater along the North Coast and treatment of the brackish groundwater with a reverse osmosis system. The Loch Lomond enlargement would be accomplished by constructing a 4-foot parapet wall across the top of the dam and raising the crest elevation of the spillway by 4 feet.

Deep groundwater resources exist along the North Coast from Laguna Creek to the vicinity of Davenport. Water bearing formations exist between 600 and 2,000 feet below sea level and are assigned to the Santa Margarita sandstone and possibly the Lompico sandstone, as well as sandstone beds in the Monterey shale. For this project, several deep wells would be installed, along with a brackish water reverse osmosis treatment system to reduce the TDS of the raw water to drinking water levels. Yields of individual wells could range from 200 to as much as 700 gpm, depending on subsurface conditions, with an average well depth of 1,500 feet. For this project, it is assumed that two well fields would be installed, one in the Majors Creek area and one in the Davenport area.

10.5.2 Estimated Incremental Yield

The enlargement of Loch Lomond would provide a yield of 110 MG/yr during the short-term critically dry drought period. A yield of 880 MG/year would be required from the reverse osmosis water treatment plant to meet the total shortfall of 990 MG/year. The estimated yield from Loch Lomond during the long-term milder drought is 60 MG/yr. A yield of 530 MG/yr would be required from the reverse osmosis treatment plant. Therefore, facility sizing for the reverse osmosis treatment plant was based on short-term critical drought conditions. Yield estimates for the enlargement of Loch Lomond are based on existing freeboard requirements. It may be possible to negotiate with the Division of Dam Safety for a smaller amount of freeboard.

10.5.3 Facilities Requirements

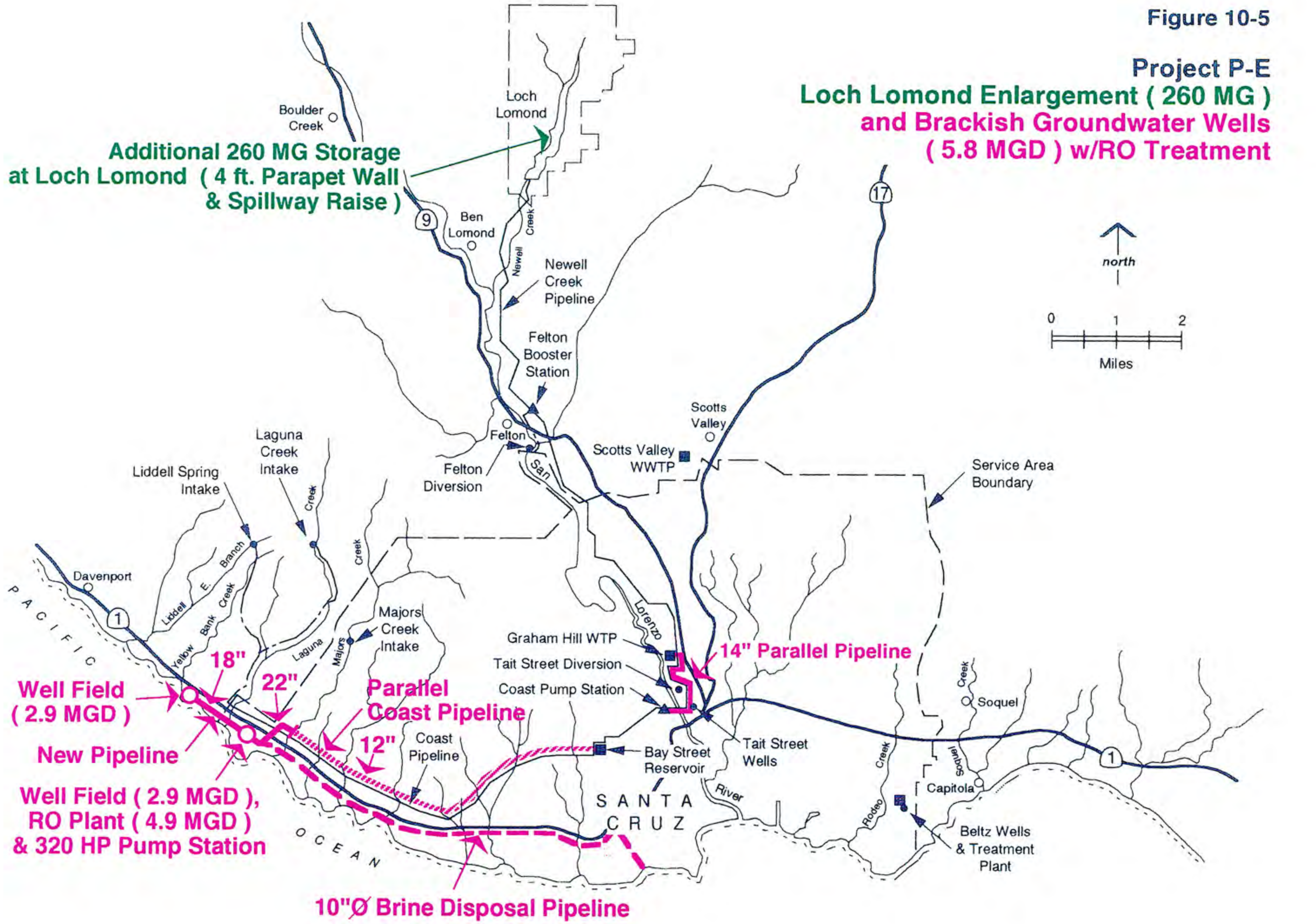
The proposed facilities for this alternative are shown on Figure 10-5. The following facilities would be required:

Loch Lomond Enlargement
- 750-foot long 4-foot high parapet wall across dam.
- 4-foot spillway raise.

Brackish Groundwater with Reverse Osmosis Water Treatment Plant
- Four 1,500-foot deep wells, 16-inch diameter, with pumps for the well field south of Davenport. Total well field capacity of 2.9 MGD (2,000 GPM).
- 20,000 feet of 18-inch diameter pipeline from Davenport well field to the Majors area.
- Four 1,500-foot deep wells, 16-inch diameter, with pumps at Majors. Total well field capacity of 2.9 MGD (2,000 GPM).

Figure 10-5

Project P-E
Loch Lomond Enlargement (260 MG)
and Brackish Groundwater Wells (5.8 MGD) w/RO Treatment



- Reverse osmosis treatment plant consisting of:
  - 4.9 MGD treatment plant producing 3.9 MGD treated water and 1.0 MGD brine.
  - 0.9 MGD brackish water bypass.

  The 3.9 MGD treated water would be mixed with the 0.9 MGD brackish water bypass to produce a 4.8 MGD blended supply.
- New 320 HP booster pump station at reverse osmosis treatment plant.
- 6,000 feet of new 22-inch diameter pipeline to tie into existing Coast Pipeline at Majors Creek/Coast pipeline junction.
- Approximately 25,000 feet of 12-inch diameter pipeline from Majors Creek to the existing Bay Street Reservoir.
- Approximately 36,000 feet of 10-inch diameter brine disposal pipeline from the reverse osmosis treatment plant to the existing Santa Cruz Wastewater Treatment Plant outfall.
- 30 HP brine disposal pump station.
- Approximately 6,000 feet of 14-inch diameter pipeline from existing Coast Pump Station to Graham Hill WTP.

The two brackish groundwater well fields were each sized for operation at 2,000 gpm during summer months of drought years, which is equivalent to a annual yield of 1,000 gpm.

10.5.4 Engineering Analysis

10.5.4.1 Facilities Sizing

Facilities were sized assuming that a continuous, constant supply would be produced from the reverse osmosis treatment plant during summer months of drought years and that the enlarged Loch Lomond supply would be used to meet short-term peak requirements during this period. The reverse osmosis treatment plant size was based on providing a yield of up to 880 MG/yr from May through October of drought years. Based on these assumptions, 4.8 MGD of treated supply would be required from the reverse osmosis treatment plant. No allowance was made for downtime over the summer period, since it was assumed that: (1) normal maintenance would be performed during the winter months when the plant would not be operating; and (2) there would be sufficient redundancy for sustained operation at the design capacity during the summer months.

The reverse osmosis treatment plant was sized to provide a blended water product at Graham Hill WTP with a total dissolved solids (TDS) goal of 300 mg/l, which is slightly higher than the City's existing TDS of about 260 mg/l. The 300 mg/l goal was established based on discussions with the City. Some of the City's existing supplies, particularly the North Coast supplies have lower TDS and are slightly corrosive. Therefore, raising the TDS to 300 mg/l was viewed as an opportunity to reduce the corrosivity of the existing supply.

Based on exploration data, the brackish water source is estimated to have a TDS level ranging from 800 mg/l to 5,000 mg/l. A sensitivity analysis was made to determine the potential variation in treatment plant sizing for different assumptions in brackish water TDS levels. Depending upon the TDS level of the brackish supply, the facility size would range from 3.5 MGD to 5.9 MGD.

The reverse osmosis water treatment facilities have been initially sited along the North Coast. However, alternative locations, including sites near the City wastewater treatment plant, may have advantages which should be evaluated as part of the preliminary design.

10.5.4.2 Estimated Project Costs

The estimated capital cost of this project is $38 million in 1993 dollars.

10.5.4.3 Brine Disposal

Brine disposal costs assume that a new pipeline would convey brine from the reverse osmosis treatment plant to the City's existing wastewater treatment plant outfall in downtown Santa Cruz. The estimated cost for a brine disposal pump station and pipeline is $3.9 million, not including contingencies. This cost was used as a conservative estimate for brine disposal. Other brine disposal options which may be technically feasible and less costly include deep well injection, beach well injection or construction of a new outfall at the reverse osmosis treatment plant site. The Water Quality Control Plan for the Central Coast Basin has specific provisions for brine disposal. Therefore each of these options would be feasible from a permitting standpoint.

10.5.4.4 Geotechnical Issues

No active faults cross the dam site. Splays of the Zayante fault cross Loch Lomond, but do not cross Newell Creek Dam. The dam has a highest predicted acceleration of 0.57 g. While high, these accelerations can be accounted for in design.

Several landslides upstream of Newell Creek Dam were investigated by Earth Sciences Associates for Santa Cruz in 1982. A field investigation was made of these locations as part of this study. A geologic work map is shown in Appendix B.

Landslides are common in the Loch Lomond area, particularly within the Zayante fault zone and Monterey Formation rocks to the south. Many of these landslides are dormant and few signs of activity that would disturb the present tree cover were identified on the aerial photographs. Two landslides are located nearby, upstream of the dam: one on the east reservoir shore about 1,500 feet upstream and a second on the west side of the reservoir about 500 feet upstream of the dam. Both of these landslides would require repair for this project. A third, smaller landslide was found to pose a potential hazard to the spillway due to undercutting at the plunge pool. However, repair of this landslide is also possible.

10.5.4.5 Hydrogeologic Issues

The project includes the construction of several deep wells in the North Coast area at locations ranging from Laguna Creek to the vicinity of Davenport. The hydrogeologic aspects of this alternative were evaluated based on a review of published and unpublished data, including the logs of deep oil exploratory test holes, and a brief field reconnaissance of the area. The main hydrogeologic factors for this project were: a determination of a safe yield for both well fields; and the effect that pumping might have on the base flow of streams in the area. Based on a cursory evaluation of known hydrogeologic conditions, the two dispersed well fields should not exceed the average long-term annual recharge and would not reduce the base flow of the area's streams. Recharge areas and recharge amounts will need to be defined if this project is selected for further evaluation.

10.5.5 Regulatory and Institutional Analysis

The following permits would be required for this project:

- Permit to Appropriate Water (State Water Resources Control Board, Division of Water Rights)
- Streambed Alteration Agreement (State Department of Fish and Game)
- Approval of Plans and Specifications and Certificate of Approval to Construct or Enlarge a Dam or Reservoir (State Department of Water Resources, Division of Safety of Dams)
- Section 404 Permit to excavate or discharge dredged material into waters of the United States (Army Corps of Engineers)
- Potential for "Take" Permit (U.S. Fish and Wildlife Service and Army Corps of Engineers)
- Coastal Development Permit (Santa Cruz County Planning Department)
- Encroachment Permit (Caltrans)
- National Pollutant Discharge Elimination System (NPDES) Permit (State Water Resources Control Board, Regional Water Quality Control Board)
- Building Permit (Santa Cruz County Planning Department)
- Potential for Encroachment Permit (Southern Pacific Railroad)

This project includes a reverse osmosis system which would result in 20 to 25 percent of the reverse osmosis feedwater being discharged as concentrated brine. The 1972 amendments to the Federal Clean Water Act prohibit the discharge of pollutants to navigable waters from a point source unless the discharge is authorized by the NPDES permit. An NPDES permit would be required for brine discharge for this project. The Central Coast Regional Water Quality Control Board was contacted to discuss brine disposal options and potential Regional Board requirements. Three disposal options were reviewed with the Regional Board: disposal of the brine using the City's existing wastewater outfall in downtown Santa Cruz; construction of a new outfall at the WTP site; and use of beach injection wells near the reverse osmosis treatment plant site. The Water Quality Control Plan for the Central Coast Basin has provisions for brine disposal so any of the disposal methods would be feasible from a permitting perspective. Brine disposal using the existing outfall would be the Regional Board's preferred alternative.

In addition, any discharge of brine into the Monterey Bay National Marine Sanctuary would require review of permit conditions by the National Oceanic and Atmospheric Administration (NOAA). NOAA has a Memorandum of Understanding with the Regional Board to review NPDES permits for discharges into the waters of the Sanctuary.

Depending upon the siting of the reverse osmosis treatment plant, an encroachment permit may be required to construct a pipeline crossing the Southern Pacific Railroad right-of-way.

10.5.6 Environmental Analysis

10.5.6.1 Cultural Resources

A cultural resources review was conducted by the California Archaeological Inventory at Sonoma State University for the groundwater well sites, reverse osmosis treatment plant site, and associated pipeline alignments. Native American resources have been located in a number of areas along the Santa Cruz coast. The pipeline alignments have the highest potential to impact cultural resources. A cultural resources review was not conducted for Loch Lomond because the potential for cultural resources is assumed to be low, based on the disturbance which has already occurred at the site.

10.5.6.2 Vegetation and Wildlife

The vegetation surrounding Loch Lomond consists of mixed evergreen forest dominated by live oak, Douglas-fir, tanbark-oak, madrone, and occasional redwoods. Slope and aspect probably affect which species are dominant at a given site. Chaparral associated with knobcone pines occur above the reservoir and near the present dam site, and could be affected by raising the reservoir level. The mixed evergreen forest extends to the reservoir banks. Newell Creek has small amounts of riparian vegetation that would be affected by raising the dam.

The Loch Lomond site has some potential for sensitive species or habitat. Field surveys would be required to determine the presence or absence of such species. Likely candidates include the California tiger salamander, Santa Cruz long-toed salamander, red-legged frog, and one or more raptor species. Potential sensitive habitats include freshwater marsh, and riparian forest or woodland. The Majors and Davenport areas are primarily agricultural, where there is little likelihood of encountering sensitive habitats or species. The pipeline route could impact maritime chaparral.

10.5.6.3 Fisheries Analysis

The fisheries evaluation for Newell Creek consisted of reviewing available information, walking Newell Creek, performing limited IFIM hydraulic modeling and meeting with the Department of Fish and Game.

Existing habitat is in poor condition due to the presence of Newell Creek Dam. Based on preliminary estimates of instream flow releases, higher instream flow releases would be required to enhance fishery habitat on Newell Creek. The Department of Fish and Game has indicated that offsite mitigation could be an alternative to higher flow releases since there is limited habitat on Newell Creek. Offsite mitigation would most likely involve re-evaluation of instream flow releases at the City's existing San Lorenzo River diversions at Tait Street and at Felton. Evaluations of this project in earlier phases of work identified the problem that significant increases in the bypass flow requirements at Newell Creek would decrease the project yield to zero. Therefore, this project was configured without additional bypass flows. As a result, this project would not provide any additional flows past existing diversions. Alternative mitigation options may include negotiating with the Division of Safety of Dams for a lower freeboard requirement and using additional yield to provide instream releases, or releasing water into Newell Creek and picking it up at the San Lorenzo River diversion at Tait Street. This may satisfy Department of Fish and Game concerns at Felton Diversion. However, bypass flows at the San Lorenzo Diversion of Tait Street would still need to be negotiated.

10.5.6.4 Threatened and Endangered Species

It is unlikely that either Loch Lomond or the Majors and Davenport areas contain federal- or state-listed endangered or threatened species. However, habitats such as riparian forest and wetlands can be difficult and costly to mitigate. It is assumed that any loss of critical wetlands or habitat could be mitigated.

10.5.7 Summary of Significant Project Constraints

- Mitigation for fisheries impacts could potentially involve re-negotiation of fishery bypass releases at the City's existing diversions on the San Lorenzo River.
- This project has the potential to impact cultural resources along the Coast pipeline alignment. It is anticipated that these impacts could be mitigated.
- Any requirement of fish releases above the existing 1 cfs fish release at Loch Lomond could reduce the additional yield generated by raising Loch Lomond to zero.
- This project would involve brine disposal into the Monterey Bay National Marine Sanctuary. Brine disposal is consistent with the Central Coast Basin Water Quality Control Plan, so this is not a significant constraint. However, the time required to implement this project could be affected.

10.6 Project P-F - Loch Lomond 500 MG Enlargement and Brackish Groundwater Wells With Reverse Osmosis Treatment

10.6.1 Description of Project

This project consists of enlarging the existing Loch Lomond to provide additional storage capacity of 500 MG and extraction of brackish groundwater along the North Coast and treatment of the brackish groundwater with a reverse osmosis system. The Loch Lomond enlargement would be accomplished by constructing an 8-foot parapet wall across the top of the dam and raising the crest elevation of the spillway by 8 feet. The 8-foot parapet wall is the maximum allowable parapet wall raised, based on geologic considerations.

Deep groundwater resources exist along the North Coast from Laguna Creek to the vicinity of Davenport. Water bearing formations exist between 600 and 2,000 feet below sea level and are assigned to the Santa Margarita sandstone and possibly the Lompico sandstone, as well as sandstone beds in the Monterey shale. For this project, several deep wells would be installed, along with a brackish water reverse osmosis treatment system to reduce the TDS of the raw water to drinking water levels. Yields of individual wells could range from 200 to as much as 700 gpm, depending on subsurface conditions, with an average well depth of 1,500 feet. For this project, it is assumed that two well fields would be installed, one in the Majors Creek area and one in the Davenport area.

10.6.2 Estimated Incremental Yield

The enlargement of Loch Lomond would provide a yield of 240 MG/yr during the critical (2-year) drought period. A yield of 750 MG/year would be required from the reverse osmosis treatment plant to meet the total shortfall of 990 MG/year. The estimated yield from Loch Lomond during the extended drought is 90 MG/yr. A yield of 500 MG/yr would be required from the reverse osmosis treatment plant. Therefore, facility sizing for the reverse osmosis treatment plant was based on short-term critical drought conditions.

10.6.3 Facilities Requirements

The proposed facilities for this alternative are shown on Figure 10-6. The following facilities would be required:

Loch Lomond Enlargement

- 750-foot long 8-foot high parapet wall across dam.
- 8-foot spillway raise.
- Relocation of concession stand and boat ramp.
- Landslide mitigation near the dam.

Brackish Groundwater with Reverse Osmosis Water Treatment Plant

- Three 1,500-foot deep wells, 16-inch diameter, with pumps for the well field south of Davenport. Total well field capacity of 2.45 MGD (1,700 GPM).
- 20,000 feet of 16-inch diameter pipeline from Davenport well field to the Majors area.
- Three 1,500-foot deep wells, 16-inch diameter, with pumps at Majors. Total well field capacity of 2.45 MGD (1,700 GPM).
- Reverse osmosis treatment process consisting of:
  - 4.1 MGD treatment plant producing 3.3 MGD treated water and 0.8 MGD brine.
  - 0.8 MGD brackish water bypass.

  The 3.3 MGD treated water would be mixed with the 0.8 MGD brackish water bypass to produce a 4.1 MGD blended supply.
- New 270 HP booster pump station at the reverse osmosis water treatment plant.
- 6,000 feet of new 22-inch diameter pipeline to tie into existing Coast Pipeline at Majors Creek/Coast pipeline junction.
- Approximately 36,000 feet of 10-inch diameter brine disposal pipeline from the reverse osmosis treatment plant to the existing Santa Cruz Wastewater Treatment Plant outfall.
- 20 HP brine disposal pump station.
- Approximately 6,000 feet of 14-inch diameter pipeline from the existing Coast Pump Station to Graham Hill WTP.

The two brackish groundwater well fields were each sized for peak operation at 1,700 gpm during summer months of drought years which is equivalent to an annual yield of 850 gpm.

10.6.4 Engineering Analysis

10.6.4.1 Facilities Sizing

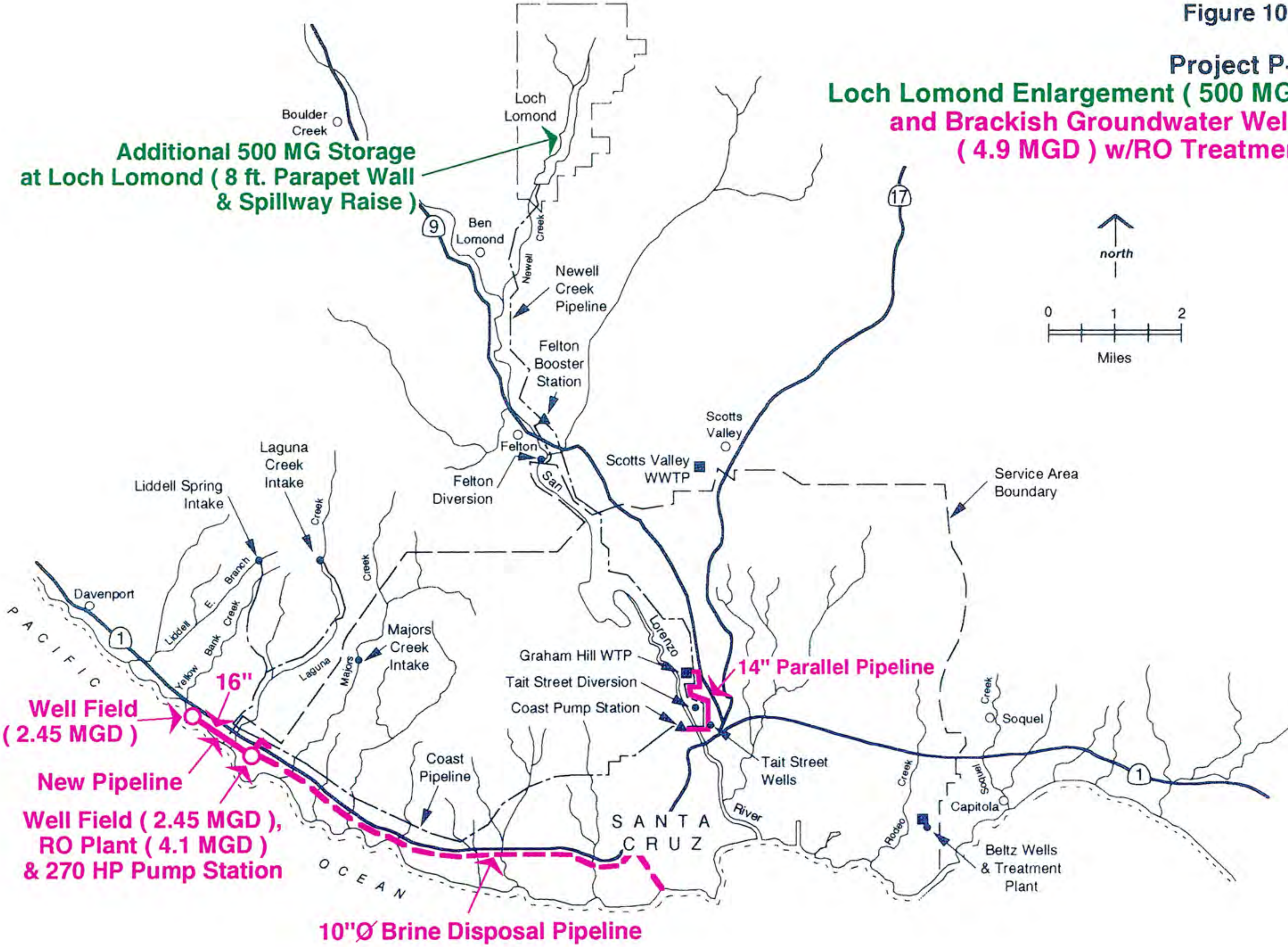
Facilities were sized assuming that a continuous, constant supply would be produced from the reverse osmosis treatment plant during summer months of drought years and that the enlarged Loch Lomond supply would be used to meet short-term peak requirements during this period. The reverse osmosis treatment plant size was based on providing a yield of up to 750 MG/yr from May through October of drought years. Based on these assumptions, 4.1 MGD of treated supply would be required from the reverse osmosis treatment plant.

The reverse osmosis treatment plant was sized to provide a blended water product at Graham Hill WTP with a total dissolved solids (TDS) goal of 300 mg/l, which is slightly higher than the City's existing TDS of about 260 mg/l. The 300 mg/l goal was established based on discussions with the City.

Based on exploration data, the brackish water source is estimated to have a TDS level ranging from 800 mg/l to 5,000 mg/l. A sensitivity analysis was made to determine the potential variation in reverse osmosis treatment plant sizing for different assumptions in influent TDS

Figure 10-6

Project P-F
Loch Lomond Enlargement (500 MG) and Brackish Groundwater Wells (4.9 MGD) w/RO Treatment



levels. Depending on the TDS level of the brackish water supply, the facility size would range from 2.9 MGD to 5.0 MGD.

The reverse osmosis water treatment facilities have been initially sited along the North Coast. However, alternative locations, including sites near the City wastewater treatment plant, may have advantages which should be evaluated as part of the preliminary design.

10.6.4.2 Estimated Project Costs

The estimated capital cost of this project is $34 million in 1993 dollars.

10.6.4.3 Brine Disposal

Brine disposal costs assume that a new pipeline would convey brine from the reverse osmosis treatment plant to the City's existing wastewater treatment plant outfall in downtown Santa Cruz. The estimated cost for a brine disposal pump station and pipeline is $3.9 million, not including contingencies. This cost was used as a conservative estimate for brine disposal.

10.6.4.4 Geotechnical Issues

No active faults cross Newell Creek Dam. Splays of the Zayante fault cross Loch Lomond but not Newell Creek Dam. The highest predicted acceleration at the site is 0.57 g. While high, these accelerations can be accounted for in design.

Several landslides upstream of Newell Creek Dam were investigated by Earth Sciences Associates for Santa Cruz in 1982. A field investigation was made of these locations as part of this study. A geologic work map is shown in Appendix B.

Landslides are common in the Loch Lomond area. Two landslides are located nearby, upstream of the dam: one on the east reservoir shore about 1,500 feet upstream and a second on the west side of the reservoir about 500 feet upstream of the dam. Both of these landslides would require repair for this project. A third, smaller landslide was found to pose a potential hazard to the spillway due to undercutting at the plunge pool. However, repair of this landslide is also possible.

10.6.4.5 Hydrogeologic Issues

The project includes the construction of several deep wells in the North Coast area at locations ranging from Laguna Creek to the vicinity of Davenport. Based on a cursory evaluation of known hydrogeologic conditions, the two dispersed well fields should not exceed the average long-term annual recharge and would not reduce the base flow of the area's streams. Recharge areas and recharge amounts will need to be defined if this project is selected for further evaluation.

10.6.5 Regulatory and Institutional Analysis

The following permits would be required for this project:

- Permit to Appropriate Water (State Water Resources Control Board, Division of Water Rights)
- Streambed Alteration Agreement (State Department of Fish and Game)

- Approval of Plans and Specifications and Certificate of Approval to Construct or Enlarge a Dam or Reservoir (State Department of Water Resources, Division of Safety of Dams)
- Section 404 Permit to excavate or discharge dredged material into waters of the United States (Army Corps of Engineers)
- Potential for "Take" Permit (U.S. Fish and Wildlife Service and Army Corps of Engineers)
- Coastal Development Permit (Santa Cruz County Planning Department)
- Encroachment Permit (Caltrans)
- National Pollutant Discharge Elimination System (NPDES) Permit (State Water Resources Control Board, Regional Water Quality Control Board)
- Building Permit (Santa Cruz County Planning Department)
- Potential for Encroachment Permit (Southern Pacific Railroad)

This project includes a reverse osmosis system which would result in 20 to 25 percent of the reverse osmosis feedwater being discharged as concentrated brine. The Central Coast Regional Water Quality Board was contacted to discuss brine disposal options and potential Regional Board requirements. Three disposal options were reviewed with the Regional Board: disposal of the brine using the City's existing wastewater outfall in downtown Santa Cruz; construction of a new outfall at the reverse osmosis treatment plant site; and use of beach injection wells near the reverse osmosis treatment plant site. The Water Quality Control Plan for the Central Coast Basin has provisions for brine disposal so any of the disposal methods would be feasible from a permitting perspective. Brine disposal using the existing outfall would be the Regional Board's preferred alternative.

In addition, any discharge of brine into the Monterey Bay National Marine Sanctuary would require review of permit conditions by the National Oceanic and Atmospheric Administration (NOAA). NOAA has a Memorandum of Understanding with the Regional Board to review NPDES permits for discharges into the waters of the Sanctuary.

Depending upon the siting of the reverse osmosis treatment plant, an encroachment permit may be required to construct a pipeline crossing the Southern Pacific Railroad right-of-way.

10.6.6 Environmental Analysis

10.6.6.1 Cultural Resources

A cultural resources review was conducted by the California Archaeological Inventory at Sonoma State University for the groundwater well sites, reverse osmosis treatment plant site, and associated pipeline alignments. Native American resources have been located in a number of areas along the Santa Cruz coast. The pipeline alignments have the highest potential to impact cultural resources. A cultural resources review was not conducted for Loch Lomond because the potential for cultural resources is assumed to be low, based on the disturbance which has already occurred at the site.

10.6.6.2 Vegetation and Wildlife

The vegetation surrounding Loch Lomond consists of mixed evergreen forest dominated by live oak, Douglas-fir, tanbark-oak, madrone, and occasional redwoods. Slope and aspect probably affect which species are dominant at a given site. Chaparral associated with knobcone pines occur above the reservoir and near the present dam site, and could be affected by raising the reservoir level. The mixed evergreen forest extends to the reservoir banks. Newell Creek has small amounts of riparian vegetation that would be affected by raising the dam.

The Loch Lomond site has some potential for sensitive species or habitat. Field surveys would be required to determine the presence or absence of such species. Likely candidates include the California tiger salamander, Santa Cruz long-toed salamander, red-legged frog, and one or more raptor species. Potential sensitive habitats include freshwater marsh, and riparian forest or woodland. The Majors and Davenport areas are primarily agricultural, where there is little likelihood of encountering sensitive habitats or species. The pipeline route could impact maritime chaparral.

10.6.6.3 Fisheries Analysis

The fisheries evaluation for Newell Creek consisted of reviewing available information, walking Newell Creek, performing limited IFIM hydraulic modelling and meeting with the Department of Fish and Game.

Existing habitat is in poor condition due to the presence of Newell Creek Dam. Based on preliminary estimates of instream flow releases, higher instream flow releases would be required to enhance fishery habitat on Newell Creek. The Department of Fish and Game has indicated that offsite mitigation could be an alternative to higher flow releases since there is limited habitat on Newell Creek. Offsite mitigation would most likely involve re-evaluation of instream flow releases at the City's existing San Lorenzo River diversions at Tait Street and at Felton. Evaluations of this project in earlier phases of work identified the problem that significant increases in the bypass flow requirements at Newell Creek would decrease the project yield to zero. As a result, this project was configured without additional bypass flows. Therefore, this project would not provide any additional flows past existing diversions. Alternative mitigation options may include negotiating with the Division of Safety of Dams for a lower freeboard requirement and using additional yield to provide instream releases or releasing water into Newell Creek and picking it up at the San Lorenzo River diversion at Tait Street. This may satisfy Department of Fish and Game concerns at Felton Diversion. However, bypass flows at the San Lorenzo Diversion at Tait Street would still need to be negotiated.

10.6.6.4 Threatened and Endangered Species

It is unlikely that either Loch Lomond or the Majors and Davenport areas contain federal- or state-listed endangered or threatened species. However, habitats such as riparian forest and wetlands can be difficult and costly to mitigate. It is assumed that any loss of critical wetlands or habitat could be mitigated.

10.6.7 Summary of Significant Project Constraints

- Mitigation for fisheries impacts could potentially involve re-negotiation of fishery bypass releases at the City's existing diversions on the San Lorenzo River.
- Any requirement of fish releases above the existing 1 cfs fish release at Loch Lomond could reduce the additional yield generated by raising Loch Lomond to zero.
- This project would involve brine disposal into the Monterey Bay National Marine Sanctuary. Brine disposal is consistent with the Central Coast Basin Water Quality Control

Plan, so this is not a significant constraint. However, the time required to implement this project could be affected.

10.7 Project P-G - Loch Lomond 1,010 MG Enlargement and Brackish Groundwater Wells With Reverse Osmosis Treatment

10.7.1 Description of Project

This project consists of enlarging the existing Loch Lomond to provide additional storage capacity of 1,010 MG and extraction of brackish groundwater along the North Coast and treatment of the brackish groundwater with a reverse osmosis system. The Loch Lomond enlargement would be accomplished by raising the existing embankment and spillway by 14 feet.

Deep groundwater resources exist along the North Coast from Laguna Creek to the vicinity of Davenport. Water bearing formations exist between 600 and 2,000 feet below sea level and are assigned to the Santa Margarita sandstone and possibly the Lompico sandstone, as well as sandstone beds in the Monterey shale. For this project, several deep wells would be installed, along with a brackish water reverse osmosis treatment system to reduce the TDS of the raw water to drinking water levels. Yields of individual wells could range from 200 to as much as 700 gpm, depending on subsurface conditions, with an average well depth of 1,500 feet. For this project, it is assumed that two well fields would be installed, one in the Majors Creek area and one in the Davenport area.

10.7.2 Estimated Incremental Yield

The enlargement of Loch Lomond would provide a yield of 450 MG/yr during the short-term critically dry drought period. A yield of 540 MG/year would be required from the reverse osmosis treatment plant to meet the total shortfall of 990 MG/year. The estimated yield from Loch Lomond during the long-term drought is 200 MG/yr. A yield of 390 MG/yr would be required from the reverse osmosis treatment plant. Therefore, facility sizing for the reverse osmosis treatment plant was based on short-term critical drought conditions.

10.7.3 Facilities Requirements

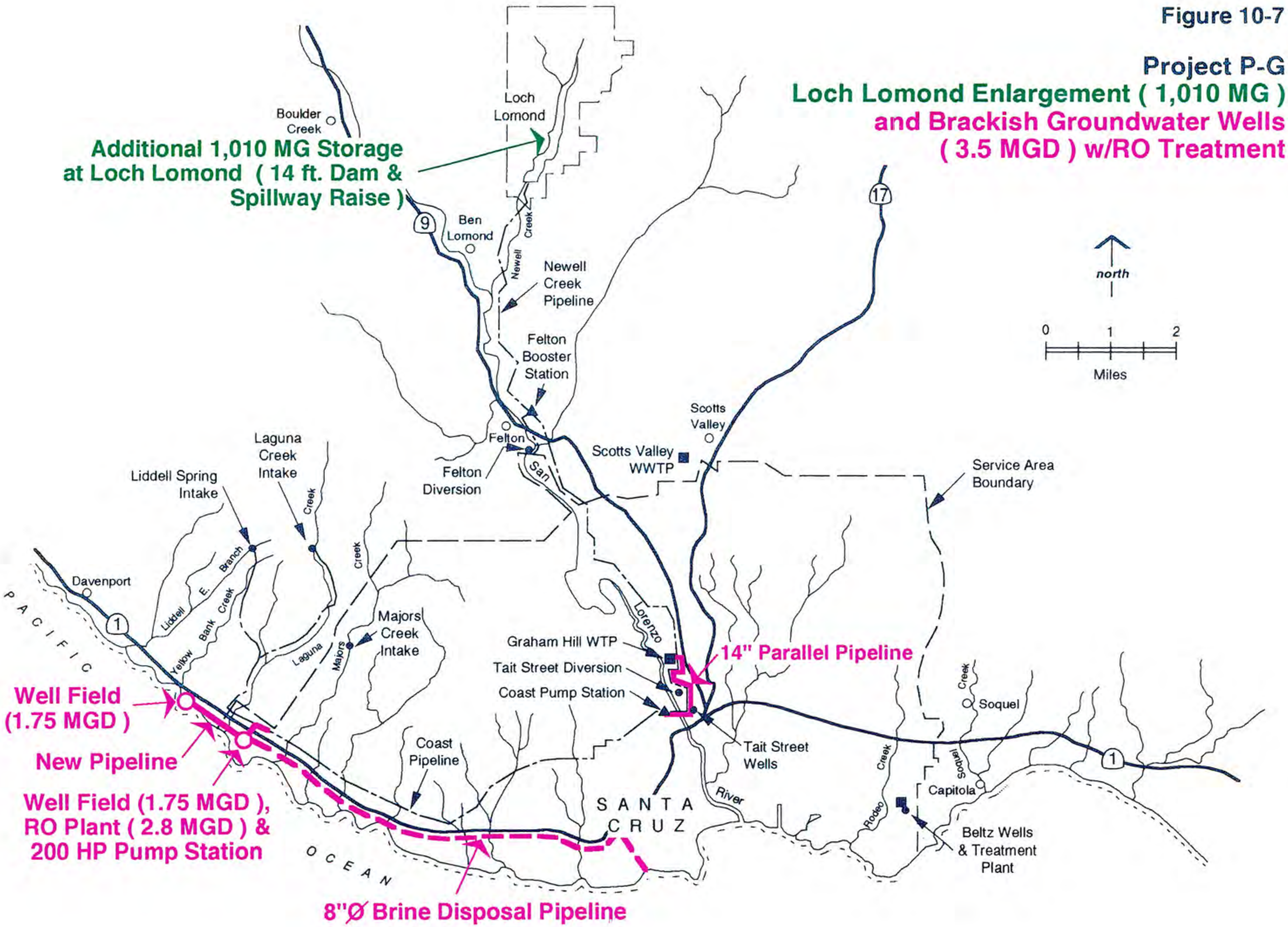
The proposed facilities for this alternative are shown on Figure 10-7. The following facilities would be required:

Loch Lomond Enlargement

- Raise zoned fill embankment by 14 feet with slopes ranging from 1.5:1 to 2:1.
- Modification of outlet works.
- Spillway raise.
- Relocation of concession stand and boat ramp.
- Landslide mitigation near the dam.

Figure 10-7

Project P-G
Loch Lomond Enlargement (1,010 MG)
and Brackish Groundwater Wells
(3.5 MGD) w/RO Treatment



Brackish Groundwater with Reverse Osmosis Water Treatment Plant

- Two 1,500-foot deep wells, 16-inch diameter, with pumps for the well field south of Davenport. Total well field capacity of 1.75 MGD (1,200 GPM).
- 20,000 feet of 14-inch diameter pipeline from Davenport well field to the Majors area.
- Two 1,500-foot deep wells, 16-inch diameter, with pumps at Majors. Total well field capacity of 1.75 MGD (1,200 GPM).
- Reverse osmosis treatment process consisting of:
  - 2.8 MGD treatment plant producing 2.2 MGD treated water and 0.6 MGD brine.
  - 0.7 MGD brackish water bypass.

  The 2.2 MGD treated water would be mixed with the 0.7 MGD brackish water bypass to produce a 2.9 MGD blended supply.
- New 200 HP booster pump station at the reverse osmosis treatment plant.
- 6,000 feet of new 18-inch diameter pipeline to tie into existing Coast pipeline at Majors Creek/Coast pipeline junction.
- Approximately 36,000 feet of 8-inch diameter brine disposal pipeline from the reverse osmosis treatment plant to the existing Santa Cruz Wastewater Treatment Plant outfall.
- 20 HP brine disposal pump station.
- Approximately 6,000 feet of 14-inch diameter pipeline from the existing Coast Pump Station to Graham Hill WTP.

The two brackish groundwater well fields were each sized for operation at 1,200 gpm during summer months of drought years, which is equivalent to an annual yield of 600 gpm.

10.7.4 Engineering Analysis

10.7.4.1 Facilities Sizing

Facilities were sized assuming that a continuous, constant supply would be produced from the reverse osmosis treatment plant during summer months of drought years and that the enlarged Loch Lomond supply would be used to meet short-term peak requirements during this period. The reverse osmosis treatment plant size was based on providing a yield of up to 750 MG/yr from May through October of drought years. Based on these assumptions, 2.9 MGD of treated water supply would be required from the reverse osmosis treatment plant.

The reverse osmosis treatment plant was sized to provide a blended water product at Graham Hill WTP with a total dissolved solids (TDS) goal of 300 mg/l, which is slightly higher than the City's existing TDS of about 260 mg/l. The 300 mg/l goal was established based on discussions with the City.

Based on exploration data, the brackish water source is estimated to have a TDS level ranging from 800 mg/l to 5,000 mg/l. A sensitivity analysis was made to determine the potential variation in WTP sizing for different assumptions in influent TDS levels. Depending upon the TDS level of the brackish water supply, the facility size would range from 1.9 MGD to 3.5 MGD.

The reverse osmosis water treatment facilities have been initially sited along the North Coast. However, alternative locations, including sites near the City wastewater treatment plant, may have advantages which should be evaluated as part of the preliminary design.

10.7.4.2 Estimated Project Costs

The estimated capital cost of this project is $30 million in 1993 dollars.

10.7.4.3 Brine Disposal

Brine disposal costs assume that a new pipeline would convey brine from the reverse osmosis treatment plant to the City's existing wastewater treatment plant outfall in downtown Santa Cruz. The estimated cost for a brine disposal pump station and pipeline is $3.2 million, not including contingencies. This cost was used as a conservative estimate for brine disposal.

10.7.4.4 Geotechnical Issues

No active faults cross Newell Creek Dam. Splays of the Zayante fault cross Loch Lomond but not Newell Creek Dam. The highest predicted acceleration at the site of 0.57 g. While high, these accelerations can be accounted for in design.

Several landslides upstream of Newell Creek Dam were investigated by Earth Sciences Associates for Santa Cruz in 1982. A field investigation was made of these locations as part of this study. A geologic work map is shown in Appendix B.

Landslides are common in the Loch Lomond area. Two landslides are located nearby, upstream of the dam: one on the east reservoir shore about 1,500 feet upstream and a second on the west side of the reservoir about 500 feet upstream of the dam. Both of these landslides would require repair for this project. A third, smaller landslide was found to pose a potential hazard to the spillway due to undercutting at the plunge pool. However, repair of this landslide is also possible.

10.7.4.5 Hydrogeologic Issues

The project includes the construction of several deep wells in the North Coast area at locations ranging from Laguna Creek to the vicinity of Davenport. Based on a cursory evaluation of known hydrogeologic conditions, the two dispersed well fields should not exceed the average long-term annual recharge and would not reduce the base flow of the area's streams. Recharge areas and recharge amounts will need to be defined if this project is selected for further evaluation.

10.7.5 Regulatory and Institutional Analysis

The following permits would be required for this project:

- Permit to Appropriate Water (State Water Resources Control Board, Division of Water Rights)
- Streambed Alteration Agreement (State Department of Fish and Game)
- Approval of Plans and Specifications and Certificate of Approval to Construct or Enlarge a Dam or Reservoir (State Department of Water Resources, Division of Safety of Dams)
- Section 404 Permit to excavate or discharge dredged material into waters of the United States (Army Corps of Engineers)
- Potential for "Take" Permit (U.S. Fish and Wildlife Service and Army Corps of Engineers)
- Coastal Development Permit (Santa Cruz County Planning Department)
- Encroachment Permit (Caltrans)

- National Pollutant Discharge Elimination System (NPDES) Permit (State Water Resources Control Board, Regional Water Quality Control Board)
- Building Permit (Santa Cruz County Planning Department)
- Potential for Encroachment Permit (Southern Pacific Railroad)

This project includes a reverse osmosis system which would result in 20 to 25 percent of the reverse osmosis feedwater being discharged as concentrated brine. The Central Coast Regional Board was contacted to discuss brine disposal options and potential Regional Board requirements. Three disposal options were reviewed with the Regional Board: disposal of the brine using the City's existing wastewater outfall in downtown Santa Cruz; construction of a new outfall at the reverse osmosis treatment plant site; and use of beach injection wells near the reverse osmosis treatment plant site. The Water Quality Control Plan for the Central Coast Basin has provisions for brine disposal so any of the disposal methods would be feasible from a permitting perspective. Brine disposal using the existing outfall would be the Regional Board's preferred alternative.

In addition, any discharge of brine into the Monterey Bay National Marine Sanctuary would require review of permit conditions by the National Oceanic and Atmospheric Administration (NOAA). NOAA has a Memorandum of Understanding with the Regional Board to review NPDES permits for discharges into the waters of the Sanctuary.

Depending upon the siting of the reverse osmosis treatment plant, an encroachment permit may be required to construct a pipeline crossing the Southern Pacific Railroad right-of-way.

10.7.6 Environmental Analysis

10.7.6.1 Cultural Resources

A cultural resources review was conducted by the California Archaeological Inventory at Sonoma State University for the groundwater well sites, reverse osmosis treatment plant site, and associated pipeline alignments. Native American resources have been located in a number of areas along the Santa Cruz coast. The pipeline alignments have the highest potential to impact cultural resources. A cultural resources review was not conducted for Loch Lomond because the potential for cultural resources is assumed to be low, based on the disturbance which has already occurred at the site.

10.7.6.2 Vegetation and Wildlife

The vegetation surrounding Loch Lomond consists of mixed evergreen forest dominated by live oak, Douglas-fir, tanbark-oak, madrone, and occasional redwoods. Slope and aspect probably affect which species are dominant at a given site. Chaparral associated with knobcone pines occur above the reservoir and near the present dam site, and could be affected by raising the reservoir level. The mixed evergreen forest extends to the reservoir banks. Newell Creek has small amounts of riparian vegetation that would be affected by raising the dam.

The Loch Lomond site has some potential for sensitive species or habitat. Intensive field surveys would be required to determine the presence or absence of such species. Likely candidates include California tiger salamander, Santa Cruz long-toed salamander, red-legged frog, and one or more raptor species. Potential sensitive habitats include freshwater marsh, and riparian forest or woodland. The Majors and Davenport areas are primarily agricultural, where there is little likelihood of encountering sensitive habitats or species. The pipeline route could impact maritime chaparral.

10.7.6.3 Fisheries Analysis

The fisheries evaluation for Newell Creek consisted of reviewing available information, walking Newell Creek, performing limited IFIM hydraulic modeling and meeting with the Department of Fish and Game.

Existing habitat is in poor condition due to the presence of Newell Creek Dam. Based on preliminary estimates of instream flow releases, higher instream flow releases would be required to enhance fishery habitat on Newell Creek. The Department of Fish and Game has indicated that offsite mitigation could be an alternative to higher flow releases since there is limited habitat on Newell Creek. Offsite mitigation would most likely involve re-evaluation of instream flow releases at the City's existing San Lorenzo River diversions at Tait Street and at Felton. Evaluations of this project in earlier phases of work identified the problem that significant increases in the bypass flow requirements at Newell Creek would decrease the project yield to zero. As a result, this project was configured without additional bypass flows. Therefore, this project would not provide any additional flows past existing diversions. Alternative mitigation options may include negotiating with the Division of Safety of Dams for a lower freeboard requirement and using additional yield to provide instream releases or releasing water into Newell Creek and picking it up at the San Lorenzo River diversion at Tait Street. This may satisfy Department of Fish and Game concerns at Felton Diversion. However, bypass flows at the San Lorenzo Diversion at Tait Street would still need to be negotiated.

10.7.6.4 Threatened and Endangered Species

It is unlikely that either Newell Creek Reservoir or the Majors and Davenport areas contain federal- or State-listed endangered or threatened species. However, habitats such as riparian forest and wetlands can be difficult and costly to mitigate. It is assumed that any loss of critical wetlands or habitat could be mitigated.

10.7.7 Summary of Significant Project Constraints

- Mitigation for fisheries impacts could potentially involve re-negotiation of fishery bypass releases at the City's existing diversions on the San Lorenzo River.
- This project has the potential to impact cultural resources along the Coast pipeline alignment. It is anticipated that these impacts could be mitigated.
- Any requirement of fish releases above the existing 1 cfs fish release at Loch Lomond could reduce the additional yield generated by raising Loch Lomond to zero.
- This project would involve brine disposal into the Monterey Bay National Marine Sanctuary. Brine disposal is consistent with the Central Coast Basin Water Quality Control Plan, so this is not a significant constraint. However, the time required to implement this project could be affected.

10.8 Project P-H - Thurber Lane Groundwater Wells and Brackish Groundwater Wells With Reverse Osmosis Treatment

10.8.1 Description of Project

This project consists of two wells in the Purisima formation in the vicinity of the Thurber Lane Pump Station, each with a sustained capacity of 250 gpm and extraction of brackish groundwater along the North Coast and treatment of the brackish groundwater with a reverse osmosis system. The Thurber Lane wells would require treatment to remove iron and manganese, as well as hydrogen sulfide.

Deep groundwater resources exist along the North Coast from Laguna Creek to the vicinity of Davenport. Water bearing formations exist between 600 and 2,000 feet below sea level and are assigned to the Santa Margarita sandstone and possibly the Lompico sandstone, as well as sandstone beds in the Monterey shale. For this project, several deep wells would be installed, along with a brackish water reverse osmosis treatment system to reduce the TDS of the raw water to drinking water levels. Yields of individual wells could range from 200 to as much as 700 gpm, depending on subsurface conditions, with an average well depth of 1,500 feet. For this project, it is assumed that two well fields would be installed, one in the Majors Creek area and one in the Davenport area.

10.8.2 Estimated Incremental Yield

The estimated incremental yield of the Thurber Lane wells is 120 MG/year for a short-term or long-term drought. This yield is based on the estimated sustained capacities of the wells, operation of the wells for the May through October drought period, and a 10 percent downtime allowance. A yield of 870 MG/year would be required from the reverse osmosis water treatment plant to meet the total shortfall of 990 MG/year for the critically dry short-term drought and a yield of 470 MG/yr would be required for the milder long-term drought. Therefore, facility sizing for the reverse osmosis treatment plant was based on short-term critical drought conditions.

10.8.3 Facilities Requirements

The proposed facilities for this alternative are shown on Figure 10-8. The following facilities would be required:

Thurber Lane Wells

- One 500-foot deep, 12-inch diameter well at lower Thurber Lane well site. Flowrate of 250 gpm.
- 1,500 feet of 8-inch diameter pipeline to upper Thurber Lane well site.
- One 500-foot deep, 12-inch diameter well at upper Thurber Lane site.
- One 500 gpm iron and manganese WTP at upper Thurber Lane site.
- 2,000 feet of 12-inch diameter pipeline to tie into water system.

Brackish Groundwater Wells with Reverse Osmosis Treatment Plant

- Four 1,500-foot deep wells, 16-inch diameter, with pumps for the well field south of Davenport. Total well field capacity of 2.9 MGD (2,000 GPM).
- 20,000 feet of 18-inch diameter pipeline from Davenport well field to the Majors area.
- Four 1,500-foot deep wells, 16-inch diameter, with pumps at Majors. Total well field capacity of 2.9 MGD (2,000 GPM).
- Reverse osmosis treatment plant consisting of:
  - 4.9 MGD treatment plant producing 3.9 MGD treated water and 1.0 MGD brine.
  - 0.9 MGD brackish water bypass.

  The 3.9 MGD treated water would be mixed with the 0.9 MGD brackish water bypass to produce a 4.8 MGD blended supply.
- New 320 HP booster pump station at the reverse osmosis treatment plant.
- 6,000 feet of new 22-inch diameter pipeline to tie into existing Coast pipeline at Majors Creek/Coast pipeline junction.
- Approximately 25,000 feet of 12-inch diameter pipeline from Majors Creek to the existing Bay Street Reservoir.
- Approximately 36,000 feet of 10-inch diameter brine disposal pipeline from the reverse osmosis treatment plant to the existing Santa Cruz Wastewater Treatment Plant outfall.
- 30 HP brine disposal pump station.
- Approximately 6,000 feet of 14-inch diameter pipeline from existing Coast Pump Station to Graham Hill WTP.

During investigations by Luhdorff and Scalmanini (1990), a test production well was installed and pump tested at the lower site, and a monitoring well was installed at the upper site. Water quality data collected during pump testing of the test production well indicate that the levels of iron and manganese from this test data only slightly exceed federal water quality standards. The cost of iron and manganese treatment was included to provide water quality from this project consistent with other projects being evaluated. Treatment options should be investigated if this project is selected for further evaluation.

The two brackish groundwater well fields were each sized for operation at 2,000 gpm during summer months of drought years which is equivalent to an annual yield of 1,000 gpm.

10.8.4 Engineering Analysis

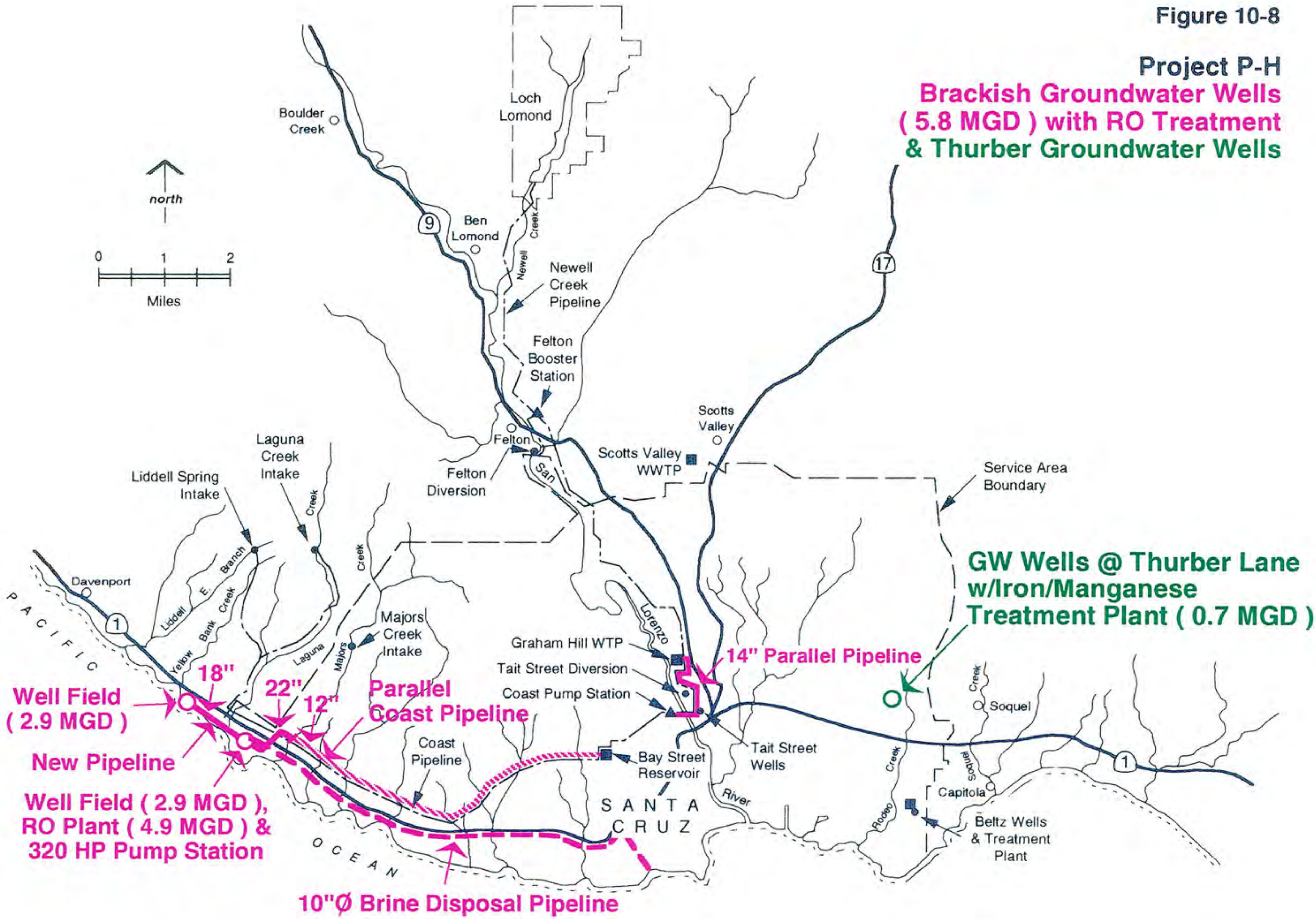
10.8.4.1 Facilities Sizing

Facilities were sized assuming that a continuous, constant supply would be produced from the Thurber Lane wells and the reverse osmosis treatment plant during summer months of drought years and that the existing Loch Lomond supply would be used to meet short-term peak requirements during this period.

The reverse osmosis treatment plant was sized to provide a blended water product at Graham Hill WTP with a total dissolved solids (TDS) goal of 300 mg/l, which is slightly higher than the City's existing TDS of about 260 mg/l. The 300 mg/l goal was established based on discussions with the City. Some of the City's existing supplies, particularly the North Coast supplies have lower TDS and are slightly corrosive. Therefore, raising the TDS to 300 mg/l was viewed as an opportunity to reduce the corrosivity of the existing supply.

Figure 10-8

Project P-H
Brackish Groundwater Wells (5.8 MGD) with RO Treatment & Thurber Groundwater Wells



Based on exploration data, the brackish water source is estimated to have a TDS level ranging from 800 mg/l to 5,000 mg/l. A sensitivity analysis was made to determine the potential variation in treatment plant sizing for different assumptions in brackish water TDS levels. Depending upon the TDS level of the brackish supply, the facility size would range from 3.5 MGD to 5.9 MGD.

The reverse osmosis water treatment facilities have been initially sited along the North Coast. However, alternative locations, including sites near the City wastewater treatment plant, may have advantages which should be evaluated as part of the preliminary design.

10.8.4.2 Project Cost Estimate

The estimated cost of this project is $40 million in 1993 dollars.

10.8.4.3 Hydrogeologic Issues

This project includes the construction of several deep wells in the North Coast area at locations ranging from Laguna Creek to the vicinity of Davenport. The hydrogeologic aspects of this project were evaluated based on a review of published and unpublished data, including the logs of deep oil exploratory test holes, and a brief field reconnaissance of the area. Based on a cursory evaluation of known hydrogeologic conditions, the two dispersed well fields should not exceed the average long-term annual recharge and would not reduce the base flow of the area's streams. Recharge areas and recharge amounts will need to be defined if this project is selected for further evaluation.

At the Thurber Lane groundwater well site, previous studies were conducted by Luhdorff and Scalmanini, which consisted of test well drilling and hydrogeologic analysis to determine aquifer transmissivity and sustained well capacities. The hydrogeologic analysis by Luhdorff and Scalmanini was reviewed and used to develop the estimated safe yield of the wells.

During the Luhdorff and Scalmanini investigations, a test production well was installed and pump tested at the lower site, and a monitoring well was installed at the upper site. The information developed by Luhdorff and Scalmanini was used in this study to develop area of influence curves for the Thurber Lane wells to estimate the drawdown area of influence. Based on the analysis, it was determined that the lower site is not suitable for two wells because the cones of depression around the wells may interfere with each other at the desired pumping rates. Only one well could be located at the lower site. The second site, further up Thurber Lane which was the former location of a hydropneumatic tank, could be used for a second well.

The City's Santa Cruz Gardens Pump Station is located on the lower Thurber Lane site. There would not be sufficient room for an iron and manganese treatment facility at this location. Therefore, the treatment plant was also located at the upper Thurber Lane site.

10.8.5 Regulatory and Institutional Analysis

The following permits would be required for this project:

- Coastal Development Permit (Santa Cruz County Planning Department)
- Encroachment Permit (Caltrans)

- National Pollutant Discharge Elimination System (NPDES) Permit (State Water Resources Control Board, Regional Water Quality Control Board)
- Building Permit (Santa Cruz County and City Planning Departments)
- Potential for Encroachment Permit (Southern Pacific Railroad)

This project includes a reverse osmosis system which would result in 20 to 25 percent of the reverse osmosis feedwater being discharged as concentrated brine. The Central Coast Regional Board was contacted to discuss brine disposal options and potential Regional Board requirements. Three disposal options were reviewed with the Regional Board: disposal of the brine using the City's existing wastewater outfall in downtown Santa Cruz; construction of a new outfall at the reverse osmosis treatment plant site; and use of beach injection wells near the reverse osmosis treatment plant site. The Water Quality Control Plan for the Central Coast Basin has provisions for brine disposal so any of the disposal methods would be feasible from a permitting perspective. Brine disposal using the existing outfall would be the Board's preferred alternative.

In addition, any discharge of brine into the Monterey Bay National Marine Sanctuary would require review of permit conditions by the National Oceanic and Atmospheric Administration (NOAA). NOAA has a Memorandum of Understanding with the Regional Board to review NPDES permits for discharges into the waters of the Sanctuary.

Depending upon the siting of the reverse osmosis treatment plant, an encroachment permit may be required to construct a pipeline crossing the Southern Pacific Railroad right-of-way.

10.8.6 Environmental Analysis

10.8.6.1 Cultural Resources

A cultural resources review was conducted by the California Archaeological Inventory at Sonoma State University for the groundwater well sites, reverse osmosis treatment plant site, and associated pipeline alignments. Native American resources have been located in a number of areas along the Santa Cruz coast. The pipeline alignments have the highest potential to impact cultural resources. A cultural resources review was not conducted for the Thurber Lane sites because the potential for cultural resources is assumed to be low, based on the disturbance which has already occurred at the sites.

10.8.6.2 Vegetation and Wildlife

The Majors and Davenport areas are primarily agricultural, where there is little likelihood of encountering sensitive habitats or species. It is anticipated that there is a low or moderate potential for encountering environmental problems with this alternative.

The Thurber Lane location (both upper and lower sites) is in an urban area which is already disturbed. Therefore, there is little likelihood of encountering sensitive habitats or species. It is anticipated that there is a low potential for encountering environmental problems at the site.

10.8.6.3 Threatened and Endangered Species

Neither of the sites are expected to support any federal- or state-listed endangered or threatened species. However, site specific surveys would need to be conducted to determine the presence or absence or rare, threatened or endangered species. It is assumed that any loss of critical wetlands or habitat could be mitigated.

10.8.7 Summary of Significant Project Constraints

- This project has the potential to impact cultural resources along the Coast pipeline alignment. It is anticipated that these impacts could be mitigated.
- This project would involve brine disposal into the Monterey Bay National Marine Sanctuary. Brine disposal is consistent with the Central Coast Basin Water Quality Control Plan, so this is not a significant constraint. However, the time required to implement this project could be affected.

10.9 Project P-I - Smaller Reservoir at Yellow Bank Creek, Thurber Lane Groundwater Wells, and Wastewater Reclamation

10.9.1 Description of Alternative

This project consists of a smaller reservoir at Yellow Bank Creek, sized at 2,600 MG, groundwater wells at Thurber Lane, and wastewater reclamation facilities at Scotts Valley Wastewater Treatment Plant (WWTP) to serve Pasatiempo Golf Course and the Oddfellow Cemetery. The Yellow Bank Reservoir site was selected based on preliminary results of the Phase III evaluation, which indicated that the Yellow Bank Reservoir Project is the best of the reservoir projects.

10.9.2 Estimated Incremental Yield

The Thurber Lane groundwater wells would provide a yield of 120 MG/yr during drought periods and the wastewater reclamation project would reduce customer demands by 70 MG/yr during drought periods. Therefore, the reservoir was sized to meet a shortfall of 400 MG/yr based on the long-term milder drought. The reservoir would also provide 800 MG/year during the short-term critical drought period.

10.9.3 Facilities Requirements

The proposed facilities for this alternative are shown on Figure 10-9 and include the following:

Yellow Bank Reservoir

- Five 1,000 gpm wells to divert Scott Creek underflow, 16-inch diameter, 200-feet deep.
- 700 HP pump station at Scott Creek.
- Approximately 33,000 feet of 24-inch diameter pipeline from Scott Creek to the reservoir.
- Reservoir sized at 2,600 MG.
- Roller-compacted concrete dam approximately 200 feet high and 730 feet in length.
- 14,000 feet of 20-inch diameter pipeline from the reservoir to the Coast pipeline at Majors Creek.
- 320 HP pump station at the reservoir.
- Approximately 35,000 feet of 8-inch diameter pipeline from Majors Creek to the existing Coast Pump Station.

- Approximately 6,000 feet of 14-inch diameter pipeline from existing Coast Pump Station to Graham Hill WTP.
- Upgrade of existing Coast Pump Station by 75 HP.

Thurber Lane Wells
- One 500-foot deep, 12-inch diameter well at lower Thurber Lane well site. Flowrate of 250 gpm.
- 1,500 feet of 8-inch diameter pipeline to upper Thurber Lane well site.
- One 500-foot deep, 12-inch diameter well at upper Thurber Lane site.
- One 500 gpm iron and manganese treatment plant at upper Thurber Lane site.
- 2,000 feet of 12-inch diameter pipeline to tie into water system.

Wastewater Reclamation
- 0.95 MGD tertiary treatment facilities at Scotts Valley WWTP (see discussion below).
- 50 HP booster pump station at Scotts Valley WWTP.
- Approximately 4,000 feet of 10-inch diameter PVC pipeline from the new golf course service connection to the existing Pasatiempo 0.3 MG tank.
- New reclaimed water distribution line for Pasatiempo Golf Course, including 900 feet of 8-inch PVC pipeline and 4,600 feet of 10-inch PVC pipeline.
- Modifications to re-plumb drinking water facilities at golf course.
- Modifications to existing service connection at the Oddfellow Cemetery.

The estimated peak demand for Pasatiempo Golf Course and Oddfellow Cemetery is 0.55 MGD. The Scotts Valley Wastewater Treatment Plant is currently being expanded and will have a peak capacity of 0.95 MGD. In order to use the existing outfall line for reclaimed water delivery, all of the water in the outfall line would need to be treated at the tertiary treatment facility. For the purposes of this study, it was assumed that the City of Santa Cruz would pay for installation and treatment of up to 0.95 MGD. If this project is pursued, the opportunity for cost sharing with other users would need to be explored.

10.9.4 Engineering Analysis

10.9.4.1 Facilities Sizing

Facilities were sized assuming that a continuous, constant release would be made from the reservoir during summer months of drought years and that the existing Loch Lomond supply would be used to meet short-term peak requirements during this period. If the reservoir project were to be used to provide higher flows during peak periods, the new parallel Coast pipeline would need to be sized at a larger diameter.

10.9.4.2 Estimated Project Costs

The estimated capital cost of this project is $74 million in 1993 dollars, not including land acquisition. Approximately 50 percent of the construction cost is due to the dam.

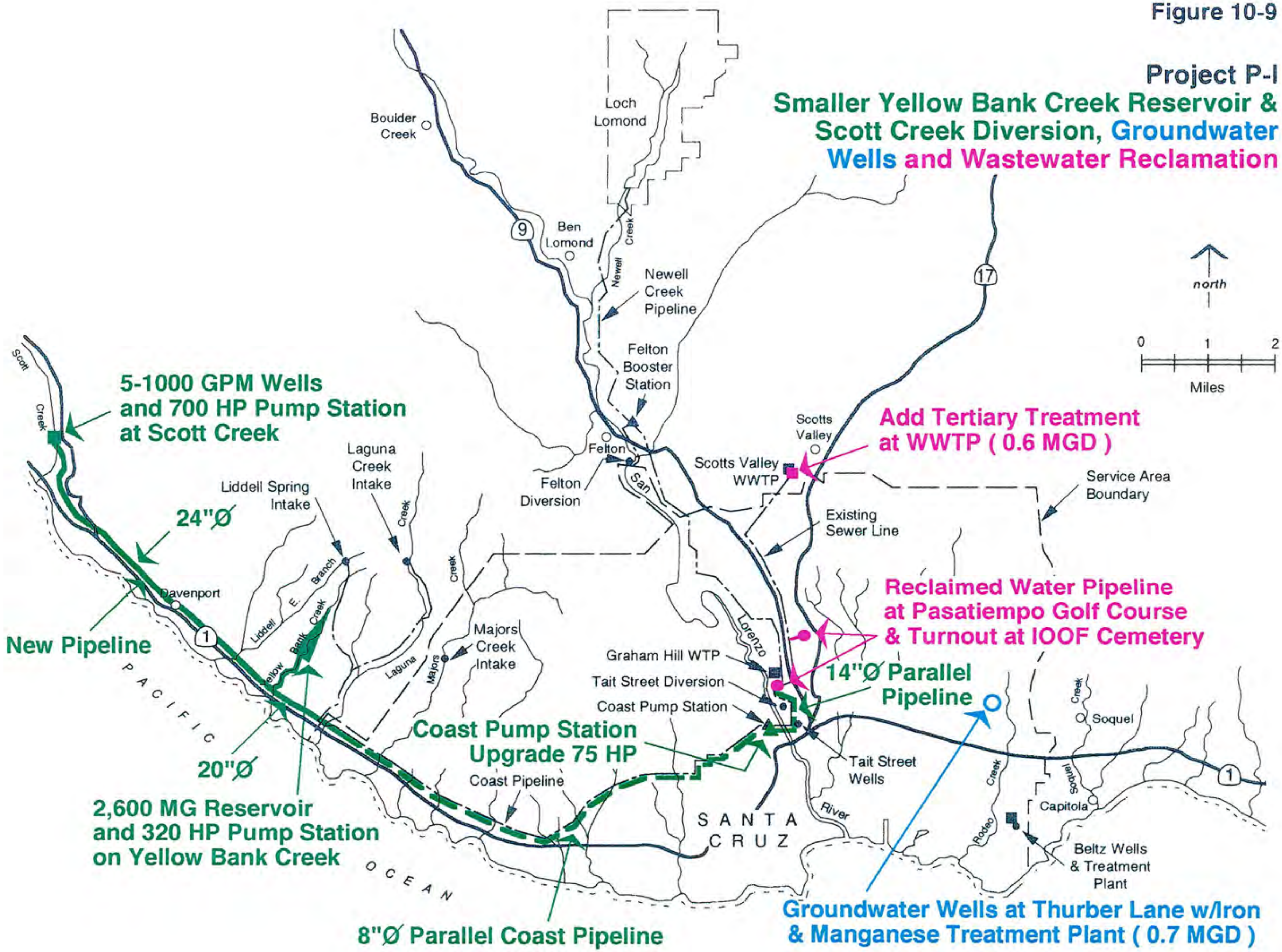
10.9.4.3 Wastewater Reclamation Facilities

As part of the Phase III evaluation, Ken Anderson, the City Public Works Director for Scotts Valley was contacted to discuss the City of Scotts Valley's wastewater reclamation program and possibility for participating in this program. Scotts Valley has identified other potential reclaimed water users including Glenwood Estates golf course, Borland, freeway median

Figure 10-9

Project P-I

Smaller Yellow Bank Creek Reservoir & Scott Creek Diversion, Groundwater Wells and Wastewater Reclamation



irrigation, and a local park. However, Scotts Valley currently has no plans to install tertiary treatment facilities because no funding has been identified.

Earlier in this study, it was determined that the second parallel pipeline from the Scotts Valley WWTP is no longer considered necessary and that a new pipeline would be required to deliver treated water to Pasatiempo Golf Course and Oddfellow Cemetery. Further discussion of this plan with Mr. Anderson determined that it would be possible to pressurize Scotts Valley's existing pipeline and use the existing pipeline to deliver treated wastewater. This would require treating all of Scotts Valley's wastewater to a tertiary treatment level. The plant, which is currently being expanded, will have a capacity of 0.95 MGD. It may be possible to share the cost of facilities with other users. However, for purposes of this analysis, it was assumed that the City would pay the full cost of tertiary treatment for 0.95 MGD, even though the two identified users would only use 0.55 MGD. If funding is identified for Scotts Valley to construct tertiary treatment facilities, and other demands are identified, the potential water available to the City of Santa Cruz could be reduced. Specific facilities for the wastewater reclamation portion of this project are shown on Figure 10-10.

10.9.4.4 Geotechnical Issues

Like the stand-alone reservoir project on Yellow Bank Creek, this project would also require construction of a roller-compacted concrete dam. This is due to: (1) the relatively steep topography, (2) the competency of the foundation rock, (3) the difficulty in providing sufficient space for a conventional spillway, and (4) the lack of adequate volumes of competent soil and rock materials. The local bedrock at this site consists of Santa Cruz Mudstones, which have a very low specific gravity (less than 1.5), and is not considered appropriate for use in a zoned embankment. As a result, the total cost of this project is high because of the relatively high dam required for the necessary reservoir size.

10.9.4.5 Hydrologic Issues

Diversion facilities at Scott Creek were sized the same as Project P-D, Yellow Bank Creek Reservoir and Scott Creek Diversion Project. The time required to fill the reservoir with these facilities is 5 years, assuming average hydrology.

10.9.5 Regulatory and Institutional Analysis

The following permits would be required for this project:

- Permit to Appropriate Water (State Water Resources Control Board)
- Streambed Alteration Agreement (State Department of Fish and Game)
- Approval of Plans and Specifications and Certificate of Approval to Construct or Enlarge a Dam or Reservoir (State Department of Water Resources, Division of Safety of Dams)
- Section 404 Permit to excavate or discharge dredged material into waters of the United States (Army Corps of Engineers)
- Potential for "Take" Permit (U.S. Fish and Wildlife Service and Army Corps of Engineers)
- Coastal Development Permit (Santa Cruz County Planning Department)
- Encroachment Permit (Caltrans)
- Building Permit (County Planning Department)

This project is in the Coastal Zone as defined in the Santa Cruz County Coastal Plan, and would require a Coastal Development Permit. It would also need to be demonstrated that the project is consistent with both the County General Plan and the County Coastal Plan. Although it is likely that the need for a Coastal Development Permit would impact the time required for project review and implementation, no specific issues were identified which would preclude obtaining the permit.

New pipeline facilities would be located in the Highway 1 right-of-way and would require an Encroachment Permit from Caltrans.

10.9.6 Environmental Analysis

10.9.6.1 Cultural Resources

A cultural resources review for the Yellow Bank Creek reservoir site and pipeline alignments was conducted by the California Archaeological Inventory at Sonoma State University. Although no Native American resources were identified at the reservoir site, the potential for such resources is considered high based on the site characteristics. The literature review gave no indications of historical resources within the study area. This project includes new pipelines from Scott Creek to the Majors area and a new pipeline in the existing Coast pipeline corridor. Six archaeological sites have been recorded within this area. Given the environmental features of the pipeline alignments, there is a high possibility of additional Native American resources.

10.9.6.2 Vegetation and Wildlife

The Scott Creek and Yellow Bank Creek sites have some potential for sensitive species or habitat. Intensive field surveys would be required to determine the presence or absence of such species. Potential candidates include the saltmarsh common yellowthroat, California tiger salamander, red-legged frog, the marbled murrelet, and one or more raptor species. Potential sensitive habitats include freshwater marsh, any riparian forest or woodland, maritime chaparral, and maritime coast range ponderosa pine forest.

10.9.6.3 Fisheries and Aquatic Resources

Aquatic resources in the Scott Creek watershed include tidewater goby, red-legged frog, steelhead trout and coho salmon. The Department of Fish and Game has stated that they would oppose a surface diversion which would present a barrier to fish migration or cause sedimentation upstream of a dam. Minimum bypass flows would need to be established, below which no water could be diverted from Scott Creek. An IFIM study would be required to identify instream flow release requirements of the Department of Fish and Game during the CEQA review phase if this alternative is selected. A Scott Creek lagoon study to analyze how streamflow is related to sandbar passage and water quality will also be required.

Yellow Bank Creek presumably had a steelhead population before the construction of coastal agricultural dams. A resident trout population now exists in Yellow Bank Creek. This project could provide mitigation by enhancing resident rainbow trout habitat below the reservoir, within the reservoir and upstream. Red-legged frogs within the inundation zone may require relocation to perennial stream habitat lacking this species, if a suitable stream can be found. The red-legged frog issue was not included within fishery discussions with the Department of Fish and Game,

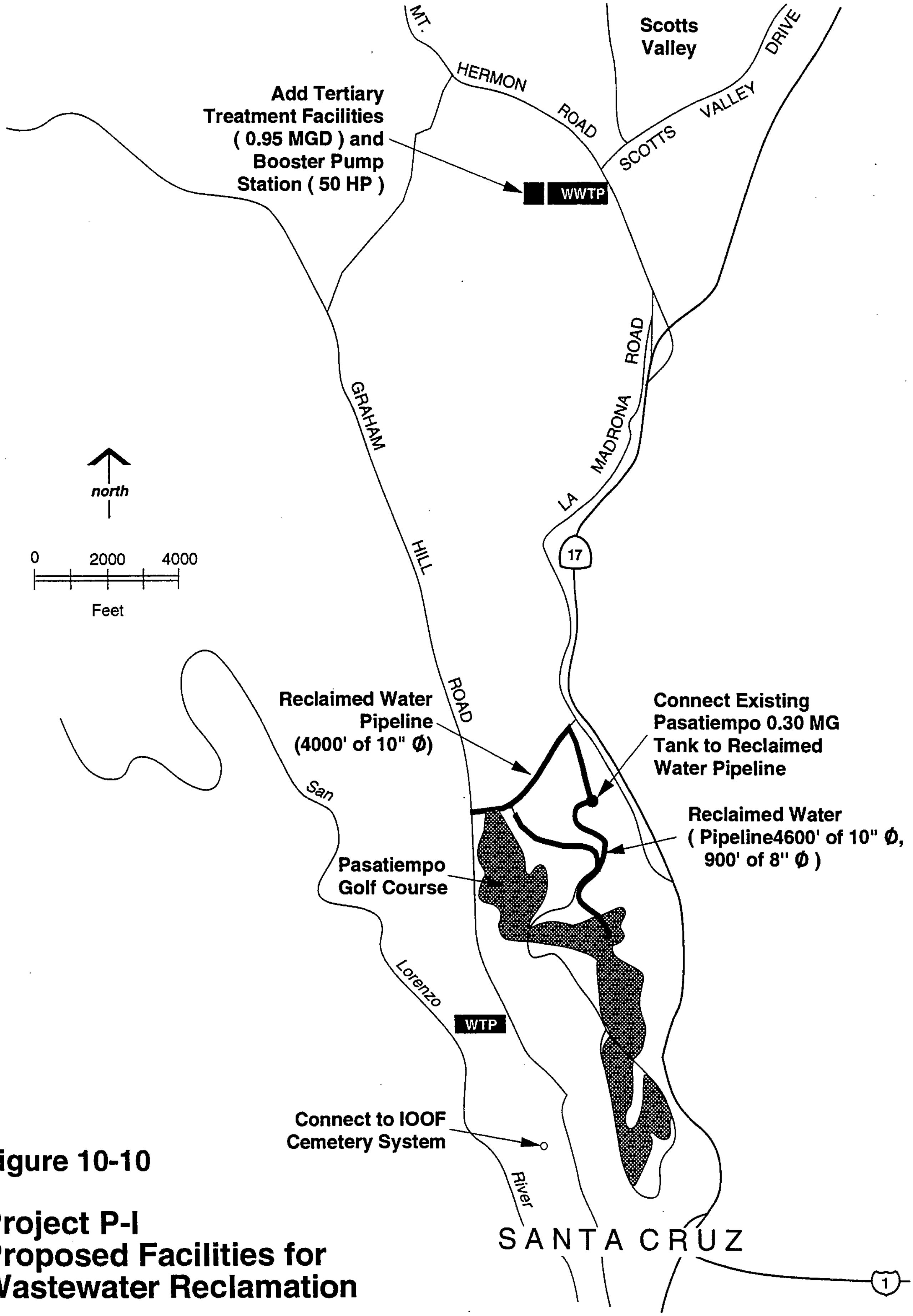


Figure 10-10

Project P-I Proposed Facilities for Wastewater Reclamation

Source: 1988 Water Master Plan

however. An IFIM study may be required to establish instream flow releases below the reservoir.

10.9.6.4 Threatened and Endangered Species

The Yellow Bank and Scott Creek sites are not expected to support any federal- or state-listed endangered or threatened species. However, site specific surveys would be needed to determine the presence or absence of rare, threatened, or endangered species. It is assumed that any loss of critical wetlands or habitat could be mitigated.

10.9.7 Summary of Significant Project Constraints

- An earth embankment dam could not be constructed at this site, because the native material is unsuitable for embankment fill. The dam would be RCC.
- The cost of this project is the third highest of all of the projects. This is due to the high cost of RCC construction and the large volume of material which would be required for the dam.
- This project includes a new pipeline from Scott Creek to Majors and a new pipeline parallel to the existing Coast pipeline. There is a high probability of encountering cultural resources during construction of the pipelines. This could be mitigated.
- The diversion adjacent to Scott Creek has the potential to impact fishery resources in Scott Creek. The project would need to provide mitigation to protect fishery habitat.

Section 11
Evaluation Criteria

The section describes the evaluation criteria used to compare and rank projects. The section discusses how the evaluation criteria were selected, and presents a brief overview of each of the criteria and the project ranking process.

11.1 Evaluation Criteria Selection

The potential water supply projects have been evaluated and ranked with respect to engineering, environmental, institutional, and cost factors. The objectives of the evaluation process are: 1) to help identify the best project(s); 2) to facilitate understanding of the relative merits of each project; and 3) to establish a framework to reach a consensus option.

To provide decision makers with relevant information in a usable form, it was necessary to develop a limited number of evaluation criteria that incorporate key issues. These criteria are general categories under which particular concerns/issues can be grouped. Each criterion may incorporate a number of key concerns/issues that would be considered in the detailed evaluation of a particular project.

Ten of the Technical Advisory Committee members participated in Workshop No. 1, held in June 1993, to review key issues and to select the criteria to be used in evaluating water supply projects and to develop relative weights for the criteria. At the workshop, the Committee established the criteria which were used for the Phase III evaluation of projects and developed relative weights for the criteria.

In the workshop, the Committee first identified the project stakeholders, or those who would have an interest in the project. These were then broken up into four general groups to pair stakeholders with similar interests. The general groups identified were: 1) the City and its ratepayers who would pay for a project; 2) local agencies and individuals who would be concerned about potential impacts to the local community; 3) environmental groups and agencies concerned about the environmental impacts of a project; and, 4) other state and local agencies who would issue permits for projects.

The Committee members, CDM, and members of the public attending the meeting were then assigned to one of the four groups to discuss the issues which would be of importance to that group of stakeholders. These issues were then presented to the whole committee and discussed. Finally, each of the issues was assigned to one of five general categories or criteria. CDM made an initial selection of categories and assignments to categories. These lists were then discussed and refined by the Committee.

Once the criteria were established, the Committee developed relative weights for the criteria. Committee members were asked to compare each of the criteria and assign a relative importance to each of the criteria. Each of the Committee members was asked to rate the criteria individually. The individual scores for each of the comparisons were then tallied. Individual scores were discussed, particularly on issues with a wide range of scores. The group was then asked to develop a group score through consensus, where the definition of consensus is "... a decision all decision makers can understand and support even if it is not their personal favorite." The group-developed criteria and relative weights are:

Criterion	Relative Weight
Environmental	24
Cost	22
Operations/Reliability	19
Implementability	15
Political/Institutional/Public	20
	100

These criteria were used to compare and rank each of the potential projects in the Phase III evaluation. A comparison of individual weightings and the group consensus weightings is presented below:

Criteria Weighting From Workshop No. 1
(percent)

Scores	Environmental	Cost	Operations/ Reliability	Implementability	Political/ Institutional/ Public	Total
Individual Weights	25	23	20	17	15	100
	22	17	24	18	19	100
	16	23	29	14	18	100
	19	28	22	8	23	100
	27	16	16	24	17	100
	24	16	22	18	20	100
	33	27	7	14	19	100
	23	22	25	15	15	100
	31	22	15	14	18	100
	16	25	19	21	19	100
Average of Group	24	22	20	16	18	100
Consensus Weight	24	22	19	15	20	100
High Value	33	28	29	24	23	-
Low Value	16	16	7	8	15	-

11.2 Evaluation Criteria Summary

In Workshop No. 1, particular concerns and issues were grouped by the general categories or criteria. For the Phase III evaluation, these issues, many of which were specific to certain projects, were grouped by their similarities. Each of the projects was then compared for each of the key issues identified. This section presents a brief overview of the criteria and the key issues which were used in the project evaluation.

11.2.1 Environmental

Any project selected will be subject to preparation of environmental documentation under the guidelines of the California Environmental Quality Act (CEQA). The evaluation of the environmental issues associated with potential water supply projects placed particular emphasis on identification of potential fatal flaws, significant mitigation measures, or protracted permitting process requirements. Feasibility-level project screening was performed consistent with CEQA requirements. The following issues were identified in Workshop No. 1:

- CEQA Compliance
- Cultural Resources
- Impacts to Trails (Waterman Gap)
- Construction Impacts
- Ocean Discharges
- Sanctuary Interests/Protection
- Hydromodification (Impacts to Hydrology)
- Natural Systems/Wetlands
- Spills/Hazardous Materials
- Downstream Water Quality
- General Environmental Degradation
- Negative Streamflow Impacts
- Negative Impact to Watershed/Diversion Sites

Since many of the issues identified were closely inter-related, the issues were consolidated into groups using the workshop concerns and CEQA requirements. The following key issues were included in the environmental evaluation:

- Cultural Resources
- Construction Impacts
- Marine Sanctuary Interests/Protection
- Spills/Hazardous Materials
- Vegetation and Wildlife
- Fisheries and Aquatic Habitat
- Threatened and Endangered Species

11.2.2 Cost

The cost criterion allows a quantitative comparison of projects based on their estimated costs. Feasibility-level cost estimates have been developed for each of the projects. Cost considerations include both capital costs and operational costs for the projects. All of the cost issues identified in Workshop No. 1 were included in the Phase III evaluation. The following key issues were identified for the cost evaluation:

- Capital Cost
- Unit Cost of Water ($/acre-foot)

- Operating Cost (Power, Labor, Chemical)
- Life Cycle Costs (Present Worth)

11.2.3 Operations/Reliability

The Operations/Reliability criterion focuses on whether projects are able to provide a reliable source of supply, the flexibility in using a project and the ease with which a project can be operated in conjunction with the City's existing supplies. The following issues relating to the Operations/Reliability criterion were identified in Workshop No. 1:

- Reliability
- Emergency Response
- Service to University of California at Santa Cruz at Low Cost
- Limited Supply to North Coast Customers
- Ability to Phase Project
- Reservoir Siltation
- Operational Flexibility
- Efficiency of Operation

The issues dealing with service to specific customers were not included in the Phase III evaluation since all of the projects would provide equal levels of service. The Ability to Phase Projects issue was moved to the Implementability criterion. Therefore, the issues developed in Workshop No. 1 were consolidated into the following categories:

- Reliability
- Emergency Response
- Reservoir Siltation
- Operational Flexibility
- Ease of Operation

11.2.4 Implementability

This criterion focuses on the ability of the City to implement a project and constraints which would significantly delay development of a project. The following issues were identified in Workshop No. 1:

- Easements
- Seismic Design
- Permits/Land Use in Coastal Zone
- Local Plan Consistency
- Enforcement/Operating Permits - Department of Health Services
- Bonding Schedule
- City Planning - Processing and Review
- Project Schedule

The issue of Seismic Design was included both in the Cost criterion and in the Political/Institutional/Public criterion. Also the Ability to Phase Project issue identified in the Operations/Reliability criterion was moved to this category. Because the issues of Easements and Land Acquisition are so closely related, the Easements issue was combined with Land

Acquisition in the Political/Institutional/Public criterion. Therefore, these issues were consolidated into the following groups:

- Permits/Land Use in the Coastal Zone
- Ability to Phase Project
- Local Plan Consistency
- Department of Health Services Operating Permits
- Project Schedule

11.2.5 Political/Institutional/Public

This criterion deals with the political, institutional, and public issues which need to be addressed in implementing a project. For this criterion, the focus was to identify specific concerns of regulatory agencies, local agencies, or individuals. Some of the issues included in this criterion, such as land acquisition, downstream flooding potential, and seismic design, are technical or cost issues, which have been accounted for in developing project facilities requirements and project cost estimates. They are also addressed here, however, because they are issues which could also create a public perception problem for a project. Potential community benefits were also identified in this analysis. The following issues were identified in Workshop No. 1:

- Strain on Local Agencies if Withdrawals From Appropriated Watersheds
- Political/Territorial Acrimony
- Deny Ability of Others To Make Land Use Decisions
- Regional Water Benefits
- County in Position of Mediating/Approving of Projects
- Boating
- Camping
- Fishing
- Safety
- Downstream Flooding Potential
- General Plan Compliance
- Land Acquisition
- Landowner Displacement
- Interagency Agreements
- Landslides
- Seismic Safety
- Drinking Water Quality
- Recreational Use
- Public Access
- Public Health
- Water Quality
- Water Rights for Projects
- Water Rights of Upstream/Downstream Users
- Impacts to California Polytechnic University Agriculture Station (Scott Creek)
- Upstream Land Use Restrictions
- Negative Socioeconomic Impacts

Because a large number of these issues are inter-related, and several are project-specific, the issues were consolidated into the following categories:

- Impacts to Local Agencies
- Recreational Use/Public Access
- Downstream Flooding Potential/Safety
- Land Acquisition/Easements
- Permitting
- Seismic Design/Safety/Landslides
- Drinking Water Quality
- Interagency Agreements
- Socioeconomic Impacts

11.3 Key Issues Weightings

As part of the Phase III evaluation, each of the potential projects was compared and scores for each of the key issues developed. Each project was rated using a scoring system of 1 to 10, where a score of 1 is a poor rating and a score of 10 is an excellent rating. If a project did not meet a particular objective, a score of 0 was assigned. Preliminary scores were developed for each of the issues by members of the consulting team. The consulting team then held a workshop to review and discuss the scorings.

Because each of the key issues identified have different levels of importance, relative weights were developed for each of the issues. Relative weights were assigned by the consulting team in the workshop to develop preliminary project rankings. Relative weights were assigned by first reviewing each of the issues associated with a criterion and ranking them in their order of importance. Based on the rankings, relative weights were then developed for each of the issues. The summary of key issues and their relative weights is presented in Table 11-1. Because a project might score quite differently for the different issues identified for each criterion, the overall project score is very dependent upon the relative weights selected for comparing the issues.

Project scores were developed for each criterion by multiplying the scores assigned for each issue by the relative weights assigned to the issues and summing them to develop an overall score for the criterion. These scores were used, along with the criteria weightings developed in Workshop No. 1 to develop overall project scores and rankings.

TABLE 11-1
SUMMARY OF KEY ISSUES AND THEIR RELATIVE WEIGHTS

CRITERION/ ISSUE	Weight (%)
Environmental	
Cultural/Historical Resources	5
Construction Impacts	10
Sanctuary Interests/Protection	5
Vegetation and Wildlife	15
Spills/Hazardous Materials	5
Fisheries and Aquatic Habitat	40
Threatened and Endangered Species	20
TOTAL	100
Cost	
Capital Cost	65
Unit Cost	5
Operating Cost	25
Life Cycle Cost	5
TOTAL	100
Operations/ Reliability	
Reliability	45
Emergency Response	5
Reservoir Siltation	5
Operational Flexibility	25
Ease of Operation	20
TOTAL	100
Implementability	
Permits/Land Use in Coastal Zone	10
Local Plan Consistency	10
Operating Permits	10
Ability to Phase Project	30
Project Schedule	40
TOTAL	100
Political/ Institutional/ Public	
Impacts to Local Agencies	5
Recreational Use/Public Access	5
Downstream Flooding/Safety	15
Land Acquisition/Easements	30
Permitting	20
Seismic Design/Safety/Landslides	10
Drinking Water Quality	5
Interagency Agreements	5
Socioeconomic Impacts	5
TOTAL	100

Section 12
Comparison and Ranking of Potential Projects

This section presents an overview of the evaluation criteria developed at Workshop No. 1. Each of the criteria and the key issues are presented and the potential projects are compared and rated for each of the key issues.

12.1 Overview of Evaluation Criteria

Workshop No. 1 was held in June 1993 to select the criteria for evaluating the water supply projects. In the workshop, the Technical Advisory Committee selected five evaluation criteria and assigned relative weights to these criteria. The criteria and their relative weights are:

Criterion	Relative Weight
Environmental	24
Cost	22
Operations/Reliability	19
Implementability	15
Political/Institutional/Public	20

Several key issues were identified for each criterion in the workshop. In the Phase III evaluation, similar issues were grouped and projects were then compared and rated for each of the key issues. Each of the key issues for a criterion was also assigned a relative weight to develop an overall score for each potential project for each of the criteria. Preliminary scores and weights were developed by members of the project consulting team. The project team then held an internal workshop to review and discuss the project ratings.

This section provides an overview of each of these criteria, discusses the projects for each of the key issues identified, and presents a summary of the project rankings.

The ratings for each of the projects range from 1 to 10. The higher the rating, the better the project meets the issue objective.

12.2 Environmental Criterion

Any project selected will be subject to preparation of environmental documentation under the guidelines of CEQA. The evaluation of the environmental issues associated with potential water supply projects placed particular emphasis on identification of potential fatal flaws, significant mitigation measures, or protracted permitting process requirements. Feasibility-level project screening was performed consistent with CEQA requirements. Several environmental issues were identified in Workshop No. 1. Since many of the issues identified were closely inter-related, the issues were consolidated into groups using the Workshop No. 1 concerns and CEQA requirements. The following key issues were included in the environmental evaluation:

- Cultural Resources
- Construction Impacts
- Marine Sanctuary Interests/Protection
- Spills/Hazardous Materials
- Vegetation and Wildlife
- Fisheries and Aquatic Habitat
- Threatened and Endangered Species

Project scores for each of the issues is presented in Table 12-1. Relative weights for each of the issues were assigned based on the sensitivity of an issue and the potential that the issue could involve significant mitigation. Fisheries and Aquatic Habitat, Threatened and Endangered Species, and Vegetation and Wildlife issues were given the highest relative weights.

12.2.1 Cultural Resources

A cultural resources review for the potential projects was conducted by the California Archaeological Inventory at Sonoma State University. The Loch Lomond and Thurber Lane sites were not reviewed by Sonoma State and were assumed to be disturbed sites where no cultural resources are expected. During future CEQA review, any of the proposed projects will require a more extensive review of cultural resources.

The reservoir projects (Projects P-A through P-D and P-I), and projects with brackish groundwater wells and reverse osmosis treatment (Projects P-E through P-H) will require a field review for archaeological resources. According to the preliminary literature research, these sites have the potential for Native American archaeological resources. The likelihood of encountering cultural resources for Projects P-E through P-H is judged to be lower because the amount of land affected is much smaller.

Although no known cultural resources were identified at any of the reservoir locations, the potential for such resources is considered highest in the Waterman Gap area (Project P-A) due to the location of the Saratoga Toll Road, the Southern Pacific Railroad Boulder Creek Spur, and other trails that are considered historic features that would be inundated by the reservoir project. This site would also have the potential for other cultural resources due to the associations of human habitation and migration associated with the trails. Although no historic features were identified at the other reservoir sites, there is also a potential for cultural resources at these sites given the environmental features of the sites.

Projects which also include a parallel Coast pipeline (Projects P-C, P-D, P-E, and P-H) also have a potential to impact cultural resources. The pipeline alignment includes terraces on the coastal shelf with numerous seasonal and perennial watercourses. Six archaeological sites have been recorded in the coastal area and there is a high possibility of encountering additional cultural resources. Therefore, these projects were rated lower than projects which do not have a parallel pipeline.

Table 12-1

Environmental Criterion

Santa Cruz Water Department - Water Supply Alternatives Study

Scoring (10 Point System)
10 = Excellent
5 = Average
1 = Poor
N/A = Not Applicable

Projects

Issues	Issue Weight	P-A : Waterman Gap Reservoir	P-B : Kings Creek Reservoir	P-C : Liddell Creek Reservoir & Scott Creek Diversion	P-D : Yellow Bank Creek Reservoir & Scott Creek Diversion	P-E : Loch Lomond 260 MG Enlargement & GW Wells W/RO WTP	P-F : Loch Lomond 500 MG Enlargement & GW Wells W/RO WTP	P-G : Loch Lomond 1010 MG Enlargement & GW Wells W/RO WTP	P-H : Brackish GW W/RO WTP Thurber Lane Groundwater	P-I : Reservoir W/Thurber Lane GW & WW Reclamation
Cultural/Historical Resources	5	2	4	3	3	5	6	6	5	4
Construction Impacts	10	1	3	5	5	5	5	4	7	5
Sanctuary Interests/Protection	5	7	7	5	5	4	4	4	4	5
Spills/Hazardous Materials	5	3	5	6	7	4	4	4	3	4
Vegetation and Wildlife	15	2	3	2	3	8	7	6	9	3
Fisheries and Aquatic Resources	40	4	5	2	2	1	1	1	9	2
Threatened and Endangered Species	20	3	3	3	3	6	6	6	9	3
Total Criterion Score	--	**3.2**	**4.15**	**2.9**	**3.1**	**3.95**	**3.85**	**3.6**	**8.05**	**3.0**

Note: The Total Criterion Score Equals the Sum of Issues Weights Times Issues Scores Divided by 100

Project scores for the Cultural Resources issue are:

P-A	P-B	P-C	P-D	P-E	P-F	P-G	P-H	P-I
2	4	3	3	5	6	6	5	4

12.2.2 Construction Impacts

The level of construction impact primarily depends on the number of nearby residences which could be affected. Construction impacts are identified as noise, dust, traffic disruption, and construction disturbance and inconvenience. Construction impacts are highest at new reservoir sites due to the amount of construction that would occur. The scores distinguished between the San Lorenzo River reservoir sites (Projects P-A and P-B), which would be surrounded by residential development, and the North Coast reservoir sites (Projects P-C and P-D) which are more remote and accessed only by private roads accessible only through locked gates. The reservoir at Waterman Gap (Project P-A) was further penalized in the scoring because the relocation of Highway 9 would involve additional construction which would result in substantial disturbance to local residents in this area, as well as the large number of commuters who use the road.

The Scott Creek diversion which is proposed in conjunction with the north coast reservoirs (Projects P-C and P-D) would be located in an agricultural area and follow the rights-of-way for other existing pipelines. Because the site is located in a rural area away from most residential development, the construction impact associated with the Scott Creek diversion is considered moderate.

The Loch Lomond reservoir site is located in an area that is accessible through Lompico or Ben Lomond. Although the site is located in a rural area away from most residential development, the construction vehicles would require access through residential areas. The potential for construction impacts for Projects P-E and P-F, which would require construction of a parapet wall on the existing dam, is considered moderate. Project P-G, which would require raising the dam embankment would require more construction and therefore, was rated as less desirable than Projects P-E and P-F.

Projects P-E, P-F, and P-G also include brackish groundwater wells with reverse osmosis treatment. Construction would occur some distance from coastal residential development and on a site near the coast not far from Majors Creek. The groundwater wells and associated pipeline would be constructed in agricultural land and in existing rights-of-way and would not be expected to cause significant disruption. Because there is some flexibility in locating the treatment plant, the construction impact is considered moderate.

Project P-H includes groundwater wells at Thurber Lane and brackish groundwater wells with reverse osmosis treatment. Although construction of the Thurber Lane wells would occur in a residential neighborhood, construction of the groundwater wells in this location would likely be of a much shorter duration than for other projects. Therefore, this project was rated more highly than other projects.

Project P-I, which includes a smaller reservoir at Yellow Bank Creek , Thurber Lane groundwater wells and wastewater reclamation was given the same rating as Project P-D, because the level of construction impact is expected to be similar.

Project scores for the Construction Impacts issue are:

P-A	P-B	P-C	P-D	P-E	P-F	P-G	P-H	P-I
1	3	5	5	5	5	4	7	5

12.2.3 Marine Sanctuary Interests/Protection

The Monterey Bay National Marine Sanctuary is located off the coast of Santa Cruz and Monterey Counties and is known for its unique marine resources. The primary projects having the potential to affect the Sanctuary are those which include the reverse osmosis treatment plant (Projects P-E, P-F, P-G, and P-H). A by-product of the reverse osmosis desalination process is concentrated brine, which must be disposed in an approved location. This disposal will require permits from one or more of the following agencies: the Regional Board, NOAA on behalf of the Monterey Bay National Marine Sanctuary, and possibly the EPA, if deep injection wells are involved. A Coastal Development Permit will also be required for these projects. Brine disposal options were discussed with the Regional Board. Brine disposal is consistent with the Regional Board's Water Quality Control Plan for the Central Coast Basin. However, due to the potential sensitivity of disposal in the Sanctuary, these projects were rated the lowest of all of the projects.

Projects involving new reservoirs (Projects P-A through P-D and P-I) have the potential to affect the Sanctuary because each of the watersheds drain to Monterey Bay. Both the San Lorenzo River and Scott Creek form seasonal lagoons at the mouth of the creeks. The potential to impact the Sanctuary was judged to be higher for the North Coast Reservoir projects (Projects P-C, P-D and P-I) because potential impacts to the lagoon at Scott Creek could affect tidewater goby in the lagoon.

Projects were scored as follows for the Marine Sanctuary Interests/Protection issue:

P-A	P-B	P-C	P-D	P-E	P-F	P-G	P-H	P-I
7	7	5	5	4	4	4	4	5

12.2.4 Spills/Hazardous Materials

The potential for spills of hazardous materials would be primarily associated with fuels or other hazardous materials used at construction sites or chemicals associated with water treatment. The potential for contamination to a water supply due to spills of hazardous materials was also considered in evaluating projects.

For the reservoir projects, primary considerations include the potential for spills of hazardous materials during construction. The San Lorenzo River projects were also deemed more sensitive due to the potential for contamination of the San Lorenzo River which would be used to convey water from the reservoirs to Graham Hill Water Treatment Plant. The Waterman Gap Reservoir project (Project P-A) was ranked the lowest because of its proximity to Highway 9, a major road in the area. For the North Coast Reservoir projects, the East Branch Liddell Creek Project (Project P-C) was also rated slightly lower than the Yellow Bank Creek Project (Project P-D) due to the potential for contamination from upstream quarry operations.

Projects which include reverse osmosis treatment facilities (Projects P-E through P-H) or iron and manganese treatment facilities (Projects P-H and P-I) have a potential for hazardous spills during chemical handling at the treatment plants. Therefore, these projects were rated lower.

The project scores for the Spills/Hazardous Materials issue are:

P-A	P-B	P-C	P-D	P-E	P-F	P-G	P-H	P-I
3	5	6	7	4	4	4	3	4

12.2.5 Vegetation and Wildlife

The new reservoir projects (Projects P-A through P-D and P-I) would result in the highest impacts to vegetation and wildlife simply due to their size and scale. Impacts to vegetation and wildlife would be greater at the Waterman Gap site (Project P-A) because of the relocation of Highway 9. The habitat at the East Branch Liddell Creek site was judged to have higher value due to the presence of second growth redwoods. Therefore, these projects were rated the lowest. Project P-I, which would include a smaller reservoir at the Yellow Bank Creek site was rated the same as the stand-alone reservoir project on Yellow Bank Creek (Project P-D).

Loch Lomond has small amounts of riparian vegetation that would be affected by raising the dam. Therefore, projects which include expansion of Loch Lomond (Projects P-E, P-F, and P-G) would have a minor impact on vegetation or wildlife habitat. These projects also include brackish groundwater wells with reverse osmosis treatment which is not expected to result in significant effects on plants or wildlife at the treatment plant site or within the pipeline corridors.

Project P-H (brackish groundwater with reverse osmosis treatment and Thurber Lane groundwater wells) was judged to have the least potential for impacts to vegetation and wildlife and was rated the highest. The Thurber Lane well sites have been disturbed and it is expected that there would be no loss of important plant or wildlife resources.

Project scores for Vegetation and Wildlife are:

P-A	P-B	P-C	P-D	P-E	P-F	P-G	P-H	P-I
2	3	2	3	8	7	6	9	3

12.2.6 Fisheries and Aquatic Habitat

Each of the new reservoir sites (Projects P-A through P-D and P-I) contains fishery resources. The Waterman Gap reservoir site (Project P-A) supports steelhead trout. The Kings Creek reservoir site (Project P-B) supports resident rainbow trout. Steelhead and coho salmon habitat exists downstream of both sites. Fishery releases from these reservoirs have the potential to enhance downstream steelhead and coho salmon habitat. Because the Waterman Gap Reservoir Project would inundate steelhead trout habitat, which is considered more valuable than the rainbow trout habitat, it was rated lower than the Kings Creek Reservoir Project. The Department of Fish and Game has stated that mitigation of impacts for a new reservoir would be considered along with the impacts on fisheries due to existing diversions. According to the Department of Fish and Game, bypass flows at the City's existing San Lorenzo River diversions at Tait Street and at Felton would be subject to re-evaluation as part of Project P-A or P-B. Bypass flows would also be required for a new reservoir. In addition, an IFIM and lagoon water quality analysis that relates streamflow to freshwater conversion and lagoon size will be required during the CEQA review phase if either of the new reservoir sites are selected. Projects P-A and P-B were ranked relatively high because of the good opportunity for mitigation.

Both branches of Liddell Creek (Project P-C) support steelhead populations. Yellow Bank Creek (Projects P-D and P-I) presumably had a steelhead population prior to construction of downstream agricultural dams near the coast. Presently a resident trout population survives in Yellow Bank Creek.

Both Projects P-C and P-D would divert water from Scott Creek to the reservoir during the rainy season. Aquatic resources in the Scott Creek watershed include tidewater goby, red-legged frog, steelhead trout, and coho salmon. The Department of Fish and Game has stated that they would oppose a surface diversion from Scott Creek because it would present a barrier to fish migration and cause sedimentation upstream of the diversion. Minimum bypass flows would also need to be established for Scott Creek. An IFIM study would be required to identify instream flow release requirements during the CEQA review phase if this project is selected. The Department of Fish and Game performed IFIM work at Scott Creek during the 1992-1993 rainy season. A Scott Creek lagoon study analysis of how streamflow is related to sandbar passage and water quality will also be required.

Projects P-C, P-D, and P-I were ranked relatively low because they have the potential to impact coho salmon and tidewater goby in Scott Creek. Reservoir releases would need to be made to enhance fishery habitat on Yellow Bank Creek or Liddell Creek. However, the potential for negative impacts to the Scott Creek fishery was judged to outweigh the enhancement opportunities at Yellow Bank and Liddell Creek, so these projects were rated lower than the San Lorenzo River Reservoir Projects.

Existing steelhead habitat below Loch Lomond (P-E, P-F, P-G) is in poor condition due to the presence of Newell Creek Dam. Based on preliminary estimates of instream flow releases for Newell Creek, higher instream flow releases may be required to enhance fishery habitat. Due to the limited yield from projects, no increase in instream flows was assumed for these projects. The Department of Fish and Game has indicated that offsite mitigation could be an alternative to higher flow releases since there is limited habitat on Newell Creek. However, offsite mitigation would most likely involve re-evaluation of instream flow releases at the City's existing San Lorenzo River diversions at Tait Street and at Felton and increased bypass flows at these locations.

These projects also include brackish water wells with reverse osmosis. There is a very limited potential to impact aquatic resources in Monterey Bay due to the effects of brine disposal. The discharge of brine into the Monterey Bay National Marine Sanctuary will require review of permit conditions by NOAA. Any disposal options will need to be coordinated with the NOAA and the Regional Board.

Projects P-E, P-F, and P-G were given the lowest scores because they do not provide bypass flows past the Tait Street Diversion for protection and maintenance of lagoon habitat. These bypass flows would likely negate any additional storage capacity from the projects.

Project P-H includes groundwater wells at Thurber Lane and brackish groundwater wells with reverse osmosis treatment. The Thurber Lane wells would not impact aquatic resources. The brackish groundwater wells have a very limited potential to impact fishery resources in Monterey Bay. Therefore this project was rated more highly than any of the reservoir projects.

Project scores for the Fisheries and Aquatic Resources issue are:

P-A	P-B	P-C	P-D	P-E	P-F	P-G	P-H	P-I
4	5	2	2	1	1	1	9	2

12.2.7 Threatened and Endangered Species

The California Natural Diversity Data Base was reviewed to identify sensitive species/biotic community information. In addition to the site reconnaissance, floodplain maps and aerial photographs were used to identify additional biological issues of concern. Once a project is selected, an intensive survey for potential rare, threatened, or endangered species will need to be conducted for any of the project sites with the possible exception of Thurber Lane, a disturbed urban site.

All of the new reservoir sites were scored lower (Projects P-A through P-D and P-I) because of the higher likelihood of encountering sensitive species due to the amount of habitat which would be inundated.

Projects which include enlargement of Loch Lomond (Projects P-E through P-G) would impact a small amount of riparian habitat on Newell Creek. Because the amount of habitat which would be impacted is significantly less at Loch Lomond than for the new reservoir projects, Projects P-E through P-G were rated higher.

Project P-H, which includes brackish groundwater wells with reverse osmosis treatment and Thurber Lane groundwater wells was rated the highest because of the small amount of habitat affected by this project. Additionally, there would be some flexibility in siting the brackish groundwater wells and the reverse osmosis treatment plant to avoid sensitive areas.

The projects were scored as follows for the Threatened and Endangered Species issue:

P-A	P-B	P-C	P-D	P-E	P-F	P-G	P-H	P-I
3	3	3	3	6	6	6	9	3

12.3 Cost Criterion

The cost criterion allows a quantitative comparison of projects based on their estimated costs. Feasibility-level cost estimates have been developed for each of the projects. Cost considerations include both capital costs and operational costs for the projects. The following key issues were identified for the cost evaluation:

- Capital Cost
- Operating Cost
- Unit Cost
- Life Cycle Cost

Project scores are summarized in Table 12-2. Because life cycle costs and unit costs are different ways of measuring the combined effects of project capital and operating costs, the capital cost and operating cost issues were given a higher weight and life cycle cost and unit cost issues were given a low relative weight.

A summary of project costs for each of the potential projects is presented in Table 12-3. Detailed cost estimates are provided in Appendix A.

12.3.1 Capital Cost

Capital costs have been developed for all of the facilities required for each of the projects, including dams and reservoirs, pipelines, pump stations, and water treatment plants. Capital cost estimates are based on July 1993 costs, using an Engineering News Record index of 6,400 for the San Francisco Bay Area. Construction costs include base costs with the following multipliers, all taken as a percentage of the base costs:

- Contingencies: 30 percent
- Engineering: 20 percent
- Legal and Administration: 5 percent
- Environmental Mitigation and Monitoring: 5 percent

Costs for the CEQA review process were also estimated for each project. Projects were scored based on their total capital costs.

The project scores for the Capital Cost issue are:

P-A	P-B	P-C	P-D	P-E	P-F	P-G	P-H	P-I
4	4	1	3	7	8	8	7	3

12.3.2 Operating Costs

Operating costs were developed for each of the projects for power, labor, and chemical costs. The costs are uniform annual costs based on a 50 year project life and escalation for inflation at 4 percent per year. Costs assume that normal conditions would occur in 9 out of 10 years and drought conditions would occur in 1 out of 10 years. Although projects would not be operated during normal years, some operating costs would still be incurred. Operating costs in normal

Table 12-2

Cost Criterion

Santa Cruz Water Department - Water Supply Alternatives Study

Scoring (10 Point System)

10 = Excellent
5 = Average
1 = Poor
N/A = Not Applicable

Projects

Issues	Issue Weight	P-A : Waterman Gap Reservoir	P-B : Kings Creek Reservoir	P-C : Liddell Creek Reservoir & Scott Creek Diversion	P-D : Yellow Bank Creek Reservoir & Scott Creek Diversion	P-E : Loch Lomond 260 MG Enlargement & GW Wells W/RO WTP	P-F : Loch Lomond 500 MG Enlargement & GW Wells W/RO WTP	P-G : Loch Lomond 1010 MG Enlargement & GW Wells W/RO WTP	P-H : Brackish GW W/RO WTP Thurber Lane Groundwater	P-I : Reservoir W/Thurber Lane GW & WW Reclamation
Capital Cost	65	4	4	1	3	7	8	8	7	3
Operating Cost (Power, Labor, Chemical)	25	8	8	5	6	3	4	5	3	6
Unit Cost of Water	5	4	4	1	2	4	5	6	4	2
Life Cycle Costs (Present Worth)	5	4	4	1	2	4	5	6	4	2
Total Criterion Score	--	**5.0**	**5.0**	**2.0**	**3.65**	**5.7**	**6.7**	**7.05**	**5.7**	**3.65**

Note: The Total Criterion Score Equals the Sum of Issues Weights Times Issues Scores Divided by 100

Table 12-3
Summary of Project Costs

	Summary of Costs, in Millions of Dollars								
	P-A	P-B	P-C	P-D	P-E	P-F	P-G	P-H	P-I
Capital Cost, 1993 $	$54.0	$58.4	$117.3	$79.0	$38.3	$34.0	$30.4	$39.6	$73.5
Annual Costs (1)									
Bond Re-payment	$4.41	$4.77	$9.78	$6.68	$3.79	$3.33	$2.88	$3.64	$6.35
O&M - Power	$0.05	$0.05	$0.22	$0.14	$0.40	$0.31	$0.23	$0.41	$0.17
O&M - Chemicals	$0.00	$0.00	$0.00	$0.00	$0.03	$0.02	$0.01	$0.03	$0.01
O&M - Labor	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.02	$0.02
O&M - Total	$0.06	$0.06	$0.23	$0.15	$0.44	$0.34	$0.25	$0.46	$0.20
Total Annual Costs (Annual Bond Repayment + O&M	$4.47	$4.83	$10.01	$6.83	$4.23	$3.67	$3.13	$4.41	$6.55
Present Worth Bond Re-payment + O&M	$55.3	$59.6	$124.6	$85.0	$55.7	$48.3	$40.7	$58.1	$81.8
Unit Costs ($/MG) (2)									
Critical Drought Period (990 MG/yr)	$4,515	$4,879	$10,111	$6,902	$4,273	$3,707	$3,162	$4,455	$6,616
Mild Drought Period (590 MG/yr)	$7,576	$8,186	$16,966	$11,581	$7,169	$6,220	$5,305	$7,475	$11,102
Unit Costs ($/AF)									
Critical Drought Period	$1,471	$1,590	$3,295	$2,249	$1,392	$1,208	$1,030	$1,451	$2,156
Mild Drought Period	$2,469	$2,667	$5,528	$3,774	$2,336	$2,027	$1,729	$2,436	$3,617

(1) Annual costs based on 1993 capital costs, amortized at 8% bond rate and 1993 O&M costs, escalated at 4% inflation rate over 50 years
(2) Unit Costs = Total Annual Cost/Project Yield

years would include maintenance of facilities, standby power costs for pump stations and water treatment plants, and, for North Coast Reservoir Projects (Projects P-C, P-D, and P-I) pumping costs to replace water released for instream flows and evaporative losses.

The most significant project operations and maintenance cost is power costs for pump stations, groundwater wells, and water treatment plants. Projects which include reverse osmosis treatment have the highest power requirements. Therefore, these projects were rated the lowest for this issue. Projects P-E and P-H were rated the lowest because they include the largest reverse osmosis treatment facility.

The project scores for the Operating Costs issue are:

P-A	P-B	P-C	P-D	P-E	P-F	P-G	P-H	P-I
8	8	5	6	3	4	5	3	6

12.3.3 Unit Cost of Water

The unit cost of water provides a measure of the unit project costs of a project in dollars per million gallon or dollars per acre-foot. Unit costs were computed using the amortized construction costs and operation and maintenance costs divided by the project yield. Unit costs were computed for both the short-term critical drought and the longer-term milder drought periods. For the most part, project capital costs far outweigh operating and maintenance costs. For these projects, unit cost rankings are the same as capital cost rankings. For projects with higher power costs (Projects P-E, P-F, and P-H), project scores are lower to reflect higher operating and maintenance costs.

The project scores for the Unit Cost of Water issue are:

P-A	P-B	P-C	P-D	P-E	P-F	P-G	P-H	P-I
4	4	1	2	4	5	6	4	2

12.3.4 Life Cycle Cost

Life cycle costs are the sum of the bond repayment costs and operating and maintenance costs. Like unit cost of water, life cycle costs are another way of measuring the relative costs of bond repayment and operating and maintenance costs. Therefore, these projects were rated the same as for the unit cost issue.

The project scores for the Life Cycle Cost issue are:

P-A	P-B	P-C	P-D	P-E	P-F	P-G	P-H	P-I
4	4	1	2	4	5	6	4	2

12.4 Operations/Reliability Criterion

The Operations/Reliability criterion focuses on whether projects are able to provide a reliable source of supply, the flexibility in using a project, and the ease with which a project can be operated in conjunction with the City's existing supplies. Several issues relating to the Operations/Reliability criterion were identified in Workshop No. 1. The issues developed in Workshop No. 1 were consolidated into the following categories:

- Reliability
- Emergency Response
- Reservoir Siltation
- Operational Flexibility
- Ease of Operation

Each of these issues is briefly discussed and the projects are compared for each issue. Project ratings for each of the issues is presented in Table 12-4. In developing relative weights for the issues, the highest weights were assigned to Reliability, Operational Flexibility, and Efficiency of Operation.

12.4.1 Reliability

Project reliability is one of the basic requirements of any water supply, treatment, and/or distribution system. Reliability is a measure of the ability of the system to meet its objective of having the required supply available in the event of a drought or emergency. In addition, the transmission, pumping, and treatment facilities must be available to convey and treat the water when it is needed, either during a drought or emergency. A gravity system is preferable to one requiring major pumping. However, the reliability of the transmission facilities can be improved much more easily than the supply itself. As such, the primary emphasis of the reliability evaluation is supply.

All of the supply projects have been sized to meet the estimated supply shortfall. However, some of these projects may have more reliable supplies than others. The reservoir projects are subject to the uncertainties associated with variations in runoff, and the length of time necessary to fill these reservoirs. In addition, there is uncertainty associated with the fisheries requirements. The groundwater projects will have a higher level of reliability, as they are not as dependent on climatic conditions. Even if a well or the treatment facilities were to fail, they could be replaced in a reasonably short period of time. However, if reservoir storage is not full, it cannot be replenished during the drought.

All of the new reservoir projects would take a long time to initially fill and to re-fill after a drought period. These projects were sized for the long-term mild drought condition and would be empty at the end of such a drought. For the North Coast projects, supplemental water could be withdrawn from Scott Creek to fill the reservoir to compensate for the long fill times. This would require additional wells at Scott Creek and a larger diameter pipeline. Because of this opportunity, these projects were rated as average. For the Upper San Lorenzo River Projects, no supplemental source of supply would be available. The reliability of each of these projects could be severely constrained for several years after such a drought event. Therefore, these projects were scored lower than all of the other projects.

Table 12-4

Operations/Reliability Criterion

Santa Cruz Water Department - Water Supply Alternatives Study

Scoring (10 Point System)

10 = Excellent
5 = Average
1 = Poor
N/A = Not Applicable

Projects

Issues	Issue Weight	P-A : Waterman Gap Reservoir	P-B : Kings Creek Reservoir	P-C : Liddell Creek Reservoir & Scott Creek Diversion	P-D : Yellow Bank Creek Reservoir & Scott Creek Diversion	P-E : Loch Lomond 260 MG Enlargement & GW Wells W/RO WTP	P-F : Loch Lomond 500 MG Enlargement & GW Wells W/RO WTP	P-G : Loch Lomond 1010 MG Enlargement & GW Wells W/RO WTP	P-H : Brackish GW W/RO WTP Thurber Lane Groundwater	P-I : Reservoir W/Thurber Lane GW & WW Reclamation
Reliability	45	3	1	4	5	6	5	5	7	6
Emergency Response	5	6	6	6	6	8	8	8	8	8
Reservoir Siltation	5	5	5	7	8	5	5	5	10	8
Operational Flexibility	25	4	4	3	3	8	6	6	8	6
Ease of Operation	20	8	8	6	6	5	5	5	3	2
Total Criterion Score	**--**	**4.5**	**3.6**	**4.4**	**4.9**	**6.35**	**5.4**	**5.4**	**6.65**	**5.4**

Note: The Total Criterion Score Equals the Sum of Issues Weights Times Issues Scores Divided by 100

Several of the new projects rely on the use of existing pipelines to convey water to the Graham Hill WTP. The San Lorenzo River projects (Projects P-A and P-B) would make use of the existing Newell Creek pipeline. The North Coast reservoir and groundwater projects (Projects P-C through P-I) would make use of the existing Coast pipeline. All of these projects would be susceptible to outages of these conveyance facilities. The projects which have a parallel pipeline to the Coast pipeline (P-C, P-D, P-E, and P-H) would have better reliability since the new pipeline would be a partially redundant facility to the existing pipeline. Projects which rely on existing facilities were rated as average. Projects which have new parallel pipelines were rated slightly above average.

The project scores for the Reliability issue are:

P-A	P-B	P-C	P-D	P-E	P-F	P-G	P-H	P-I
3	1	4	5	6	5	5	7	6

12.4.2 Emergency Response

Emergency response is the ability of the different project supplies to be made available on an emergency basis and their ability to be connected quickly into the system as part of that response.

Depending upon the timing of the emergency event, supplemental supply projects may or may not be able to be easily integrated into the system. For any of the North Coast alternatives, an issue in using the supply would be the availability of capacity in the Coast pipeline. For the upper San Lorenzo River alternatives, timing would also be an issue for the use of Felton Diversion and the Newell Creek supply system to be able to pick up the water from the San Lorenzo River. However, pipeline capacity is more likely to be limited during rainy season months when demands are low and the City can typically meet demands with existing sources of supply. There is more likely to be available pipeline capacity in summer months, when production from existing surface water sources of supply is limited.

Any projects which include brackish groundwater and reverse osmosis may require a short time to get the facility ready for operation. Since the reverse osmosis treatment plant would normally be a drought-year, summertime supply, the plant could be "mothballed" during periods of non-use to preserve and prolong the life of the equipment. Readying the facility to bring it on-line could take one to two days of preparation. Projects with brackish groundwater and reverse osmosis also include Loch Lomond additional storage or Thurber Lane groundwater wells, which could be readily integrated into the existing system. Therefore, these projects would have more flexibility overall in providing supply during an emergency.

Emergency Response issue scores are:

P-A	P-B	P-C	P-D	P-E	P-F	P-G	P-H	P-I
6	6	6	6	8	8	8	8	8

12.4.3 Reservoir Siltation

The deposition of sediment in reservoirs and in stream channels can reduce the effective storage of a reservoir and the conveyance capacity of the stream channel. In addition, sedimentation in the stream channel could adversely impact fisheries by reducing the amount of available fishery habitat for spawning and rearing.

An evaluation of each watershed was made to assess potential erosion and sediment yield. Data were gathered on the geology, soils, climate, runoff, topography, ground cover, land use, upland erosion, channel erosion, and sediment transport for each of the basins. Information was gathered from personal interviews, hydrologic records, photographs, maps, and various reports. Based upon the available information, a relative scale was used to rate erosion and sediment yield conditions for each basin.

The small basins have the lowest sediment yields due to the limited watershed and insufficient runoff to transport substantial amounts of material. Yellow Bank Creek has the smallest erosion potential of all of the basins. Liddell Creek has a higher sediment yield, due to the active quarry in the upper reaches of the basin. The quarry does manage sediment reduction through the use of detention basins.

Newell Creek, Kings Creek, and the San Lorenzo River have sufficient runoff to transport sediment and have a larger source of sediment. Newell Creek sediment yield may be slightly greater, because the watershed is the largest of the three basins and there is active upland erosion in the form of gullies on some of the steeper ridges. However, none of the basins appear to be subject to excessive erosion. Potential mitigation for erosion control could include revegetation, installing erosion preventing devices, river training works and debris dams.

Project scores for the Reservoir Siltation issue are:

P-A	P-B	P-C	P-D	P-E	P-F	P-G	P-H	P-I
5	5	7	8	5	5	5	10	8

12.4.4 Operational Flexibility

The flexibility of a project is dependent upon its ability to use multiple sources of water supply and/or to provide emergency service to different customers.

Any of the projects which have multiple supply components would be more flexible since each of the sources of supply could be operated individually or in conjunction with each other. Conversely, any of the new stand alone reservoir projects (Projects P-A through P-D) would have the least flexibility. The Upper San Lorenzo River projects (Projects P-A and P-B) were rated slightly higher than the North Coast projects (Projects P-C and P-D) because water released from the reservoirs could be taken either at Felton Diversion or at the San Lorenzo River Diversion at Tait Street.

All of the projects with brackish groundwater wells (Projects P-E through P-H) were rated more highly than reservoir projects because they could also provide supplies during non-drought years. Projects with a parallel Coast pipeline were ranked the highest..

Projects were scored as follows for Operational Flexibility:

P-A	P-B	P-C	P-D	P-E	P-F	P-G	P-H	P-I
4	4	3	3	8	6	6	8	6

12.4.5 Ease of Operation

The ease of operation of a project can be measured both by the operational complexity of a particular project or facility and by the ease with which the facility can be operated in conjunction with other supplies.

In comparing the operational ease of the projects, Projects P-E through P-G, which include a reverse osmosis treatment plant would be more operationally complex than the new reservoir projects. Both types of facilities could be operated remotely. However, a reverse osmosis facility would require daily on-site checks, as well as additional time for data collection, analysis, and reporting. Normally, start-up of the facility would also require on-site personnel for equipment monitoring. It is estimated that projects including a reverse osmosis facility would require the addition of one permanent operating staff position. Project P-H, which includes both a reverse osmosis treatment plant and an iron and manganese treatment plant at Thurber Lane would be the most labor intensive of all of the projects due to the additional monitoring and on-site maintenance which would be required for both of the new treatment facilities.

In considering the operation of projects in conjunction with other facilities, the North Coast projects would be more operationally complex, due to the use of the Coast pipeline, which will also be conveying flows from the existing Coast supplies and the San Lorenzo River at Tait Street. Project P-I would also be more complex to operate because there are three different sources of new supply which would have to be integrated into the system.

Projects which would be the easiest to operate would be the San Lorenzo River reservoir projects (Projects P-A and P-B), which would not require operation of any new pump stations or pipelines, and would make use of existing facilities to convey flow to Graham Hill WTP. However, the reservoir releases would have to be maintained and monitored.

Project rankings for Ease of Operation are:

P-A	P-B	P-C	P-D	P-E	P-F	P-G	P-H	P-I
8	8	6	6	5	5	5	3	2

12.5 Implementability Criterion

This criterion focuses on the ability of the City to implement a project and constraints which would significantly delay development of a project. The following key issues were included in the evaluation for this criterion:

- Permits/Land Use in the Coastal Zone
- Ability to Phase Project
- Local Plan Consistency
- Department of Health Services Operating Permits
- Project Schedule

Each of these issues is briefly discussed and the projects are compared for each issue. Project scores for each of the issues is presented in Table 12-5. Project Schedule and Ability to Phase Project issues were given the highest relative weights for this criterion.

12.5.1 Permits/Land Use in the Coastal Zone

Some of the projects will be located in the coastal zone and/or will have pipelines and pump stations located in the Coastal Zone. This issue provides a comparison and discussion of the potential impact of being in the Coastal Zone.

Projects in the North Coast area are in the Coastal Zone as defined in the Santa Cruz County Coastal Plan and would require a Coastal Development Permit. Santa Cruz County has a state-certified local coastal program which is administered by the County Planning Department. A development permit would be applied for once a project is well defined and the CEQA environmental review is complete.

The Local Coastal Program Land Use Plan was reviewed to identify policies which apply to water supply projects. Section 30236 of the Land Use Plan specifically addresses water supply development, stating that:

> "Channelization, dams, or other substantial alterations of rivers and streams shall incorporate the best mitigation measures feasible, and be limited to necessary water supply projects"

The Land Use Plan also stipulates that:

- The development of new major water supply projects be prohibited unless they are adequately conditioned to protect beneficial instream uses and riparian habitat (Section 1.7.2).

- New development be prohibited adjacent to marshes, streams, and bodies of water if such development would cause adverse impacts on water quality which cannot be mitigated or will not be fully mitigated by the project proponent (Section 1.10.1).

- The placement of sewer or water lines, other than for agricultural use, be prohibited on prime agricultural lands in the Coastal Zone (Section 2.5.2).

Table 12-5

Implementability Criterion

Santa Cruz Water Department - Water Supply Alternatives Study

Scoring (10 Point System)

10 = Excellent
5 = Average
1 = Poor
N/A = Not Applicable

Projects

Issues	Issue Weight	P-A : Waterman Gap Reservoir	P-B : Kings Creek Reservoir	P-C : Liddell Creek Reservoir & Scott Creek Diversion	P-D : Yellow Bank Creek Reservoir & Scott Creek Diversion	P-E : Loch Lomond 260 MG Enlargement & GW Wells W/RO WTP	P-F : Loch Lomond 500 MG Enlargement & GW Wells W/RO WTP	P-G : Loch Lomond 1010 MG Enlargement & GW Wells W/RO WTP	P-H : Brackish GW W/RO WTP Thurber Lane Groundwater	P-I : Reservoir W/Thurber Lane GW & WW Reclamation
Permits/Land Use in Coastal Zone	10	7	7	3	3	5	6	6	5	3
Local Plan Consistency	10	5	5	3	3	7	7	7	7	3
Operating Permits	10	6	6	7	7	8	8	8	8	5
Ability to Phase Project	30	1	1	1	1	8	9	9	8	7
Project Schedule	40	1	0	1	1	5	4	3	6	2
Total Criterion Score	--	**2.5**	**2.1**	**2.0**	**2.0**	**6.4**	**6.4**	**6.0**	**6.8**	**4.0**

Note: The Total Criterion Score Equals the Sum of Issues Weights Times Issues Scores Divided by 100

- New development be sited, designed, and landscaped so as to be visually compatible and integrated with the character of surrounding areas. (Section 6.2.2) Section 6.2 also designates both Highway 1 and Swanton Road (adjacent to Scott Creek) as scenic corridors.

Although the plan also addresses maintaining bay and coastal water quality, the plan specifically regulates wastewater discharges and does not address brine discharges.

The Upper San Lorenzo River projects (P-A and P-B) are the only projects which would not fall within the Coastal Zone jurisdiction. Therefore, they were given the highest scores of all projects.

The Scott Creek Diversion Project (Projects P-C, P-D, and P-I) would involve the use of wells to divert subsurface flows from Scott Creek during the rainy season to a reservoir located on either the East Branch of Liddell Creek or Yellow Bank Creek. The adjacent property is currently leased to Cal Poly as an agricultural station. The projects have the potential to impact the adjacent agricultural property on Scott Creek although this impact is not expected to be significant since project diversions would take place during rainy season months when agricultural water use is low. Project diversions would not be made during the summer months when agricultural crops would require irrigation.

Project diversions would also have to provide adequate mitigation to protect the fishery resources in Scott Creek.

Both of the dam site locations on Yellow Bank Creek and the East Branch of Liddell Creek are far enough up in the watershed so that they should not be visible from Highway 1 which is designated as a scenic corridor.

Projects P-E through P-H all involve brackish groundwater wells with a reverse osmosis treatment plant. The groundwater facilities, reverse osmosis water treatment plant, and pipelines would all need to be sited and constructed consistent with Coastal Zone policies. Several brine disposal options would be available for the reverse osmosis treatment plant. Brine disposal using the existing outfall would be the easiest to permit of the disposal options. If shallow beach wells were to be used, the injection wells may be more easily located near the mouth of Majors Creek than the mouth of Laguna Creek. The Laguna Creek beach area is designated in the Coastal Land Use Plan as having unique features (i.e. a seal rookery, dramatic rock forms, etc.). The Land Use Plan designates the Majors Creek beach area as being of interest but not having unique features. Projects P-E and P-H, which require a parallel Coast pipeline, would likely have more impacts to sensitive environmental features which would require additional mitigation measures for these projects. Because there are several brine disposal options available, these projects were rated as average or slightly above average. Projects which include a parallel Coast pipeline (Projects P-E and P-H) were rated slightly lower than projects which do not have a parallel Coast pipeline (Projects P-F and P-G).

Project elements for Project P-I include a smaller reservoir at the Yellow Bank Creek reservoir site, groundwater wells at Thurber Lane, and wastewater reclamation. Project P-I received the same rating as the Yellow Bank Reservoir and Scott Creek Diversion Project (Project P-D) because the construction of a reservoir and Scott Creek diversion would require permits for construction in the Coastal Zone.

Project scores for Permits/Land Use in the Coastal Zone are:

P-A	P-B	P-C	P-D	P-E	P-F	P-G	P-H	P-I
7	7	3	3	5	6	6	5	3

12.5.2 Local Plan Consistency

The CEQA Guidelines indicate that a project will normally have a significant land use impact if it would conflict with adopted land use plans and zoning ordinances of the community where the project is located. A significant impact is identified when proposed changes in type or intensity of land uses are not compatible with existing or approved land uses on or adjacent to the project site. Of particular concern are situations which could result where sensitive land uses (i.e., schools, child care facilities, senior housing developments, etc.) could be adversely affected. A significant impact is also identified where the project would contribute to cumulative land use changes which would result in substantial changes to the land use pattern in the vicinity. Additionally, a significant impact could be identified if the project converts prime agricultural land to non-agricultural uses; impairs the productivity of prime agricultural land; or contributes to significant cumulative losses of prime agricultural lands.

Existing land uses and zoning maps were reviewed for each of the projects to identify significant land use impacts. In addition, Important Farmland Maps were reviewed to determine the status of agricultural lands along the coast and in the proposed reservoir locations. Finally, the Santa Cruz General Plan was reviewed to determine project conformance.

The Santa Cruz General Plan is the policy document for the County and provides guidance for development of projects within the County's jurisdiction. All projects will be located within County jurisdiction and will be reviewed for conformance with the General Plan. The General Plan has specific policies relating to watersheds. The Scott Creek and Big Creek watersheds above their confluence and the Wilder Creek and Majors Creek arroyos are considered "Least Disturbed Watersheds." The San Lorenzo River watershed is considered by the County a "Critical Water Supply Stream." Liddell Creek, Majors Creek, Newell Creek, and the San Lorenzo River are designated by the County as Water Supply Watersheds. None of the alternative reservoirs appear on the list of Proposed Water Supply Reservoirs presented in the General Plan.

The General Plan's objectives for watersheds is:

- To protect and manage the watersheds of existing and future surface water supplies to preserve the quality and quantity of water produced and stored in these areas to meet the needs of County residents, local industry, agriculture and the natural environment (2.1.1).

- To restore, manage, and protect the partially urbanized water-supply watershed of the San Lorenzo River to maximize the quality and quantity of water produced from and stored in that watershed (2.1.2).

- To protect the Least Disturbed Watershed areas that support the remaining clear running streams to preserve their water supply, recreation, and wildlife support values (2.1.3).

- To protect and restore surface water quality and stream flow for water supply, recreation, wildlife, aesthetic values and maintenance of aquatic ecosystems (2.1.4).

The County has developed the following applicable programs with respect to watersheds:

- Monitor existing and proposed, public and private, stream diversions and applications for water rights. Work with water users to minimize existing impacts where possible and to protect adequate instream flows based on the following considerations.

  (a) Normal summer and fall streamflows should be preserved and enhanced where feasible;
  (b) Adequate winter and spring baseflows should be preserved for fish migration and spawning;
  (c) Storm flows should be maintained at adequate levels for sediment transport to preserve and enhance downstream habitat, and to maintain county beaches.

  Protest water right applications inconsistent with policies for streamflow protection. Responsibility: Watershed Management Section, Board of Supervisors (2.1.104).

- Require annual review, in connection with the review of the General Plan of designated reservoir sites to eliminate sites not currently proposed for actual reservoir use in the future; and an annual review of Water Supply Watersheds for proposed additions and deletions. Responsibility: Planning Department, Planning Commission, Water Purveyors, Board of Supervisors (2.1.110).

The County has also developed policies to protect the quality and quantity of groundwater, protection of commercial agriculture, timber, and the protection of Monterey Bay and coastal water quality and fish and wildlife habitat.

The County has specific objectives for the provision of adequate quantities of high quality domestic water and to ensure that the level of population is supportable within the limits of the County's finite natural resources allowing the County to maintain environmental quality (7.1.1, 7.1.2). Policies include encouraging water conservation, water recycling, and use of water saving devices. The County has also developed programs for the provision and protection of domestic water. Applicable programs are identified below:

- Initiate water system improvement programs for distribution and storage facilities to adequately supply domestic water and necessary fire suppression demands (7.1.104).

- Establish management programs to ensure the availability of an adequate quantity and quality of domestic water supplies for urban and suburban areas (7.1.105).

All of the projects are in basic conformance with County policies. Care will need to be taken to protect the County's natural resources through appropriate mitigation measures.

The Upper San Lorenzo River reservoir projects (Projects P-A and P-B) would be located in an area that is zoned for Timber Production, Special Use, Park and Recreation, and Rural Agricultural. Small residential communities are located close to both of the reservoir sites. Construction of the reservoirs in this area will involve relocation of property owners and the Waterman Gap Reservoir (Project P-A) will require relocation of a portion of Highway 9. The Waterman Gap Reservoir also has the potential to affect State Park property as it will be located near Castle Rock State Park. Although these projects would involve some disruption to adjacent land uses, they were rated as average for General Plan consistency.

The North Coast reservoir projects (Projects P-C, P-D, and P-I) would be located in remote valleys accessible only through private roads. These areas are primarily surrounded by open space with few individual homes. The potential reservoir areas and surrounding land uses are zoned Commercial Agriculture, Timber Production, and Special Use. The Scott Creek diversion facilities would be located on land leased to Cal Poly for use as an agricultural experiment station, which is zoned as Agricultural. Construction of facilities could impact some adjacent lands. The coastal pipeline (Projects P-C, P-D, P-E, and P-H) is expected to be contained in an existing right-of-way and would not disturb or disrupt agricultural operations along the coast. Although these projects are consistent with the General Plan, they have more facilities which have the potential to impact adjacent land uses. Therefore, they were rated lower than the Upper San Lorenzo River reservoir sites.

Projects P-E through P-G include brackish groundwater wells with reverse osmosis treatment and enlargement of Loch Lomond. The groundwater wells and reverse osmosis plant would be located along the coast in the Majors Creek area. These facilities could possibly affect agricultural lands in the Majors Creek area. The California coast has a substantial amount of land on both sides of Highway 1 that is considered Prime Farmland, Farmland of Statewide Significance, and Unique Farmland. The potential impact of these facilities is expected to be small due to the small amounts of acreage required. Loch Lomond is located in an area zoned for Timber Production and Special Use. The timber areas are located south, southeast, and southwest of the reservoir. Because this would be an expansion of an existing reservoir, this project element would be consistent with existing land use in the area. Therefore, these projects were rated as above average.

Project P-H includes brackish groundwater wells with reverse osmosis treatment and groundwater wells on Thurber Lane. Thurber Lane is a residential street located in the Live Oak area of Santa Cruz. The groundwater wells would be placed on City owned properties. The lower site at Thurber Lane has an existing pump station. The upper site is the former location of a hydropneumatic tank. Therefore, use of these properties would be consistent with current and past property use. Therefore, this project was rated the same as Projects P-E through P-G.

Project scores for Local Plan Consistency are:

P-A	P-B	P-C	P-D	P-E	P-F	P-G	P-H	P-I
5	5	3	3	7	7	7	7	3

12.5.3 Department of Health Services Operating Permits

All of the projects will require operating permits from the State of California Department of Health Services. The treated water quality from all of the projects will meet state and federal standards and be of similar quality. The Department of Health Services permit requirements are not expected to be significantly different. Any of the surface water projects (Projects P-A through P-D) may require additional monitoring and/or control due to the potential for exposure to contaminants and the potential for typical water quality issues associated with reservoir stored water (eg., seasonal tastes and odors, higher disinfection by-product levels, higher levels of iron and manganese). Projects in the Upper San Lorenzo River watershed would likely require more monitoring and/or control due to the number of residences located along the San Lorenzo River. Project P-I which includes both a new reservoir and use of reclaimed wastewater is assumed to have the most stringent reporting and monitoring requirements.

Project scores for the Department of Health Services Operating Permits issue are:

P-A	P-B	P-C	P-D	P-E	P-F	P-G	P-H	P-I
6	6	7	7	8	8	8	8	5

12.5.4 Ability to Phase Project

Some of the projects, especially those which have multiple supply elements, may provide additional flexibility to the City in allowing phasing of the various elements. This could have the advantage of allowing the funding for these projects to be spread over a longer period of time.

Projects which could be easily constructed in phases include Projects P-F (Loch Lomond 500 MG enlargement and brackish groundwater with reverse osmosis treatment) and P-G (Loch Lomond 1,010 MG enlargement and brackish groundwater with reverse osmosis treatment). These projects consist of two or more project components which could be constructed sequentially.

Projects P-E (Loch Lomond 260 MG enlargement and brackish groundwater with reverse osmosis treatment) and P-H (Thurber Lane groundwater wells and brackish groundwater with reverse osmosis treatment) also consist of two components and could also be easily phased. Although the yield from the Thurber Lane wells and the Loch Lomond 260 MG enlargement is a small portion of the total project yield, the brackish groundwater with reverse osmosis treatment component could also be constructed in phases. It would be possible to develop one of the two well fields and construct the reverse osmosis treatment plant at a smaller size with the potential to expand the treatment plant to its full capacity at a later date. Pipeline facilities which would be needed to tie into the existing supply transmission system would not be cost effective to phase. Therefore, the pipelines sized to meet the full project capacity would be installed as part of the initial project construction.

Project P-I (Smaller Reservoir , Thurber Lane Groundwater Wells, and Wastewater Reclamation) has three different supply elements which would lend the project to phasing. However, the reservoir component of the project would be a very expensive element, so phasing would not have as much advantage as it would in other projects which have multiple supply elements.

Projects P-A (Waterman Gap Reservoir), P-B (Kings Creek Reservoir), P-C (Scott Creek Diversion and Liddell Creek Reservoir) and P-D (Scott Creek Diversion and Yellow Bank Reservoir) could not be constructed in phases due to the significant complexity and expense of modifying the dam, once it has been completed to a smaller size. Also, road relocations and pipelines, both major components for these projects could not be constructed in phases.

The scores for Ability to Phase Project are:

P-A	P-B	P-C	P-D	P-E	P-F	P-G	P-H	P-I
1	1	1	1	8	9	9	8	7

12.5.5 Project Schedule

Project schedules were prepared for each of the potential projects. Project schedules were broken down into the following components:

- Feasibility Study/Preliminary Design
- CEQA Review
- Final Design
- Construction
- Project on-line

The project on-line item is included to allow for reservoir projects which would require filling before they would be fully operational. A summary of the project schedules is presented in Table 12-6.

Table 12-6
Project Schedule (Years)

	P-A	P-B	P-C	P-D	P-E	P-F	P-G	P-H	P-I
Feasibility/Preliminary Design	2	1.5	1.5	1.5	1	1	1	1	1.5
CEQA Review	3.5	3	3	3	2.5	2.5	2.5	2	3
Final Design	2	1.5	1.5	1.5	.5	.5	1	.5	1.5
Construction	2	2	2	2	1	1	2	1	2
Project On-Line(1)	11	18	12	8	1	2	3	0	5
Total	20.5	26	20	16	6	7	9.5	4.5	`13

(1)Reservoir projects include filling time based on average hydrology.

New reservoir projects will be the most time consuming to implement due to both the extensive time required for environmental review and the lengthy time required for design. All of the reservoir projects will come under the jurisdiction of the California Department of Water Resources, Division of Safety of Dams (DSOD). It is very important that DSOD be invited to participate in the early planning stages of a reservoir project, including such technical elements as spillway capacity, type and size of outlet facilities, dam type, slope inclination, and freeboard, since they will have strong views regarding certain design objectives that must be clearly understood and implemented by the design team. All of the reservoir projects would take years to fill once the projects are completed. Therefore, the full water supply would not be available at the end of the construction period.

Project P-A has the potential for the most scheduling problems due to the extensive involvement with Caltrans required for the re-location of Highway 9. Project P-A also has a very long average fill time of 11 years. Project P-B has a slightly shorter project schedule but requires an unreasonably long average time of 18 years to fill the reservoir. The two Upper San Lorenzo River projects also have the greatest potential for legal delays due to the number of property owners which would be displaced by the construction of the dam. Because of these potential scheduling impacts, both of these projects were rated poorly.

Schedules for Projects P-E through P-G all have similar construction times. However, projects would require the filling of additional storage once construction of Loch Lomond is completed. Therefore, the projects with a larger Loch Lomond component were rated lower. Project P-H was ranked the highest because it has the second lowest estimated project schedule and would be fully operational once project construction is completed.

Project scores for the Project Scheduling issue are:

P-A	P-B	P-C	P-D	P-E	P-F	P-G	P-H	P-I
1	0	1	1	5	4	3	6	2

12.6 Political/Institutional/Public Criterion

This criterion focuses on the political, institutional, and public issues which need to be addressed in implementing a project. In preparing the evaluation for this criterion, the focus was to identify specific concerns of regulatory agencies, local agencies, or individuals. Some of the issues included in this criterion, such as land acquisition, downstream flooding potential, and seismic design are technical or cost issues, which have been accounted for in developing project facilities and project cost estimates. They are also addressed here, however, because they are issues which could also create a public perception problem for a project. Potential community benefits were also identified in this analysis. Based on the issues identified in Workshop No. 1, the following issues were included in this evaluation:

- Impacts to Local Agencies
- Recreational Use/Public Access
- Downstream Flooding Potential/Safety
- Land Acquisition/Easements
- Permitting
- Seismic Design/Safety/Landslides
- Drinking Water Quality
- Interagency Agreements

Table 12-7

Political/Institutional/Public Criterion

Santa Cruz Water Department - Water Supply Alternatives Study

Scoring (10 Point System)

10 = Excellent
5 = Average
1 = Poor
N/A = Not Applicable

Projects

Issues	Issue Weight	P-A : Waterman Gap Reservoir	P-B : Kings Creek Reservoir	P-C : Liddell Creek Reservoir & Scott Creek Diversion	P-D : Yellow Bank Creek Reservoir & Scott Creek Diversion	P-E : Loch Lomond 260 MG Enlargement & GW Wells W/RO WTP	P-F : Loch Lomond 500 MG Enlargement & GW Wells W/RO WTP	P-G : Loch Lomond 1010 MG Enlargement & GW Wells W/RO WTP	P-H : Brackish GW W/RO WTP Thurber Lane Groundwater	P-I : Reservoir W/Thurber Lane GW & WW Reclamation
Impacts to Local Agencies/ Individuals	5	3	4	5	5	5	5	5	7	5
Recreation Use/Public Access	5	7	9	9	9	5	5	6	4	8
Safety/Downstream Flooding Potential	15	4	4	8	8	8	7	6	10	8
Land Acquisition/Easements	30	2	1	5	5	8	8	8	8	5
Permitting	20	2	3	4	4	6	6	5	7	4
Seismic Design/ Seismic Safety/Landslides	10	3	2	6	6	5	5	4	9	6
Drinking Water Quality	5	5	5	6	6	7	7	7	8	6
Interagency Agreements	5	5	5	5	5	5	5	5	5	8
Socioeconomic Impacts	5	2	4	8	8	5	6	7	5	8
Total Criterion Score	**--**	**3.0**	**3.05**	**5.75**	**5.75**	**6.65**	**6.55**	**6.2**	**7.65**	**5.85**

Note: The Total Criterion Score Equals the Sum of Issues Weights Times Issues Scores Divided by 100

- Socioeconomic Impacts

A summary of the project scores for this criterion is presented in Table 12-7. Land Acquisition and Permitting issues were assigned the highest relative weights for this criterion.

12.6.1 Impacts to Local Agencies

Several of the projects could impact local agencies. Potential impacts include: limiting or restricting land use; and creation of political/territorial acrimony. This issue compares projects and their potential impacts to other agencies. The potential impacts of the projects to local individuals are addressed under Land Acquisition and Construction Impacts.

The Waterman Gap Project (Project P-A) and Kings Creek Project (Project P-B) both have a potential to impact local agencies. Portions of the Waterman Gap and Kings Creek watersheds, at the reservoir sites, are owned by the San Lorenzo Valley Water District, which has stated its opposition to each of these projects. The San Lorenzo River watershed is also considered a fully appropriated stream by the State Water Resources Control Board. Water rights for these projects could be obtained by transferring water rights set aside for the Zayante Dam project. The Waterman Gap project would also require re-location of Highway 9 which would be very disruptive. Because of these issues, the San Lorenzo Valley Water District and others within the watershed can be expected to be vocal opponents of these projects. Therefore, these projects were rated lower for this issue.

The reservoir sites for the East Branch Liddell and Scott Creek Diversion Project (Project P-C) and the Yellow Bank Creek and Scott Creek Diversion Project (Project P-D) are in a more remote area and no impacts to local agencies were identified. Therefore, these projects were rated higher than the San Lorenzo River Projects.

All of the Loch Lomond enlargement and brackish groundwater wells with reverse osmosis treatment projects (Project P-E through P-G) have a smaller potential to impact local agencies. Like the projects in the upper San Lorenzo River watershed, the San Lorenzo Valley Water District has voiced its opposition to these projects. However, because the projects involve significantly smaller amounts of water and enlargement of an existing dam rather than construction of a new reservoir, these projects were rated higher than the Upper San Lorenzo River watershed projects.

Project P-H (brackish groundwater wells with reverse osmosis and Thurber Lane groundwater wells) received the highest rating. No agency impacts were identified for this project.

Project P-I (Smaller new reservoir with Thurber Lane groundwater wells and wastewater reclamation) would have similar impacts to the Scott Creek Diversion and Yellow Bank Creek Reservoir Project (Project P-D).

Project scores for the Impacts to Local Agencies issue are:

P-A	P-B	P-C	P-D	P-E	P-F	P-G	P-H	P-I
3	4	5	5	5	5	5	7	5

12.6.2 Recreational Use/Public Access

Varying potential levels of benefit for recreational use, including public access to boating, camping, fishing, and hiking are associated with each of the projects. This issue provides an assessment of those potential benefits.

All of the reservoir projects (Projects P-A through P-D and P-I) have the potential for recreational use including camping, fishing and/or hiking. The Waterman Gap Project (Project P-A) would negatively impact existing recreational opportunities, however, since it would inundate an existing State Department of Parks and Recreation trail through the reservoir area which connects Castle Rock State Park with Big Basin State Park.

Projects P-E through P-G (Enlargement of Loch Lomond and brackish groundwater wells with reverse osmosis) would not provide additional recreation/public access opportunities but would not negatively impact recreation opportunities at the existing reservoir. Project P-H (Brackish groundwater wells with reverse osmosis treatment and Thurber Lane groundwater wells) also would not provide additional recreation/public access.

Project scores for Recreational Use/Public Access are:

P-A	P-B	P-C	P-D	P-E	P-F	P-G	P-H	P-I
7	9	9	9	5	5	6	4	8

12.6.3 Downstream Flooding Potential/Safety

All of the projects will be required to meet all of the safety requirements established by the State, County, and the City. However, the new reservoir projects have the potential to impact larger numbers of people in the event of a dam failure. The projects will need to be designed to high seismic standards and the potential for dam failure would be small. However, this issue addresses both the potential population which could be affected in the event of a dam failure and the public perception of the relative safety of various projects.

A cursory study was performed in order to estimate the effects of downstream flooding from the four potential dam sites and the existing dam in terms of the potential for inundation of populated areas. Estimates of potential downstream inundation areas were made from U.S. Geological Survey 7.5 minute quadrangle maps. It was assumed that the effects of flooding could extend up to 10 miles downstream. Population densities were estimated based on the presence of communities or individual residences. From this, a rough comparison of the potential effects of flooding was made for the different dam sites. Topographic maps used for the study were last revised 25 years ago. Therefore, this study made no attempt to determine exact number of people or the value of property potentially affected by sudden dam failure. A detailed evaluation, which would include an evaluation of the Peak Maximum Flood, current population, expected growth rates in the area, and river topography considerations, would be required by The Division of Safety of Dams as part of the permitting of a new project.

The Waterman Gap and Kings Creek Reservoir projects (Projects P-A and P-B) have the highest potential to cause flooding impacts. The communities of Redwood Grove and Wildwood are located near the confluence of Kings Creek with the San Lorenzo River and would likely be inundated, along with portions of Highway 9. Dam failure could also potentially affect the communities of Boulder Creek and Ben Lomond.

The East Branch of Liddell Creek and Yellow Bank Creek Reservoir sites are located in sparsely populated areas. Failure of these dams could cause the inundation of Highway 1.

Loch Lomond is located approximately 1.5 miles upstream of the confluence of Newell Creek and the San Lorenzo River. Inundation studies have been performed for the existing dam which is situated upstream of a densely populated area. Because the reservoir is an existing facility, the potential impact for an enlargement of Loch Lomond was viewed as an incremental impact. The potential impacts of the different enlargement projects would be related to the amount of additional storage provided at the dam. The inundation maps for the existing Newell Creek Dam indicate that the communities of Ben Lomond, Glen Arbor, Brackney, Felton, and Santa Cruz could potentially be affected.

The potential projects were scored as follows for Downstream Flooding Potential/Safety:

P-A	P-B	P-C	P-D	P-E	P-F	P-G	P-H	P-I
4	4	8	8	8	7	6	10	8

12.6.4 Land Acquisition/Easements

As part of the Phase III evaluation, the Santa Cruz Water Department staff reviewed assessor's records for the Upper San Lorenzo River and North Coast reservoir areas to determine the number of property owners who would potentially be affected by the reservoir projects. The methodology included review of assessor's parcel maps to determine the specific parcels which would be affected by projects. Tax records were then used to determine whether parcels included improvements and the assessed value of the property. Estimates of the assessed value of property which would need to be purchased have been included in the project cost estimates. This issue addresses the disruption to property owners and potential difficulties in proceeding with a project which would displace a large number of property owners.

Each of the projects could require easements for pipelines, pump stations or treatment facilities. Temporary easements will be required for construction access and permanent easements for maintenance and access to facilities. Some of these easements may be more difficult to obtain than others, especially those where multiple property owners may be involved. Pipeline facilities in Caltrans rights-of-way will require an encroachment permit from Caltrans, which is addressed in the Permitting issue as part of the Political/Institutional/Public criterion.

Projects in the upper San Lorenzo River watershed have the potential to be the most disruptive and require a large number of property owner re-locations. The majority of land in the Waterman Gap reservoir site is owned by the San Lorenzo Valley Water District which has voiced its opposition to the project. It is anticipated that land acquisition could be time consuming and subject to delays. Twenty eight property owners were identified in the vicinity of the Kings Creek reservoir site. The time required to purchase all of these properties could significantly delay the project.

In addition to those property owners who are within the proposed reservoir areas, several local residents in the vicinity of the project could also be affected by these projects. Approximately 2.4 miles of new road would need to be constructed to replace portions of Highway 9 which would be inundated by the Waterman Gap reservoir. The Kings Creek project would inundate portions of Kings Creek Road which is used as an access point for residences further up in the Kings Creek watershed. Approximately 4.4 miles of existing private roads would need to be improved for this project. These private roads provide less direct access to the upper portion of the watershed. Therefore, the loss of either of these roads would require additional land acquisitions and would be an inconvenience for local residents. Because of the high potential for impacts to local individuals, both of these projects were rated very low.

The North Coast Diversion and Reservoir Projects (Projects P-C and P-D) are in more remote areas. One house is located in the Yellow Bank proposed reservoir area. No houses are believed to be in the Liddell Creek watershed in the proposed reservoir area. While the property inundated by the reservoirs would need to be purchased, the potential for disruption to existing residents is low. Both the projects have the potential to impact local property owners in the Scott Creek watershed, particularly adjacent property which is leased to Cal Poly and is operated as an agricultural experiment station. Access for proposed facilities to the Scott Creek area could likely be done by permanent easement agreements rather than purchase of the property.

The North Coast Reservoir Projects (Projects P-C and P-D) would also need easements for facilities located at Scott Creek, for pipelines to and from the reservoirs from the coast and potentially for portions of a new pipeline paralleling the Coast pipeline. The existing Coast pipeline right-of-way was reviewed between the Coast Diversions and the Coast Pump Station to determine whether there is adequate room for a new pipeline. Most of the pipeline right-of way is 10 feet, but in short reaches, the right-of-way drops to six feet. Although a 10-foot right-of-way is likely sufficient for permanent right-of-way, a wider temporary construction easement will be required. These projects require a significant amount of land acquisition and potentially have several easements at Scott Creek. However, because fewer property owners are involved and the projects are in a remote area, they were rated higher than the San Lorenzo River Reservoir Projects.

Projects which include brackish groundwater with reverse osmosis treatment (Projects P-E through P-H) would require land purchase for the treatment plant site. There would be some flexibility in siting a facility and the amount of land required is small. The City already owns the land at Loch Lomond and at Thurber Lane. Projects involving brackish groundwater wells with reverse osmosis treatment (Projects P-E through P-H) would also require easements for the wells, the pipelines from the well fields to the reverse osmosis water treatment plant, and the pipelines connecting to the Coast pipeline. Because the amount of land required for easements and purchase is small, compared with reservoir projects, these projects were rated highly.

Project P-I (Smaller Reservoir with Thurber Lane groundwater wells and Wastewater Reclamation) would also require land acquisition for the reservoir site. The Thurber Lane wells would be located on City-owned property and pipelines would be located within public streets so no easements would be required for this project element. Likewise, the construction of the wastewater distribution lines could likely be done within public streets, so the number of easements required should be minimized. This project would still require a number of easements and significant land acquisition and is rated the same as Projects P-C and P-D.

The potential projects were scored as follows for Land Acquisition/Easements:

P-A	P-B	P-C	P-D	P-E	P-F	P-G	P-H	P-I
2	1	5	5	8	8	8	8	5

12.6.5 Permitting

Projects were compared based on the number of permits required for each project and the complexity of the permitting process. A summary of permits/requirements for each of the projects is presented in Table 12-8.

New reservoir projects (Projects P-A through P-D and P-I) were deemed to be the most complex for permitting requirements, and, therefore, received the lowest ratings for permit requirements. The proposed reservoirs for the Upper San Lorenzo River area (Projects P-A and P-B) were rated slightly lower because of the relocation of Highway 9 and the inundation of Kings Creek Road.

Projects which include brackish groundwater with reverse osmosis treatment and enlargement of Loch Lomond (Projects P-E through P-G) were estimated to be average to above average for permitting. These projects would require a National Pollutant Discharge Elimination System (NPDES) permit from the Regional Board for brine disposal. However, since brine disposal is consistent with the Water Quality Control Plan for the Central Coast Basin, permitting is judged to be less complex than for reservoir projects, because these projects do not require as much land disturbance or have as much potential for adverse impacts as reservoir projects. The projects which include only a parapet wall raise at Loch Lomond (Projects P-E and P-F) were rated higher because permits for these projects would be less complex than for Project P-G which would involve raising the Newell Creek dam embankment.

Project P-H was scored highest because it is the only alternative that does not involve a reservoir and because the Thurber Lane groundwater wells should not involve a complex permitting effort.

Project scores for Permitting are:

P-A	P-B	P-C	P-D	P-E	P-F	P-G	P-H	P-I
2	3	4	4	6	6	5	7	4

12.6.6 Seismic Design/Safety/Landslides

Seismic design of the projects will be affected by the proximity to existing faults and/or landslides. These design considerations have been taken directly into account in cost estimating for the projects. Although all of the projects will meet all of the requirements of the Division of

Table 12-8
Potential Permit Requirements for Water Supply Projects

Permit Requirements	P-A	P-B	P-C	P-D	P-E	P-F	P-G	P-H	P-I
Permit to Appropriate Water/Statement of Water Diversion (State Water Resources Control Board)	X	X	X	X	X	X	X		X
Timber Harvesting Permit (State Dept. of Forestry)	X	X	X	X			X		X
Section 404 Permit (U.S. Army Corps.)	X	X	X	X					X
Instream Flow Release Requirements (State Dept. of Fish & Game)	X	X	X	X	Y	Y	Y		X
Approval of Plans/Dam (DWR, Division of Safety of Dams)	X	X	X	X	X	X	X		X
Streambed Alteration Agreement (State Dept. of Fish & Game)	X	X	X	X	Y	Y	X		X
"Take" Permit (State Dept. of Fish & Game)	Y	Y	Y	Y					Y
Environmental Impact Report (CEQA)	X	X	X	X	X	X	X	X	X
Encroachment Permit (Caltrans)	X		X	X	X	X	X	X	X
Conformance with Local Plans and Policies (County of Santa Cruz)	X	X	X	X	X	X	X	X	X
Conformance with Local Coastal Program			X	X	X	X	X	X	X
Coastal Development Permit (Santa Cruz County)			X	X	X	X	X	X	X
NPDES Permit (Regional Water Quality Control Board)					X	X	X	X	
Private Land Acquisition	X	X	X	X	X	X	X	X	X
County Building Permit	X	X	X	X	X	X	X	X	X
Encroachment Permit (Southern Pacific Railroad)					Y	Y	Y	Y	
Trenching Permit (CalOSHA)			X	X	X	X	X	X	X

X - Permit would be required
Y - There is the possibility that a permit would be required

Safety of Dams, there may be a public perception that the design for one project may not be as safe as another. This issue compares projects for this perception issue..

Landslides are common in the Waterman Gap area (Project P-A) and in the Kings Creek area (Project P-B). Much of the Kings Creek dam site is located near a large landslide. The landslide appears to be dormant but would require mitigation (included in the costs for this project) and could be perceived as a potential safety issue.

Landslides are also common at the East Branch Liddell Creek reservoir site (Project P-C) and at the Yellow Bank Creek reservoir site (Project P-D). In both cases, adjustments were made in the initially selected dam alignments to avoid landslides in the vicinity of the dam. Like the Upper San Lorenzo River projects, these projects could also be perceived as having potential safety problems due to landslides. However, due to the remoteness of these sites and the fact that these reservoir areas are virtually unpopulated, these projects were rated higher than the Upper San Lorenzo River Projects.

Projects P-E, P-F, and P-G all include enlargement of Loch Lomond. Landslides are common in the Loch Lomond area, particularly where the Zayante fault zone crosses the middle portion of the reservoir. Many of these landslides are dormant and few signs of activity were identified. Two landslides immediately upstream of Newell Creek Dam are active and would require repair. Repair of these landslides have been taken into account in developing cost estimates. From a public perception perspective, these projects were scored higher than the Upper San Lorenzo River projects but lower than the North Coast Reservoir projects.

Project P-H is the "no reservoir" project and does not include a new reservoir or an expansion of Loch Lomond. No significant safety issues were identified with a groundwater project; therefore, this project was rated highly.

Project P-I includes a smaller reservoir at the Yellow Bank Creek site. This project was scored the same as Project P-D.

The project scores for the Seismic Design/Seismic Safety/Landslides issue are:

P-A	P-B	P-C	P-D	P-E	P-F	P-G	P-H	P-I
3	2	6	6	5	5	4	9	6

12.6.7 Drinking Water Quality

All of the projects will be operated to meet federal and state drinking water quality standards. Water quality for the different projects is not expected to vary significantly.

All of the reservoir projects (Projects P-A through P-D and Project P-I) and the brackish groundwater wells with reverse osmosis treatment (Projects P-E through P-H) would be conveyed to the Graham Hill WTP for treatment. (This is necessary in the case of the brackish groundwater because it would be mixed with untreated surface water in the Coast pipeline). Although there will be slight differences in water quality from these different sources of supply, water quality from each of the sources will be similar. Groundwater would have a slightly higher quality than the surface water. In general, groundwater has lower levels of natural organic matter and taste and odor compounds. Although the brackish groundwater projects will also slightly raise the TDS level of the City's supply from 260 mg/l to 300 mg/l, increasing mineralization by this amount should not be noticeable. Therefore, these projects are rated slightly higher.

The projects in the Upper San Lorenzo River watershed are more susceptible to contamination because releases to meet demands would be conveyed in the San Lorenzo River channel. Therefore, these projects were scored slightly lower.

Projects P-H and P-I include groundwater wells at Thurber Lane (Projects P-H and P-I) which would be treated for iron and manganese removal and pumped directly into the treated water distribution system. The water quality of this source should be similar to the treated brackish groundwater.

Project P-I (smaller reservoir, groundwater wells at Thurber Lane, and reclaimed water supply) was rated the same as Project P-D since the reservoir is located at Yellow Bank Creek. Although this project also includes reclaimed water which would be served to Pasatiempo Golf Course and Oddfellow Cemetery, this would not be a potable water supply.

The project scores for Drinking Water Quality are:

P-A	P-B	P-C	P-D	P-E	P-F	P-G	P-H	P-I
5	5	6	6	7	7	7	8	6

12.6.8 Interagency Agreements

Most of the projects are independent water supply projects which would not require interagency agreements. Although the need for interagency agreements could affect the schedule for implementing a project, a project which requires the mutual cooperation of local agencies could be well perceived by the community.

The only project which has a supply element which uses the facilities of another agency is Project P-I, which includes a wastewater reclamation project, using the Scotts Valley Wastewater Treatment Plant effluent. This project could be perceived as a very positive one in the environmentally-oriented community of Santa Cruz, since it involves re-use of an existing resource.

No other projects would include interagency agreements. Therefore, they received an average score for this issue.

The project scores for Interagency Agreements are:

P-A	P-B	P-C	P-D	P-E	P-F	P-G	P-H	P-I
5	5	5	5	5	5	5	5	8

12.6.9 Socioeconomic Impacts

Socioeconomic impacts are a measure of the potential positive and negative economic impacts to the local community. Potential positive impacts would include providing jobs in the community. Potential negative impacts would include displacement of property owners, or other disruptions to a local community.

The Waterman Gap Reservoir Project (Project P-A) was rated the lowest of all of the projects due to the potential relocation of Highway 9. This would result in an impact on the community because it would require that private property be purchased for the reservoir and the new route for Highway 9. It would also result in changing the community access due to the relocation of the road. The Kings Creek Reservoir Project (Project P-B) was rated similarly because of the number of property owners who would be displaced by the reservoir. These negative impacts were judged to outweigh significantly any job benefits the projects would provide.

The North Coast Reservoir projects (Project P-C and P-D and P-I) were rated the highest because there is virtually no residential development in the area and the projects would provide a number of jobs.

Projects P-E, P-F, and P-G were rated average to slightly above average. There would not be as many job opportunities for these projects and there is some potential for disruption to the surrounding communities of Lompico and Majors. Project P-G was rated slightly higher than the other projects because the project would involve major construction at Newell Creek Dam and would provide more construction related jobs to the local community.

Project scores for the Socioeconomics issue are:

P-A	P-B	P-C	P-D	P-E	P-F	P-G	P-H	P-I
2	4	8	8	5	6	7	5	8

12.7 Summary of Potential Project Scores and Rankings

Based on the project ratings for each of the key issues, project scores were developed for each of the criteria. The key issues weightings were multiplied by the project scores to develop a raw score for each criterion. Raw scores were divided by 100 so they would be on a 1 to 10 scale. The table below summarizes the raw scores for each criterion:

Project Raw Scores for Each Criterion

	P-A	P-B	P-C	P-D	P-E	P-F	P-G	P-H	P-I
Environmental	3.2	4.15	2.9	3.1	3.95	3.85	3.6	8.05	3.0
Cost	5.0	5.0	2.0	3.65	5.7	6.7	7.05	5.7	3.65
Operations/Reliability	4.5	3.6	4.4	4.9	6.35	5.4	5.4	6.65	5.4
Implementability	2.5	2.1	2.0	2.0	6.4	6.4	6.0	6.8	4.0
Political/Institutional/Public	3.0	3.05	5.75	5.75	6.65	6.55	6.2	7.65	5.85

Project scores were developed for each criterion by taking the project raw scores (a possible 1 to 10), and multiplying by the criterion weight to develop a criterion score. For example, a project with a raw score of 5 for the environmental criterion would have a total score of 5 X 24 or 120 for the environmental criterion. A higher overall score indicates a better project. The total score a project could receive is 1000. A summary of project scores is presented below.

Project Weighted Scores

Criterion	Weight	P-A	P-B	P-C	P-D	P-E	P-F	P-G	P-H	P-I
Environmental	24	77	100	70	74	95	92	86	193	72
Cost	22	110	110	44	80	125	147	155	125	80
Operations/Reliability	19	86	68	84	93	121	103	103	126	103
Implementability	15	38	32	30	30	96	96	90	102	60
Political/Inst./Public	20	60	61	115	115	133	131	124	153	117
Total Score	100	371	371	343	392	570	569	558	699	432
Rankings	-	7	7	9	6	2	3	4	1	5

Project P-H, brackish groundwater with reverse osmosis treatment and Thurber Lane wells, was the best rated project overall. This is because the project compares favorably for reliability, has a lower potential for environmental impacts and is among the lowest cost alternatives. The most significant issue identified for this project is the issue of brine disposal. However, brine disposal is consistent with the Central Coast Water Quality Control Plan and several possible disposal options were identified.

Projects P-E through P-G which include brackish groundwater with reverse osmosis treatment and enlargement of Loch Lomond were rated highly, although they were ranked well below Project P-H. These projects were rated lower primarily because of concerns that these projects do not provide for maintenance of fishery habitat on the San Lorenzo River and have the potential to open negotiations of bypass flows at the City's existing diversions on the San Lorenzo River. In fact, depending on California Department of Fish and Game requirements, the yields from Loch Lomond could be reduced to the point of making the projects infeasible.

All of the stand-alone reservoir projects (Projects P-A through P-D) and the smaller Yellow Bank reservoir with Thurber Lane groundwater wells and reclaimed water rated below the other projects. This was due to a number of factors, including: their lower reliability due to lengthy construction and fill times; higher potential for environmental impacts, particularly to fishery resources; higher cost; and, greater potential for institutional and political impacts. In the Phase III evaluation, Project P-B, the Kings Creek Reservoir Project, was found to be fatally flawed based on an estimated reservoir filling time of 18 years. However, this project was included in the project comparison and ranking analysis for comparative purposes.

A sensitivity analysis was performed using the individual criteria weightings developed in Workshop No. 1. Each of the projects were scored using the individual weightings to see what impact individual scores had on the overall rankings. In all cases, Project P-H remained the highest ranked project. This is because Project P-H had the highest score in each category except cost. In the cost category, the project was ranked third overall. Individual scores are shown below:

Individual	P-A	P-B	P-C	P-D	P-E	P-F	P-G	P-H	P-I
1	373	372	327	380	565	565	555	696	423
2	365	358	349	393	578	568	554	701	441
3	386	370	351	407	588	580	572	686	450
4	389	385	357	417	579	581	575	689	445
5	349	352	326	366	566	563	546	708	421
6	361	358	349	392	574	565	550	706	438
7	365	384	318	372	544	560	549	707	374
8	379	373	336	390	571	565	556	694	432
9	366	377	331	381	552	555	543	708	416
10	371	362	332	385	587	591	580	686	437

Projects were compared using equal weightings for each of the criteria. Projects were also compared using equal weightings for each of the key issues identified for the criteria. In both cases, Project P-H remained the highest ranked project.

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Section 13
Conclusions and Discussion of Recommended Project

13.1 Study Conclusions

Based on the comparison and ranking of alternatives the following conclusions have been developed:

Project P-H, which consists of groundwater wells at Thurber Lane and brackish groundwater wells with reverse osmosis treatment, was the highest ranking project overall. The project has the highest ranking for the Environmental, Operations/Reliability, Implementability, and Political/Institutional/Public criteria. The project ranked third for the Cost criterion. The project was also the highest ranking project when criteria weighting factors developed by each individual on the Committee were used.

The results of the project evaluation and scoring were presented at a second workshop with the Technical Advisory Committee in September 1993, and the project results were adopted by the Committee. This project is recommended for preliminary design and environmental review.

13.2 Discussion of Recommended Project

Deep groundwater resources exist along the North Coast from Laguna Creek to the vicinity of Davenport. Water bearing formations exist between 600 and 2,000 feet below sea level and are identified in the Santa Margarita sandstone and possibly the Lompico sandstone, both within the Monterey formation. Field data indicate that the water is brackish, with a total dissolved solids (TDS) level ranging from 800 milligrams/liter (mg/l) to 5,000 mg/l. For this project, several deep wells would be installed, along with a brackish water reverse osmosis system to reduce the TDS of the raw water to drinking water levels.

Brackish water is typically classified as water with a total dissolved solids (TDS) level between 1,000 milligrams per liter (mg/l) and 5,000 mg/l. For comparison, Title 22 of the California Administrative Code has a secondary goal for TDS levels in drinking water of 500 mg/l. On the other extreme is seawater, which has a TDS level of 35,000 mg/l. The projects were sized using an assumed TDS level of 1,500 mg/l.

13.2.1 Project Facilities

The recommended project consists of several deep brackish groundwater wells in the North Coast area with reverse osmosis treatment facilities. The recommended project also includes two new groundwater wells located at Thurber Lane. The Thurber Lane wells would likely require iron and manganese treatment. The key project facilities for the recommended project are shown on Figure 13-1, and would include:

Thurber Lane Wells

- One 500-foot deep, 12-inch diameter well at lower Thurber Lane well site. Flow rate of 250 gpm.
- 1,500 feet of 8-inch diameter pipeline to upper Thurber Lane well site.

- One 500-foot deep, 12-inch diameter well at upper Thurber Lane site.
- One 500 gpm iron and manganese treatment plant at upper Thurber Lane site.
- 2,000 feet of 12-inch diameter pipeline to tie into water system.

Brackish Groundwater Wells with Reverse Osmosis Treatment Plant

- Four 1,500-foot deep wells, 16-inch diameter, with pumps for the well field south of Davenport. Total well field capacity of 2.9 MGD (2,000 GPM).
- 20,000 feet of 18-inch diameter pipeline from Davenport well field to the Majors area.
- Four 1,500-foot deep wells, 16-inch diameter, with pumps at Majors. Total well field capacity of 2.9 MGD (2,000 GPM).
- Reverse osmosis treatment plant consisting of:
  - 4.9 MGD treatment plant producing 3.9 MGD treated water and 1.0 MGD brine.
  - 0.9 MGD brackish water bypass.

  The 3.9 MGD treated water would be mixed with the 0.9 MGD brackish water bypass to produce a 4.8 MGD blended supply.
- New 320 HP booster pump station at the reverse osmosis treatment plant.
- 6,000 feet of new 22-inch diameter pipeline to tie into existing Coast pipeline at Majors Creek/Coast pipeline junction.
- Approximately 25,000 feet of 12-inch diameter pipeline from Majors Creek to the existing Bay Street Reservoir.
- Approximately 36,000 feet of 10-inch diameter brine disposal pipeline from the reverse osmosis treatment plant to the existing Santa Cruz Wastewater Treatment Plant outfall.
- 30 HP brine disposal pump station.
- Approximately 6,000 feet of 14-inch diameter pipeline from existing Coast Pump Station to Graham Hill WTP.

13.2.2 Project Sizing

The project was sized to meet a total shortfall of 990 MG/year, based on the critically dry short-term drought. Since no surface water storage is included with this project, the short-term critical drought shortfall of 990 MG/yr drives the project sizing, rather than the long-term extended drought shortfall of 590 MG/yr. The estimated yield from the brackish groundwater wells with reverse osmosis treatment is 870 MG/year. The estimated yield of the Thurber Lane wells is 120 MG/year. Facilities were sized assuming that a continuous, constant supply would be produced from the Thurber Lane wells and the reverse osmosis treatment plant during summer months of drought years and that the existing Loch Lomond supply would be used to meet short-term peak requirements during this period.

The brackish groundwater wells have an estimated sustained capacity of 1,000 gpm for each well field, or a total sustained capacity of 2,000 gpm for the two well fields. The well fields were sized for peak operation at 4,000 gpm, assuming operation during summer months of drought years only. No downtime allowance was included for the reverse osmosis project operation. The Thurber Lane wells were sized based on an estimated sustained capacity of 500 gpm, operating during summer months of drought years. A 10 percent downtime allowance was included in the operation of the Thurber Lane wells.

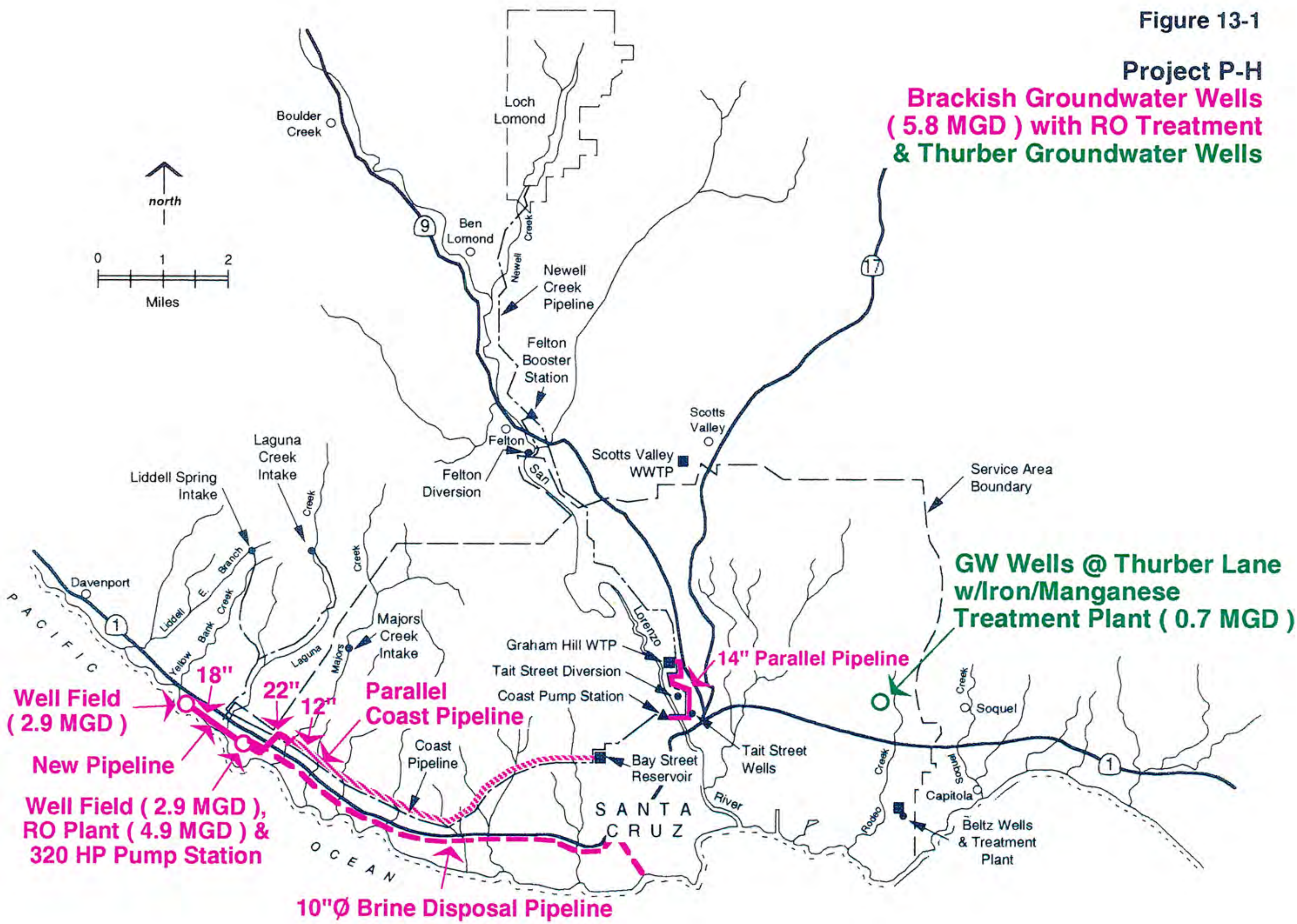


Figure 13-1
Project P-H
Brackish Groundwater Wells
(5.8 MGD) with RO Treatment
& Thurber Groundwater Wells
north
0 1 2
Miles
Boulder Creek
Loch Lomond
Ben Lomond
Newell Creek
Newell Creek Pipeline
Felton Booster Station
Felton
Felton Diversion
Scotts Valley
Scotts Valley WWTP
Service Area Boundary
Laguna Creek Intake
Liddell Spring Intake
Davenport
PACIFIC
OCEAN
Liddell
E. Branch
Bank Creek
Yellow
Laguna
Majors
Majors Creek Intake
San Lorenzo River
GW Wells @ Thurber Lane w/Iron/Manganese Treatment Plant (0.7 MGD)
Graham Hill WTP
Tait Street Diversion
Coast Pump Station
14" Parallel Pipeline
Well Field (2.9 MGD)
18"
22"
12"
Parallel Coast Pipeline
New Pipeline
Coast Pipeline
Bay Street Reservoir
Tait Street Wells
Well Field (2.9 MGD), RO Plant (4.9 MGD) & 320 HP Pump Station
SANTA CRUZ
10"Ø Brine Disposal Pipeline
Soquel
Soquel Creek
Rodeo Creek
Capitola
Beltz Wells & Treatment Plant
9
17
1

13.2.3 Project Estimated Cost

The construction cost estimate for this project is approximately $40 million in 1993 dollars. This includes an estimated $25 million in base construction costs, $7 million for contingencies, and $8 million for engineering, legal, administration, environmental documentation and environmental mitigation and monitoring. While the use of a 30 percent contingency on base costs is conservative, costs of some elements of the project, such as brine disposal and groundwater well construction, are less certain. A summary of project costs is shown in Table 13-1.

It may be possible to defer some of the capital costs until the project is needed. This could be done with equipment which can be ordered and installed quickly. For example, the membranes could be purchased only when they are needed rather than at the time of construction of the reverse osmosis treatment plant. Membranes account for approximately $700,000 of the $5.1 million estimated base construction cost of the reverse osmosis treatment plant. However, the City should probably complete the facilities as soon as possible, and then replace the membranes as needed.

The estimated present worth cost of the project, including capital, operating and maintenance costs is $58 million in 1993 dollars. The amortized capital cost was computed using an economic life of 25 years for pump stations, groundwater wells and treatment facilities, and 50 years for pipeline facilities. Operating and maintenance costs were estimated assuming operation of the facility once in every ten years, on average with replacement of reverse osmosis membranes during each operating period. Based on this operation, the breakdown of the $58 million is $48 million for amortization of capital facilities and $10 million for operating and maintenance costs, or about 17 percent of the total present worth cost. Operating the facility more frequently would affect the operating and maintenance cost proportionally. For example, operating the facility once in five years at the same production rate would raise the present worth cost to $20 million for operation and maintenance to $68 million overall.

13.2.4 Hydrogeologic Issues

The hydrogeologic aspects of this project were evaluated based on a review of published and unpublished data, including the logs of deep oil exploratory test holes, and a brief reconnaissance of the area. Two main hydrogeologic factors evaluated were a calculation of the estimated safe yield for both wells fields, and the potential effect that pumping might have on the base flow of streams in the area. Based on a cursory evaluation of known hydrogeologic conditions, the two dispersed wells fields should not exceed the average long-term annual recharge and would not reduce the base flow of the area's streams. Recharge areas and recharge amounts will need to be defined if this project is selected for further evaluation. A summary of the hydrogeologic evaluation is presented in Appendix A.

13.2.5 Reverse Osmosis Treatment

Brackish water with high total dissolved solids and other ionic constituents can be treated using several technologies such as thermal processes (multiple effect flash distillation, vapor compression), ion exchange, electrodialysis and reverse osmosis. Furthermore, within these

Table 13-1
Cost Summary for Recommended Project

Item Description	Quantity	Unit	Unit Cost ($/unit)	Total Cost ($)
Brackish Groundwater With Reverse Osmosis				
Davenport Area Wells	4	wells	$551,300	$2,205,200
Majors Area Wells	4	wells	$551,300	$2,205,200
Pipeline from Davenport Well Field to RO WTP	20,000	ft of 18"	$180	$3,600,000
Reverse Osmosis WTP-4.9 MGD	1	lump sum	$5,105,000	$5,105,000
Reverse Osmosis WTP Booster PS	320	HP	$2,338	$748,000
Pipeline from RO WTP to Coast PL at Majors Creek	6,000	ft of 22"	$220	$1,320,000
Pipeline from Majors Creek to Bay Street Reservoir	27,500	ft of 12"	$120	$3,300,000
Pipeline from Coast PS to Graham Hill WTP	6,000	ft - 14"	$140	$840,000
Brine Disposal Booster PS-20 HP	1	lump sum	$300,000	$300,000
Brine Disposal Pipeline	35,800	ft of 10"	$100	$3,580,000
Land Acquisition	0.5	ac	$5,000	$2,500
Subtotal				$23,205,900
Thurber Lane Groundwater Wells				
Thurber Lane Wells	2	wells	$298,500	$597,000
Iron and Manganese WTP-0.72 MGD	1	lump sum	$475,000	$475,000
Thurber Lane Pipeline (upper)	1,500	ft of 8"	$80	$120,000
Thurber Lane Pipeline (tie-in)	2,000	ft of 12"	$120	$240,000
Subtotal				$1,432,000
Subtotal*				$24,637,900
Contingencies (30%)				$7,391,370
Engineering (20%)				$4,927,580
Legal, Administration (5%)				$1,231,895
Environmental Mitigation/Monitoring (5%)				$1,231,895
Environmental Documentation				$150,000
TOTAL*				$39,570,640

* 1993$ -- ENR = 6400

broad categories there are many variations that relate to the operating parameters and resulting water quality. For this feasibility study, low pressure reverse osmosis was selected for the general comparison of alternatives because it has been used successfully in many facilities and has proven cost effective. As part of the preliminary design of any treatment facility, a more detailed comparison of alternatives should be prepared to determine technologies appropriate for this specific installation. In addition, alternative locations for the treatment facilities should be evaluated. A diagram of the treatment process is shown in Figure 13-2 to illustrate the features of a brackish water reverse osmosis treatment system. These elements are described below.

The brackish water wells supply the water directly to the reverse osmosis system at a pressure of approximately 50 pounds per square inch (psi). The reverse osmosis feed raw water is typically dosed with acid to reduce the pH and the calcium carbonate scaling potential. The treated feed water is then passed through a 5-10 micron cartridge filter to protect the membrane elements.

The feedwater pumps increase the pressure of the feedwater to 150 to 200 psi and the feedwater then flows to the stage 1 membranes. Approximately 50 to 60 percent of the flow passes through or permeates the membrane as low TDS water. The remaining water with the concentrated ions flows to the second stage membranes where again 50 to 60 percent of the flow permeates the membrane. The remaining concentrate, approximately 15 to 20 percent of the original flow is discharged as brine.

The very low TDS permeate is collected and blended with 20 to 30 percent raw water and passed through a decarbonator to achieve a less corrosive finished water. The finished water is dosed with sodium hydroxide to further reduce corrosion potential and dosed with disinfectant to provide a residual in the distribution system.

The project would feed water to Santa Cruz via the existing Coast Pipeline and a new pipeline parallel to the Coast pipeline. Water in the existing Coast Pipeline would be re-treated at Graham Hill WTP. Water in the new pipeline could be tied directly to the distribution system at Bay Street Reservoir.

The site layout for the reverse osmosis treatment plant can be varied depending on site constraints. The only requirement is to provide a space approximately 20 feet wide by 40 feet long for each reverse osmosis equipment skid (1.6 MGD). The project would require three equipment skids.

13.2.6 Brine Disposal Issues

Four disposal options were identified for disposal of brine generated at the reverse osmosis treatment plant. These options are: disposal of brine using the City's existing wastewater treatment plant outfall in downtown Santa Cruz; construction of a new outfall at the reverse osmosis treatment plant site; the use of beach injection wells near the treatment plant site; or the use of deep injection wells near the reverse osmosis treatment plant site. Each of these disposal options were discussed with the Regional Water Quality Control Board. The Regional Board would have jurisdiction over any disposal option which would involve a discharge to Monterey Bay. The use of deep injection wells would require a permit by the Environmental Protection Agency. The Regional Board's Central Coast Basin Plan has provisions for brine disposal. Brine disposal will require a National Pollutant Discharge Elimination System (NPDES) permit. With the designation of Monterey Bay as a national marine sanctuary, the National Oceanic and Atmospheric Association (NOAA) would also be involved in the permit process. NOAA has a memorandum of understanding with the Regional Board to review NPDES permits for discharges into the waters of the Sanctuary.

Disposal using the existing wastewater treatment plant outfall would likely be easier to permit than the other disposal options. It was used in the cost estimates as a conservative estimate for brine disposal. Disposal options will need to be reviewed in the preliminary design phase of the project.

13.2.7 Iron and Manganese Treatment for Thurber Lane Wells

In 1990, Luhdorff and Scalmanini installed and pump tested a test production well and monitoring well at Thurber Lane. Water quality data collected during pump testing of the test production well indicated that the levels of iron and manganese slightly exceed federal water quality standards. In this study, iron and manganese treatment was included with the Thurber Lane wells to provide water quality from this project consistent with other projects being evaluated. The need for and level of treatment should be evaluated as part of the preliminary design phase for the project.

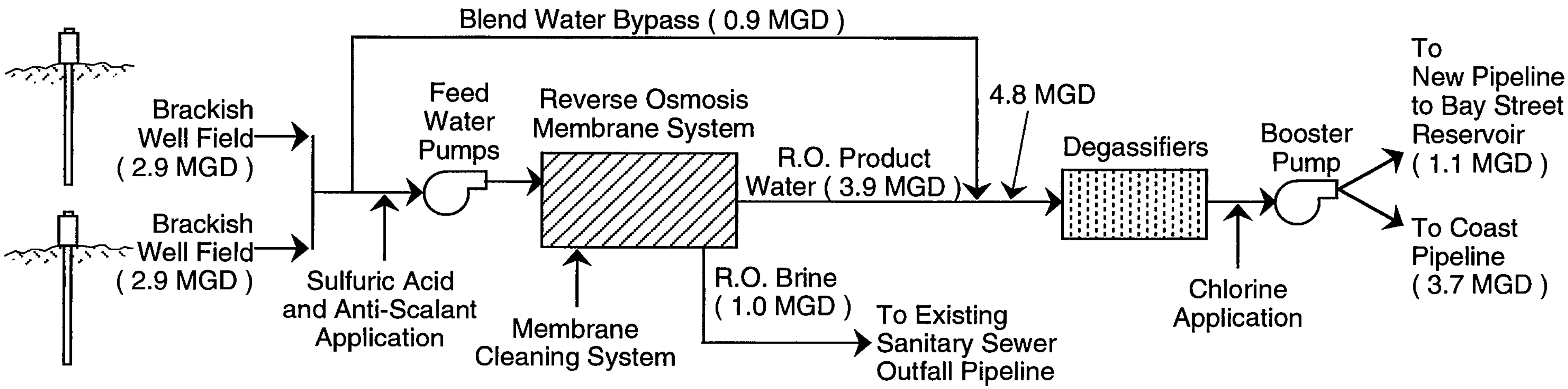
The basic conventional water treatment process of iron and manganese treatment is to convert soluble iron and manganese to an insoluble form which then precipitates. The resulting precipitant is then settled out or filtered so that the insoluble particles are not released to the distribution system. There are several methods to convert the soluble iron and manganese to the insoluble form for the conventional treatment process. In the most common systems, the iron and manganese are converted to insoluble form or oxidized using aeration or chemicals (i.e., chlorine, ozone or potassium permanganate). The precipitant is then removed by filtration. Different filter media may be used depending upon the oxidation process. Figure 13-2 shows a process diagram for a chlorination-filtration system. Different treatment options would need to be investigated as part of the preliminary design for the project.

13.3 Project Timeline

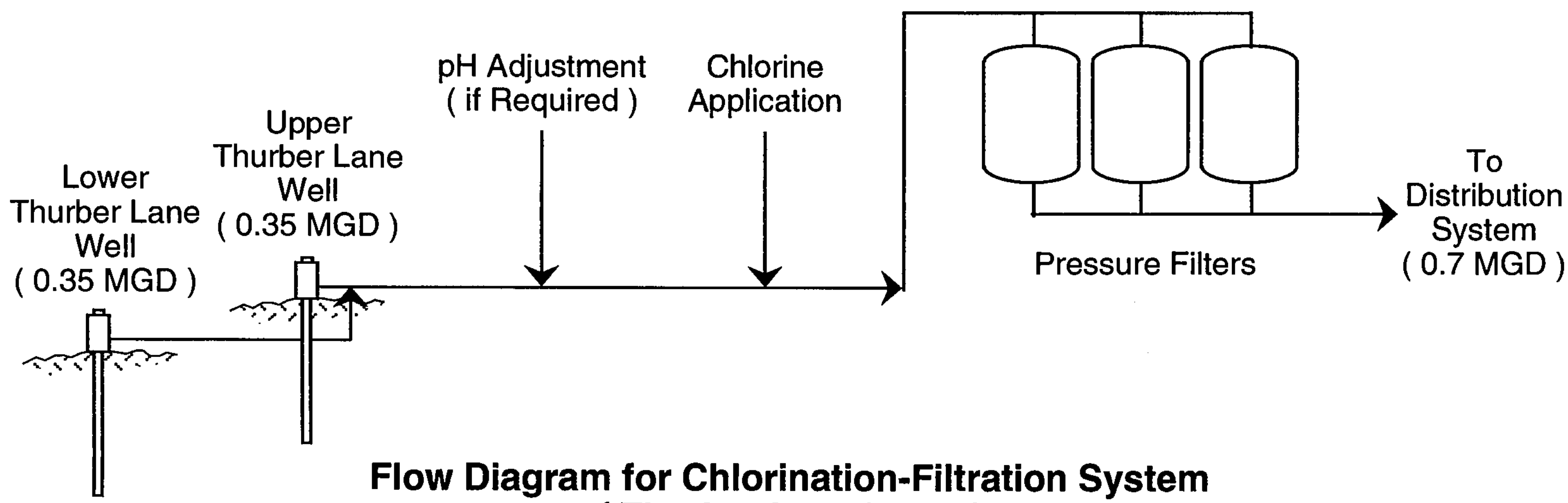
With the selection of a recommended project in this study, the next steps in the planning process will be the preliminary design and project environmental review phases. Several key issues will need to be addressed in the preliminary design phase of the project. Some of these issues include:

- the sustained yield of brackish groundwater resources;
- the location of brackish groundwater wells and reverse osmosis treatment plant;
- the method of brine disposal; and
- the location for the reverse osmosis treatment facilities.

Specific tasks to address these issues may include the installation of deep test wells to assess aquifer water quality and yield; studies to assess brine disposal options; and discussions with the Regional Board regarding permitting requirements. These tasks would be performed during the preliminary design phase of the project. It may be possible to perform some of the environmental review and preliminary design concurrently. However, project elements will



Flow Diagram for Reverse Osmosis System
(Brackish Groundwater)

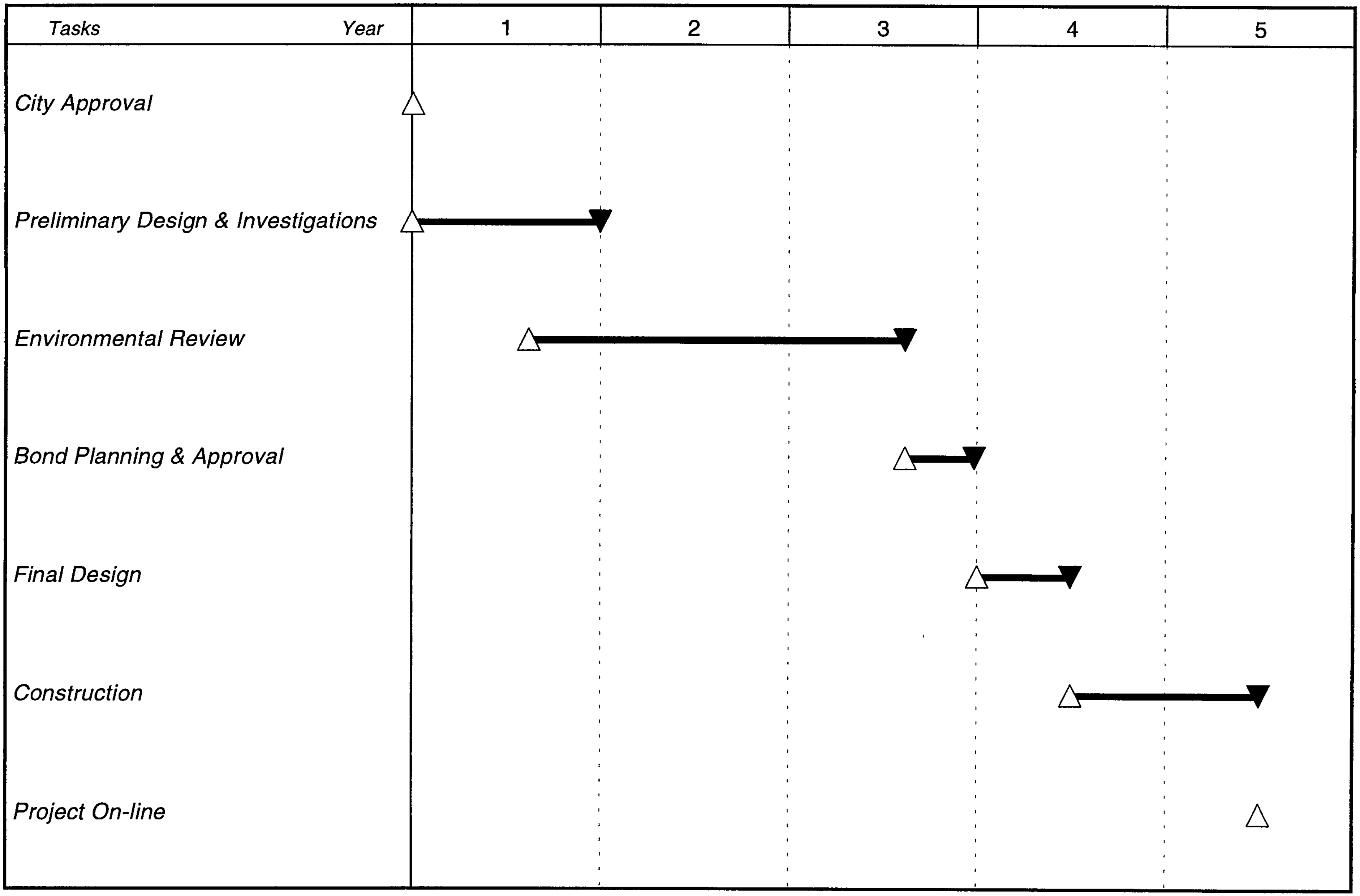


Flow Diagram for Chlorination-Filtration System
(Thurber Lane Wells)

Figure 13-2

Treatment Flow Diagrams for Recommended Project

Figure 13-3
Proposed Project Timeline
Brackish GW Wells with RO Treatment & Thurber Lane GW Wells



need to be well defined before the environmental review can be conducted. A timeline to implement the project is shown on Figure 13-3.

Appendix A
Hydrogeologic Evaluation of Brackish Groundwater

A.1 Introduction

A.1.1 General

The purpose of this report is to provide some background hydrogeologic data concerning the brackish groundwater project. Deep, brackish ground-water resources exist along the North Coast from the vicinity of Laguna Creek to the vicinity of Davenport. Water-bearing formations exist between 600 and 2,000 feet below sea level and are assigned to the Santa Margarita and Lompico sandstone units. Additional sandstone aquifers occur within the Monterey shale. Information regarding the quality of water from these deep formations is limited to a few water wells and test holes for oil and gas exploration. There are no production wells producing brackish water (generally defined as 1,000 mg/l to 10,000 mg/l total dissolved solids) currently in operation in the study area.

Initially, it appeared that this alternative might prove to be feasible, in spite of the fact that the water would need reverse-osmosis treatment, for the following reasons:

- the deep aquifer is "unused" at the present time
- well fields could be located near the City's North Coast raw-water pipeline
- well yields could potentially provide the needed water on a seasonal or emergency basis, based on available data and comparison with yields secured from deep production wells completed in similar formations elsewhere in Santa Cruz County
- environmental impacts are expected to be minimal

A.1.2 Location

The proposed brackish ground-water well fields are located between the settlement of Majors and the community of Davenport, as shown on Figure A-1. More specifically, one proposed well field is near the mouth of Yellow Bank Creek and the other is near the mouth of Laguna Creek. These well fields would provide non-potable ground water for a reverse osmosis desalinization plant located along Highway 1 next to the terminus of the existing North Coast Pipeline near Laguna Creek.

A.2 Regional Hydrogeology

The North Coast displays a varied topography including marine terraces, and deeply incised creek channels. Active tectonic uplift and subsequent erosion have exposed both the ancient basement granitic and metamorphic rocks, as well as the overlying cover of sedimentary rocks. Some of the sedimentary rocks act as aquicludes, such as the Santa Cruz mudstone, and some are aquifers such as the Santa Margarita and Lompico sandstone units. The generalized distribution of these formations in the study area is shown on Figure A-1, and subsurface relationships are shown on Figure A-2.

A.2.1 Potential Aquifers

Basement Rocks

Well yields are generally small in the fractured basement granitic and metamorphic rocks (Akers and Jackson, 1977). Yields may be small to moderate in fractured and/or karst environments where marble is located; the marble aquifers may have some potential of yielding greater amounts of water especially in the U.C. Santa Cruz area (Akers and Jackson, 1977 and Weber and Associates, 1989). Granitic basement rocks crop out near the southwest portion of Majors Creek, and may be found at a depth of at least 3,000 feet, northwest toward Davenport.

Lompico Sandstone and Monterey Formation

The Lompico sandstone of Miocene age is fine to medium grained and locally cemented with calcareous material. It is locally exposed in the area (Figure 1), and in the subsurface it is about 440 feet thick in the Shell Davenport corehole (Well No. 2, Figure 1). The sandstone is reported to yield moderate supplies of ground water ranging from 50 gallons per minute (gpm) to over 100 gpm (Akers and Jackson, 1977). Farther from the study area, two wells in Scotts Valley (Wells 7A and 11 of the Scotts Valley Water District) produce from 700 to over 1,000 gpm, respectively, from the deep Lompico sandstone units.

The Lompico sandstone in some places in the study area interfingers with the Monterey shale, and individual sandstone aquifers are often present within the shale. Some of the sandstone units can be 50 to 100 feet in thickness, as determined from available well logs.

Akers and Jackson (1977) report well yields ranging from 40 to 200 gpm, but water sampling results indicated poor water quality. High concentrations of iron, sulfate, and hydrogen sulfide are often present.

Santa Margarita Sandstone

The Santa Margarita sandstone of upper Miocene age is an extensive aquifer in the North Coast area that unconformably overlies the Monterey formation. Within the study area, the formation has a maximum thickness of 300 to 400 feet, as known from subsurface information (Wells 1 and 2, Figure A-1). Well yields often are in the range of 200 gpm to 700 gpm.

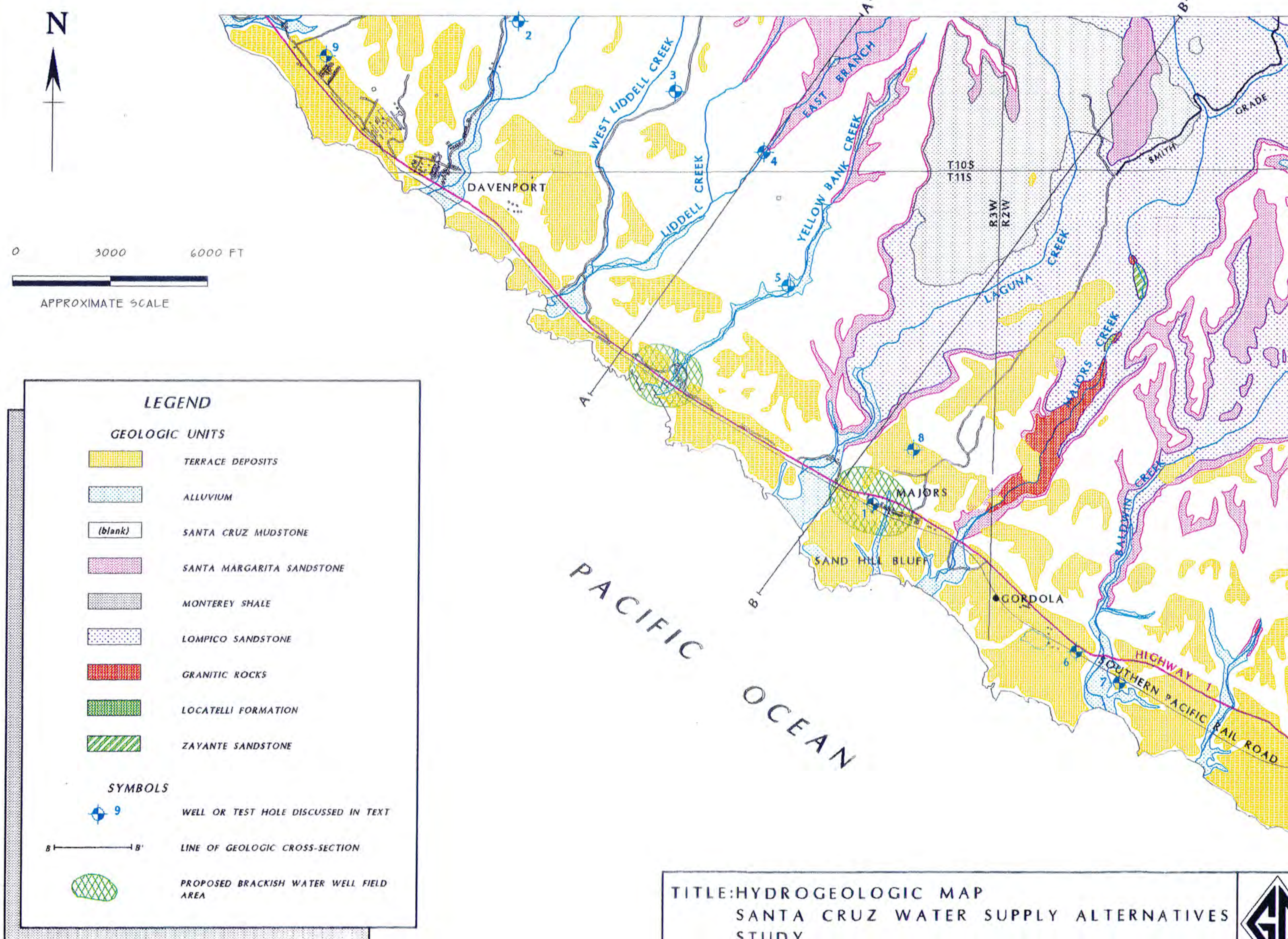
Subsurface geologic relationships between the basement rocks and the overlying aquifer units are shown on Figure A-2.

A.3 Local Hydrogeology

The two primary aquifers in the Majors to Yellow Bank Creek area are the Lompico and Santa Margarita sandstone units. "Hard" data on physical properties of the aquifers, such as transmissivity, and water quality are scarce. However, some of the available data is discussed below.

Well 1 (Figure A-1) which is 500 feet deep is completed in the Santa Margarita and possibly Lompico sandstones, and as a test well produced 50 gpm of water having an electrical conductivity (EC) of 1250 mmhos or about 900 milligrams per liter (mg/l) total dissolved solids

FIGURE A-1



TITLE: HYDROGEOLOGIC MAP
SANTA CRUZ WATER SUPPLY ALTERNATIVES STUDY

SOURCE : CLARK, 1981 AND OTHER SOURCES

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Project No. G621-02

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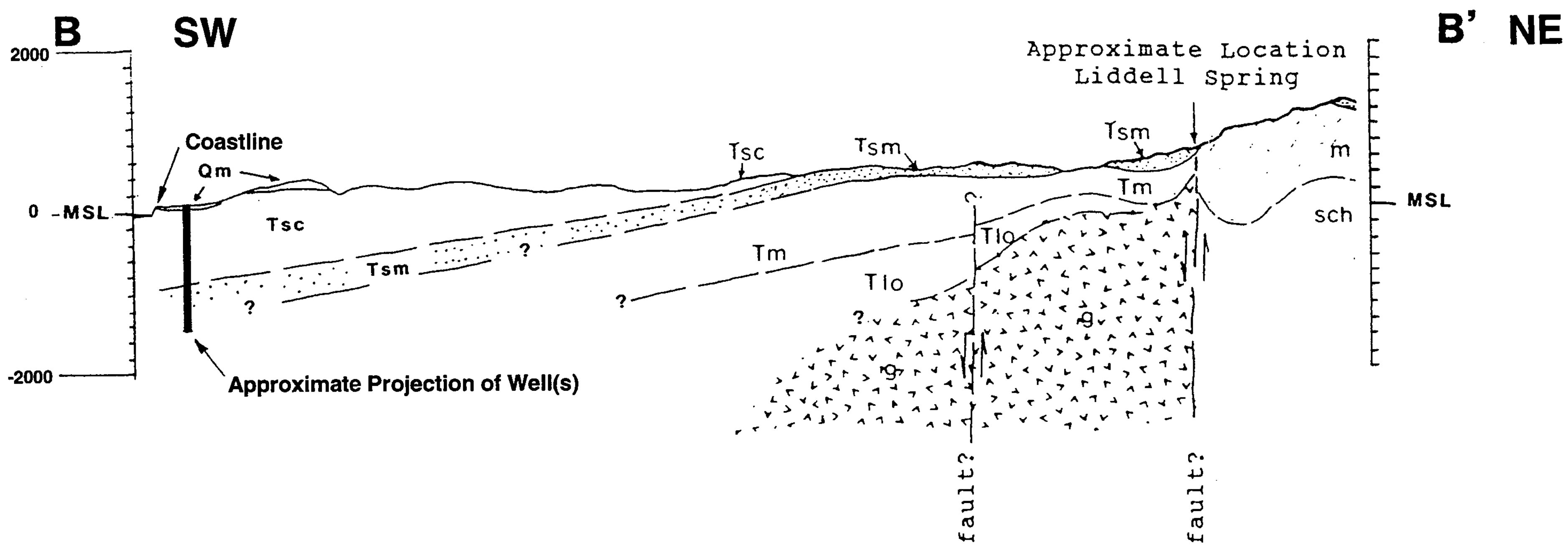


DESCRIPTION OF MAP UNITS

SURFICIAL SEDIMENTS

Qal - Alluvium
Qs - Sand Dunes
Qm - Marine Terrace Deposit

UPPER MIOCENE TO PLIOCENE SEDIMENTARY SEQUENCE

Tsc - Santa Cruz Mudstone
Tsm - Santa Margarita Sandstone

MIDDLE MIOCENE SEDIMENTARY SEQUENCE

Tm - Monterey Formation
Tlo - Lompico Sandstone

EOCENE TO LOWER MIOCENE SEDIMENTARY SEQUENCE

Tz - Zayante Sandstone

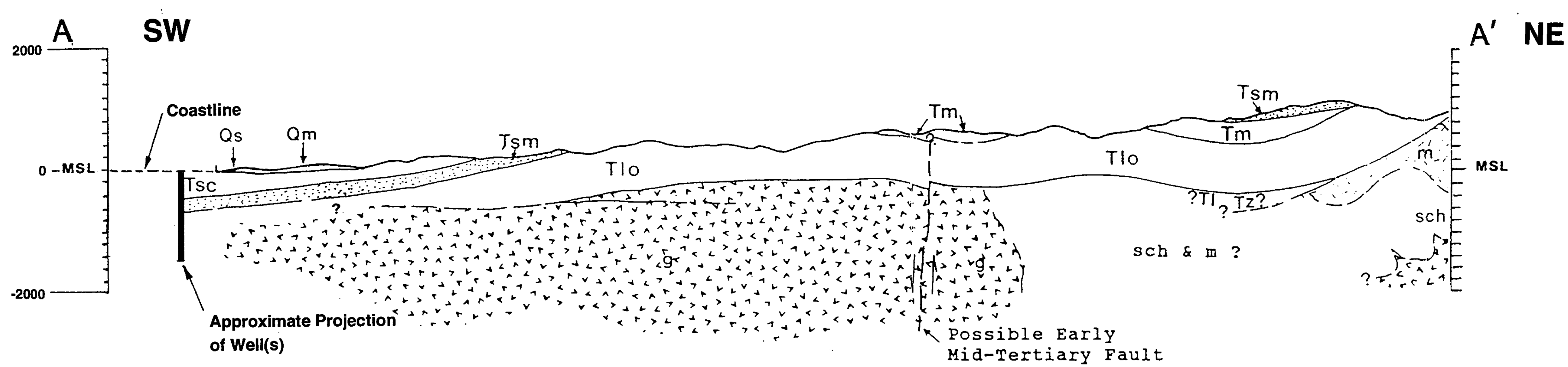
PALEOCENE SEDIMENTARY SEQUENCE

Tl - Locatelli Formation

CRYSTALLINE PLUTONIC AND METAMORPHIC ROCKS

g - Granite
sch - Metasedimentary Rocks (schist & quartzite)
m - Marble

Scale: 1" - 2000' Horizontal and Vertical



NOTE: For locations of cross-sections, see Figure A-1

GEOLOGIC CROSS-SECTIONS

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10/93

FROM WEBER AND ASSOCIATES, 1989

FIGURE A-2

(TDS). (Cardona and Associates, 1981). Specific capacity is 2.5 gallons per minute per foot of drawdown, which would equate to a transmissivity (T) of about 5,000 gpd/ft.

A similar well (No. 6, Figure A-1) also has a similar transmissivity value of 5,000 gpd/ft (Johnson, 1984). A little farther to the southeast, well No. 7, had a reported yield of 125 gpm, with 1,100 mg/l total dissolved solids, and chloride content of 400 mg/l (David Landino, personal communication).

In well No. 8 (Figure A-1) which was completed in the Lompico sandstone at a depth of about 800 feet, the total dissolved solids are in excess of 2,000 mg/l.

Calculations of water quality to be expected from the sandstone units penetrated by the Shell coreholes (Nos. 2 and 3, Figure A-1) from the electrical logs suggest that the total dissolved solids may range from 1500 to as high as 5,000 mg/l, and this is supported by water quality data from the Davenport area (Well 9) which shows an EC of 2,230 and chloride concentrations of 430 mg/l (Johnson, 1984, Table 7).

Locally, both the sandstone units appear to contain more calcareous cement in the subsurface than in the outcrop section, which may locally reduce the expected yield.

To summarize the above data, it is apparent that transmissivity (T) values of the brackish aquifers may be on the order of 5,000 gpd/ft, and the total dissolved solids (TDS) may range from slightly less than 1,000 to 5,000 mg/l based on available information.

A.4 Conclusions

General

Based on limited existing data, it is our opinion that the brackish groundwater resources could be developed within the study area at the two proposed locations. It is possible, although it remains to be verified, that yields of individual wells could range from 200 gpm to as high as 700 gpm. Based on the range of depths shown on the cross-sections on Figure A-2, an average well depth of 1,500 feet was assumed.

A scenario for development might involve one well field in the Majors area (which is close to the existing pipeline), and another in the Yellow Bank Creek area, each producing 500 to 1,000 gpm, assuming several wells in each well field. Based on estimates given by Johnson (1984) it is possible that two dispersed well fields pumping at the above rates would not exceed the average long-term recharge, and would not substantially reduce the base flow of any streams in the area. We understand that preliminary engineering design for the brackish groundwater alternative calls for a "peak" yield of 2,000 gpm assuming operation only during summer months in drought years. The proposed well fields are expected to meet this demand, but further studies will be necessary to verify this, as outlined below.

A.4.2 Impact on Bonnie Doon Area

Figure A-3 shows a schematic geologic cross section through the Bonnie Doon area, south to the Coast, which is taken from Johnson (1984). It can be seen that the sandstone aquifer at Bonnie Doon lies on the granitic basement rocks, and is totally isolated from the south-dipping aquifer section that is of interest to this study. Thus, there is no real hydrologic connection between the two areas, and there should be no impact from the pumping of brackish water wells at the Coast.

A.5 Recommendations

Further on-site studies are needed to characterize the brackish ground-water environment in the study area and to establish the feasibility of pumping rates, water quality, and brine disposal. These studies should include (but not be limited to):

- Geophysical exploration
- Test drilling and geophysical logging of the resulting test holes
- Construction of small-diameter test wells and monitor wells
- Pumping tests and water quality analyses
- Further on-site evaluation of proposed brine disposal areas by geophysical surveys and test drilling.
- Evaluation of any potential environmental impacts, such as a variation of the "base flow" of streams.

Selected References

Akers, J.P. and Jackson, L.E. Jr., 1977: Geology and Ground Water Western Santa Cruz County, California; U.S. Geological Survey Water Resources Investigations 77-15.

Cardona and Associates, 1981: North Coast Groundwater Exploration; unpublished report for Santa Cruz Municipal Utilities.

Clark, J.C., 1981: Stratigraphy, Paleontology, and Geology of the Central Santa Cruz Mountains, California Coast Ranges; U.S. Geological Survey Professional Paper 1168.

Earth Sciences Associates, 1979: Study of Ground Water Development Potential, City of Santa Cruz; unpublished report for the City of Santa Cruz Water Department.

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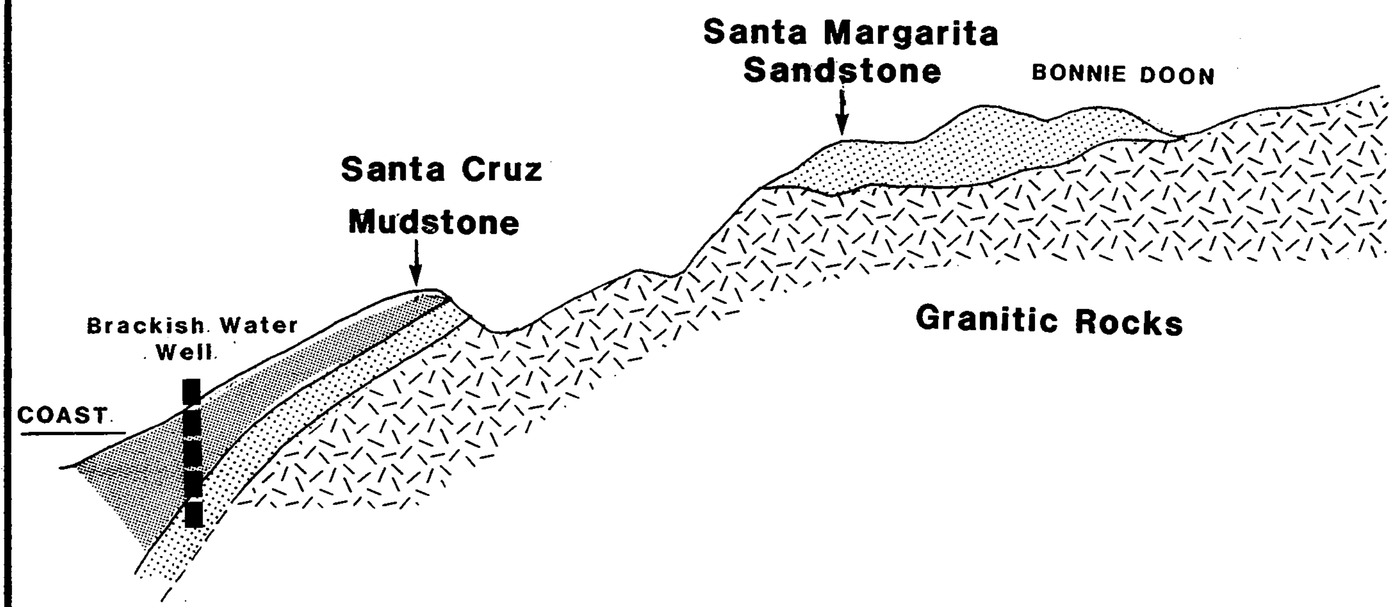
Weber and Associates, 1989: North Coast Groundwater Exploration Program, Phase I; unpublished report prepared for the City of Santa Cruz Water Department.



HYDROGEOLOGIC CROSS SECTION

NOT TO SCALE

AFTER JOHNSON, 1984

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San Jose, California 95112

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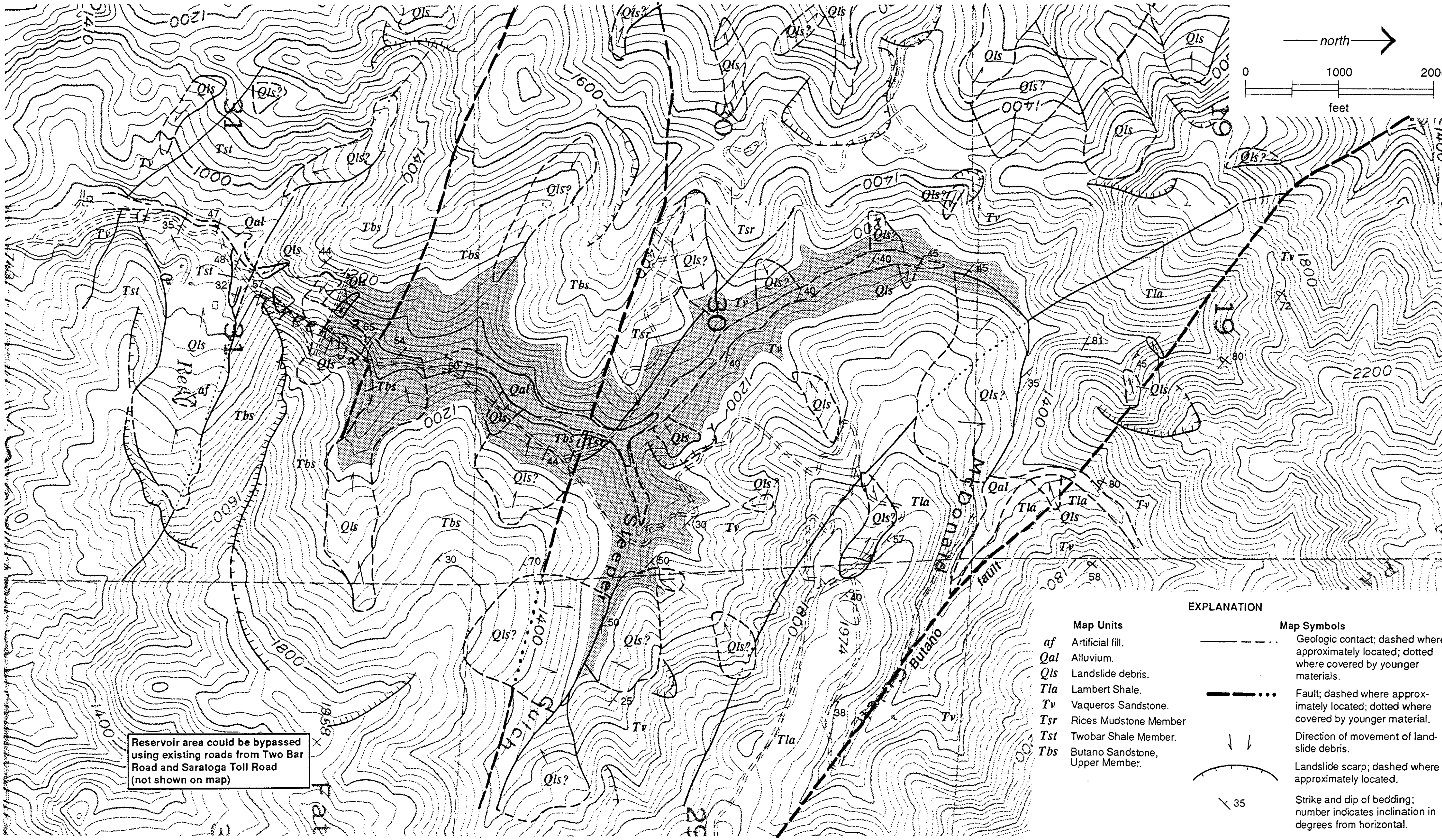
FIGURE A-3

Appendix B
Geology Maps for Reservoir Sites

Title *Page*



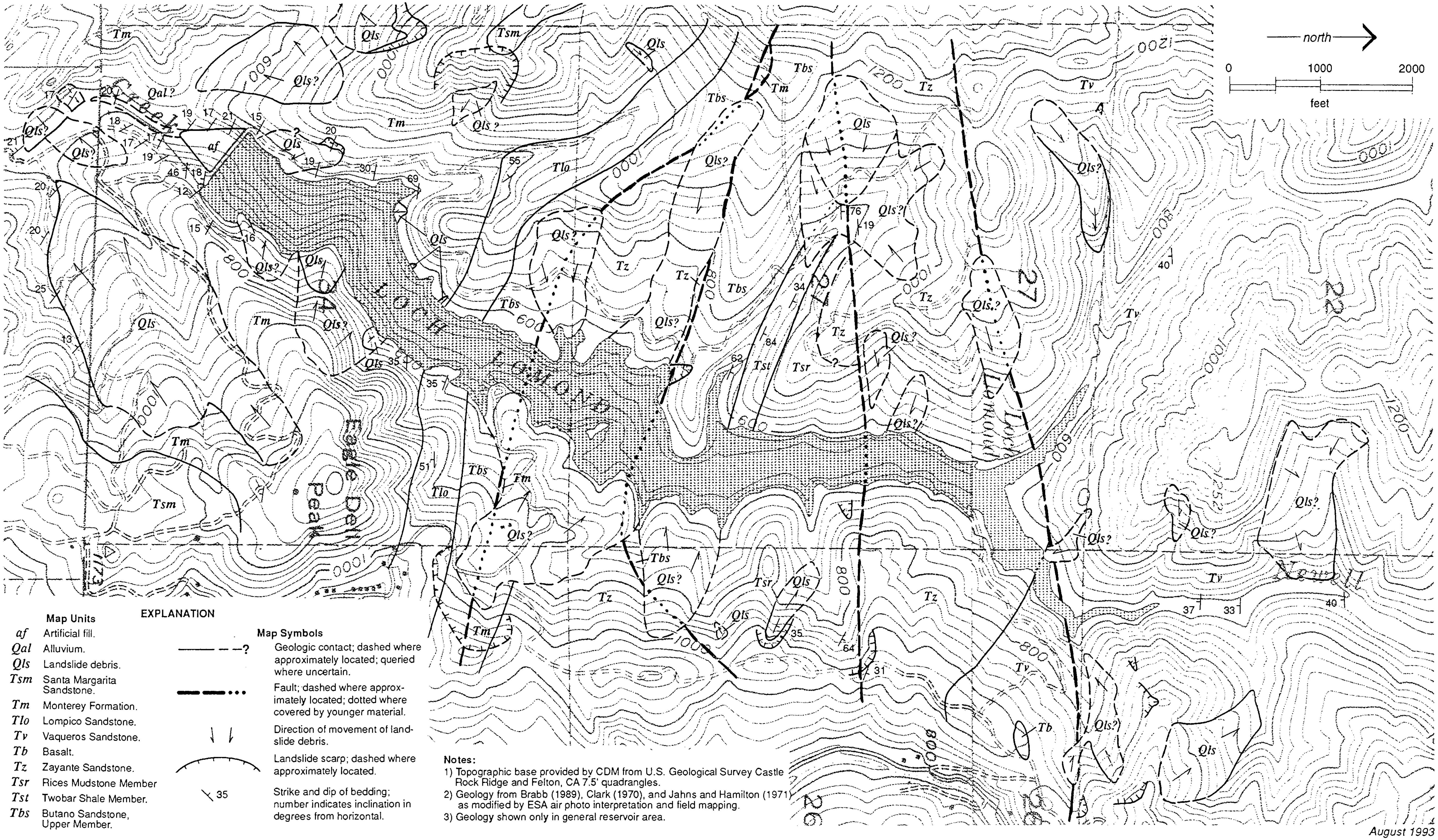
August 1993

Notes:
1) Topographic base provided by CDM from U.S. Geological Survey Big Basin and Castle Rock Ridge, CA 7.5' quadrangles.
2) Geology from Brabb (1969, 1989), Brabb and Dibblee (1979), Clark (1981), and Hall and others (1974) as modified by ESA air photo interpretation and field mapping.
3) Geology shown only in general reservoir area.

ESA Consultants

CDM Camp Dresser & McKee Inc.

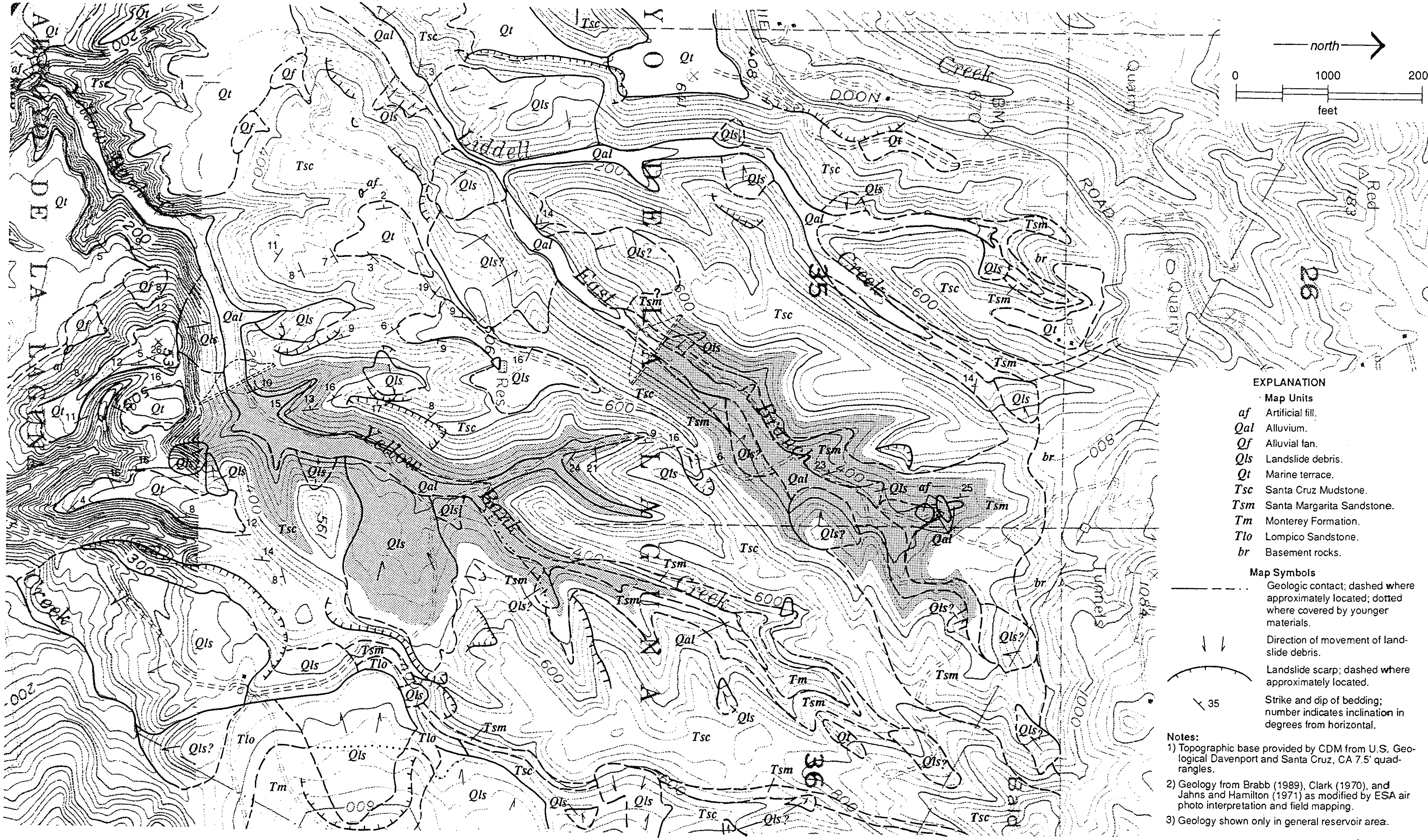
Geologic Map of the Potential Kings Creek Reservoir Area



ESA Consultants

CDM Camp Dresser & McKee Inc.

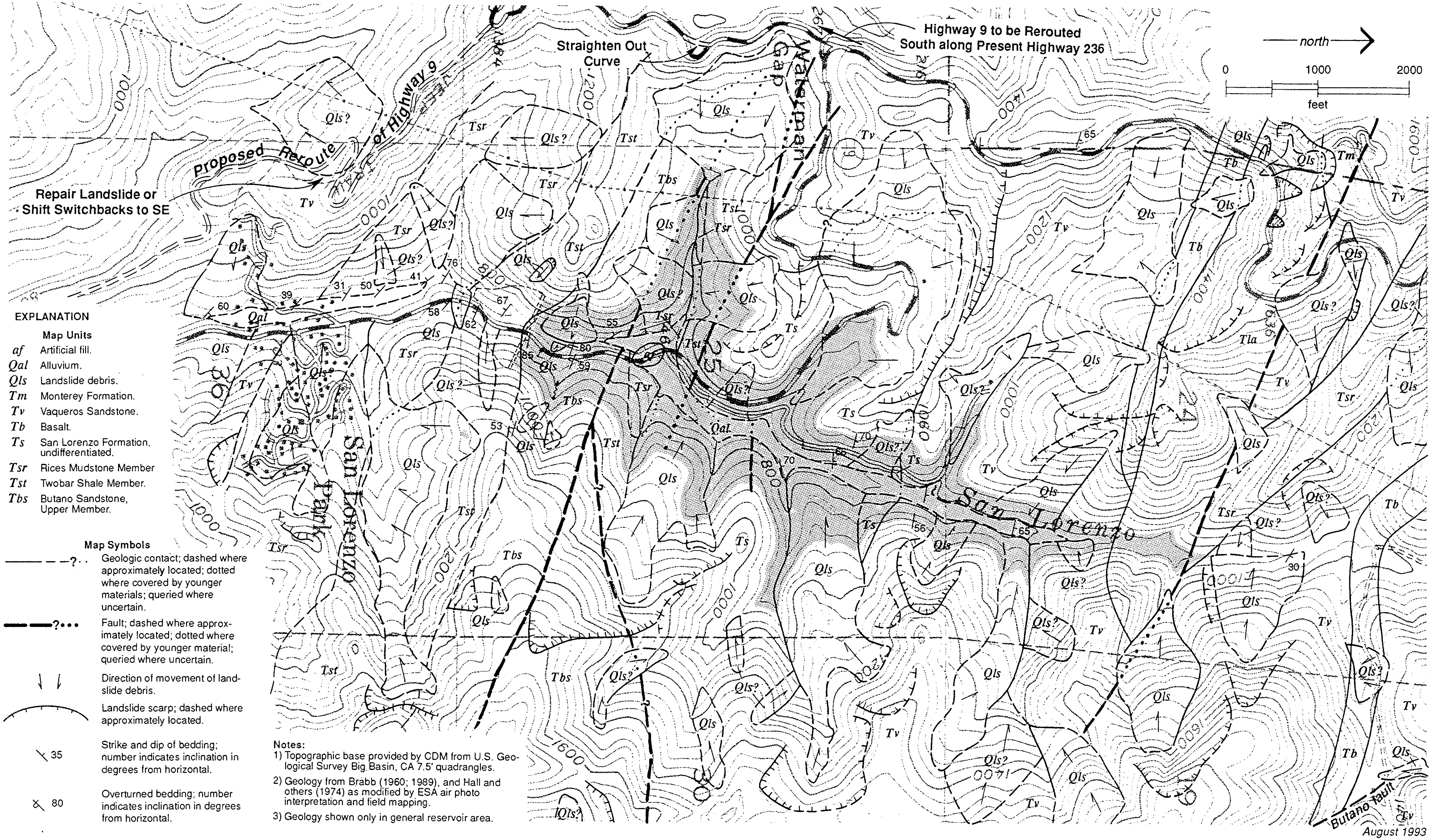
Geologic Map of the Existing Loch Lomond Reservoir Area



ESA Consultants

CDM Camp Dresser & McKee Inc.

Geologic Map of the Potential Liddell Creek and Yellow Bank Creek Reservoir Areas



ESA Consultants

CDM Camp Dresser & McKee Inc.

Geologic Map of the Potential Waterman Gap Reservoir Area

Appendix C
Detailed Cost Estimates

Basis for Costs

Capital costs were developed for all of the facilities required for each of the projects, including dams and reservoirs, pipelines, pump stations, and water treatment plants. Capital cost estimates are based on July 1993 costs, using an Engineering News Record index of 6,400 for the San Francisco Bay Area. Construction costs include base costs with the following multipliers, all taken as a percentage of the base costs:

- Contingencies: 30 percent
- Engineering: 20 percent
- Legal and Administration: 5 percent
- Environmental Mitigation and Monitoring: 5 percent

Costs for the CEQA review process were also estimated for each project. Projects were scored based on their total capital costs.

Operating costs were developed for each of the projects for power, labor, and chemical costs. The costs are uniform annual costs based on a 50 year project life and escalation for inflation at 4 percent per year. Costs assume that normal conditions would occur in 9 out of 10 years and drought conditions would occur in 1 out of 10 years. Although projects would not be operated during normal years, some operating costs would still be incurred. Operating costs in normal years would include maintenance of facilities, standby power costs for pump stations and water treatment plants, and pumping costs to replace water released for instream flows and evaporative losses.

Summary of Project Capital Costs
1993 Dollars

	Project Yield (MG/yr) Critical (2-year) drought	Extended (5-year) drought	Project Capital Cost Million $ (1993)
Project P-A			
Waterman Gap Reservoir	990	590	$54.0
Project P-B			
Kings Creek Reservoir	990	590	$58.4
Project P-C			
Liddell Creek Reservoir/Scott Creek Diversion Facilities	990	590	$117.3
Project P-D			
Yellow Bank Crk Reservoir/Scott Creek Diversion Facilitie	990	590	$79.0
Project P-E			
Loch Lomond 260 MG Enlargement	110	60	$0.8
Brackish GW with Reverse Osmosis Treatment (4.9 MGD)	880	530	$37.1
Environmental Documentation			$0.4
			$38.3
Project P-F			
Loch Lomond 500 MG Enlargement	240	90	$5.2
Brackish GW with Reverse Osmosis Treatment	750	500	$28.4
Environmental Documentation			$0.4
			$34.1
Project P-G			
Loch Lomond 1,010 MG Enlargement	450	200	$8.1
Brackish GW with Reverse Osmosis Treatment	540	390	$21.9
Environmental Documentation			$0.4
			$30.4
Project P-H			
Thurber Lane Wells	120	120	$2.3
Brackish GW with Reverse Osmosis Treatment	870	870	$37.1
Environmental Documentation			$0.2
			$39.6
Project P-I			
Smaller Reservoir			$66.8
Thurber Lane Wells	120	120	$2.3
Wastewater Reclamation	70	70	$4.0
Environmental Documentation			$0.4
			$73.5

City of Santa Cruz Water Supply Alternatives Study
Project P–A: Waterman Gap Reservoir

Item Description	Quantity	Unit	Unit Cost ($/unit)	Total Cost ($)
1. Dams				
Dam–Zoned Earth Embankment	2,500,000	CY	$9.40	$23,500,000
Reservoir Preparation	260	ac	$5,000	$1,300,000
Road Relocation	2.4	miles	$2,000,000	$4,800,000
Concession Stand & Boat Ramp Relocation	0	lump sum		$0
Parking Lot Relocation	0	lump sum		$0
Spillway	1	lump sum	$900,000	$900,000
Outlet	1	lump sum	$900,000	$900,000
Landslide Mitigation	0	lump sum		$0
2. Treatment Facilities				
Reverse Osmosis WTP	0	lump sum		$0
Iron and Manganese WTP	0	lump sum		$0
Tertiary WTP (Reclaimed Water)	0	lump sum		$0
3. Groundwater Wells				
Scott Creek Well	0	well		$0
Thurber Lane Well	0	well		$0
Davenport Area Well Brackish	0	well		$0
Majors Area Well Brackish	0	well		$0
4. Pump Stations				
Scott Creek PS	0	HP		$0
North Coast Reservoir PS	0	HP		$0
Reverse Osmosis WTP Booster PS	0	HP		$0
Reclaimed Water Booster PS	0	HP		$0
Coast PS Upgrade	0	HP		$0
Brine Disposal Booster PS	0	HP		$0
5. Pipelines				
Scott Creek to North Coast Reservoir	0	ft		$0
North Coast Reservoir to Majors Creek	0	ft		$0
Majors Creek to Bay Street Reservoir	0	ft		$0
Bay Street Reservoir to Coast PS	0	ft		$0
Coast PS to Graham Hill WTP	0	ft		$0
Davenport Well Field to RO WTP	0	ft		$0
RO WTP to Majors Creek	0	ft		$0
Brine Disposal Pipeline	0	ft		$0
Thurber Lane Pipeline	0	ft		$0
Thurber Lane Pipeline	0	ft		$0
Reclaimed Water Pipeline	0	ft		$0
Reclaimed Water Pipeline	0	ft		$0
6. Other				
Land Acquisition	387	ac	$5,000	$1,933,500
Modifications at Pasatiempo Golf Course	0	lump sum		$0
Subtotal*				$33,333,500
Contingencies (30%)				$10,000,050
Engineering (20%)				$6,666,700
Legal, Administration (5%)				$1,666,675
Environmental Mitigation/Monitoring (5%)				$1,666,675
Environmental Documentation				$650,000
TOTAL*				$53,983,600
* 1993$–ENR=6400				

City of Santa Cruz Water Supply Alternatives Study
Annual Costs
Project P–A: Waterman Gap Reservoir

Item Description	Total Cost
A. Construction (incl. multipliers and life cycle costs)	
1. Dams (50 year)	$50,240,000
2. Treatment Facilities (25 year)	$0
2. RO Membrane Replacement (10 year)	$0
3. Groundwater Wells (25 year)	$0
4. Pump Stations (25 year)	$0
5. Pipelines (50 year)	$0
6. Other (50 year)	$3,093,600
7. Environmental Doc	$650,000
TOTAL Present Worth	$53,983,600
TOTAL Equiv Uniform Annual Cost @ bond rate	$4,412,774
B. Power Costs (90% Normal years, 10% dry years)	
Treatment Facilities	$0
Groundwater Wells	$0
Pump Stations	$1,070,000
TOTAL Present Worth	$1,070,000
TOTAL Equiv Uniform Annual Cost @ inflation rate	$49,809
C. Chemical Costs (Dry Years only)	
TOTAL Present Worth	$0
TOTAL Equiv Uniform Annual Cost @ inflation rate	$0
D. Labor Costs (90% Normal years, 10% dry years)	
TOTAL Present Worth	$200,000
TOTAL Equiv Uniform Annual Cost @ inflation rate	$9,310
Total O&M Present Worth	$1,270,000
TOTAL Equiv Uniform Annual Cost	$59,119
SUMMARY:	
Capital Cost – Present Worth	$53,983,600
O&M Cost – Present Worth	$1,270,000
TOTAL Cost – Present Worth	$55,253,600
Capital Cost – Equiv. Uniform Annual	$4,412,774
O&M Cost – Equiv. Uniform Annual	$59,119
TOTAL Cost – Equiv. Uniform Annual	$4,471,893
* Time period used is 50 yrs at 8% discount rate and 4% inflation rate	

City of Santa Cruz Water Supply Alternatives Study
Project P–B: Kings Creek Reservoir

Item Description	Quantity	Unit	Unit Cost ($/unit)	Total Cost ($)
1. Dams				
Dam–Zoned Earth Embankment	3,000,000	CY	$9.00	$27,000,000
Reservoir Preparation	240	ac	$5,000	$1,200,000
Road Improvements/Landslide Repair	1	lump sum	$3,200,000	$3,200,000
Concession Stand & Boat Ramp Relocatior	0	lump sum		$0
Parking Lot Relocation	0	lump sum		$0
Spillway	1	lump sum	$900,000	$900,000
Outlet	1	lump sum	$900,000	$900,000
Landslide Mitigation	0	lump sum		$0
2. Treatment Facilities				
Reverse Osmosis WTP	0	lump sum		$0
Iron and Manganese WTP	0	lump sum		$0
Tertiary WTP (Reclaimed Water)	0	lump sum		$0
3. Groundwater Wells				
Scott Creek Well	0	well		$0
Thurber Lane Well	0	well		$0
Davenport Area Well	0	well		$0
Majors Area Well	0	well		$0
4. Pump Stations				
Scott Creek PS	0	HP		$0
North Coast Reservoir PS	0	HP		$0
Reverse Osmosis WTP Booster PS	0	HP		$0
Reclaimed Water Booster PS	0	HP		$0
Coast PS Upgrade	0	HP		$0
Brine Disposal Booster PS	0	HP		$0
5. Pipelines				
Scott Creek to North Coast Reservoir	0	ft		$0
North Coast Reservoir to Majors Creek	0	ft		$0
Majors Creek to Bay Street Reservoir	0	ft		$0
Bay Street Reservoir to Coast PS	0	ft		$0
Coast PS to Graham Hill WTP	0	ft		$0
Davenport Well Field to RO WTP	0	ft		$0
RO WTP to Majors Creek	0	ft		$0
Brine Disposal Pipeline	0	ft		$0
Thurber Lane Pipeline	0	ft		$0
Thurber Lane Pipeline	0	ft		$0
Reclaimed Water Pipeline	0	ft		$0
Reclaimed Water Pipeline	0	ft		$0
6. Other				
Land Acquisition	395	ac	$7,500	$2,958,750
Modifications at Pasatiempo Golf Course	0	lump sum		$0
Subtotal*				$36,158,750
Contingencies (30%)				$10,847,625
Engineering (20%)				$7,231,750
Legal, Administration (5%)				$1,807,938
Environmental Mitigation/Monitoring (5%)				$1,807,938
Environmental Documentation				$500,000
TOTAL*				$58,354,000
* 1993$–ENR=6400				

City of Santa Cruz Water Supply Alternatives Study
Annual Costs
Project P–B: Kings Creek Reservoir

Item Description	Total Cost
A. Construction (incl. multipliers and life cycle costs)	
1. Dams (50 year)	$53,120,000
2. Treatment Facilities (25 year)	$0
2. RO Membrane Replacement (10 year)	$0
3. Groundwater Wells (25 year)	$0
4. Pump Stations (25 year)	$0
5. Pipelines (50 year)	$0
6. Other (50 year)	$4,734,000
7. Environmental Doc	$500,000
TOTAL Present Worth	$58,354,000
TOTAL Equiv Uniform Annual Cost @ bond rate	$4,770,023
B. Power Costs (90% Normal years, 10% dry years)	
Treatment Facilities	$0
Groundwater Wells	$0
Pump Stations	$1,070,000
TOTAL Present Worth	$1,070,000
TOTAL Equiv Uniform Annual Cost @ inflation rate	$49,809
C. Chemical Costs (Dry Years only)	
TOTAL Present Worth	$0
TOTAL Equiv Uniform Annual Cost @ inflation rate	$0
D. Labor Costs (90% Normal years, 10% dry years)	
TOTAL Present Worth	$200,000
TOTAL Equiv Uniform Annual Cost @ inflation rate	$9,310
Total O&M Present Worth	$1,270,000
TOTAL Equiv Uniform Annual Cost	$59,119
SUMMARY:	
Capital Cost – Present Worth	$58,354,000
O&M Cost – Present Worth	$1,270,000
TOTAL Cost – Present Worth	$59,624,000
Capital Cost – Equiv. Uniform Annual	$4,770,023
O&M Cost – Equiv. Uniform Annual	$59,119
TOTAL Cost – Equiv. Uniform Annual	$4,829,141
* Time period used is 50 yrs at 8% discount rate and 4% inflation rate	

City of Santa Cruz Water Supply Alternatives Study
Project P–C: East Branch Liddell Creek Reservoir and Scott Creek Diversion

Item Description	Quantity	Unit	Unit Cost ($/unit)	Total Cost ($)
1. Dams				
Dam–Roller Compacted Concrete	1,050,000	CY	$49	$51,450,000
Reservoir Preparation	1	Included with Dam Cost		$0
Road Relocation	0	miles		$0
Concession Stand & Boat Ramp Relocation	0	lump sum		$0
Parking Lot Relocation	0	lump sum		$0
Spillway	1	Included with Dam Cost		$0
Outlet	1	Included with Dam Cost		$0
Landslide Mitigation	0	lump sum		$0
2. Treatment Facilities				
Reverse Osmosis WTP	0	lump sum		$0
Iron and Manganese WTP	0	lump sum		$0
Tertiary WTP (Reclaimed Water)	0	lump sum		$0
3. Groundwater Wells				
Scott Creek Well–200' deep, 16", 1000 gpm	5	wells	$275,000	$1,375,000
Thurber Lane Well	0	well		$0
Davenport Area Well	0	well		$0
Majors Area Well	0	well		$0
4. Pump Stations				
Scott Creek PS	1,000	HP	$1,681	$1,681,000
North Coast Reservoir PS	150	HP	$3,430	$514,500
Reverse Osmosis WTP Booster PS	0	HP		$0
Reclaimed Water Booster PS	0	HP		$0
Coast PS Upgrade	1	lump sum	$100,000	$100,000
Brine Disposal Booster PS	0	HP		
5. Pipelines				
Scott Creek to North Coast Reservoir	32,500	ft of 24"	$240	$7,800,000
North Coast Reservoir to Majors Creek	16,000	ft of 22"	$220	$3,520,000
Majors Creek to Bay Street Reservoir	27,500	ft of 14"	$140	$3,850,000
Bay Street Reservoir to Coast PS	7,500	ft of 14"	$140	$1,050,000
Coast PS to Graham Hill WTP	6,000	ft of 14"	$140	$840,000
Davenport Well Field to RO WTP	0	ft		$0
RO WTP to Majors Creek	0	ft		$0
Brine Disposal Pipeline	0	ft		$0
Thurber Lane Pipeline	0	ft		$0
Thurber Lane Pipeline	0	ft		$0
Reclaimed Water Pipeline	0	ft		$0
Reclaimed Water Pipeline	0	ft		$0
6. Other				
Land Acquisition	182	ac	$5,000	$911,000
Modifications at Pasatiempo Golf Course	0	lump sum		$0
Subtotal*				$73,091,500
Contingencies (30%)				$21,927,450
Engineering (20%)				$14,618,300
Legal, Administration (5%)				$3,654,575
Environmental Mitigation/Monitoring (5%)				$3,654,575
Environmental Documentation				$360,000
TOTAL*				$117,306,400
* 1993$–ENR=6400				

City of Santa Cruz Water Supply Alternatives Study
Annual Costs
Project P–C: East Branch Liddell Creek Reservoir and Scott Creek Diversion

Item Description	Total Cost
A. Construction (incl. multipliers and life cycle costs)	
1. Dams (50 year)	$82,320,000
2. Treatment Facilities (25 year)	$0
2. RO Membrane Replacement (10 year)	$0
3. Groundwater Wells (25 year)	$3,056,372
4. Pump Stations (25 year)	$5,102,474
5. Pipelines (50 year)	$27,296,000
6. Other (50 year)	$1,457,600
7. Environmental Doc	$360,000
TOTAL Present Worth	$119,592,445
TOTAL Equiv Uniform Annual Cost @ bond rate	$9,775,828
B. Power Costs (90% Normal years, 10% dry years)	
Treatment Facilities	$0
Groundwater Wells	$0
Pump Stations	$4,822,000
TOTAL Present Worth	$4,822,000
TOTAL Equiv Uniform Annual Cost @ inflation rate	$224,465
C. Chemical Costs (Dry Years only)	
TOTAL Present Worth	$0
TOTAL Equiv Uniform Annual Cost @ inflation rate	$0
D. Labor Costs (90% Normal years, 10% dry years)	
TOTAL Present Worth	$200,000
TOTAL Equiv Uniform Annual Cost @ inflation rate	$9,310
Total O&M Present Worth	$5,022,000
TOTAL Equiv Uniform Annual Cost	$233,775
SUMMARY:	
Capital Cost – Present Worth	$119,592,445
O&M Cost – Present Worth	$5,022,000
TOTAL Cost – Present Worth	$124,614,445
Capital Cost – Equiv. Uniform Annual	$9,775,828
O&M Cost – Equiv. Uniform Annual	$233,775
TOTAL Cost – Equiv. Uniform Annual	$10,009,603
* Time period used is 50 yrs at 8% discount rate and 4% inflation rate	

City of Santa Cruz Water Supply Alternatives Study

Project P–D: Yellow Bank Creek Reservoir and Scott Creek Diversions

Item Description	Quantity	Unit	Unit Cost ($/unit)	Total Cost ($)
1. Dams				
Dam–Roller Compacted Concrete	520,000	CY	$52	$27,040,000
Reservoir Preparation	1	Included with Dam Cost		$0
Road Relocation	0	miles		$0
Concession Stand & Boat Ramp Relocation	0	lump sum		$0
Parking Lot Relocation	0	lump sum		$0
Spillway	1	Included with Dam Cost		$0
Outlet	1	Included with Dam Cost		$0
Landslide Mitigation	0	lump sum		$0
2. Treatment Facilities				
Reverse Osmosis WTP	0	lump sum		$0
Iron and Manganese WTP	0	lump sum		$0
Tertiary WTP (Reclaimed Water)	0	lump sum		$0
3. Groundwater Wells				
Scott Creek Well–200' deep, 16", 1000 gpm	5	wells	$275,000	$1,375,000
Thurber Lane Well	0	well		$0
Davenport Area Well	0	well		$0
Majors Area Well	0	well		$0
4. Pump Stations				
Scott Creek PS	700	HP	$2,650	$1,855,140
North Coast Reservoir PS	400	HP	$2,360	$943,800
Reverse Osmosis WTP Booster PS	0	HP		$0
Reclaimed Water Booster PS	0	HP		$0
Coast PS Upgrade	1	lump sum	$100,000	$100,000
Brine Disposal Booster PS	0	HP		$0
5. Pipelines				
Scott Creek to North Coast Reservoir	33,500	ft of 24"	$240	$8,040,000
North Coast Reservoir to Majors Creek	14,000	ft of 22"	$220	$3,080,000
Majors Creek to Bay Street Reservoir	27,500	ft of 14"	$140	$3,850,000
Bay Street Reservoir to Coast PS	7,500	ft of 14"	$140	$1,050,000
Coast PS to Graham Hill WTP	6,000	ft of 14"	$140	$840,000
Davenport Well Field to RO WTP	0	ft		$0
RO WTP to Majors Creek	0	ft		$0
Brine Disposal Pipeline	0	ft		$0
Thurber Lane Pipeline	0	ft		$0
Thurber Lane Pipeline	0	ft		$0
Reclaimed Water Pipeline	0	ft		$0
Reclaimed Water Pipeline	0	ft		$0
6. Other				
Land Acquisition	206	ac	$5,000	$1,031,500
Modifications at Pasatiempo Golf Course	0	lump sum		$0
Subtotal*				$49,205,440
Contingencies (30%)				$14,761,632
Engineering (20%)				$9,841,088
Legal, Administration (5%)				$2,460,272
Environmental Mitigation/Monitoring (5%)				$2,460,272
Environmental Documentation				$320,000
TOTAL*				$79,048,704
* 1993$–ENR=6400				

City of Santa Cruz Water Supply Alternatives Study
Annual Costs
Project P–D: Yellow Bank Creek Reservoir and Scott Creek Diversions

Item Description	Total Cost
A. Construction (incl. multipliers and life cycle costs)	
1. Dams (50 year)	$43,264,000
2. Treatment Facilities (25 year)	$0
2. RO Membrane Replacement (10 year)	$0
3. Groundwater Wells (25 year)	$3,056,372
4. Pump Stations (25 year)	$6,443,809
5. Pipelines (50 year)	$26,976,000
6. Other (50 year)	$1,650,400
7. Environmental Doc	$320,000
TOTAL Present Worth	$81,710,581
TOTAL Equiv Uniform Annual Cost @ bond rate	$6,679,256
B. Power Costs (90% Normal years, 10% dry years)	
Treatment Facilities	$0
Groundwater Wells	$0
Pump Stations	$3,093,000
TOTAL Present Worth	$3,093,000
TOTAL Equiv Uniform Annual Cost @ inflation rate	$143,980
C. Chemical Costs (Dry Years only)	
TOTAL Present Worth	$0
TOTAL Equiv Uniform Annual Cost @ inflation rate	$0
D. Labor Costs (90% Normal years, 10% dry years)	
TOTAL Present Worth	$200,000
TOTAL Equiv Uniform Annual Cost @ inflation rate	$9,310
Total O&M Present Worth	$3,293,000
TOTAL Equiv Uniform Annual Cost	$153,290
SUMMARY:	
Capital Cost – Present Worth	$81,710,581
O&M Cost – Present Worth	$3,293,000
TOTAL Cost – Present Worth	$85,003,581
Capital Cost – Equiv. Uniform Annual	$6,679,256
O&M Cost – Equiv. Uniform Annual	$153,290
TOTAL Cost – Equiv. Uniform Annual	$6,832,546
* Time period used is 50 yrs at 8% discount rate and 4% inflation rate	

City of Santa Cruz Water Supply Alternatives Study
Project P–E: Loch Lomond 260 MG Enlargement and Brackish Groundwater Wells with Reverse Osmosis Treatment

Item Description	Quantity	Unit	Unit Cost ($/unit)	Total Cost ($)
1. Dams				
Dam–750' long, 4' high parapet wall	1	lump sum	$500,000	$500,000
Reservoir Preparation	0	ac		$0
Road Improvements–3.8 miles	1	Included with Dam Cost		$0
Concession Stand & Boat Ramp Relocation	0	lump sum		$0
Parking Lot/Road Relocation	0	lump sum		$0
Spillway–4' raise	1	Included with Dam Cost		$0
Outlet	0	lump sum		$0
Landslide Mitigation	0	lump sum		$0
2. Treatment Facilities				
Reverse Osmosis WTP–4.9 MGD	1	lump sum	$5,105,000	$5,105,000
Iron and Manganese WTP	0	lump sum		$0
Tertiary WTP (Reclaimed Water)	0	lump sum		$0
3. Groundwater Wells				
Scott Creek Well	0	well		$0
Thurber Lane Well	0	well		$0
Davenport Area Well–1,500' deep, 16", 500 gpm	4	wells	$551,300	$2,205,200
Majors Area Well–1,500' deep, 16", 500 gpm	4	wells	$551,300	$2,205,200
4. Pump Stations				
Scott Creek PS	0	HP		$0
North Coast Reservoir PS	0	HP		$0
Reverse Osmosis WTP Booster PS	320	HP	$2,343	$749,760
Reclaimed Water Booster PS	0	HP		$0
Coast PS Upgrade	0	HP		$0
Brine Disposal Booster PS–30 HP	1	lump sum	$300,000	$300,000
5. Pipelines				
Scott Creek to North Coast Reservoir	0	ft		$0
North Coast Reservoir to Majors Creek	0	ft		$0
Majors Creek to Bay Street Reservoir	27,500	ft of 12"	$120	$3,300,000
Bay Street Reservoir to Coast PS	0	ft		$0
Coast PS to Graham Hill WTP	6,000	ft of 14"	$140	$840,000
Davenport Well Field to RO WTP	20,000	ft of 18"	$180	$3,600,000
RO WTP to Majors Creek	6,000	ft of 22"	$220	$1,320,000
Brine Disposal Pipeline	35,800	ft of 10"	$100	$3,580,000
Thurber Lane Pipeline	0	ft		$0
Thurber Lane Pipeline	0	ft		$0
Reclaimed Water Pipeline	0	ft		$0
Reclaimed Water Pipeline	0	ft		$0
6. Other				
Land Acquisition	0.5	ac	$5,000	$2,500
Modifications at Pasatiempo Golf Course	0	lump sum		$0
Subtotal*				$23,707,660
Contingencies (30%)				$7,112,298
Engineering (20%)				$4,741,532
Legal, Administration (5%)				$1,185,383
Environmental Mitigation/Monitoring (5%)				$1,185,383
Environmental Documentation				$400,000
TOTAL*				$38,332,256
* 1993$–ENR=6400				

City of Santa Cruz Water Supply Alternatives Study
Annual Costs
Project P–E: Loch Lomond 260 MG Enlargement and Brackish Groundwater Wells with Reverse Osmosis Treatment

Item Description	Total Cost
A. Construction (incl. multipliers and life cycle costs)	
1. Dams (50 year)	$800,000
2. Treatment Facilities (25 year)	$9,791,503
2. RO Membrane Replacement (10 year)	$3,022,944
3. Groundwater Wells (25 year)	$9,803,507
4. Pump Stations (25 year)	$2,333,423
5. Pipelines (50 year)	$20,224,000
6. Other (50 year)	$4,000
7. Environmental Doc	$400,000
TOTAL Present Worth	$46,379,376
TOTAL Equiv Uniform Annual Cost @ bond rate	$3,791,183
B. Power Costs (90% Normal years, 10% dry years)	
Treatment Facilities	$1,528,740
Groundwater Wells	$5,520,450
Pump Stations	$1,443,810
TOTAL Present Worth	$8,493,000
TOTAL Equiv Uniform Annual Cost @ inflation rate	$395,351
C. Chemical Costs (Dry Years only)	
TOTAL Present Worth	$565,000
TOTAL Equiv Uniform Annual Cost @ inflation rate	$26,301
D. Labor Costs (90% Normal years, 10% dry years)	
TOTAL Present Worth	$300,000
TOTAL Equiv Uniform Annual Cost @ inflation rate	$13,965
Total O&M Present Worth	$9,358,000
TOTAL Equiv Uniform Annual Cost	$435,617
SUMMARY:	
Capital Cost – Present Worth	$46,379,376
O&M Cost – Present Worth	$9,358,000
TOTAL Cost – Present Worth	$55,737,376
Capital Cost – Equiv. Uniform Annual	$3,791,183
O&M Cost – Equiv. Uniform Annual	$435,617
TOTAL Cost – Equiv. Uniform Annual	$4,226,800
* Time period used is 50 yrs at 8% discount rate and 4% inflation rate	

City of Santa Cruz Water Supply Alternatives Study
Project P–F: Loch Lomond 500 MG Enlargement and Brackish Groundwater Wells with Reverse Osmosis Treatment

Item Description	Quantity	Unit	Unit Cost ($/unit)	Total Cost ($)
1. Dams				
Dam–750' long, 8' high parapet wall	1	lump sum	$1,000,000	$1,000,000
Reservoir Preparation	60	ac	$5,000	$300,000
Landslide Repair	1	lump sum	$400,000	$400,000
Concession Stand & Boat Ramp Relocation	1	lump sum	$261,000	$261,000
Parking Lot/Road Relocation	1	lump sum	$500,000	$500,000
Spillway–8' raise	1	lump sum	$800,000	$800,000
Outlet	0	lump sum		$0
Landslide Mitigation	0	lump sum		$0
2. Treatment Facilities				
Reverse Osmosis WTP–4.1 MGD	1	lump sum	$4,434,000	$4,434,000
Iron and Manganese WTP	0	lump sum		$0
Tertiary WTP (Reclaimed Water)	0	lump sum		$0
3. Groundwater Wells				
Scott Creek Well	0	well		$0
Thurber Lane Well	0	well		$0
Davenport Area Well–1,500' deep, 16", 570 gpm	3	wells	$551,300	$1,653,900
Majors Area Well–1,500' deep, 16", 570 gpm	3	wells	$551,300	$1,653,900
4. Pump Stations				
Scott Creek PS	0	HP		$0
North Coast Reservoir PS	0	HP		$0
Reverse Osmosis WTP Booster PS	270	HP	$2,884	$778,680
Reclaimed Water Booster PS	0	HP		$0
Coast PS Upgrade	0	HP		$0
Brine Disposal Booster PS – 20 HP	1	lump sum	$300,000	$300,000
5. Pipelines				
Scott Creek to North Coast Reservoir	0	ft		$0
North Coast Reservoir to Majors Creek	0	ft		$0
Majors Creek to Bay Street Reservoir	0	ft		$0
Bay Street Reservoir to Coast PS	0	ft		$0
Coast PS to Graham Hill WTP	6,000	ft of 14"	$140	$840,000
Davenport Well Field to RO WTP	20,000	ft of 16"	$160	$3,200,000
RO WTP to Majors Creek	6,000	ft of 22"	$220	$1,320,000
Brine Disposal Pipeline	35,800	ft of 10"	$100	$3,580,000
Thurber Lane Pipeline	0	ft		$0
Thurber Lane Pipeline	0	ft		$0
Reclaimed Water Pipeline	0	ft		$0
Reclaimed Water Pipeline	0	ft		$0
6. Other				
Land Acquisition	0.5	ac	$5,000	$2,500
Modifications at Pasatiempo Golf Course	0	lump sum		$0
Subtotal*				$21,023,980
Contingencies (30%)				$6,307,194
Engineering (20%)				$4,204,796
Legal, Administration (5%)				$1,051,199
Environmental Mitigation/Monitoring (5%)				$1,051,199
Environmental Documentation				$400,000
TOTAL*				$34,038,368
* 1993$–ENR=6400				

City of Santa Cruz Water Supply Alternatives Study
Annual Costs
Project P–F: Loch Lomond 500 MG Enlargement and Brackish Groundwater Wells with Reverse Osmosis Treatment

Item Description	Total Cost
A. Construction (incl. multipliers and life cycle costs)	
1. Dams (50 year)	$5,217,600
2. Treatment Facilities (25 year)	$8,522,276
2. RO Membrane Replacement (10 year)	$2,591,094
3. Groundwater Wells (25 year)	$7,352,630
4. Pump Stations (25 year)	$2,397,707
5. Pipelines (50 year)	$14,304,000
6. Other (50 year)	$4,000
7. Environmental Doc	$400,000
TOTAL Present Worth	$40,789,307
TOTAL Equiv Uniform Annual Cost @ bond rate	$3,334,235
B. Power Costs (90% Normal years, 10% dry years)	
Treatment Facilities	$2,023,500
Groundwater Wells	$3,642,300
Pump Stations	$1,079,200
TOTAL Present Worth	$6,745,000
TOTAL Equiv Uniform Annual Cost @ inflation rate	$313,981
C. Chemical Costs (Dry Years only)	
TOTAL Present Worth	$480,000
TOTAL Equiv Uniform Annual Cost @ inflation rate	$22,344
D. Labor Costs (90% Normal years, 10% dry years)	
TOTAL Present Worth	$300,000
TOTAL Equiv Uniform Annual Cost @ inflation rate	$13,965
Total O&M Present Worth	$7,525,000
TOTAL Equiv Uniform Annual Cost	$350,290
SUMMARY:	
Capital Cost – Present Worth	$40,789,307
O&M Cost – Present Worth	$7,525,000
TOTAL Cost – Present Worth	$48,314,307
Capital Cost – Equiv. Uniform Annual	$3,334,235
O&M Cost – Equiv. Uniform Annual	$350,290
TOTAL Cost – Equiv. Uniform Annual	$3,684,525
* Time period used is 50 yrs at 8% discount rate and 4% inflation rate	

City of Santa Cruz Water Supply Alternatives Study

Project P–G: Loch Lomond 1,010 MG Enlargement and Brackish Groundwater Wells with Reverse Osmosis Treatment

Item Description	Quantity	Unit	Unit Cost ($/unit)	Total Cost ($)
1. Dams				
Dam–Raise Zoned Fill Embankment 14'	100,000	CY	$25	$2,500,000
Reservoir Preparation	80	ac	$5,000	$400,000
Landslide Repair	1	lump sum	$400,000	$400,000
Concession Stand & Boat Ramp Relocation	1	lump sum	$261,000	$261,000
Parking Lot/Road Relocation	1	lump sum	$500,000	$500,000
Spillway–14' raise	1	lump sum	$1,000,000	$1,000,000
Outlet	0	lump sum		$0
Landslide Mitigation	0	lump sum		$0
2. Treatment Facilities				
Reverse Osmosis WTP–2.8 MGD	1	lump sum	$3,171,000	$3,171,000
Iron and Manganese WTP	0	lump sum		$0
Tertiary WTP (Reclaimed Water)	0	lump sum		$0
3. Groundwater Wells				
Scott Creek Well	0	well		$0
Thurber Lane Well	0	well		$0
Davenport Area Well–1,500' deep, 16", 600 gpm	2	wells	$551,300	$1,102,600
Majors Area Well–1,500' deep, 16", 600 gpm	2	wells	$551,300	$1,102,600
4. Pump Stations				
Scott Creek PS	0	HP		$0
North Coast Reservoir PS	0	HP		$0
Reverse Osmosis WTP Booster PS	200	HP	$3,121	$624,200
Reclaimed Water Booster PS	0	HP		$0
Coast PS Upgrade	0	HP		$0
Brine Disposal Booster PS– 20 HP	1	lump sum	$300,000	$300,000
5. Pipelines				
Scott Creek to North Coast Reservoir	0	ft		$0
North Coast Reservoir to Majors Creek	0	ft		$0
Majors Creek to Bay Street Reservoir	0	ft		$0
Bay Street Reservoir to Coast PS	0	ft		$0
Coast PS to Graham Hill WTP	6,000	ft of 14"	$140	$840,000
Davenport Well Field to RO WTP	20,000	ft of 14"	$140	$2,800,000
RO WTP to Majors Creek	5,000	ft of 18"	$180	$900,000
Brine Disposal Pipeline	35,800	ft of 8"	$80	$2,864,000
Thurber Lane Pipeline	0	ft		$0
Thurber Lane Pipeline	0	ft		$0
Reclaimed Water Pipeline	0	ft		$0
Reclaimed Water Pipeline	0	ft		$0
6. Other				
Land Acquisition	0.5	ac	$5,000	$2,500
Modifications at Pasatiempo Golf Course	0	lump sum		$0
Subtotal*				$18,767,900
Contingencies (30%)				$5,630,370
Engineering (20%)				$3,753,580
Legal, Administration (5%)				$938,395
Environmental Mitigation/Monitoring (5%)				$938,395
Environmental Documentation				$400,000
TOTAL*				$30,428,640
* 1993$–ENR=6400				

City of Santa Cruz Water Supply Alternatives Study
Annual Costs
Project P–G: Loch Lomond 1,010 MG Enlargement and Brackish Groundwater Wells with Reverse Osmosis Treatment

Item Description	Total Cost
A. Construction (incl. multipliers and life cycle costs)	
1. Dams (50 year)	$8,097,600
2. Treatment Facilities (25 year)	$6,159,422
2. RO Membrane Replacement (10 year)	$1,727,396
3. Groundwater Wells (25 year)	$4,901,753
4. Pump Stations (25 year)	$2,054,326
5. Pipelines (50 year)	$11,846,400
6. Other (50 year)	$4,000
7. Environmental Doc	$400,000
TOTAL Present Worth	$35,190,898
TOTAL Equiv Uniform Annual Cost @ bond rate	$2,876,605
B. Power Costs (90% Normal years, 10% dry years)	
Treatment Facilities	$1,627,065
Groundwater Wells	$2,415,945
Pump Stations	$887,490
TOTAL Present Worth	$4,930,500
TOTAL Equiv Uniform Annual Cost @ inflation rate	$229,516
C. Chemical Costs (Dry Years only)	
TOTAL Present Worth	$260,000
TOTAL Equiv Uniform Annual Cost @ inflation rate	$12,103
D. Labor Costs (90% Normal years, 10% dry years)	
TOTAL Present Worth	$300,000
TOTAL Equiv Uniform Annual Cost @ inflation rate	$13,965
Total O&M Present Worth	$5,490,500
TOTAL Equiv Uniform Annual Cost	$255,584
SUMMARY:	
Capital Cost – Present Worth	$35,190,898
O&M Cost – Present Worth	$5,490,500
TOTAL Cost – Present Worth	$40,681,398
Capital Cost – Equiv. Uniform Annual	$2,876,605
O&M Cost – Equiv. Uniform Annual	$255,584
TOTAL Cost – Equiv. Uniform Annual	$3,132,188
* Time period used is 50 yrs at 8% discount rate and 4% inflation rate	

City of Santa Cruz Water Supply Alternatives Study
Project P–H: Thurber Lane Groundwater Wells and Brackish Groundwater Wells with Reverse Osmosis Treatment

Item Description	Quantity	Unit	Unit Cost ($/unit)	Total Cost ($)
1. Dams				
Dam	0	CY		$0
Reservoir Preparation	0	ac		$0
Road Relocation	0	miles		$0
Concession Stand & Boat Ramp Relocation	0	lump sum		$0
Parking Lot Relocation	0	lump sum		$0
Spillway	0	lump sum		$0
Outlet	0	lump sum		$0
Landslide Mitigation	0	lump sum		$0
2. Treatment Facilities				
Reverse Osmosis WTP–4.9 MGD	1	lump sum	$5,105,000	$5,105,000
Iron and Manganese WTP–0.72 MGD	1	lump sum	$475,000	$475,000
Tertiary WTP (Reclaimed Water)	0	lump sum		$0
3. Groundwater Wells				
Scott Creek Well	0	well		$0
Thurber Lane Well–500' deep, 12", 250 gpm	2	well	$298,500	$597,000
Davenport Area Well–1,500' deep, 16", 500 gpm	4	wells	$551,300	$2,205,200
Majors Area Well–1,500' deep, 16", 500 gpm	4	wells	$551,300	$2,205,200
4. Pump Stations				
Scott Creek PS	0	HP		$0
North Coast Reservoir PS	0	HP		$0
Reverse Osmosis WTP Booster PS	320	HP	$2,338	$748,000
Reclaimed Water Booster PS	0	HP		$0
Coast PS Upgrade	0	HP		$0
Brine Disposal Booster PS–20 HP	1	lump sum	$300,000	$300,000
5. Pipelines				
Scott Creek to North Coast Reservoir	0	ft		$0
North Coast Reservoir to Majors Creek	0	ft		$0
Majors Creek to Bay Street Reservoir	27,500	ft of 12"	$120	$3,300,000
Bay Street Reservoir to Coast PS	0	ft		$0
Coast PS to Graham Hill WTP	6,000	ft – 14"	$140	$840,000
Davenport Well Field to RO WTP	20,000	ft of 18"	$180	$3,600,000
RO WTP to Majors Creek	6,000	ft of 22"	$220	$1,320,000
Brine Disposal Pipeline	35,800	ft of 10"	$100	$3,580,000
Thurber Lane Pipeline	1,500	ft of 8"	$80	$120,000
Thurber Lane Pipeline	2,000	ft of 12"	$120	$240,000
Reclaimed Water Pipeline	0	ft		$0
Reclaimed Water Pipeline	0	ft		$0
6. Other				
Land Acquisition	0.5	ac	$5,000	$2,500
Modifications at Pasatiempo Golf Course	0	lump sum		$0
Subtotal*				$24,637,900
Contingencies (30%)				$7,391,370
Engineering (20%)				$4,927,580
Legal, Administration (5%)				$1,231,895
Environmental Mitigation/Monitoring (5%)				$1,231,895
Environmental Documentation				$150,000
TOTAL*				$39,570,640
* 1993$–ENR=6400				

City of Santa Cruz Water Supply Alternatives Study
Annual Costs
Project P–H: Thurber Lane Groundwater Wells and Brackish Groundwater Wells with Reverse Osmosis Treatment

Item Description	Total Cost
A. Construction (incl. multipliers and life cycle costs)	
1. Dams (50 year)	$0
2. Treatment Facilities (25 year)	$10,847,341
2. RO Membrane Replacement (10 year)	$3,022,944
3. Groundwater Wells (25 year)	$11,130,528
4. Pump Stations (25 year)	$2,329,511
5. Pipelines (50 year)	$20,800,000
6. Other (50 year)	$4,000
7. Environmental Doc	$150,000
TOTAL Present Worth	$48,284,323
TOTAL Equiv Uniform Annual Cost @ bond rate	$3,946,899
B. Power Costs (90% Normal years, 10% dry years)	
Treatment Facilities	$1,590,300
Groundwater Wells	$5,742,750
Pump Stations	$1,501,950
TOTAL Present Worth	$8,835,000
TOTAL Equiv Uniform Annual Cost @ inflation rate	$411,271
C. Chemical Costs (Dry Years only)	
TOTAL Present Worth	$665,000
TOTAL Equiv Uniform Annual Cost @ inflation rate	$30,956
D. Labor Costs (90% Normal years, 10% dry years)	
TOTAL Present Worth	$350,000
TOTAL Equiv Uniform Annual Cost @ inflation rate	$16,293
Total O&M Present Worth	$9,850,000
TOTAL Equiv Uniform Annual Cost	$458,519
SUMMARY:	
Capital Cost – Present Worth	$48,284,323
O&M Cost – Present Worth	$9,850,000
TOTAL Cost – Present Worth	$58,134,323
Capital Cost – Equiv. Uniform Annual	$3,946,899
O&M Cost – Equiv. Uniform Annual	$458,519
TOTAL Cost – Equiv. Uniform Annual	$4,405,418
* Time period used is 50 yrs at 8% discount rate and 4% inflation rate	

City of Santa Cruz Water Supply Alternatives Study
Project P–I: Smaller Reservoir at Yellow Bank Creek, Thurber Lane Groundwater Wells, and Wastewater Reclamation

Item Description	Quantity	Unit	Unit Cost ($/unit)	Total Cost ($)
1. Dams				
Dam–Roller Compacted Concrete	403,000	CY	$55	$22,165,000
Reservoir Preparation	0	Included with Dam Cost		$0
Road Relocation	0	miles		$0
Concession Stand & Boat Ramp Relocation	0	lump sum		$0
Parking Lot Relocation	0	lump sum		$0
Spillway	0	Included with Dam Cost		$0
Outlet	0	Included with Dam Cost		$0
Landslide Mitigation	0	lump sum		$0
2. Treatment Facilities				
Reverse Osmosis WTP	0	lump sum		$0
Iron and Manganese WTP–0.72 MGD	1	lump sum	$475,000	$475,000
Tertiary WTP (Reclaimed Water)–0.95 MGD	1	lump sum	$1,260,000	$1,260,000
3. Groundwater Wells				
Scott Creek Well	5	well	$275,000	$1,375,000
Thurber Lane Well–500' deep, 12", 250 gpm	2	well	$298,500	$597,000
Davenport Area Well	0	well		$0
Majors Area Well	0	well		$0
4. Pump Stations				
Scott Creek PS	700	HP	$2,650	$1,855,000
North Coast Reservoir PS	320	HP	$2,338	$748,160
Reverse Osmosis WTP Booster PS	0	HP		$0
Reclaimed Water Booster PS–50 HP	1	lump sum	$300,000	$300,000
Coast PS Upgrade – 75 HP	1	lump sum	$100,000	$100,000
Brine Disposal Booster PS	0	HP		
5. Pipelines				
Scott Creek to North Coast Reservoir	33,500	ft – 24"	$240	$8,040,000
North Coast Reservoir to Majors Creek	14,000	ft – 20"	$200	$2,800,000
Majors Creek to Bay Street Reservoir	27,500	ft – 8"	$80	$2,200,000
Bay Street Reservoir to Coast PS	7,500	ft – 8"	$80	$600,000
Coast PS to Graham Hill WTP	6,000	ft – 14"	$140	$840,000
Davenport Well Field to RO WTP	0	ft		$0
RO WTP to Majors Creek	0	ft		$0
Brine Disposal Pipeline	0	ft		$0
Thurber Lane Pipeline	1,500	ft of 8"	$80	$120,000
Thurber Lane Pipeline	2,000	ft of 12"	$120	$240,000
Reclaimed Water Pipeline	8,500	ft of 10"	$100	$850,000
Reclaimed Water Pipeline	900	ft of 8"	$80	$72,000
6. Other				
Land Acquisition	207	ac	$5,000	$1,033,500
Modifications at Pasatiempo Golf Course	1	lump sum	$5,600	$5,600
Subtotal*				$45,676,260
Contingencies (30%)				$13,702,878
Engineering (20%)				$9,135,252
Legal, Administration (5%)				$2,283,813
Environmental Mitigation/Monitoring (5%)				$2,283,813
Environmental Documentation				$370,000
TOTAL*				$73,452,016
* 1993$–ENR=6400				

City of Santa Cruz Water Supply Alternatives Study
Annual Costs
Project P–I: Smaller New Reservoir with Thurber Lane Groundwater Wells and Wastewater Reclamatio

Item Description	
A. Construction (incl. multipliers and life cycle costs)	
1. Dams (50 year)	$35,464,000
2. Treatment Facilities (25 year)	$3,856,585
2. RO Membrane Replacement (10 year)	$0
3. Groundwater Wells (25 year)	$4,383,393
4. Pump Stations (25 year)	$6,675,471
5. Pipelines (50 year)	$25,219,200
6. Other (50 year)	$1,662,560
7. Environmental Doc	$370,000
TOTAL Present Worth	$77,631,209
TOTAL Equiv Uniform Annual Cost @ bond rate	$6,345,797
B. Power Costs (90% Normal years, 10% dry years)	
Treatment Facilities	$361,650
Groundwater Wells	$180,825
Pump Stations	$3,074,025
TOTAL Present Worth	$3,616,500
TOTAL Equiv Uniform Annual Cost @ inflation rate	$168,349
C. Chemical Costs (Dry Years only)	
TOTAL Present Worth	$190,000
TOTAL Equiv Uniform Annual Cost @ inflation rate	$8,845
D. Labor Costs (90% Normal years, 10% dry years)	
TOTAL Present Worth	$350,000
TOTAL Equiv Uniform Annual Cost @ inflation rate	$16,293
Total O&M Present Worth	$4,156,500
TOTAL Equiv Uniform Annual Cost	$193,486
SUMMARY:	
Capital Cost – Present Worth	$77,631,209
O&M Cost – Present Worth	$4,156,500
TOTAL Cost – Present Worth	$81,787,709
Capital Cost – Equiv. Uniform Annual	$6,345,797
O&M Cost – Equiv. Uniform Annual	$193,486
TOTAL Cost – Equiv. Uniform Annual	$6,539,283
* Time period used is 50 yrs at 8% discount rate and 4% inflation rate	